CANADA

NATIONAL ADVISORY COMMITTEE ON RESEARCH IN THE GEOLOGICAL SCIENCES

ELEVENTH ANNUAL REPORT

1960-61

(Including Survey of Current Research in the Geological Sciences in Canada, 1960-61)

Price 50 cents

OTTAWA

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Department of Mines and Technical Surveys

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601 Booth Street,
Ottawa, October 31, 1961.

The Honorable Walter Dinsdale,
Acting Minister of Mines and Technical Surveys,
Ottawa, Ontario.

Sir:

I have the honor to submit to you the Eleventh Annual Report of the National Advisory Committee on Research in the Geological Sciences covering the period September 1, 1960 to August 31, 1961

Respectfully submitted,

J.M. Harrison,
Chairman.

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MEMBERS OF COMMITTEE

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Prof. F.H. Edmunds	University of Saskatchewan, Saskatoon, Saskatchewan.
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Prof. Robert J. Uffen	University of Western Ontario, London, Ontario.
Prof. H.D.B. Wilson	University of Manitoba, Winnipeg, Manitoba.

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Meetings:

March 18-19, 1961, Quebec City, P.Q.

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Dr. C.S. Lord ..... Geological Survey of Canada,
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Dr. C.S. Lord ..... Geological Survey of Canada,
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London, Ontario.

Prof. H.D.B. Wilson ..... University of Manitoba,
Winnipeg, Manitoba.

Meetings:

June 7, 1961, McGill University, Montreal, Quebec.

THE YEAR IN REVIEW

The National Advisory Committee on Research in the Geological Sciences has a threefold purpose: to stimulate and coordinate geological research in Canada; to suggest research projects that should receive attention; and to aid in having these projects undertaken. Its function is to stimulate research by the universities, the federal and provincial departments of mines, and by other organizations equipped for the work.

The first part of this report gives a summary of the work of the Committee during the period September 1, 1960 to August 31, 1961. This is followed by the reports of the subcommittees covering the different fields of the geological sciences which record developments in 1960-61 and suggest further problems for study.

The second part of the report includes the annual survey of current research in the geological sciences in Canada. This records information on research by the universities, federal and provincial departments of mines and research councils and foundations between June 1960 and May 1961.

RESEARCH GRANTS TO UNIVERSITIES

Grants by the Geological Survey of Canada were initiated in 1951, at the instigation of this Committee, 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. They are reviewed by the Projects Subcommittee of the National Advisory Committee and the grants are awarded by the Survey on the basis of the resulting recommendations.

Through the years the funds provided for the grants have been increased, in several steps, from $10,000 in 1951 to $50,000 in 1958, 1959, and 1960. With the increase in applications over the past few years it has been impossible to support continuing projects and at the same time provide adequate support for worth while new projects and the National Advisory Committee has urged that the funds for the grants be increased substantially. For 1961-62 the amount provided has been increased from $50,000 to $75,000 which has done much to alleviate this situation.

For 1961-62, fifty-three applications were received (compared with thirty-six in 1960-61), and the total of the grants applied for was $127,910 (compared with $102,677 in 1960-61). Of the fifty-three applications, 18 amounting in the aggregate to $56,655 were for further support of projects supported previously; the remaining 35 applications aggregating $71,245 were for support of new projects. Grants totalling $75,000 were awarded to 16 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 II (Pt. I, p. 91).

Over the past 10 years 134 papers have been published in scientific periodicals recording results from projects supported by the grants of which 17 have been published in the review year. Sixty have been published in Canada, 50 in the United States, 15 in Great Britain and 9 in other countries. Reports on many of the projects presently in progress are given in Appendix I (Pt. I, p. 82).

The National Research Council of Canada is awarding grants-in-aid of research in the geological sciences in Canadian universities on a substantial and increasing scale. In 1959-60, a total of $333,768 was awarded in support of research in the Earth Sciences of which about $150,000 was in support of geological projects and geophysical projects concerned with geological problems. In 1960-61, $399,550 was awarded of which about $190,000 was in support of geological projects and geophysical projects of interest to geologists. The amount of grants has been increased again substantially in 1961-62[1].

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[1] Report on University Support for 1959-60; National Research Council No. 5914; and for 1960-61, N.R.C. No. 6390.

Coordination of Award of National Research Council and Geological Survey Grants. Every effort has been made to coordinate the award of National Research Council and Geological Survey grants-in-aid of research in the geological sciences.

Applications for National Research Council grants-in-aid are received up to February 1 of each year. Successful applicants are notified of awards in March immediately following approval by Council. Applications for Geological Survey of Canada grants are received up to May 1 of each year. The applications are reviewed by the Projects Subcommittee of the National Advisory Committee on Research in the Geological Sciences in June and applicants are notified immediately whether or not they have been recommended for grants.

Applicants for National Research Council grants know early in April whether or not they will receive grants thus permitting those applicants whose projects are not considered suitable for N.R.C. support, to apply for Geological Survey grants. Applicants also have an opportunity to apply for grants-in-aid of projects that become practicable after the closing time for applying for National Research Council grants.

When the Projects Subcommittee of the National Advisory Committee reviews applications for Geological Survey grants in June, it has full knowledge of grants in the geological sciences awarded the preceding March by the National Research Council. In addition, one or more members of the Projects Subcommittee of the National Advisory Committee serve on the National Research Council Grant Application Screening Committee. In this way grants-in-aid of research in the geological sciences by both organizations are fully coordinated.

In the future, Geological Survey funds will be directed mainly to support projects involving, in general, the study of rocks and minerals in field and laboratory directed toward the solution of specific geological problems; as opposed to more experimental projects such as those involving the simulation of geological processes in the laboratory. Applications for grants for major items of equipment, costly services, and continuing support of technicians salaries etc. also may be better directed to the National Research Council.

COMPREHENSIVE STUDY OF A CANADIAN ORE DEPOSIT

This project is a cooperative, comprehensive study, or series of studies, of the copper orebody of the Coronation Mine, a few miles southeast of Flin Flon, Manitoba. It was initiated in 1960, at the instigation of this Committee, with participation by geologists, geochemists, geophysicists and mineralogists from several organizations in the hope that such a comprehensive, integrated investigation of a single orebody would extend our knowledge of how and why orebodies of this general type are formed.

Dr. D.R.E Whitmore, Geological Survey of Canada, the coordinator of the project, reported at some length in the 1959-60 Annual Report of this Committee on the nine studies underway at that time[1]. Dr. Whitemore reports on subsequent progress up to October,

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[1] National Advisory Committee on Research in the Geological Sciences, Tenth Annual Report, 1959-60, pp. 3-4.

1961 as follows:

> "Activity during the 1961 field season resulted in virtual completion of surface and underground mapping of the Coronation Mine.
>
> "Further collection of samples from the mine and vicinity was carried out in connection with the geological, geophysical and geochemical studies described in last year's report.
>
> "In a new project, initiated in the 1961 field season, M.J. Rutherford will study fluid inclusions in quartz of the Coronation Mine and surrounding area.
>
> "Another project, mentioned as planned in last year's report, is now underway. This involves the modal analysis of polished sections made from a suite of specimens systematically collected from the orebody to find out the distribution of sulphides, A graduate student, under the supervision of Prof. H.D.B. Wilson, University of Manitoba, has undertaken this study.
>
> "All the projects mentioned in last year's report are either actively in progress or have been completed. Those that have been completed are:
>
> (1) A Study of the Temperature of Formation of the Coronation Sulphide Orebody. The results are embodied in M.Sc. thesis, University of Saskatchewan, 1961, by C.S. Ferris.
>
> (2) Aeromagnetic Map of the Coronation Mine Area; Geol. Surv., Canada Map 1028G, 1961.
>
> (3) Airborne Electromagnetic Survey of the Coronation Mine Area. The results of this work by Canadian Aero

Service Ltd. were presented in a paper by A. Rattew to the Geology Division, Canadian Institute of Mining and Metallurgy, Quebec, in March 1961."

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES

The International Union of Geological Sciences was constituted in Paris, France in March, 1961. Dr. J.M. Harrison, Director of the Geological Survey of Canada and Chairman of this Committee was elected as the first President. The International Union of Geological Sciences was admitted as a member of the International Council of Scientific Unions in London, England in September, 1961.

According to the statutes - "The aims and objects of the International Union of Geological Sciences are:

"(a) to promote and encourage the study of geological problems

(b) to facilitate international cooperation in geology and related sciences

(c) to provide continuity in international cooperation in geology and related sciences

(d) to assist the International Geological Congresses, it being understood that the long established activities of the Congresses shall be safe guarded.

"Each country may adhere to the Union through either its national committee for geology, its national academy, or through another representative body of geologists appointed by the Government. Each country shall pay annually a subscription according to its category of membership.

"The work of the Union shall be directed by (a) the Council of the Union, and (b) the Executive Committee.

"The Council of the Union consists of the individual representatives of the national adhering organizations, i.e. one representative for each member country, and the Executive Committee of the Union which consists of the President, six Vice-Presidents, the past-President, a General Secretary and a Treasurer."

For most International Science Unions the National Research Council is responsible for Canadian membership. In the case of the International Union of Geological Sciences, the Geological Survey of Canada, which is specifically related to these sciences, will assume responsibility and pay the annual subscription for Canadian membership. However, because the Geological Survey is unable to supply funds for other than its staff to attend international meetings, funds for Canadian representatives to attend meetings of the Union must come from the National Research Council.

The Executive Committee of the National Advisory Committee on Research in the Geological Sciences, with additional members of the National Advisory Committee that it may select, will act as the Canadian National Committee for Geology in all matters

pertaining to the International Union of Geological Sciences.

INTERNATIONAL COMMITTEE FOR COORDINATION OF GEOPHYSICAL AND GEOLOGICAL WORK

The International Geological Congress meeting in Copenhagen in August 1960, decided to form a Committee for the Coordination of Geophysical and Geological Work to maintain contact with a Committee of the International Union of Geodesy and Geophysics that was set up to study the "Upper Mantle and Its Influence on the Development of the Earth's Crust". The Congress nominated Jean Goguel as President and left further organization of the Committee to him.

In a letter dated December 21, 1960 addressed to the National Committee for Geology for Canada, Dr. Goguel states that the International Committee for Coordination of Geophysical and Geological Work has set up headquarters on the premises of the International World Map Committee, 18 rue Léonard de Vinci, Paris. He points out that when the newly formed International Union of Geological Sciences starts to function this Committee will likely yield its place to a "Joint Commission" formed by common agreement between the International Union of Geodesy and Geophysics and the International Union of Geological Sciences. In the meantime, that a start may be made, he asks each National Committee for Geology to delegate a geologist as a member of the International Committee. The chief function of the national members will be to keep contact between the International Committee and interested geologists in their country.

In response to this request, Dr. R.E. Folinsbee has been designated to represent Canada on the International Committee for Coordination of Geophysical and Geological work. Dr. Folinsbee is also a member of the Scientific Committee on the Upper Mantle (SCUM) - a committee established by the National Research Council Associate Committee on Geodesy and Geophysics to fulfill Canada's obligation to the I.U.G.G. Upper Mantle Project (see Pt. I, p. 30).

Dr. Goguel asks also in his letter that the research program of the International Union of Geodesy and Geophysics for study of the Upper Mantle be made known to Canadian geologists. This applies particularly to projects that are more specifically geological. This program and the part that Canada proposes to play in it is outlined in the report of the subcommittee on Physical Methods Applied to Geological Problems (Pt. I, p. 29).

EXTENSION OF ACTIVITIES OF GEOLOGICAL SURVEY OF CANADA

The need for a geological institute in Canada is discussed in the 1959-60 Annual Report[1]. The conclusion is reached

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[1] National Advisory Committee on Research in the Geological Sciences, Tenth Annual Report, 1959-60, p. 4)

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that it is preferable to continue to build up research facilities in the universities in which considerable progress has been made in the last

10 years, rather than divert effort and money to establishment of an institute. The Geological Survey of Canada which is fulfilling some of the functions of a geological institute was asked to consider the feasibility of assuming more of these functions. These functions include:

(1) Use of research fellows and post-doctorate fellows from universities to carry out basic research. This is being done by using National Research Council post-doctorate fellows. For 1961-62 the number of post-doctorate fellows with the Geological Survey has been increased from two to four men.

(2) Provision of thesis areas with special problems for Ph.D. students. For such work laboratory research is carried out mainly in the universities but in part with the support of Survey laboratories. This is being done on an increasing scale and in 1961 some 15 Ph.D. aspirants were assigned thesis areas.

(3) Provision of space and facilities at the Geological Survey for research men from industry and the universities to carry out investigations on special problems for limited periods. The Survey is willing to accommodate such workers. Professors on sabbatical leave might obtain some financial support from the National Research Council; salaries of men from industry would be paid by their companies. Space and facilities at the Survey are limited and not more than two men could be accommodated at a time. Publication of results of such research would rest with the man carrying on the work but the results, if not published, must be made available to anyone interested.

The new Geological Survey building in Ottawa is already fully occupied and by the autumn of 1961, the equivalent of 23 offices must be provided outside the Survey building. The building is designed mainly for laboratories and with increasing need for laboratory space more and more office space will be lost.

If the Geological Survey is to continue to expand the logical step is to expand the Western Plains Branch in Calgary, rather than allow continued concentration in Ottawa. Negotiations are underway for land for a Federal Building in proximity to the Calgary Branch of the University of Alberta. This building will be used mainly by the Geological Survey of Canada. Plans for the Western Plains Branch are based on continuation of the present rate of expansion of the Survey for the next four to five years.

If present plans reach fruition the expansion of the Survey, largely in the West, will mean creation there of a first rate research unit specializing in stratigraphic and petroleum geology. All cores and samples from wells in the Northwest Territories and Yukon would be stored in Calgary and probably geological workers in the Cordillera and Arctic would be based there.

JOURNAL OF THE EARTH SCIENCES

In the 1959-60 report[1] of the National Advisory Committee

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[1] National Advisory Committee on Research in the Geological Sciences, Tenth Annual Report, 1959-60, p. 29.

the subcommittee on Mineral Deposits notes that Canadian papers in the Earth Sciences are scattered widely in a variety of publications, and that a high proportion of the better papers are published in foreign journals, mainly because Canadian journals have comparatively small circulations. The report of this subcommittee concludes that the time has arrived for the institution of a Canadian "Journal of the Earth Sciences", to be issued several times a year, which would assemble papers in all earth sciences. In discussing this report at the April, 1960 meeting, differing views were expressed by members on the need for such a journal but there was general agreement that over the year, members should give serious thought to the matter. Dr. H.D.B. Wilson was asked to keep in touch with developments and opinions as to the need for a journal of this character.

At the April, 1961 meeting of the National Advisory Committee, Dr. Wilson presented data on the number of pages in United States publications devoted to Canadian geological papers. These figures which are listed below, indicate that 45 per cent of papers on geological subjects by Canadians are published in the United States.

Number of Pages Devoted to Canadian Papers

American Publications	1960	1959	1958	1957	Average
Bull. G.S.A.	103	30	84	138	89
Econ. Geol.	196	234	116	107	163
Amer. Jour. Sci.		55	15	31	34
Jour. Geol.		60	22	35	39
					325
Canadian Publications					
G.A.C.	126	133	137	102	124
C.I.M. Bull.[1]	177	156	111	92	134
Can. Min. Jour.	136	102	138		125
					383

[1] Pages much larger than those in other journals.

Members again differed on the need for a Journal of the Earth Sciences. Some felt the subjects covered in such a journal (the geological sciences, geophysics, soil and snow mechanics, meteorology, etc.) would be too diverse to include in a single publication; others saw little objection to the publication of such a high proportion of papers by Canadians in United States journals which have a wider circulation than any Canadian journal could hope to achieve. Others pointed out that the National Research Council is now awarding about 1/2 million dollars and the Geological Survey of Canada an additional 75,000 dollars annually to support university research in the Earth Sciences. Other sciences such as physics, chemistry, and biology which are

supported on a comparative scale are provided with Canadian outlets for publication of results in the National Research Council Journals of Canadian Research. Now that the Earth Sciences are recognized by support on a major scale - a development over only the last 5 years - should there not be a journal of research in this field?

Some members felt that, instead of creating a new journal, existing ones should be supported and improved. A new journal would weaken existing Canadian geological publications such as those of the Geological Association of Canada, the Mineralogical Association of Canada and Section IV of the Royal Society of Canada because it would draw the best papers and become the leading publication in the geological sciences in Canada. It was suggested that this end might be attained by incorporating some or all existing Canadian geological publications in one journal to be issued six or more times a year. Organizations such as the Geological and Mineralogical Associations of Canada and Section IV of the Royal Society of Canada might be willing to cooperate in such a project if given recognition for papers originating from their meetings.

General agreement was reached on the desirability of establishing a Canadian geological journal of world-wide distribution that would attract some of the many Canadian papers presently published in the United States. Although no unanimity of opinion was reached as to how this might be best accomplished, the Committee recorded its general support of efforts to initiate the publication of such a journal.

"THE CANADIAN MINERALOGIST"

In 1955 the newly formed Mineralogical Association of Canada sought the support of the National Advisory Committee in finding means of publishing the journal of the Association. Recognizing that publication of results is one of the best ways of stimulating research, the National Advisory Committee recommended to the Geological Survey of Canada a grant of $2,478 in 1956 and smaller grants in subsequent years, in support of publication of "The Canadian Mineralogist".

A report dated April 24, 1961 by L.G. Berry, Editor, on the five numbers of the Canadian Mineralogist that have been published, follows:

> "Four numbers of The Canadian Mineralogist, volume 6, have now been distributed to members of the Mineralogical Association of Canada. Part 5, which includes ten major papers and some shorter notes aggregating 164 pages, is in press and will be mailed to members about June 1st. Three or four manuscripts are on hand for inclusion in a future number.
>
> "Part 5, which will complete volume 6, includes an author-subject index and table of contents for volume 6. This required an additional ten pages.
>
> "Volume 6 includes fifty major papers; comprising twenty-four from university staff members, often with collaborating graduate students, seven solely by graduate students, and nineteen by government employees, including some visiting post-doctorate fellows. In subject matter the papers may be classified as follows: Crystallography 7,

Geochemistry 9, Petrology 6, Ore studies 10, Mineralogy 18. The length of these papers varies from five to thirty-three pages, averaging thirteen pages. About twenty shorter communications of one to four pages were also printed; these include discussions of some of the major papers.

"The cost of printing volume 6 of The Canadian Mineralogist, together with the manner of meeting this cost, was as follows:

Part	Cost		Paid from G.S.C. grants	Paid by M.A.C.
1	160 pages $2707.05		$2407.05	$ 300.00
	(no free separates)	Envelopes	68.71	
2	152 pages $3401.87		2102.25	1504.08
	Separates $ 204.46	Express	1.45	
3	120 pages $2641.35		1800.00	990.94
	Separates $149.59			
4	148 pages $3025.20		1800.00	1414.17
	Separates $ 188.97			
5	172 pages $3560.00(est)		1748.55	2062.00(est)
	Separates $ 250.00(est)			

"The fees received for 1960-61 by The Mineralogical Association of Canada will cover the extra cost of part 5 ($2062.00), plus mailing charges. The fees received for 1961 (April) - 1962 (March) will be available for the special Sudbury Memoir described in a new grant request (see Pt. I, p. 96).

"At the annual meeting of M.A.C. to be held in Calgary in September the members will be asked to approve changes in by-laws changing the Association year to the calendar year, and an increase of annual fees to $4.00 for regular members and $7,00 for corporate members, effective for the calendar year 1962[1]. If this is approved

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[1] The increase in annual fees was approved at the Calgary meeting.

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it is hoped the M.A.C. will be able to increase the size of our annual publication and also carry a larger share of the cost of publication.

"The Canadian Mineralogist is now becoming well established. Many leading institutions are receiving the journal and the number is growing[2]. It is hoped that the

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[2] From 100 members in 1955 to more than 600 in 1961 with members from 37 countries.

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support from the Geological Survey grants will continue at least for this coming year. A proposed Canadian Journal of Earth Sciences, presumably of very broad scope, would be a suitable publication medium for only

a few of the papers published in the Canadian Mineralogist. Most authors would prefer a specialized publication and if such a general journal were the only one available in Canada, would send their manuscripts to specialized publications in other countries."

RECONSTITUTION OF NATIONAL ADVISORY COMMITTEE, 1960

The National Advisory Committee was established by the Committee of the Privy Council on Scientific and Industrial Research on February 15, 1949[1]. The Order-in-Council establishing the Committee

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[1] National Advisory Committee on Research in the Geological Sciences, First Annual Report, 1950-51, p. 3.

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was revoked in February, 1960. The Committee was then reconstituted with the same members by the Minister of Mines and Technical Surveys.

Under the original Order-in-Council of 1949, members of the Committee were selected from certain specified Provincial Departments of Mines, Universities, etc. In the National Advisory Committee as reconstituted by the Minister of Mines and Technical Surveys in 1960, more latitude is allowed in the selection of members of the Committee. The Committee is to include:

(1) A maximum of 6 members representing provincial governments and research councils.

(2) A maximum of 10 members representing Canadian universities.

(3) A maximum of 4 members representing the Canadian mineral industry.

(4) A maximum of 2 members representing the Geological Survey of Canada.

(5) One officer of the Geological Survey of Canada who will act as secretary of the Committee.

(6) Notwithstanding the foregoing, the Minister of Mines and Technical Surveys may make such changes in the personnel of the Committee as he may deem expedient to the work of the Committee.

CHANGES IN PERSONNEL OF COMMITTEE

J.W. Ambrose, J.E. Blanchard, J.F. Davies and Franc R. Joubin retired from the Committee in 1960. All members join in expressing appreciation of the contribution of time and effort made by these men during their terms of office, and look forward to their continued support.

New members succeeding those who have retired are A.W. Jolliffe, Professor of Geology, Queen's University; Robert E. Uffen, Professor of Geophysics and Principal of University College,

University of Western Ontario; C.P. Gravenor, Chief, Earth Sciences Branch, Research Council of Alberta and David F. Francis, Chief Geologist, Department of Mineral Resources, Regina, Saskatchewan, F.F. Osborne, Professor of Geology, Laval University and H.D.B. Wilson, Professor of Geology, University of Manitoba have been re-appointed for another three-year term.

Cooperation and liaison between the National Advisory Committee and the National Research Council has always been excellent but to further enhance it, Robert F. Legget, Director of Division of Building Research and co-convenor of the Grant Application Screening Committee in the Earth Sciences of the National Research Council, has been appointed a member of the National Advisory Committee.

SUBCOMMITTEE REPORTS

(Summary Statements and Discussion)

The different fields in the geological sciences are covered by seven subcommittees that maintain a continuous survey of developments in their fields and the problems most in need of investigation. The reports of these subcommittees, which were presented at the annual meeting of the National Advisory Committee in March, 1961, are given in full in this report (Pt. I, p. 19). Summaries of the reports and of the discussions that followed their presentation follow.

The Subcommittee on Pleistocene Geology reports that although research in the several fields of the subcommittee is at an all time high, much remains to be done, especially in ground-water and engineering geology. The Universities in particular should play a more active role and provide leadership in research in these fields. The report suggests that certain large projects of general (as opposed to provincial or local) interest might well be undertaken as cooperative projects with government agencies and universities participating, supplemented by some aid from the National Advisory Committee. If the National Advisory Committee so desires, the subcommittee will present suitable projects of this type for consideration at the next meeting (1961).

The report presents for each province and territory in Canada, a succinct summary of mapping and research programs in Pleistocene, engineering and ground-water geology by geological surveys, research institutions, and universities during 1960-61.

In presenting this report Dr. Gravenor stressed the need for specialized courses in ground-water hydrology in Canadian universities. Undergraduate instruction is being given as part of courses in Pleistocene geology, but there are few universities where a student may specialize. The importance and need for ground-water hydrology is growing rapidly—so rapidly that in not many years Dr. Gravenor thought more geologists would be employed in ground-water work than are employed at present in petroleum geology. The United States Geological Survey employes some 800 men in ground-water work and recently, as the number of geologists working on uranium deposits was reduced, the men were replaced by ground-water specialists. He is confident the increasing emphasis on ground-water studies will continue in the future.

Dr. Gravenor estimated that 80 to 90 per cent of ground water comes from bedrock and suggested there was little or no reason for equating ground water with Pleistocene deposits as is commonly done in Canada. Professor Edmunds pointed out that in Saskatchewan more water is obtained from Pleistocene deposits than bedrock and that Pleistocene geology and ground water cannot be divorced in that province. Mr. Legget mentioned that the Division of Building Research, National Research Council, is carrying out soil-mechanics studies that may help in determining the origin of clays such as the preglacial clays near Vancouver. The secretary read a summary, contributed by Dr. H.S. Bostock, of a long range glaciological study of the St. Elias Mountains, Yukon Territory sponsored jointly by the American Geographical Society and the Arctic Institute of North America. A full scale program will be developed from a reconnaissance air supported study of the Ice Field Ranges in 1961. This area, mainly in Canada, was chosen by Dr. Walter Wood and others as the most accessible in the world for such a study. It is to be hoped that Canadian universities and other interested Canadian organizations may participate.

As suggested in their report (Pt. I, 21) the sub-committee on Pleistocene geology was requested to present proposals for joint research programs involving government agencies and universities.

The Subcommittee on Physical Methods Applied to Geological Problems reports a year of expanded activity in the use of these methods to solve fundamental problems but of their reduced use in exploration. Canadian graduate schools continue to expand in geophysics and the National Research Council has increased the amount provided for grants-in-aid to universities for research in the Earth Sciences. Plans are outlined for an international program of research on the "Upper Mantle and Its Influence on the Earth's Crust" including the broad program of research, the part Canada will play in the overall project and the organization of committees, national and international, that have been set up to see the project is carried through.

Current projects of interest to geologists are reviewed in each field of the geophysical sciences. In gravity the activities of the Dominion Observatory include publication of a new 'Gravity Map Series' of Canada, gravity measurements on both land and on sea ice in the Arctic, provision of means of testing airborne gravity measuring instruments, and gravity studies of meteorite craters. In seismology the plans of the Dominion Observatory to accelerate the establishment of 25 to 30 seismic stations distributed throughout Canada at 500 mile intervals are described, as are the activities of the Seismic Section of the Geological Survey of Canada in helping solve geological problems in the Arctic. Seismic work in progress at the University of Western Ontario, Nova Scotia Research Foundation, McGill University, and the Universities of Saskatchewan, Manitoba, and British Columbia is also discussed. Studies of terrestrial heat flow in Canada will be expanded by the establishment by the Dominion Observatory of a Terrestrial Heat Flow Section. Heat measurements underway at the Universities of Western Ontario, Alberta, and McGill are described briefly. Research in geomagnetism, including palaeomagnetism, is in progress at the Dominion Observatory, Geological Survey, and the Universities of Western Ontario, Toronto, and British Columbia. Brief reviews are given of current work in tectonophysics, glaciology, geophysical exploration, high pressure-high temperature, and atomic and nuclear studies. A table lists Canadian laboratories engaged in studies of the isotopic constitution of rocks.

In discussion of the report the Chairman mentioned the cost sharing cooperative plans of the Federal and several Provincial governments for aeromagnetic surveys of large areas. Projects in Ontario and Saskatchewan will be carried out by commercial companies; in British Columbia, Geological Survey instruments will be used in commercial aircraft. In reply to a query he said that in future Geological Survey aeromagnetic work will be largely experimental; routine coverage of large areas will be left to commercial companies. In reply to a query as to why the federal-provincial projects did not include scintillometer and electromagnetic surveys, the Chairman said the flight lines would be at too high an elevation and too wide a spacing to be suitable for an electromagnetic survey. In reply to a question, Dr. Uffen stated that no coesite or other minerals diagnostic of high pressures had been found so far in Canadian meteorite craters; the reluctance by many in Canada to believe the craters were formed by meteorites was hard to understand with the many similar craters plainly visible on the moon. Dr. Okulitch suggested that the origin of the craters on the moon was still questionable; some geologists thought they were of volcanic origin.

The Subcommittee on Structural Geology notes a paucity of projects in structural geology in our universities, and that, in many of the projects listed as structural, the concern with structural geology is secondary. Nor is the compilation of current structural projects at all complete. It does not include projects being carried out by Canadian graduate students attending foreign universities or the large amount of structural research by the oil and gas industry, which is probably as much or more than the total of structural projects reported.

Attention is called to the new Tectonic Map of Canada, a joint project of the Geological Association of Canada, the Alberta Society of Petroleum Geologists and the Geological Survey of Canada. Several structural studies are suggested including (1) structural study of British Columbia mining camps and mineral belts by cooperative effort of public and private geological services, (2) detailed and regional structural mapping of the Rocky Mountains, particularly the thrust faults, and (3) study of the earth's crust along the Nelson River lineament, Manitoba.

A brief review is given of Memoir 79, Geological Society of America, on "Rock Deformation", with particular reference to the coordination of the work of physicists and geologists. It is suggested that development of novel methods of structural interpretation is needed and that a segment of research should be devoted to development methods that will render the interpretation and prediction of structure more accurate.

The report concludes that structure tends to be considered as only an adjunct to field mapping and to be neglected as a field for research. More special structural studies are needed not only to establish relations between rock units but to determine mechanisms and processes. Also, in the formation of orebodies, the role of structure involves more than geometry and should be given specific attention.

In presenting this report Dr. Hedley stresses the value of cooperation in geological mapping by mining companies and government agencies. To illustrate this he mentioned that company mapping had been done over parts of six contiguous 15 minute map-areas in northwestern British Columbia and that aquisition of the results of this work would greatly assist any program of mapping that might be undertaken by the British Columbia Department of Mines

and Petroleum Resources. The chairman and other members expressed agreement that such cooperation is greatly to be desired.

In discussion of the report Dr. Gussow said that under the joint sponsorship of the Geological Association of Canada and the Alberta Society of Petroleum Geologists three regional geological cross-sections had been prepared, including two east-west sections from the Rocky Mountains to the Precambrian Shield and a third extending from the northwest corner of Alberta to the Williston Basin. Negotiations for publication were underway and it was hoped to have the cross-sections ready for distribution within the year (1961). He mentioned also a regional cross-section prepared by Imperial Oil Limited, extending from Victoria, British Columbia to Calgary, Alberta which showed all available geological and geophysical data. This large cross-section had been displayed at the A.S.P.G. - A.A.P.G. meetings in Banff in 1960. In reference to the section in the report on the need for cooperation between geologists and physicists in structural studies Dr. Uffen thought it was engineers rather than physicists with which the geologist needed to cooperate. Studies such as those mentioned were really applied research and the pure physicist tended to lose interest in them and not carry through. He wondered why King Hubbert's excellent work on scale models had not been followed up; no great amount of mathematical training was required for such studies. The University of Western Ontario offered a course in geology and physics that would develop men for this type of research; it attracted few students and those who did take it usually either gave up geology and went into pure physics and chemistry, or having failed through inability to handle the mathematics, went into straight geology. Dr. Folinsbee and Dr. Okulitch mentioned that similar courses in geology and physics were offered at the University of British Columbia and the University of Alberta with much the same result.

The Subcommittee on Mineral Deposits reviews current research in Canada in this field. About two-thirds of the projects are mainly descriptive, one-quarter deal with the mineralogy and paragenesis of specific ores and distribution of contained trace elements and isotopes, and the remaining 10 per cent relate to geochemistry and ore genesis. Rather limited research on industrial minerals includes studies of gypsum and anhydrite deposits and on the nature and origin of deleterious materials in gravels, sands, limestones, etc., used in concrete aggregates, bricks and other structural materials. Current projects by the Geological Survey of Canada include study of Canadian uranium deposits, iron deposits, fluorite, barite and beryllium, placer deposits of the Klondike and the preparation of metallogenic maps of Canada. Research on geochemical prospecting was carried out in a large area in northwestern Ontario and in a more restricted area of northeastern New Brunswick. Studies of the geochemistry of the lead-zinc-copper deposits of Bathurst, New Brunswick, of pegmatites in the Northwest Territories and northern Manitoba and of the Lower Cretaceous sedimentary rocks of Alberta continued.

Suggested projects include a comprehensive study of the Porcupine-Kirkland Lake gold mining district, studies of ore-forming processes operative at or near the water-land interface, basic research on the formation of mineral deposits, and the collection and preservation of representative samples from operating mines for future study. The report cites the high proportion of Canadian papers published in 1960 by the International Geological Congress (10 per cent of all papers on mineral deposits) and in Economic Geology (15 per cent) as evidence of the activity of Canadian geologists in the field of mineral deposits. The

report concludes with a plea for more review type papers and suggestions as to how experienced, senior economic geologists might be induced to prepare them.

In presenting this report Dr. Jolliffee mentioned that Canada's metallogenetic maps exhibited at the International Geological Congress in Copenhagen had compared most favourably with those of other countries. In regard to the need for more review papers the Economic Geology series of the Geological Survey were, in a sense, review papers on various metals and minerals, particularly if they include a good section on geochemistry.

The Chairman remarked that a large number of the delegates at the International Geological Congress were Canadians which explained the high percentage of Canadian papers on ore deposits. Dr. Folinsbee suggested that because a large proportion of the world's mineral production is Canadian and more new deposits are being found here than in most other countries, Canadians should be contributing a large number of papers on economic geology. Dr. Langford commented that most papers on economic geology were descriptive and mere statements of experience; they were not a record of true research. Much of the controversy on the origin of ore deposits was caused by a number of theories not supported by satisfactory evidence. Dr. Gussow suggested many students of ore deposits were forgetting that conditions at the time some of the deposits formed were entirely different from those of today; in addition most deposits have been subjected to one or more periods of metamorphism.

Dr. Wilson suggested that action be taken on the recommendation in the report (Pt. I, p. 52) that representative samples from operating mines in Canada be collected. As shown by the questionnaire sent out in connection with the recent symposium of the Canadian Institute of Mining and Metallurgy on Canadian base metal mines, most of the operating mines have little knowledge of the minerals or trace elements in their ores[1]. The Provincial

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[1] Symposium on Occurrences of Massive Sulphides in Canada: Bull. Can. Inst. Mining and Metallurgy, Feb. 1960, pp. 75-98, and March 1960, pp. 128-156.

Departments of Mines should be the agents responsible for the collection and storage of the samples. Dr. Hedley said it would be difficult to collect material of this kind and when collected, storage would be a problem. Dr. Denis considered the scheme would not be feasible because little cooperation could be expected from the mining industry and samples that the mines were compelled to collect would be of doubtful value. Dr. McAllister thought single samples of mill feed would be of little use; hand specimens would be needed because mineral associations were as important as composition. Dr. Folinsbee expressed doubt of the value of mill feed samples because of contamination during crushing etc. of the ore. Dr. Jolliffe suggested that in view of the obvious differences of opinion among members, action be postponed for a year. In the meantime, the Subcommittee on Mineral Deposits would study the matter further, including, in particular, how the samples might be collected and preserved.

Dr. Gravenor stressed the importance of industrial minerals in our economy, mentioning in particular silica sand,

kaolinite, brines containing sodium, magnesium and calcium chloride, clay and shale, sand and gravel, gypsum, etc. There was room for more research on the formation of such minerals which would in turn help in finding new deposits. In reply to a query from Mr. Francis the Chairman said the Geological Survey wasmaking some broad studies on industrial minerals and probably should do more. However, detailed studies of individual deposits, or of potential producing areas, are more the concern of Provincial Departments.

The Subcommittee on Mineralogy, Geochemistry and Petrology points to the number of research problems under investigation as evidence that these fields of geology are flourishing. This in turn is the result of increasing financial support over the past 10 years from a Nation increasingly aware of the important part that research plays in the development of its natural resources. There follows a review of current research in these fields, province by province, based largely on letters from members of the subcommittee. In conclusion the report suggests that the question of why many Canadian geologists publish their best scientific papers in United States publications should be discussed and reported on by the National Advisory Committee.

In discussion of the report the Chairman asked if the mass spectrometer had reached the point of being standard equipment in most universities. Drs. Gravenor, Folinsbee and other members emphasized its great cost and the staff and servicing required, and agreed it was a highly specialized piece of equipment. Dr. Uffen, stressed that many equally important fields were being neglected, one being silicate chemistry at high temperatures and pressures.

The Subcommittee on Stratigraphy, Palaeontology, and Fossil Fuels reviews current research in these fields and reports an increase in the number of projects underway. Tables indicate the institutions and agencies where these projects are being undertaken and their geologic and geographic distribution. Researches suggested by subcommittee members include detailed study of Middle Ordovician and Upper Ordovician faunas of the Great Lakes area, study of Palaeozoic colonial corals and their stratigraphic distribution, and the development of methods that will allow geologists to make greater use of the stratigraphic significance of fossils in the field.

Research in petroleum geology by industry is being done by most of the major oil companies but information about it is limited and very little of the results is published. Consulting geologists are also carrying on research on the same or similar problems as industry, and the results of much of it are published. In recent years in petroleum geology in Western Canada emphasis has been placed on means of finding carbonate reservoirs. This entails an understanding of the tectonic control initiating the sedimentary deposit that becomes the reservoir, a knowledge of the shape and lithologic variations expected in the reservoir and the actual textural variations that affect porosity and permeability of various parts of the reservoir. Some of the projects currently in progress by consulting geologists in Calgary are outlined.

The report concludes with general discussion of research in the universities. It is suggested that more scholarships to promote graduate research are needed and that more funds to support graduate research in the field would be helpful.

In discussion of the report, with reference to maintenance of contacts between the universities and the Geological Survey (Pt. I, p. 75) the Chairman said university professors were always welcome to visit Geological Survey field parties. Many had and he hoped would continue to do so; he was sure they would be welcomed also by Provincial field parties. Dr. Okulitch mentioned as particularly welcome, a gift of $7,500 to Canadian universities from the Shell Oil Company for support of university students collecting material for graduate thesis work. Dr. Folinsbee pointed out that graduate students had the opportunity also of gaining field experience while employed on geological field parties of government and the oil industry and that this experience was as valuable or perhaps more valuable than working on their own.

Dr. Uffen felt the major contribution of geology to knowledge had been and would continue to be its contribution to man's concept of time. Basic geological research should be beuilt around this and not diverted to finding ore deposits and oil and gas accumulations. He suggested that altogether too much emphasis was placed on such economic applications and not enough on development of fundamental concepts which, in the end, would prove more valuable to man than the restricted applied approach stressed so much at this meeting and by geologists in general. We need to keep the fundamental aspects of research ever to the fore and not be led into bypaths. Other members agreed but pointed out that it was pleasant to have "fringe benefits" accruing by obtaining practical results from research. Dr. Okulitch said the demand was for geologists who will apply their knowledge to useful purposes and the universities were called upon to turn out such men. Dr. Uffen did not consider that this was, or should be, the main function of universities.

The Subcommittee on Scholarship and Research Training reports on its efforts to initiate a series of lecture tours whereby specialists in different fields of geology would visit Canadian universities for a series of two or three lectures. The need for such a series, selection of lecturers, sponsorship, and financing is discussed. The Geological Association of Canada was approached to organize and sponsor such a series but decided that, for the present, it could not handle the administrative and secretarial work involved. The report emphasizes the need, and recommends that efforts be continued to have the lecture series initiated.

In discussion of the report, Dr. Gussow expressed disappointment that the Geological Association of Canada had not welcomed the opportunity of sponsoring the visiting lecturer project. Secretarial staff was not essential; the American Association of Petroleum Geologists Distinguished Lecturer tour was handled by a committee which organized and looked after the whole tour. There was general agreement among members that the Geology Division, Canadian Institute of Mining and Metallurgy was not a suitable organization to sponsor such a tour. Dr. Okulitch suggested that too many visiting lecturers were disturbing to, and imposed a financial burden on, geology departments of universities and that two a year should be a maximum. Drs. Uffen, Edmunds, Folinsbee and several other members remarked on the success of the 1961 Maritime tour and suggested that the Committee should at least record its support of the project. The Chairman, in response to a query, said that if the universities took the initiative and requested specific speakers from among officers of the Geological Survey, he thought the Survey would be prepared to send such men on lecture tours and pay their transportation, although, to avoid any man being absent too long, a tour should be divided with one man

covering the east, and another the west. After further discussion, the Subcommittee on Scholarship on Research Training was asked to continue to sponsor the lecture tour, on a limited scale, until such time as the Geological Association of Canada would be prepared to take over the project.

REPORT OF THE SUBCOMMITTEE ON

PLEISTOCENE GEOLOGY

Presented by C.P. Gravenor

Members of Subcommittee

C.P. Gravenor (Chairman)	- Research Council of Alberta, Edmonton, Alberta.
I.C. Brown	- Geological Survey of Canada, Ottawa, Ontario.
E.A. Christiansen	- Saskatchewan Research Council, Saskatoon, Saskatchewan.
R.E. Deane	- University of Toronto, Toronto, Ontario.
Roland de Blois	- Department of Natural Resources, Quebec City, Quebec.
Alexis Dreimanis	- University of Western Ontario, London, Ontario.
J.A. Elson	- McGill University, Montreal, Quebec.
P.F. Karrow	- Ontario Department of Mines, Toronto, Ontario.
W.O. Kupsch	- University of Saskatchewan, Saskatoon, Saskatchewan.
R.H. MacNeill	- Acadia University, Wolfville, Nova Scotia.
W.H. Mathews	- University of British Columbia, Vancouver, British Columbia.
A.M. Stalker	- Geological Survey of Canada, Ottawa, Ontario.
A.K. Watt	- Ontario Water Resources Commission, Toronto, Ontario.

INTRODUCTION

Activities in the fields of Pleistocene, engineering and ground-water geology during the past year were highlighted by symposia bringing together engineers, geologists and soil scientists, by extensive mapping programs, and by marked increases in research in all spheres of ground-water exploration and development.

In the spring of 1960 a symposium entitled "Soils in Canada" was organized by R.F. Legget, National Research Council and

sponsored by Section 4 of the Royal Society of Canada[1]. The purpose

[1] Soils in Canada - Geological, Pedological and Engineering Studies, Edited by Robert F. Legget; Royal Society of Canada, Special Publication No. 3, 1961.

of the symposium was to present general papers on the geology, engineering, and pedological characteristics of the surficial materials found throughout Canada. The symposium was most successful; it served to illustrate the interrelationship between the three disciplines and pointed up areas of research that could best be handled by a joint approach. In a similar vein, the 14th Canadian Soil Mechanics Conference which was held in Niagara Falls brought engineers and geologists together to discuss common problems.

Although the overall picture is encouraging and research activity is at an all-time high, there is no reason for complacency - especially in the fields of ground water and engineering geology. A review of current projects indicates that many of the engineering geology projects are being sponsored by non-geological organizations - especially the National Research Council. It is also noted that over the past five years no grants to research have been recommended by the National Advisory Committee in the fields of engineering geology and ground water. Indeed, for the past five years only six per cent of the grants have been made to support Pleistocene and geomorphology studies. Undoubtedly this is due in part to the fact that many such studies involve field work and the grants are insufficient to cover large expenditures for projects of this type.

A questionnaire was sent to the members of the Pleistocene subcommittee to obtain their opinion on what might be done to stimulate research in engineering geology and ground water. As might be expected, there were as many ideas as geologists on the sub-committee. There were, however, several areas of general agreement which follow:

(1) There is a need to inform students of the possibilities in the fields of Pleistocene, engineering and ground-water geology and to encourage students to undertake graduate studies in these fields. More funds are urgently needed by the universities to sponsor students in these fields of research.

(2) There is a need for more university departments to recognize the importance of engineering geology and ground-water hydrology and to offer adequate curricula in these fields.

(3) Dr. Kupsch, University of Saskatchewan suggests that funds granted on a project basis be held in trust by the institution involved until a suitable student can be found to aid in the project. Dr. Kupsch's complaint with the present system is the short time interval between the confirmation of the grant and the end of the school term. Many students accept other offers rather than wait until the grants are confirmed. Thus, if the grants could be held over in trust the likelihood of finding a suitable student would be much better.

(4) Several members of the subcommittee have requested an up-to-date list of research projects that have been suggested in past years but not acted upon. This list will be compiled

during the year, circulated to members of the subcommittee, and a priority listing submitted to the next annual meeting of the National Advisory Committee.

(5) Almost all members of the subcommittee recognized the shortage of funds available in the form of grants.

Several members of the subcommittee from both universities and government agencies have suggested that the National Advisory Committee - through the recommendation of this sub-committee - suggest certain projects that might be carried out as joint research programs involving government agencies and universities, supplemented with some aid from the National Advisory Committee.

Such cooperative projects should be of more than local application. For example the following two programs are of a type that might be considered for joint participation:

(i) Ground water studies of sedimentary units which cross provincial boundaries where the results of such a study have application to two or more provinces

(ii) Application of surficial maps to engineering projects - in particular in highway location and construction. One such program is now underway in Ontario with the use of soil maps. Items such as the determination of the variability of engineering characteristics within geologically mappable units require attention before surficial geology maps can be effectively used for engineering purposes.

If approval in principle is given to this proposal, concrete proposals for joint projects will be presented for consideration at the next meeting of the National Advisory Committee.

CURRENT MAPPING AND RESEARCH PROGRAMS

The following is a brief summary of the mapping and research programs which have been carried out by surveys, research institutions and universities during 1960-61.

Yukon and Northwest Territories

Work in the Northwest Territories was marked by two major expeditions, one the Jacobsen-McGill Arctic Research Expedition, and the other sponsored by the Department of Mines and Technical Surveys.

The Jacobsen-McGill Arctic Research Expedition is a joint undertaking of McGill University and Dr. G. Jacobsen of Montreal. The aim of the expedition is "to study the evolution of the mountainous and strongly glacierized and glaciated area of the central part of western Axel Heiberg Island". Several Canadian government agencies are sponsoring this project including the Photogrammetric Research Branch of the National Research Council, Geographical Branch of the Department of Mines and Technical Surveys, Royal Canadian Air Force, and Meteorological Branch of the Department of Transport. The 1960 party consisted of 27 members

and involved several scientific disciplines including glaciology, geophysics (seismic and gravity), geology, geomorphology, meteorology, botany, and engineering.

Glaciological investigations involving measurements of accumulation, ablation, surface velocities, pressure waves, vertical temperature measurements (to depths of 10 m.) and ice thickness (seismic and gravity) were made on three glaciers: "Hugh Thompson Glacier", "White Glacier", and "Baby Glacier". Geomorphological studies on the morainic deposits and marine strand lines were carried out by the Geographical Branch. The expedition was continued in 1961 on a somewhat reduced scale.

The second major expedition was the Polar Continental Shelf Project. This project which was initiated in 1958, involves a general geological and geophysical investigation of the polar continental shelf area. The scientific personnel have been drawn from the Branches of the Department of Mines and Technical Surveys.

Extensive surficial geology mapping projects in the Northwest Territories have been carried out by the Geological Survey of Canada. Reconnaissance mapping of Banks, Victoria and Stefansson Islands was started in 1959 and completed in 1960. Evidence for three and possibly four glaciations was found on Banks Island. Other mapping operations were carried out in the Back River area and in the Klondike placer mining district of the Yukon. It is hoped that the Klondike studies will extend the life of the placer mining industry.

More specific studies in the Northwest Territories include a study of ground-water geology of permafrost areas in the Mackenzie District by the Geological Survey of Canada, evapotranspiration studies at Norman Wells by the Ontario Research Foundation and the National Research Council, ablation and geophysical studies on Gilman Glacier, North Ellesmere Island, soil mechanics studies carried out by the National Research Council on the Inuvik townsite, and an engineering geology study of possible dam sites along the Yukon River by the Geological Survey of Canada.

A thorough study of pingos and oriented lakes is being carried on by J.R. Mackay of the University of British Columbia. Dr. Mackay's project includes a study of the characteristics of the lake deposits on which pingos occur and a quantitative treatment of changes in climatic-permafrost regime as they affect pingo formation. Dr. Mackay is also making a Fourier analysis of the meander system of the Mackenzie River. His work is being sponsored by the Geographical Branch, Department of Mines and Technical Surveys.

Alberta

Pleistocene studies in Alberta during 1960 were carried out by the Research Council of Alberta and the Geological Survey of Canada. Mapping programs by the Research Council of Alberta were carried out in the Coronation area of eastern Alberta, the Edmonton and Calgary districts, and a start was made on the mapping of the Cypress Hills district in southeastern Alberta. Mapping of the Fernie district was completed by the Geological Survey of Canada and a start was made on the mapping of the Lethbridge district. Seven distinct tills are known to exist in the Lethbridge district and these have been subjected to fabric and compositional studies.

Over the past few years the Research Council of Alberta has sponsored a helicopter program to map the soils and surficial geology of northern Alberta. During the 1960 field season about 50,000 square miles were mapped in extreme northwestern Alberta. This reconnaissance mapping program will be completed in 1962.

Studies on the Athabasca glacier which are being carried on jointly by the Geophysics Departments of the Universities of Alberta and British Columbia were continued during 1960. The project includes drilling through the ice by the hot-point method, seismic and gravity measurements, determination of flow rate of the ice and ice temperatures. This program is being sponsored by the National Research Council. Last season the Research Council of Alberta attempted to drill holes through the glacier with a cable tool rig. Three holes were produced by this method, but unfortunately the ice conditions were such that the rig could not be easily moved about on the ice and hence, while the method proved successful, the locations of the holes were not ideal.

Ground-water studies by the Research Council of Alberta have been divided into regional ground-water resource programs and research projects on various phases of the migration and recovery of ground water under a wide variety of conditions. Several research projects have been initiated to study the fundamental characteristics of water-containing alluvial gravels in various parts of the Province. Such gravels offer one of the best hopes for the development of high-capacity wells in the Prairie Provinces and a full understanding of their hydrologic properties is essential. Other studies involve a survey of the variation in chemical quality of ground water in Alberta and a study of permeability variations in the Edmonton formation. Ground-water geophysical operations by the Research Council of Alberta have involved seismic and resistivity surveys and a minor program on correlation of earthquake data with changes in ground-water level as noted in a network of automatic water-level recorders.

British Columbia

Aside from one mapping program in the Nicola map-area by the Geological Survey of Canada, dam site studies by the British Columbia Department of Mines, and bore-hole investigation in the western part of Vancouver City by W. L. Brown, there has been little activity in British Columbia over the past year. In the Nicola area evidence has been found for two major glaciations separated by an interglacial interval marked by 75 feet of silt, sand and gravel and vegetal remains.

A ground-water survey of the East Coast of Vancouver Island between Nanaimo and Campbell River was made by the Geological Survey of Canada.

Manitoba

Activities in Manitoba were marked by one Pleistocene study in the Winnipeg district by a graduate student at the University of Manitoba, a ground-water survey of the Red Deer River basin by the Geological Survey of Canada, and an engineering study of Kelsey Generating Station by the National Research Council.

The Kelsey Generating Station of the Manitoba Hydro-Electric Board on the Nelson River is situated in an area of spotty permafrost and studies are being made on dyke movements, ground

temperatures, and climatic and dyke performance under difficult natural conditions.

Maritime Provinces

Only a few projects are underway in the Maritimes, mostly by the Geological Survey of Canada.

One-mile mapping by the Geological Survey of the surficial deposits along the St. John River between Edmundston and Fredericton has been completed. Other mapping programs by the Survey include the mapping of the Rustico area on Prince Edward Island and a study of the marine shoreline and shore deposits from Trinity Bay to White Bay and on the Burin Peninsula, Newfoundland.

Reports from Nova Scotia indicate that aside from minor ground-water and surficial studies very little has been accomplished during 1960. However one significant step taken in recognition of the ground-water problem is the institution of proceedings to have compulsory licensing of all water well drillers, and to make it mandatory that wells be properly logged and reported to a central agency - probably the Nova Scotia Department of Mines.

Aside from the ground-water work of the Nova Scotia Department of Mines, only one ground-water survey was made in the Maritimes, that by the Geological Survey of Canada in the Moncton area of New Brunswick.

Ontario

Four government organizations and three universities are active in Pleistocene and ground-water studies in Ontario. The Ontario Water Resources Commission reports that some 56 ground-water investigations were carried out during the year; most were fairly extensive surveys involving examination of the local geology. Pumping tests and the determination of aquifer characteristics resulted from numerous well exploration programs financed by the Ontario Water Resources Commission. In addition, the O.W.R.C. completed five regional water resources surveys on a county basis. The importance of ground water in Ontario is reflected in the fact that a total of 7,457 records were filled in 1960.

Pleistocene mapping programs by the Geological Survey of Canada were carried out in northwestern Ontario (Roads to Resources program), Trenton, and Ottawa areas. Mapping of the Brantford area was carried out by the Ontario Department of Mines. A project to delineate glacial lake beaches in Wentworth County was initiated by a graduate student at McMaster University.

Studies of the mineralogy of sands in Ontario were continued by the Ontario Research Foundation. Another program by the same organization involves study of the calcite-dolomite content of sands to aid in unravelling the history of the Wisconsin glacier.

A large number of Pleistocene research programs are being carried out by the universities and government agencies in Ontario. Examples of these are the study of the Pleistocene sediments along the University Subway Line in Toronto; continued lithological and stratigraphical studies on Wisconsin drifts in southern Ontario at the University of Western Ontario; geochemical prospecting studies in

drift-covered areas, also at the University of Western Ontario; and mineralogical studies of some tills in Scarborough township, at the University of Toronto.

One of the more glamorous projects in the Ontario region is that being carried out by the Great Lakes Institute. Dr. R.E. Deane of the University of Toronto reports that his main interest is in the bottom sediments and that the Pleistocene history of the lake basins is written in the sediments, or lack of sediments, on the lake floor. The Institute has sampling and Scuba diving equipment to examine the bottom sediments.

Quebec

Most of the work done in the Province of Quebec over the past year has been in the field of ground-water geology and hydrology. Several minor Pleistocene geological studies have been made in conjunction with the ground-water programs. Fifty ground-water surveys in 27 counties were carried out by the Quebec Department of Mines. These studies involved geological mapping of the areas concerned - usually of the Pleistocene - and conducting hydrological tests to assess the potentialities of the water-bearing formation.

The Geological Survey of Canada conducted three ground-water surveys in Quebec - one in the Ottawa-Hull area of Ontario and Quebec, the second in the St. Jean map-area, and the third in the Vaudreuil map-area.

Other work in Quebec has been carried out largely by the staff and graduate students at McGill University and MacDonald College. Dr. J.A. Elson of McGill University is studying the de-glaciation and sea-level fluctuations in the St. Lawrence Lowland, and the origin, nature and properties of till. A study of the landforms and surficial deposits in the North River Valley, Quebec, is being carried out by J.T. Parry as a Ph.D. thesis project.

One of the more interesting projects at McGill University involves the effect of chemical additives on the permeability of soils. To make this study, a specially built permeameter has been constructed which controls the spacing of oriented, purified clay particles; fluid under pressure can be induced to flow in a direction parallel to or perpendicular to the orientation of the particles. In part this study appears similar to a Ph.D. thesis project now near completion in the Department of Civil Engineering at the University of Alberta. This is a broad field, however, and results will have far-reaching effects on applied studies in the fields of petroleum reservoir engineering, land-slide investigations, soils and highway research projects, and a host of other related problems which have to do with the migration of water through soils and rocks.

Other studies at McGill University include a comparative study of aeolian sand grains from Hungary and Saskatchewan, photo-geological study of part of the Canadian Shield in northern Manitoba, geomorphology of anorthosites, soil structures and interparticle forces and their relation to soil properties and characteristics, and study of permafrost and frozen soil with regard to basic properties and characteristics. At MacDonald College similar studies on the water-in-clay system are being made. It is indeed encouraging to see this thorough approach being made on the properties of clay minerals; the results of this work will aid in the understanding of fundamental problems

in geology and engineering.

A glacial map of Quebec, compiled at Laval University, has been published recently[1]. The map indicates striae, eskers, groups

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[1] Glacial Map of Quebec, 1 inch to 32 miles; Dept. of Geology, Université Laval, Quebec City, 1961 ($2.50 per copy).

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of drumlins, boulder trains, occurrences and elevations of glacial-marine sediments, and occurrences of varved sediments.

Saskatchewan

Activities in Saskatchewan during 1960 were marked by an increase in quantitative ground-water studies. Three provincial agencies are actively engaged in the Saskatchewan ground-water program: Saskatchewan Research Council, Saskatchewan Department of Agriculture, and the Saskatchewan Department of Mineral Resources. During the year the first ground-water report was published, the first hydrological investigations made, and the first investigation of ground-water exploration for towns was initiated.

The Saskatchewan Research Council is involved with the research aspects of ground-water development and in 1960 completed the field work necessary for compilation of hydrogeology maps 72 I and H. These mapping programs include studies of glacial deposits, bedrock and bedrock topography. Where bedrock aquifers occur, their ground-water probability is also investigated. Resistivity studies were used by the Saskatchewan Research Council to delimit a known aquifer in the Town of Wadena. Hydrological studies of a quantitative nature were started in 1960 and the buried Yellowstone Valley aquifer was drilled and pump tested. Tritium investigations were also started to determine the age of ground water and, consequently, the time necessary for recharge.

The Geological Survey of Canada was also active in Saskatchewan over the past year. They completed the field work for the compilation of hydrogeology maps of the area south of Saskatoon, and conducted a ground-water inventory investigation in the Saskatoon area and the Weyburn area, as well as carrying out an exploratory drilling program in the buried Missouri Valley. The Geological Survey has also installed 6 observation wells with automatic recorders in Saskatchewan.

Further field mapping of Pleistocene deposits was undertaken by the Saskatchewan Research Council in a systematic study of surficial deposits in southern Saskatchewan. Among the areas studied were Regina, Willowbank area, Great Sand Hills area and Last Mountain area. To aid in the search for buried valleys drift isopach and bedrock contour maps were prepared for the Kindersley area.

Walter Kupsch reports that "A conference on 'Buried Valleys' organized by the Research Councils of both Saskatchewan and Alberta and held in Saskatoon, can only be described as very successful in that it aided greatly in assessing the characteristics of such valleys, how to locate them by geological and geophysical means, and in correlating the courses traced so far from one Province to the other. As knowledge increases it should be possible before too long to show on

a regional map the drainage of the Prairies before the advent of glaciation."

A long-range project to study early post-glacial ground wind circulations of North America as revealed by anchored dunes and other indicators was started at the University of Saskatchewan.

Several publications record the work of the Saskatchewan group during 1960. One of these that will be of interest and value to a large group of scientists is a map showing the physiographic divisions of Saskatchewan.

Summary and Conclusions

After reading the impressive list of Pleistocene, ground-water and engineering geology research projects being carried on in Canada at the present time it is difficult to believe that fifteen years ago there was almost no research being done in these fields. Much, however, still needs to be done, especially in the fields of engineering and ground-water geology. There is a need for universities to play a more active role in research in these fields, and indeed they should provide leadership. There is also a need for more funds to sponsor graduate students and it is possible that the funds should be provided in such a way that they would not have to be used immediately.

One way in which some of the larger, more expensive projects could be carried out is through the cooperation of government agencies, universities, and the National Advisory Committee. It is requested that consideration be given to this proposal so that the sub-committee members may have the opportunity of suggesting suitable research programs at the next annual meeting.

REPORT OF THE SUBCOMMITTEE ON PHYSICAL METHODS APPLIED TO GEOLOGICAL PROBLEMS

Presented by R.J. Uffen

Members of Subcommittee

R.J. Uffen (Chairman) - University of Western Ontario, London, Ontario.

J.E. Blanchard - Dalhousie University, Halifax, Nova Scotia.

M.B. Dobrin - Triad Oil Co., Calgary, Alberta.

R.M. Farquhar - University of Toronto, Toronto, Ontario.

H.W. Fleming - Kennco Exploration (Canada) Ltd., Toronto, Ontario.

G.D. Garland - University of Alberta, Edmonton, Alberta.

F.S. Grant - University of Toronto, Toronto, Ontario.

J.A. Jacobs - University of British Columbia, Vancouver, British Columbia.

L.W. Morley - Geological Survey of Canada, Ottawa, Ontario.

H.D.B. Wilson - University of Manitoba, Winnipeg, Manitoba.

INTRODUCTION

The past year (1960-61) has been one of expanded activity in the application of physical methods to solution of fundamental geological problems, but of their reduced use in exploration. Major expansions have occurred in the programs of the Federal and Provincial government agencies and of the universities, in such fields of investigation as the thickness of the continental crust, the origin and history of crustal rocks, meteor craters and regional aeromagnetic surveys. However, the lull in exploration activity in both the petroleum and mining fields continues, with consequent lack of development of geophysical instrumentation and a redistribution of technically trained people into other pursuits.

New graduates of our universities and technical institutes with adequate training have experienced no great difficulty in

obtaining permanent employment but the potential employer is more selective and more interested than ever in a firm foundation in scientific principles rather than specialized competence.

GEOPHYSICAL RESEARCH FACILITIES

Canadian graduate schools continue to expand in size and activity. The University of Toronto announced the formation of an Institute of Earth Sciences; the University of Western Ontario expanded its geophysics laboratories and increased its faculty; and McGill University appointed Dr. L.P. Geldhart as its first Professor of Applied Geophysics in the Department of Mining Engineering and Applied Geophysics. He is developing an undergraduate curriculum and a program of research in magneto-telluric currents.

The National Research Council of Canada created a new section for the Earth Sciences in its program of grants-in-aid of research to Canadian universities, and increased the amount of financial assistance. The Canadian (N.R.C.) Associate Advisory Committee on Geodesy and Geophysics approved in principle the Upper Mantle Project proposed at the meetings of the International Union of Geodesy and Geophysics in Helsinki August, 1960. As a result, the programs for seismic and geothermal research of the Dominion Observatory and Geological Survey of Canada are being accelerated greatly.

THE UPPER MANTLE PROJECT

At the meetings of the International Union of Geodesy and Geophysics in Helsinki July 25, 1960 the Executive Committee endorsed a broad program of research on "The Upper Mantle and Its Influence on the Development of the Earth's Crust". This would involve investigation of the outer 1,000 kilometres of the Earth, the source of the world's natural resources. The resolution endorsing the project is as follows:

> "The International Union of Geodesy and Geophysics, considering the importance of upper mantle studies for investigations of solid earth geophysics, decides to undertake a broad program of research, including among others the following subjects:
>
> (1) Deep drilling.
>
> (2) Development of deep sea seismographs for the exploration of the upper mantle under the oceans.
>
> (3) Special studies of deep focus earthquakes.
>
> (4) Magnetic and gravimetric studies.
>
> (5) Studies of tectonic and magmatic development of the crust.
>
> (6) Theoretical studies of phase changes, thermal conditions, equations of state.
>
> (7) High pressure laboratory studies of behavior of rocks."

The Bureau of the International Union of Geodesy and Geophysics requested National Committees to submit comments and suggestions on how best to achieve the proposed investigations for consideration by the Executive Committee at a meeting in Paris, January 30th, 1961. To this end the Associate Advisory Committee on Geodesy and Geophysics of the National Research Council of Canada at a meeting on November 4, 1960 approved the formation of a Canadian Subcommittee for the Upper Mantle Project. The initial members of the Subcommittee include Prof. R.J. Uffen (Chairman), University of Western Ontario, Prof. G. Garland, University of Alberta, Dr. L.W. Morley, Geological Survey of Canada, and Dr. J. Hodgson, Dominion Observatory[1].

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[1] The Subcommittee has been enlarged since to include J.E. Blanchard, Dalhousie University; W.M. Cameron, Department of Mines and Technical Surveys; R.E. Folinsbee, University of Alberta; T.A. Harwood, Defence Research Board; J.A. Jacobs, University of British Columbia; E.F. Roots, Department of Mines and Technical Surveys; and C.H. Smith, Geological Survey of Canada.

At the meetings of the Bureau of the International Union of Geodesy and Geophysics in Paris, January 31, 1961, the Upper Mantle project was approved as a major international scientific activity - the project to extend from January 1, 1962 to December 31, 1964. It was decided that the Upper Mantle Project would be the major theme of the next general assembly of the I.U.G.G. in Berkeley, California, August 1963. It is proposed to open the scientific session with a review of the present state of knowledge of the Upper Mantle. During the following week individual associations will be asked to organize symposia on specific areas of research. At the closing general session, selected speakers will summarize the results of these discussions.

In the following review of current geophysical work in Canada, it will be seen that a great deal of pertinent research on the Upper Mantle is already underway. What is required is that this research be accelerated, interpreted and published.

GRAVITY

Regional gravity surveys were originally carried out by the Dominion Observatory with stations spaced at intervals of 15 to 20 miles. Gravity maps with this data are available for about one half of Canada. During recent years, observations have been made at closer intervals of 6 to 8 miles. This more detailed information will be published on a new series of maps to be known as the 'Gravity Map Series', having a scale of 1:500,000 and corresponding to the National Topographic Series.

Twenty-three maps of this new series are now being compiled, seventeen for areas in the Canadian Shield in northern Quebec and Saskatchewan and the remainder for areas in the central plains. A brief report will accompany each map, giving an outline of the major gravitational features and their geological significance. The first four gravity maps of this series, the Fort George, La Grande, Lac Bienville, and Great Whale map-sheets accompanied by a preliminary report by J.G. Tanner, became available for distribution in the spring of 1961.

During 1960 about 1,900 regional gravity stations were established at 6-8 mile intervals in northern Saskatchewan and north-eastern Alberta.

A number of gravity measurements were carried out in a submarine by the Dominion Observatory in cooperation with the U.S. Hydrographic Service to test a gravimeter aligned for measurements in a surface vessel. These results are now being analysed. Further measurements are planned for Hudson Bay using a remote control instrument designed for measurements on the ocean floor.

As part of the Department of Mines and Technical Surveys' Polar Continental Shelf Project, the Dominion Observatory measured gravity at 8 mile intervals at about 400 stations on both land and sea ice in the vicinity of Ellef Ringnes, Amund Ringnes, Lougheed and Borden Islands in the Arctic. In addition, about 300 stations were observed at much closer intervals to supplement geological studies of gypsum piercement domes and to provide detailed information concerning the ice thickness of the Meighen Island Glacier. These results are now under study.

The results of two regional gravity surveys were published by the Dominion Observatory:

Tanner, G.J. and R.J. Uffen: Gravity Anomalies in the Gaspé Peninsula; Pub. of Dom. Observatory, Vol. XXI, No. 5, 1960.

Innes, M.J.S.: Gravity and Isostacy in Northern Ontario and Manitoba; Pub. of Dom. Observatory, Vol. XXI, No. 6, 1960.

During the past two years geophysicists have been investigating the possibility of measuring gravity from an aircraft. From knowledge of gravity at the earth's surface, the Dominion Observatory has completed theoretical studies to facilitate the calculation of the gravitational field at various heights above the earth. This work coupled with detailed gravity measurements in the vicinity of Ottawa is intended primarily to provide a suitable means of testing airborne gravity measuring instruments when development work on them has been completed.

Gravity surveys have an interesting application in meteorite crater studies. Negative anomalies associated with fossil craters not only serve as evidence of their origin, but provide a measure of the total amount of rock ruptured during their formation. Gravity studies of the Holleford, Brent and Deep Bay craters have been completed[1]. Preliminary gravity investigations were made at the New

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[1] P.M. Millman, B.A. Liberty, J.F. Clark, P.L. Willmore, and M.J.S. Innes, The Brent Crater. Pub. of Dom. Obs., Vol. XXIV, No. 1, 1960.
Innes, M.J.S., An Analysis of the Gravity Field over Fossil Meteorite Craters, Pub. 7, Dom. Obs., in press, 1961.

Quebec Crater in 1960, and a gravity survey on the ice was completed in March 1961.

Regional gravity surveys have been carried out in the Monteregian Hills, Quebec by Queen's University; in the Kenora

District and the Nelson River area by the University of Manitoba; in the Southern Rocky Mountain Trench by the University of Alberta; and in the Thetford area of southwestern Ontario by the University of Western Ontario. These data along with seismic observations are of considerable value in tracing major structural features of the crustal rocks.

SEISMOLOGY

Since the meetings of the Geneva Conferences for an International Nuclear Weapons Test Ban Inspection System, it has been realized that the science of earthquake seismology has been neglected and that our understanding of earthquake mechanisms, the propagation of seismic waves, and the structure and properties of the earth's interior is primitive. Consequently great attention has been focused on the need for fundamental research, and in Canada major expansions have been undertaken by the Department of Mines and Technical Surveys, the universities and the Defence Research Board.

The Dominion Observatory is accelerating its plan to establish between 25 and 30 seismic observatories distributed throughout Canada at approximately 500 mile intervals. These will be located near meteorological stations, research institutes and universities. Six are now established and the remainder can be established within three years. In addition to the usual identical short period instruments, long period seismographs will be installed at each station for the observation of surface waves. Holes about 1,000 ft. deep are to be drilled at each station in which seismographs (among other things) can be installed in an attempt to avoid surface noise. In two or three of the northernmost stations tiltmeters will be set up to measure the present rate of crustal tilting.

Electronic methods of data processing of seismic observations have been recommended to free seismologists for research on new instruments, interpretation of results and understanding of the mechanism of earthquakes.

In 1960 all personnel of the Seismic Section of the Geological Survey of Canada were seconded to the Polar Continental Shelf Project. The crew was based at Isachsen, Ellef Ringnes Island from April 26th to August 7th. It is hoped that seismic techniques will help answer a few of the geological problems associated with the Sverdrup Basin within the next two years, and in various other regions of the Canadian Arctic in succeeding years. Some of these problems are: the depth to basement, composition and configuration of the basement; the presence and configuration of Mesozoic and Palaeozoic sediments; correlation of lithologic types with seismic velocities; and the depth of the Mohorovicic discontinuity. Record interpretation is tentative at present, but more than 28,000 feet of sediments are indicated at the south end of Ellef Ringnes Island. This compares to about 7,000 feet at the north of Borden Island. The seismic velocities associated with various geological strata appear to be fairly consistent so that a correlation between certain lithologic types and seismic velocities should be possible.

A considerable amount of logistic information regarding seismic operations in the Arctic was accumulated which should be of value, particularly to industry when intensive exploration for petroleum is started there. There was not, as was feared, sufficient ice noise to interfere with seismic recording on Arctic ice. Another interesting

by-product of the Arctic work was the discovery that the base of the permafrost can be mapped by reflection seismic techniques.

A seismic refraction survey was completed by the Geological Survey near Vaudreuil, Quebec immediately west of the city of Montreal to delineate a buried river valley whose presence was postulated by Mr. J. Tremblay of the Ground water Section of the Survey. The buried channel was found to be about 200 feet deep and courses westward from the town of Vaudreuil, appearing to originate in the general region of Rigaud Mountain. Further work is planned in this area to delineate side channels and to trace the main channel farther.

A similar shallow seismic survey of the Thedford Marsh in southwestern Ontario by the University of Western Ontario has mapped part of the bedrock topography which may have controlled the development of the marsh (now an important market garden). The Geological Survey completed a seismic refraction survey in southern Ontario as a means of interpreting Palaeozoic geologic features.

The Nova Scotia Research Foundation and Dalhousie University are continuing their structural studies of the Northumberland Straight and sedimentary basins of Nova Scotia.

McGill University will extend its seismic studies on Axel-Heiberg Island in the Arctic. Crustal studies of depths and seismic velocities are planned on the Pacific Coast by the Dominion Observatory, the Pacific Naval Laboratory, and the University of British Columbia. The Universities of Saskatchewan and Manitoba plan a joint seismic profile across the boundary of the Churchill and Superior geological provinces of the central Canadian Shield. Surveys of a similar type are planned in Ontario and Quebec by the Dominion Observatory, and on the Atlantic Coast and Newfoundland by the Dominion Observatory and Bedford Oceanographic Institute.

TERRESTRIAL HEAT FLOW

A recurring recommendations has been for expansion of studies of the Earth's internal heat and of the balance between the solid Earth and its atmosphere. Such investigations in the past have been left to the universities but it has been realized that their significance to the physics and chemistry of the Earth's interior, to economic geology, to engineering geology and to meteorology warrant a permanent group in a Federal agency. To this end, the Dominion Observatory will father a terrestrial heat-flow section (initially as part of its Seismology Division).

Temperatures will be measured in each of the drill holes of the network of seismic observations mentioned under the section on Seismology (p. 32). On Axel Heiberg Island, McGill University, and on the Polar Shelf, the Geological Survey of Canada, propose to make temperature measurements in deep drill holes. In addition, the thermal conductivities of the cores will be measured so that the local heat-flow to the surface can be determined. These determinations along with existing determinations will be sufficient to produce a contour map of heat-flow distribution which will probably be the first such map for a continental area in the world.

Measurements by University of Western Ontario in several mines of Ontario and Quebec and at the Coronation Mine,

Saskatchewan; by University of Alberta at Leduc, Redwater and Norman Wells; and in the St. Lawrence Lowland by McGill University, indicate that the terrestrial heat-flow varies from 0.5 to 2.0 microcalories per square cm. per sec., i.e. by a factor of about four. It will be interesting to correlate the heat flow data on the contour map with magneto-telluric evidence of anomalous zones of electrical conductivity in the earth, and to compare the heat flow from the continent with the oceanic heat flow data of Scripps Institute of Oceanography, and Cambridge University.

Methods are being developed at University of Western Ontario for continuously recording temperatures in bore-holes, in "in situ" measurement of the thermal conductivity of rocks, and in simultaneous coring and temperature gradient measurements in the sediments of the Great Lakes.

Relatively neglected aspects of terrestrial heat flow are in the study of permafrost and engineering geology.

GEOMAGNETISM

Interest in rock magnetism for exploration and palaeomagnetic studies is increasing. Polar wandering curves will be amended by the work of the Geological Survey of Canada which has completed or is now studying palaeomagnetism of specimens from Prince Edward Island, Sudbury, the Maritimes, and the Purcell system of southern British Columbia, Alberta, and Saskatchewan. University of Western Ontario has completed a study of the reversely polarized ilmenites and hematites of the Allard Lake region of Quebec. After heat treatment these rocks can be made to reverse their magnetic polarization with only slight changes of temperature. The Dominion Observatory is investigating the magnetic properties of drill cores from geologic features of possible meteoric origin. The University of Toronto is continuing its studies of remanent magnetism as a guide to the origin of hematite in Precambrian iron formations.

Interest in magneto-telluric investigations and oscillations of the earth's magnetic field is receiving much attention because of the possibility of detecting zones of abnormal electrical conductivity within the Earth by these methods. The Dominion Observatory, University of British Columbia, and University of Alberta are actively engaged in this work and it is proposed to establish recording equipment at the seismic stations described under the section on Seismology (p. 32). New instruments will be set up also at University of Toronto, University of Western Ontario, University of British Columbia and McGill University under the auspices of the subcommittee for the Upper Mantle Project.

The Dominion Observatory is introducing computing machine handling of data in revision of regional magnetic charts and the estimation of secular variation.

The Geological Survey of Canada is developing apparatus for the qualitative and quantitative analysis of rocks and minerals using nuclear paramagnetic and electron paramagnetic resonances.

TECTONOPHYSICS

Research in this field is falling behind! Other than the work at University of Western Ontario on the energy requirements for an expanding Earth, little seems to have been accomplished. Surely it is time to make a renewed effort to compile and interpret the rapidly accumulating data of field geology, air photo interpretation, seismology, terrestrial heat flow, gravity, palaeomagnetism, isotopic studies and aeromagnetic surveys, to understand the origin and development of the Earth's oceanic and continental crust.

GLACIOLOGY

The Universities of British Columbia and Alberta and the Alberta Research Council are continuing their studies of the Athabasca Glacier. The project includes drilling through the ice, seismic and gravity measurements, determination of flow rates of ice, and ice temperatures.

The Defence Research Board is continuing ablation studies of the Gilman Glacier, Northern Ellesmere Island.

McGill University will extend its program of analysis of the development of land forms by "high arctic" geomorphic processes under the influence of "polar" glaciers on Axel Heiberg Island, Northwest Territories, as part of the McGill-Jacobsen Arctic Research Expedition.

The Arctic Institute of North America proposes to make an integrated study of the interrelationships between glaciology, oceanography and meteorology involving the transfer of energy and moisture between waters of Jones Sound and the glaciers and ice cap of Devon Island.

GEOPHYSICAL EXPLORATION

As mentioned earlier, seismic and gravity exploration in the petroleum industry has stabilized at a level of about one half the activity of four or five years ago. Small contracting companies and private consultants have suffered the greatest readjustments. Attempts to develop airborne gravity gradiometers for exploration purposes seem to have lost their impetus. There is a continuing use of induced polarization methods of exploration for disseminated mineral deposits but too little research into instruments or methods of interpretation.

Perhaps the most significant development is the predominance of aeromagnetic over aeroelectro-magnetic work. The regular yearly production of about 115 aeromagnetic maps (Maritime area) by the Geological Survey of Canada was increased in 1960 by the publication of 160 maps prepared by Spartan Air Services for the cooperative Ontario Department of Mines—Geological Survey of Canada "Roads to Resources" aeromagnetic survey in northern Ontario.

Two hydrographic ships were equipped with proton magnetometers. The work is being undertaken on behalf of the Oceanographic Institute. Two areas near Yarmouth and Cape Breton, Nova Scotia were surveyed during 1960 but data compilation by the

Geological Survey is at a stand still due to lack of staff.

Another important contribution has been the development by the Geological Survey of a light weight airborne magnetometer that can be moved easily from one aircraft to another. This instrument is being flight tested.

The Geological Survey of Canada has completed, or is continuing, its interpretation of aeromagnetic data for Arctic Island reconnaissance[1]; a profile across Hudson Bay; Marmora anomaly,

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[1] A.F. Gregory, Margaret E. Bower and L.W. Morley; Geological Interpretation of Aeromagnetic Profiles from Canadian Arctic Archipelago; Geol. Surv., Canada, Paper 60-6, 1960.

Ontario; Beaverhill Lake and Wholdaia Lake, Northwest Territories; and part of the west half of the "Roads to Resources" area in northern Ontario. The University of Western Ontario, the University of Saskatchewan, and the University of Manitoba are carrying out aeromagnetic or ground magnetic interpretations of the Lac La Ronge area, the Coronation Mine, and Saskatchewan, and of the Churchill-Superior boundary of the Canadian Shield.

The University of Western Ontario has completed a study, using the methods of Operations Research, of the optimum spacing of aeromagnetic flight lines[2]. The method includes the costs of the survey

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[2] Hammond, Barry M.; Optimization of Line Spacing in Prospecting; M.Sc. thesis, Univ. of Western Ontario, 1961.

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and expected value of any ore discovered as well as the technical problems of detecting the associated magnetic anomalies.

The University of Alberta and Dalhousie University are actively investigating instrumentation and interpretation methods for electro-magnetic prospecting for both conventional electro-magnetic equipments and natural sources of oscillations of the earth's magnetic field.

HIGH PRESSURE, HIGH TEMPERATURE STUDIES

The Mines Branch, Department of Mines and Technical Surveys; Queen's University and McGill University are continuing their studies of rock mechanics and stresses in underground workings. The Geological Survey of Canada and the Dominion Observatory are investigating cores from beneath suspected meteor craters for high pressure forms of minerals (shock induced). The University of Western Ontario is carrying out laboratory measurements of the coupling of impact and explosive energy to the ground and the measurement of the equation of state of rocks for very high amplitude stress (plastic) waves.

These are relatively neglected fields of investigation; research should be encouraged because of the importance of a proper understanding of the behavior of geological materials under very large stresses, at high temperatures and over large periods of time, both in

practical problems of mine safety and in basic processes of rock formation.

ATOMIC AND NUCLEAR STUDIES

The Geological Survey of Canada and Mines Branch, and the University of Western Ontario are completing studies of the energy spectra of natural gamma radiation from thick rock sources; the interpretation of integral counting data from the Arctic aeroradiometric survey; and the scattering of gamma radiation from artificial sources introduced into the ground.

A great deal of work is being done in the study of the isotopic constitution of rocks. Much of this is covered in the report of the subcommittee on Mineralogy, Geochemistry and Petrology (Pt. I, p.53). The potentialities of studies of the stable isotopes of sulphur, lead, magnesium, oxygen, deuterium, tritium, carbon, etc. in rocks have not yet been exploited for solution of problems such as palaeo-temperatures, origin of ore deposits and petroleum, granitization, etc. Although certain elements can be analysed on a routine basis the interpretation of the results is by no means routine. For this reason, the provision of isolated analyses on a "service" basis is of little use at present.

There are a surprising number of Canadian laboratories engaged in isotopic work (see Table I) and more will likely appear. A special plea should be made for establishment of a mechanism of communication and cooperation between those engaged in isotopic studies and geochronology and who are now identified with a variety of international organizations including the Mineralogy, Geochemistry and Petrology Sections of the International Geological Congress and the Seismology and Physics of the Earth's Interior Section of the International Union of Geodesy and Geophysics.

UNIVERSITY OR ORGANIZATION	DEPARTMENT	CHIEF RESEARCH WORKERS	RESEARCH PROGRAMS	NO. OF MASS SPECTROMETERS USED
British Columbia	Physics (geophysics)	R.D. Russell	Lead isotopes Oxygen isotopes	2
Alberta	Physics (geophysics) Geology	R.H. Krouse G.L. Cumming R.E. Folinsbee H. Baadsgaard	Lead isotopes (?) K-A dating	1
McMaster	Chemistry	H.G. Thode C.C. McMullen	Natural fission sulphur isotopes selenium isotopes boron isotopes	4
Toronto	Physics (geophysics)	R.M. Farquhar D. York	Lead isotopes sulphur isotopes U-Pb dating K-A dating Rb-Sr dating	2
Carleton	Geology	W.M. Tupper T.J.S. Cole	Sulphur isotopes K-A dating	1
Geological Survey	Mineralogy and Geochemistry	R.K. Wanless	Lead isotopes U-Pb dating K-A dating sulphur isotopes magnesium isotopes	2
St. Francis Xavier	Geology	R.F. Cormier	Rb-Sr dating	1 (?)
				13

REPORT OF THE SUBCOMMITTEE ON

STRUCTURAL GEOLOGY

Presented by M.S. Hedley

Members of Subcommittee

M.S. Hedley (Chairman)	- Department of Mines and Petroleum Resources, Victoria, British Columbia.
J.W. Ambrose	- Queen's University, Kingston, Ontario.
A.R. Byers	- University of Saskatchewan, Saskatoon, Saskatchewan.
J.B. Currie	- University of Toronto, Toronto, Ontario.
G.G.L. Henderson	- California Standard Company, Calgary, Alberta.
G.W.H. Norman	- Newmont Mining Corporation, Vancouver, British Columbia.
C.H. Stockwell	- Geological Survey of Canada, Ottawa, Ontario.

INTRODUCTION

In introducing this report it should be stated that major structures of continental implication are not considered. Also, there is admittedly a western bias to the report. Many structural studies are best made in mountain areas where marked topographic relief provides naturally a third dimension. When that dimension is extended by deep well drilling the opportunity for study is increased. The conjunction of mountains, oil and gas wells, and many geologists makes the Rocky Mountains and Foothills a particularly important region for structural research. The relative lack of intrusions and higher grades of metamorphism aid many studies of which the results are applicable in other parts of Canada.

The list of current structural research projects (Pt. II, p.108) is not illuminating. The projects seem reasonably well diversified and are geographically well distributed. Apparently, structural research is not popular in our universities, inasmuch as but one Ph.D. project is listed and of nine M.Sc. projects only about half are primarily structural in scope. In many of the projects listed under structure, the concern with structural geology is secondary. The list of projects is compiled from replies to a request sent to many organizations across Canada. It is not complete and this should be of some concern. The projects include only those being carried on in Canada, and not the work of Canadians at American or other non-Canadian universities. This is reasonable enough in most instances,

but the value of much structural work is in the field, and in some instances an extremely useful piece of Canadian work may be overlooked by this Committee because it is completed say in Califprnia or New Jersey.

Another deficiency is more serious. There is no coverage of what might be termed company research. G.G.L. Henderson, a structural specialist for a major petroleum exploration company, writes:

> "I would like to make one observation regarding the survey of the amount of structural research being done in Canada. The totals quoted for the provinces are apt to be misleading as they do not include the structural research being done by private companies. The amount being done by major oil companies alone in Western Canada is impressive; it is probably as much or more than the total recorded for Canada in last year's Annual Report."

It is not easy to better this situation. Dr. Henderson points out that in contributing to this report, because it is published, he has the problem of "how to say something which is worth while yet permissible so far as our company security regulations are concerned". If the National Committee is to know within reason what is the pattern of structural research in the potentially oil-bearing parts of Canada, some means of collection other than an open letter must be used. The same of course may be said of research in other branches of geology, but to a lesser extent than with structure.

CURRENT WORK AND RECOMMENDATIONS

C.H. Stockwell calls attention to the new Tectonic Map of Canada. The project is being undertaken jointly by the Geological Association of Canada, the Alberta Society of Petroleum Geologists, and the Geological Survey of Canada. Dr. Stockwell, who is chairman of the map committee writes:

> "Altogether some 35 geologists are directly involved and contributions from all interested geologists are solicited. The immediate objectives are twofold: (1) to make a Tectonic Map of Canada for publication by the Geological Survey of Canada on the scale of 1:5,000,000 and (2) to contribute toward the preparation of a World Tectonic Map for publication by the International Geological Congress. The project is an ambitious one; it has been underway for some time, and it may be several years yet before the map of Canada is printed.
>
> "The map of Canada will attempt to depict the main periods of orogeny as determined by age of folding, age of metamorphism, and age of intrusions. Areas of essentially undisturbed, flat-lying rocks will be distinguished from the mobile belts."

He points out that "in the Shield, isotopic age determinations have been especially useful in dating periods of metamorphism and intrusions"[1].

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[1] Stockwell, C.H.; Structural Provinces, Orogenies and Time Classification of Rocks of the Canadian Precambrian Shield; Geol. Surv., Canada, Paper 61-17, 1961, p. 108-118.

G.W.H. Norman stresses the need for study of the structure of British Columbia mining camps. He points out that physical difficulties and expense have been serious deterrents in the past but the advent of the helicopter has gone a long way toward solving logistic problems. In the general sense, it may be better to study mineral belts rather than mining camps, and he suggests for attack the eastern flank of the Coast Range, which could be tackled as a series of blocks. He writes:

> "The first stage in a group project of this type can best be handled, in my opinion, by taking a relatively small area and mapping in great detail on sufficiently large scales to resolve or at least clearly understand the problems that will be confronted. A complete and thorough mapping job should be done at this stage, with every band of rock separated out that can be recognized and followed conveniently according to the scale of mapping adopted. The mapping scale for the first stage may have to range from 100 to 1,000 feet to the inch, according to the requirements of the problems and not because of a designated requirement to cover a specified area by a specified time.
>
> "Completion of Stage I mapping will provide the information regarding the structural and lithological peculiarities of the rock formations which will help to speed up the second stage. The second stage of the group project will be the mapping of a large area, probably at least six 15-minute sheets by the group of geologists that will form the team for the operation. All should be competent investigators, who can map independently without supervision."

Further:

> "The present knowledge of structure for the future welfare of the mineral industry in British Columbia is quite inadequate. Only by adopting group tactics can any hope of progress be visualized. The most effective progress requires the proper cooperation of public and private geological services."
>
> G.G.L. Henderson writes:
>
> "As a general project and principle I would urge the subcommittee to encourage and support an increase of both detailed and regional mapping in the Cordilleran region—in particular, the Rocky Mountains. The Rocky Mountains, because of the excellent exposures, the relatively simple stratigraphic sequence, and the

increasing amount of well data, are probably one of the finest areas in Canada for the three-dimensional study and interpretation of basic structural problems. Previous work in this region, in which sufficient attention has been paid to details of structure, has yielded valuable and, in some cases, fundamental data in the field of structural geology.

"As a more specific research topic I suggest a detailed study of thrust faults in the Rocky Mountains. Many of these are well exposed and through a careful examination of such evidence as their geometry, the composition and character of gouge material, the cut-off angles of adjoining bedding, the relationships to the stratigraphic sequence, the related drag-folds and fracture patterns, etc., much valuable information would be obtained that might throw more light on their origin and temporal relationships to folding."

A.R. Byers draws attention to a study of the earth's crust along the Nelson River lineament. This study is being undertaken by the Universities of Manitoba and Saskatchewan and the Geophysical Division of the Geological Survey. He notes that a seismic survey proposed to supplement the gravity survey is at present held up through lack of funds. Work of this sort should help in tracing basement structures beneath the Plains area, amongst other things, and should be encouraged.

J.W. Ambrose kindly volunteered to review Memoir 79 of the Geological Society of America, entitled "Rock Deformation", published just a year ago. Dr. Ambrose's review is too lengthy to be included here verbatim and does not lend itself to condensation. It will be published, but in the meantime the following emerges:

Memoir 79 represents the work of a group, estimated at fifty, that is concerned with various physical and theoretical aspects of rock deformation, crystal growth and orientation, and earthquakes. It contains much new material as the result of testing and includes new theoretical approaches. It makes, as Dr. Ambrose remarks, exciting reading.

This work is of great potential importance, but the results of the tests and calculations carried out by the physicists is extremely hard to apply, for three reasons: (a) the physicists are not in the broader sense geologists, (b) the geologists are not mathematicians or physicists, and (c) many, too many, of our field data are inexact and our syntheses are speculative. The gap between geologist and physicist can be narrowed, and it is up to the geologist to do most of the narrowing. This is difficult because of the difference in types of mind, and the lack of advanced mathematics on the part of many if not of most geologists.

The geologist should make some move to meet the physicist. He should reinvestigate many of his basic concepts to see whether or not they are valid and rest on sound field data. The reinvestigation of some concepts is obviously long overdue, but the point to make is that the physicist is able to help us, or might be if we can present the right kind of data to him. This is no ordinary task, because geologists and physicists are both specialists who are not at home in each other's fields. Thoroughly trained geologists who are capable of using higher mathematics and understanding theoretical physics are rare. They

have a great potential for structural research, a fact which should be recognized by organizations capable of employing such men and using their talents.

In the same realm the remarks of J.B. Currie are directly applicable. He writes:

> "I would like to outline one aspect of structural geology and research in it which I think should be encouraged and supported. The aspect to which I refer might be included under the broad classification of methodology; specifically, the search for methods that will improve structural interpretation. I am thinking here of the interpretation and prediction of local and regional structure rather than structure of continental scale that involves a major part of the crust.
>
> "Various methods of geophysical measurement and increased rapidity of surface geological mapping have aided materially in enlarging our store of structural information. We have been less fortunate in continually developing methods that utilize these data for interpretation and prediction of structure. Often, structural research studies consist primarily of accumulating structural data in a new geographic area. The interpretation of these data is handled by routine methods which one should expect beforehand would not likely lead to a notable improvement in our knowledge of structural processes. Advances in a field of research are likely to be achieved by the application of both established and novel methods. In a sense, we need to examine some old problems by different methods."

Dr. Currie makes it clear that he does not wish to minimize the value of field mapping or to intimate that nothing is being done toward method research but that we can do more in the field of methodology, and:

> "The graduate student may be suited to this kind of research because his recently-completed formal training makes him conscious of the investigative techniques that are available. A student may have access, at this stage, to guidance from instructors in various scientific disciplines which could be of considerable aid to him. Furthermore, he is at a point in his development where new techniques may readily suggest themselves. Thus, a lack of experience in field work can be offset by the ability to look at a problem with a fresh approach. Finally, during post-graduate research the student may have the necessary segments of time to examine and develop methods that in the press of later professional work will not be available."

Dr. Currie would like to see:

> "A segment of our research devoted continuously to the development of methods that can render the interpretation and prediction of structure increasingly more accurate."

FUTURE OF STRUCTURAL RESEARCH

The subcommittee considers that structural geology is neglected as a field for research. Dr. Byers points out:

> "There are many projects in the general field of structural geology that deserve investigation. Unfortunately, financial support for straight structural research, either in the field or in the laboratory, is generally lacking. Although most geological investigations involve some structural studies, they are for the most part subordinate and are therefore limited in scope. Studies of foliation, lineation, fold and fault structures, and even primary sedimentary structures do not generally get beyond the stage of observation and description. They are rarely followed up by intensive laboratory research and analysis."

To these observations can be added that too often structure is considered only as part of an areal study and receives no more attention than it may be accorded in routine traversing. The results may be informative, but little emerges concerning structural processes. What we need are structural studies, namely studies that study structure. Delineation of form is only the first step.

It is gratifying to note that the Geological Survey is undertaking some special structural field studies in addition to systematic mapping. One study near Revelstoke, British Columbia, involves folding in the Shuswap terrane, a matter of fundamental importance in the Western Cordillera and the subject of considerable speculation during the past fifty years. More work of this sort should be done, to establish relationships and to determine mechanisms and processes. In selecting places for special study the thinking should be in terms of problems, not areas, because it may be necessary to range far beyond defined limits in search of information. Detailed work in the mountains has shown that detail is essential to the solution of some major structures, and that in order to see many a relatively small structure in proper perspective, much surrounding ground must be covered.

Finally, in the field of mineral deposits too little consideration is given to structural research. In fact, some excellent work suffers because the structural relations of a deposit have not been taken into proper account. The role of geological structure in ore deposition involves a good deal more than geometry, and should be given specific attention.

REPORT OF THE SUBCOMMITTEE ON

MINERAL DEPOSITS

Presented by A.W. Jolliffe

Members of Subcommittee

A.W. Jolliffe (Chairman)	- Queen's University, Kingston, Ontario.
R.W. Boyle	- Geological Survey of Canada, Ottawa, Ontario.
D.R. Derry	- Consulting Geologist, Toronto, Ontario.
Y.O. Fortier	- Geological Survey of Canada, Ottawa, Ontario.
M.H. Frohberg	- Mining Geologist, Toronto, Ontario.
D.F. Hewitt	- Ontario Department of Mines, Toronto, Ontario.
F.R. Joubin	- Mining Geologist, Toronto, Ontario.
A.H. Lang	- Geological Survey of Canada, Ottawa, Ontario.
G.B. Langford	- University of Toronto, Toronto, Ontario.

INTRODUCTION

In ten years of existence, this Subcommittee has enlisted the services of some 14 members, including three who have served as Chairman. Special acknowledgment must be made to H.D.B. Wilson, Chairman from 1958 to 1960, under whose leadership the comprehensive ore deposit study was initiated and several useful surveys, such as that dealing with wall-rock alteration, were completed.

In this report PART I presents a review of current research in the field of mineral deposits which is based chiefly on the survey of current research (Pt. II, p. 40) and on summaries supplied by subcommittee members; PART II includes all suggestions received by the Chairman concerning the initiation or extension of research projects in this field; and PART III contains some rather random generalities for which the Chairman must bear full responsibility.

PART I — CURRENT RESEARCH

More than one hundred projects are listed in the survey of current research under mineral deposits (Pt. II, p. 40). The number and the general pattern of distribution (29 under base metals, 10 ferrous, 10 radioactive, 13 other metals, 16 industrial minerals, and 33 general projects) remains about the same as in previous years. The list shows a few quite diverse topics to be popular such as sulphur isotopes, Sudbury, and iron formations; it also reveals some areas of comparative neglect including certain metals and industrial minerals, review type papers, and general studies of ore-forming processes.

The information on the projects is not complete enough to permit any more detailed breakdown than that given. However, a rough estimate suggests that some two-thirds of all projects listed are mainly descriptive, and that they range from descriptions of mineral deposits incidental to areal mapping, to those based on detailed study. About one-quarter of the projects appear to deal with the mineralogy and paragenesis of specific ores and the distribution of trace elements and isotopes therein. The remaining ten per cent are more general studies relating to the geochemistry and distribution of certain elements, or to matters of ore genesis.

Comprehensive Study of a Canadian Ore Deposit

A report by D.R.E. Whitmore on the comprehensive study of the Coronation Mine is presented elsewhere (Pt. I, p. 3). This project suggested by, and actively promoted by the Subcommittee on Mineral Deposits may well be one of its most notable achievements. Its aim is a synthesis of many separate studies by geologists, mineralogists, geophysicists and geochemists, with the active participation of universities, Federal and Provincial geological surveys and Research Councils, and mining companies, and all designed to fit into one general but highly intense investigation of a single ore deposit.

Industrial Minerals

D.F. Hewitt reports rather limited research in the industrial mineral field but notes progress in investigations into the deposition of salt and gypsum:

> "..... D.M. Baird is completing work on a study of Canadian gypsum deposits and as a result of this work we should have a greater understanding of the palæeo-stratigraphy and palaeophysiographic conditions at the time of formation of gypsum and anhydrite deposits. Studies of evaporite deposition are being made from core samples made available during oil and gas drilling in Saskatchewan and Manitoba. The Ontario salt deposits, which form part of the extensive Michigan Basin salt deposits, form a link between the Michigan and New York-Ohio salt basins. Research on facies analyses of cores from Michigan and Ontario has resulted in some new conclusions regarding palaeophysiographic conditions in Salina times and on conditions of deposition of the salt deposits. A continuing study of evaporite facies offers good research possibilities.
>
> "With quality control becoming more and more important in the aggregate field, more stringent testing of crushed

stone, and sand and gravel to be used as aggregate for concrete and asphalt is taking place. Deleterious materials must be identified and checked. Research projects now current in Ontario involve the study of pebble assemblages from gravel deposits being worked in southern Ontario. The Palaeozoic bedrock formations which supply deleterious materials to the gravels include the Collingwood, Dundas, Meaford and Queenston shales of the Toronto area and the chert-bearing Bois Blanc limestones of southwestern Ontario. Investigations of provenance areas supplying deleterious materials, mode and distance of transportation, and type and character of gravel deposits enables areas of gravel of marginal quality to be distinguished and delineated. It has been noted, for example, that certain laminated siltstone from the Dundas formation gives trouble if used in concrete and asphalt construction. Distance of transport has a marked effect on these pebbles: the more troublesome ones suffer rapid attrition during transportation, while the sounder ones tend to persist. Care must therefore be taken to ascertain exactly what members of a pebble assemblage are to be regarded as objectionable.

"Similar investigations of problems encountered in use of crushed stone from certain units of a formation are being undertaken. A study of types of chert occurring in various commercially quarried formations is being initiated. Some varieties of chert react with the alkalis in portland cement to form a silica gel which expands and causes popping and cracking in concrete. Since some cherts are relatively inert and others are extremely reactive, research is necessary into fundamental properties of varieties of chert.

"The nature and composition of sand has an important effect on its use as fine aggregate in concrete and brick. A research program is being carried out by the Ontario Research Foundation on the distribution and mineralogic composition of sands in Ontario. Besides being of fundamental interest to the aggregate producer, such information is of value to the agronomist and forester. Recent results of this investigation have given important new information to the Pleistocene geologist which will be of significant help in interpreting the glacial history in southern Ontario.

"Investigations of texture, structure and other physical properties of reef stone and off-reef facies in the Guelph-Lockport dolomites have led to recognition of properties in certain facies which affect the calcining of stone and the physical properties of the lime produced. Research on these and related subjects continues."

Geological Survey of Canada

A.H. Lang and Y.O. Fortier report on current investigations of mineral deposits by the Geological Survey as follows:

"J.A. Chamberlain continued the study of Canadian

uranium deposits, his field work in 1960 being in the Northwest Territories and Saskatchewan. He spent part of the season at the Eldorado Mine at Great Bear Lake, to obtain information and collections before the permanent closure of this famous mine, which took place later in the year. He is also conducting laboratory work with the collaboration of the Isotopic and Nuclear Geology Section, to investigate the mobility of uranium within small areas of a single specimen. S.M. Roscoe devoted the year to office work on his comprehensive report on the geology and origin of the Elliot Lake (Blind River) uranium deposits.

"G.A. Gross continued his comprehensive study of the geology and origin of Canadian iron deposits, his field work in 1960 being in New Quebec and Labrador. E.R. Rose made a special study of titaniferous deposits in Ontario and Quebec. A preliminary report was published in 1960[1].

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[1] Rose, E.R.; Iron and Titanium in the Morin Anorthosite, Quebec; Geol. Surv., Canada, Paper 60-11, 1960.

"C.R. McLeod continued his study of the geology of placer deposits in the Klondike area—in part to obtain data that will be difficult or impossible to gather in future, after certain mining operations have ceased.

"W.D. McCartney studied Canadian deposits of fluorite and of barium and strontium minerals. He is also investigating the possibility that, in sulphur-poor environments, lead may be incorporated in barite instead of forming galena.

"R. Mulligan studied beryllium deposits in northwestern and central Canada in connection with his comprehensive study of the geology of beryllium deposits and methods of detecting and appraising them. A preliminary report on this project was published in 1960[2].

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[2] Mulligan, Robert: Beryllium Occurrences in Canada; Geol. Surv., Canada, Paper 60-21, 1961.

"A.H. Lang prepared an exhibit of published metallogenic, mineral, and mineral-economics maps for the International Geological Congress. In collaboration with W.D. McCartney he prepared a manuscript map for display, as requested by the subcommittee for a metallogenic map of the world, showing present and former producing mines classified according to principal metals and geological types. In an attempt to determine and illustrate the extent to which data now available permits generalizations on Canadian metallogenic provinces, based on several metals and on small occurrences as

well as productive deposits, Lang collated data from eighteen metallogenic maps for individual metals compiled in previous years by various officers of the Geological Survey of Canada. This has resulted in the publication of three preliminary maps and a preliminary report[1]. One map shows areas containing more than

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[1] Lang, A.H.: Preliminary Study of Canadian Metallogenic Provinces; Geol. Surv., Canada, Paper 60-33, 1961.

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widely-scattered occurrences of seven major metals, a second shows areas of occurrences of ten minor metals, and a third outlines tectonic and other geological provinces and subprovinces so that the degree of correspondence or difference of the metallogenic data can be judged."

Investigations by the geochemistry section of the Geological Survey relating to prospecting or ore genesis are reported on by R.W. Boyle as follows:

"During 1960 research in geochemical prospecting was carried out in two field areas: one over a broad terrain in northern Ontario, and the other over a more restricted area in southeastern New Brunswick. Three field parties carried out geochemical field work, one on the geochemistry of the lead-zinc-copper deposits of Bathurst, New Brunswick, another on the geochemistry of pegmatites in Northwest Territories and northern Manitoba, and a third collected samples from the Lower Cretaceous sediments of Alberta for geochemical study. In addition, laboratory research continued on the chemistry of ore genesis, isotope geochemistry, geochemical prospecting and sedimentary geochemistry.

"The geochemical reconnaissance of southeastern New Brunswick by A.Y. Smith continued. Stream sediments, bedrock, and natural stream and spring waters were sampled. Field work was completed on the "red-bed" copper deposits of New Brunswick and Nova Scotia and laboratory studies are under way.

"R.W. Boyle continued field work on the geochemistry of the zinc-lead-copper deposits of the Bathurst area, New Brunswick. In addition he supervised (1) mapping and sampling of the Drummond Iron Pit by J.L. Davies; (2) geochemical and geological study of the gossans of the Bathurst-Newcastle area by I.D. MacGregor; and (3) the mapping and rock and ore sampling by C.H. Smallwood of an 86-square mile area centred on the Brunswick No. 6 orebody and the Austin Brook iron deposits.

"E. Presant collected some 350 soil samples from 80 localities within 40 miles of Bathurst—some from zones directly over known orebodies. Studies of these are under way.

"R. Kretz studied the geochemistry of certain pegmatite bodies in Northwest Territories, northern Manitoba, and in the Grenville region of Ontario and Quebec. The studies involve a preliminary investigation of the source of the elements in the pegmatites, and the chemical and thermodynamic relationships of elements in the pegmatites and their enclosing country rocks. Structural studies with regard to the emplacement of the pegmatites were also carried out in the Yellowknife area.

"R.H.C. Holman commenced a large-scale geochemical reconnaissance in northwestern Ontario to investigate the possibility of establishing regional geochemical provinces for various elements and thereby direct prospectors to areas of higher than average metal content.

"New equipment, techniques, and methods for both field and laboratory are being developed and tested."

Miscellaneous

Five Sections of the 21st. International Geological Congress which met in Copenhagen during 1960 were concerned with mineral deposits. About ten per cent of the papers presented in these Sections were of Canadian origin.

	Papers	
	Total	Canadian
Geochemical cycles	15	1
Geological results of applied geochemistry and geophysics	21	4
Genetic problems of uranium and thorium deposits	16	0
Genetic problems of ores	24	2
Minerals and genesis of pegmatites	13	2
	89	9

Of the papers published in Economic Geology in 1960 (Vol. 55), about 15 per cent report on studies of Canadian mineral deposits. Although not directly concerned with Canadian deposits the following four useful reviews or basic studies in the same volume warrant mention:

J.L. Gillson: Intriguing Examples of Geology Applied to Industrial Minerals; pp. 629-644.

G.W. Bain: Patterns to Ores in Layered Rocks; pp. 695-731.

Reno Sales: Critical Remarks on the Genesis of Ore as Applied to Future Mineral Exploration; pp. 805-817.

J.H. Rattigan: Residual Characteristics of Crystallates Genetically Associated with Ore Deposits; pp. 1272-1284.

PART II — RECOMMENDATIONS FOR FURTHER RESEARCH

A joint submission from several Toronto members of the Subcommittee includes the following suggestions:

(1) Since certain gold mines in the Porcupine-Kirkland Lake districts may soon close, inquiry should be made now to see if some comprehensive research program is warranted and feasible. The camps are in close proximity, show both similarities and significant differences, include some of the deepest and richest mines known, and offer an unique opportunity for comparative study—perhaps focussed on their truly remarkable vertical range of ore persistence.

(2) Canada's rapidly expanding oceanographic projects should include studies of possible ore-forming processes operative at and near the water-land interface. Marine tidal beaches must surely be marked by much chemical activity and brackish and fresh-water shores only slightly less so, but data are scanty.

(3) Useful new ideas and approaches might arise from small discussion groups (one at each university ?) composed of one or two representatives of various sciences—geology, chemistry, metallurgy, etc. —in an effort to break down barriers between their respective specialties. "Some mighty orebodies often occur at the contacts of two different rock types, maybe the same is true of two different sciences!"

(4) "Much concern is constantly voiced about the advantages of post-graduate foreign study for students. What about the same advantages for the professors? We feel that a portion of the funds that our Advisory Committee distributes could advantageously be allocated to university staff, survey personnel, practising professional geologists, etc., who apply with a promising proposal which they have the competence to follow up."

D.F. Hewitt, reporting on industrial minerals, suggests the following:

(5) "A continuing study of evaporite facies offers good research posibilities.

(6) "Some cherts are relatively inert (in concrete) and others are extremely reactive; research is needed as the fundamental properties of chert.

(7) "Investigations of the clay and shale deposits of Canada have been limited....they offer a fruitful field for research which can have important results for the ceramic and building industries."

Finally, the Chairman reiterates two recommendations that have appeared in many previous reports:

(8) The preparation of review papers should be encouraged by every possible means.

(9) A great deal more basic research into the formation of mineral deposits is needed.

These two recommendations are commented upon below, in PART III, where, also, some reasons are put forward for the tenth and final recommendation:

(10) Since mineral deposits that are being mined constitute by far the best-sampled parts of the earth's crust, and since analytical methods are being steadily improved, representative samples for each operating mine (one for each year's millheads ?) should be collected and preserved.

PART III — GENERAL REMARKS

A review of the hundred-odd projects listed under Mineral Deposits in the Survey of Current Research (Pt. II, p. 40) suggests a slight imbalance. This is of small consequence. Certain parts of the periodic table (nickel, gold, uranium) will always be of particular interest to Canadians, just as some ore-forming processes, such as laterization, are more appropriately studied elsewhere than Canada. The fact that certain topics have kept reappearing over the past ten years (sometimes under slightly different titles and occasionally at different research institutions) seems likewise of little consequence. In geological research, mineral deposits constitute a singularly ill-defined field—overlapped in part by mineralogy, structural geology, and geochemistry and sharing all the processes of general geology. Almost any investigation in the whole geoscience field may have some bearing on mineral deposits. Since scientific progress does not occur in any neat and predictable fashion and since there is no way of telling which of several projects is likely to yield the most important results, neither lack of balance or duplications should give rise to concern.

The high proportion of Canadian papers published in 1960 by the International Geological Congress (10 per cent of all papers on mineral deposits) and by Economic Geology (15 per cent of all papers) is surprising and significant. It seems to indicate that Canadian geologists are both exceptionally active in the field of mineral deposits and prolific in their writings.

Many of this Subcommittee's reports over the past ten years have referred to one of the most formidable of all tasks facing the modern scientist or engineer—that of trying to keep abreast of developments in his field of interest. This is difficult even within a narrow specialty; it becomes quite impossible in any such broad field as that of mineral deposits. Review type papers have been suggested as a partial answer to this problem, but few senior economic geologists have shown any enthusiasm for embarking on their preparation, nor is this the sort of project that can be turned over to a graduate student. Meanwhile, the flow of new data—including much that is unpublished, poorly evaluated, and ill-digested—steadily engulfs us. The powerful new analytical tools, new techniques and methods of research, even the trend of linking graduate study closely with research, all contribute to the deluge. While no one would suggest a moratorium on the production of new data, a major shift in emphasis seems required—much more work must be done on the review and analysis of this data. Some way must be found to enlist the services of senior experienced economic geologists in this task. Are there any research funds available for secretarial aid and financial assistance to retired government, university, or mining geologists who might undertake such studies? The reward would lie in the nature of the work itself—with the chance of finding meaningful repetitive patterns in a mass of unorganized information, or of establishing an important new principle.

REPORT OF THE SUBCOMMITTEE ON

MINERALOGY, GEOCHEMISTRY AND PETROLOGY

Presented by R.E. Folinsbee

Members of the Subcommittee

R.E. Folinsbee (Chairman)	- University of Alberta, Edmonton, Alberta.
L.C. Coleman	- University of Saskatchewan, Saskatoon, Saskatchewan.
R.F. Cormier	- St. Francis Xavier University, Antigonish, Nova Scotia.
R.B. Ferguson	- University of Manitoba, Winnipeg, Manitoba.
A.W. Jolliffe	- Queen's University, Kingston, Ontario.
J.A. Maxwell	- Geological Survey of Canada, Ottawa, Ontario.
S.C. Robinson	- Geological Survey of Canada, Ottawa, Ontario.
D.M. Shaw	- McMaster University, Hamilton, Ontario.
F.G. Smith	- University of Toronto, Toronto, Ontario.
R.M. Thompson	- University of British Columbia, Vancouver, British Columbia.

INTRODUCTION

From the number of research problems under investigation across the nation, in the fields of mineralogy, geochemistry, and petrology, one gathers that these branches of geology are flourishing. The investigations are using major pieces of capital equipment supplied by solid support through the fortunate fifties from a nation that has become increasingly aware of the part that research plays in the development of its natural resources. The Federal government through the National Research Council and the Geological Survey of Canada; Provincial governments through grants to universities; and interested industries; all have gone far in providing the basic tools for modern research and, perhaps more important, have nurtured the spirit of inquiry without which there would be no significant advance in the fields of science.

Ten annual reports of this committee have gone out. One would like to say that each was an improvement on its predecessor, but

this is not necessarily so; after a decade a project should be critically reappraised lest it become decadent. As a document which puts a finger on the pulse of geological research, the National Advisory Committee report has proven of great value. As a contributor to the analysis of research problems and pressures, the writer finds himself at times at diastolic ebb. To borrow a phrase from Dr. Shaw's letter of February 24, 1961, "Thank you for the invitation to contribute my yearly groan to your Committee. For once I find nothing to criticize beyond the topics I have previously covered...."

The Chairman this year has relied very heavily on the interesting letters he has received from the Subcommittee members. With some minor editing they constitute the main body of this report, as we sweep from west to eastern sea through the realms of Hutton, Werner, and Goldschmidt.

CURRENT RESEARCH

British Columbia

Drs. R.M. Thompson and H.V. Warren, University of British Columbia, list the current research in the Department of Geology at Vancouver, with comments on geochemical aspects. One might add that a very interesting contribution to geochemistry is being made by R.D. Russell[1] of the Department of Physics with his

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[1] Stanton, R.L. and R.D. Russell, 1959, Anomalous leads and the emplacement of lead sulfide ores: Economic Geology, vol. 54, pp. 588-607.

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investigation of lead isotopes in ores.

Dr. Thompson lists the following projects underway in the Department of Geology:

Drummond, A.D., The geology of the Alice molybdenum prospect, Skeena Mining Division, Alice Arm, B.C. (M.A.Sc. thesis).

MacDonald, A., The geology and mineralogy of the Hector and Calumet mines, Yukon Territory (M.Sc. thesis).

Montgomery, J.H., The structure, petrology, and origin of the Copper Mountain stock, Princeton, B.C. (Ph.D. thesis).

Northcote, K.E., Distribution of Cu, Zn, Pb, Mo, Fe, S in the sediments of Mud Bay, Crescent Beach, B.C. (M.Sc. thesis).

Sinclair, A.J., A study of lead isotopes in mineralization in the Kootenay arc (Ph.D. thesis).

Smith, C., The stratigraphy and petrology of the Pennsylvanian of northwest Washington (M.Sc. thesis).

Stanley, A.D., Laboratory deformation of ice crystals and correlation with crystal fabrics of glacier ice (Ph.D. thesis).

Mathews, W.H., Isotope age determinations of Cenozoic rocks of British Columbia.

Thompson, R.M., Pyrosynthesis of Pb, Bi, Cu, S minerals.

McTaggart, K.C. and Thompson, R.M., Geology of the Skagit River area, B.C. (A limited amount of field work remains; publication this year).

Dr. Warren reports as follows:

"In biogeochemical prospecting we have been extending our data on anomalous vegetation to other Canadian provinces and England. The work by Holman[1] on

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[1] Geol. Surv., Canada; Maps 29-1959, 26-1959, 27-1959 and 33-1959.

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sediments in Nova Scotia has been followed up by soil and vegetal sampling and close correlations have been obtained.

"In lithogeochemistry, a study of the Cu, Zn, Mo, and Pb contents of some Ontario limestones, supplied by D.F. Hewitt, Ontario Department of Mines, has shown significant variations in the various limestones in south-western Ontario. These variations have tentatively been correlated with similar variations in soils, and foods grown on these soils.

"Much work has been done on the lead content of rocks, soils, and vegetable matter, including some foods. Higher than normal amounts of lead have been found in some foods and in some instances this lead has been introduced by exhaust fumes of automobiles using gasoline containing tetraethyl lead."

Alberta

At the University of Alberta, first major results of a program in potassium-argon age determination conducted cooperatively by the Departments of Geology and Physics are now in print or press. The National Advisory Committee, who supported this research, will be interested in the following list of current papers:

Folinsbee, R.E., H. Baadsgaard, and J. Lipson, Potassium-argon Time Scale: International Geological Congress, XXI Session, 1960, Copenhagen, Pt. 3, pp. 7-17.

Baadsgaard, H., R.E. Folinsbee, and J. Lipson, Potassium-argon Dates of Biotites from Cordilleran Granites; Geol. Soc. America, vol. 72, No. 5, May 1961, pp. 689-702.

Folinsbee, R.E., H. Baadsgaard, and J. Lipson, Potassium-argon dates of Upper Cretaceous Ash Falls, Alberta, Canada: Annals New York Acad. Sciences, vol. 91, art. 2, Geochronology of Rock Systems, pt. III, The Phanerozoic Time Scale, pp. 352-363, 1961.

Lipson, J., R.E. Folinsbee, and H. Baadsgaard, Periods of Orogeny in Western Canada; Annals New York Acad. Sciences, vol. 91, art. 2, Geochronology of Rock Systems, pt. IV, The Age of the Basement Rocks of the World: North America, pp. 459-463, 1961.

Byström-Asklund, A.M., H. Baadsgaard, R.E. Folinsbee, K/Ar age of biotite, sanidine, and illite from Middle Ordovician bentonites at Kinnekulle, Sweden; Geol. Fören. Förh. (in press).

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Burwash, R.A., and H. Baadsgaard, Yellowknife-Nonacho age and structural relations: presented at Royal Society of Canada meeting in Montreal, June 1961.

At the Research Council of Alberta, with a very strong group in hydrology, members are studying the chemistry of ground waters of Alberta; Dr. Godfrey is investigating the stable hydrogen isotopes in hydrous silicate minerals; and Dr. Gorden Hodgson is in charge of a program in petroleum geochemistry that has produced some significant results[1].

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[1] Baker, Bruce L. and Gordon W. Hodson: Geochemical Significance of Nickel Complex of Pheophytin (Abstract), Bull. Amer. Assoc. Petroleum Geologists, vol. 44, No. 7, July 1960, p. 1245.

Saskatchewan

Dr. L.C. Coleman of the Department of Geology at University of Saskatchewan has submitted the following interesting report on mineralogical, geochemical, and petrological investigations in Saskatchewan, including several suggestions that merit attention:

"Mineralogical work being carried out in the Department of Geology at the University of Saskatchewan and the Geological Division of the Saskatchewan Research Council includes studies of rock-forming silicates and of sulphides.

"Dr. J.R. Smith of the Saskatchewan Research Council is continuing studies on the determinative properties and stability ranges of plutonic feldspars, particularly the Moir Lake granodiorite.

"Dr. L.C. Coleman of the Department of Geology is conducting an investigation of the relations of unit cell dimensions and optical properties of synthetic monoclinic pyroxenes to their chemical compositions.

"Dr. R.G. Arnold is continuing studies on the relationship of the composition of pyrrhotites to conditions of formation.

"Drs. Smith and Arnold are testing the feasibility of relating ore deposits to the distribution of ore metals (Cu, Pb, Zn, Ni, Ca) in Precambrian rocks of western Saskatchewan.

"E.L. Faulkner, a Ph.D. candidate in the Department of Geology, is studying trace metals in the ores of the Coronation Mine which is part of a comprehensive project being coordinated by the Geological Survey of Canada.

"Two of the needs felt most strongly at University of Saskatchewan, of which the National Advisory Committee should be advised, pertain to library facilities and visiting lecturers.

"Library facilities for research in mineralogy, geochemistry, and petrology are by no means adequate. This situation probably holds true at other western universities. The National Advisory Committee could provide real aid to research by obtaining some support for the expansion of library facilities. Some coordination could be achieved to avoid duplication of the rarer journals within the western group.

"The need for more visiting lecturers is a crying one. The stimulation of research by personal interchange is well established. At this campus we feel a sore need for visits from fellow geologists and feel that undoubtedly this is true for our colleagues at the other western universities. We feel the National Advisory Committee could greatly stimulate research by instituting and promoting a program for visiting lecturers."

Manitoba

From the University of Manitoba Dr. R.B. Ferguson gives details of some of the coordinated research projects going on in his department, and the application of laboratory studies to the solution of field problems.

"In the field of petrology Dr. H.D.B. Wilson is supervising three projects by graduate students on the Nelson River gneiss zone in the Moak Lake region of northern Manitoba. The Nelson River gneiss zone is the boundary, about 30 miles wide, between the Churchill block to the north and the Superior block to the south. J.M. Patterson is working on the gneissic rocks of the boundary zone itself; G.D. Pollock is working on the rocks to the north (in the Churchill block); and D.H. Rousell is working on the rocks to the south in the Superior block, and on some of the southernmost gneissic rocks of the boundary. These students are studying the metamorphism, sedimentation, and structure of the rocks to determine the nature of the boundary. The studies form part of an overall investigation by Dr. Wilson and he and W.C. Brisbin are making a geophysical study of the area as well.

"In the field of mineralogy two students are carrying out projects under my direction. L.T. Trembath is studying the potassium feldspars in 60 or so rocks from the Nelson River gneiss zone to see if a relation can be found between the nature of the potassium feldspar (orthoclase to maximum microcline) and the ratio of potassium feldspar to plagioclase feldspar in the rock. That such a relation should exist has been suggested by the crystal structure work that we and others have done on the feldspars. Norma A. Tweedy is studying mainly by the X-ray powder method, the pegmatitic minerals in the Winnipeg River area of southeastern Manitoba."

Ontario

From the University of Toronto, F. Gordon Smith tells of his forthcoming book on physical geochemistry, and plans for improving facilities for chemical analyses of minerals at the University of Toronto. He summarizes current research projects with which he is concerned, as follows:

"A study by G.M. Anderson of the solubility of lead sulphide in H_2S-saturated water from room temperature to 90°C is completed. It appears that the solubility of sulphides of the B-group metals, due to forming complexes in H_2S-H_2O systems, is large enough to be significant, especially at elevated temperatures and pressures.

"A study of the partition of rare earth elements between hydrous silicate melts and aqueous solutions at equilibrium, is being carried out by H. Pollak. The results may be useful in developing theories of the relationship between pegmatites and hydrothermal veins.

"A study of the partition of selected minor components between two or more minerals in equilibrium has been started by F.G. Smith. Many useful geothermometers and geobarometers could be developed by combining careful synthesis and accurate analysis of minerals which crystallized together.

"A study of the decrepitation of metamorphic minerals during heating is being carried out by W.W. Hutchison.

"J.N.E. Weber is making a study of the natural variation of composition and structure of carbonate minerals in carbonate rocks. Spectrographic data is being obtained in Dr. Shaw's laboratory at McMaster University. The substantial mass of data on composition, growth stacking disorder, mosaicness, etc., is being processed by the digital computer at Toronto."

Dr. W.W. Moorhouse summarizes current petrological and mineralogical research at the University of Toronto as follows:

"Graduate and staff research in petrology was carried out in a number of fields during the past session. Lithium-bearing pegmatites east of Lake Nipigon are the subject of an intensive mineralogical study by V.G. Milne. H. Williams during the year completed a study, under the auspices of the Geological Survey, of the Chisel Lake area in Manitoba, resulting in some interesting conclusions regarding the origin of the "quartz eye" granite in that area. Molybdenite mineralization has been the subject of investigation by F.D. Gill (in gneisses) and R.E. Robinson (in pegmatites). The petrography of base-metal veins is the theme of a master's thesis by D.L. Cooke. Granites and gneisses have been studied in a regional way by R.A. Alcock and D.P. Rogers. I have been working principally on the mineralogy and textures of iron formations, in particular the Gunflint.

"In the coming year, the iron formation study will be continued. A study of Timiskaming and Keewatin rocks in northeaster Ontario, correlated with age determinations (with the cooperation of the Geophysics group in this University) will be initiated in the fall. Aspects of the geochemistry of molybdenum will be investigated by Prof. P.A. Peach and J.R. Renault. John Gittins will be with us next year, and will continue his work on nepheline syenites, and organize a chemical analysis laboratory in the department.

"Dr. Nuffield and his assistants have been concentrating on the standardization of the fluorescence X-ray spectrograph for rock analysis, and will continue this project in the 1961-62 session. X-ray investigation of ore minerals will also be continued by Dr. Nuffield and Mr. D.C. Harris.

"Drs. Wilson and Farquhar continue their significant contributions in geophysics with some particularly interesting results on the origin of the Blind River uranium ores[1]."

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[1] Journal of Geophysical Research, January 1960.

At Queen's University Dr. L.G. Berry continues his mineralogical research and Dr. J.E. Hawley and associates their massive study of granitic rocks. Dr. Jolliffe continues his research on element associations in ore deposits and their significance.

At the University of Western Ontario Dr. Kramer is continuing his studies of the chemistry of Lake Erie, and his significant work on carbonate and sulphate minerals at low temperatures.

At Carleton University Dr. Tupper is investigating the distribution of sulphur isotopes in nature, particularly in their application to processes of sulphide genesis in sulphide ores. The influence of Dr. Thode of McMaster University, pioneer in isotopic studies of geologic application, might be detected here.

Dr. D.M. Shaw reports on activities at McMaster University as follows:

> "We have a group of graduate students doing trace element studies under my direction on various problems. These include studies of apatite, of phlogopite, of local shales and of amphibolites. In addition, two trace-element studies on ultrabasic rocks and a suite of alkalic lavas form part of broader petrological studies. Broadly speaking the aims of all these projects are either to enquire into the manner of trace element occurrence in minerals, or to try to use trace elements as criteria for the environments of origin of rocks.
>
> "Dr. B.J. Burley has a graduate group studying feldspathoid and zeolite crystal chemistry and stability relations, using hydrothermal synthesis techniques and and X-ray diffraction. It is also hoped for the future to apply this approach to experimental studies on trace element distribution.
>
> "With Dr. R.E. Jones interested in sulphide geochemistry and Dr. T.N. Irvine studying the petrology of ultrabasic rocks, we have a fairly good staff coverage of most branches of the petrological-geochemical fields. I should add that Dr. G.V. Middleton's sedimentological researches are in part collaborative geochemical studies, and his contributions are also considerable in the development and application of statistical methods.
>
> "We have recently established, with the aid of a National Research Council grant, a rock analysis laboratory using "rapid methods". This is essentially a research service laboratory for those of us whose researches require silicate rock analysis. Our analyst received a training period with Dr. J.A. Maxwell of the Geological Survey of Canada; the laboratory has just begun to operate.
>
> "In view of the availability of a reactor on the campus it has been apparent to me for several years that a nuclear geologist would form a welcome addition to our staff and fit in well with both the geology and chemistry programs. The appointment of J.H. Crocket for the 1961-62 session, who has experience in both field geology and in neutron

activation analysis (with Smales at Harwell) promises some interesting research developments in the future.

"Dr. Thode and his associates in the Chemistry Department continue the isotope studies for which they are so well known, and which constitute a large part of geochemistry today."

The Geological Survey of Canada continues its major contributions in the fields of mineralogy, geochemistry and petrology. All geologists in Canada will be glad to learn of the progress in compiling data on Canadian rocks, reported by Dr. Maxwell as follows:

"The manuscript for the first phase of this compilation project, that of finding, extracting, coding and compiling chemical analyses of Canadian rocks, minerals and ores originally published by the Geological Survey, has been completed and is now being checked before submitting it for publication.

"The material included in the compilation is for the 110-year period of Survey activity from 1845-1955. Some 1310 analyses are listed in the compilation manuscript but, since many analyses have more than one part, the final total is nearer to 1600. Related geological, geographical and other data are included with each analysis, and there are also a specimen name index, geographic index, and bibliography...."

Dr. S.C. Robinson writes:

"After your very generous references to the Geological Survey in last year's report of the Subcommittee on Petrology, Geochemistry and Mineralogy, I am not sure that we are entitled to much space this year. However, there are a number of changes and results that you may feel are worth recording...."

He goes on in such an interesting fashion that little can be edited from his report, and it is here given essentially as submitted.

"In Isotope and Nuclear Geology, the new solid source, 90-degree, 10-inch mass spectrometer fitted with an electron multiplier was put into service on a study of variations in ratios of magnesium isotopes. Raw materials for this study included virtually the whole range of geological materials from meteorites and ultrabasic rocks to sediments, sea water, and last year's vegetation. Results to date indicate that although reproducibility is difficult to achieve, there is a real and systematic variation in the Mg^{24}/Mg^{26} ratio.

"A new gas source mass spectrometer to have a resolution of 1 mass unit in 100 is now under construction. It is to be used primarily for argon analyses.

"In 1960 a total of 150 new potassium-argon age determinations were made. These are compiled in a

second annual report[1].

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[1] Age Determinations by the Geological Survey of Canada, compiled by J.A. Lowdon, Geol. Surv., Canada, Paper 61-17, 1961.

"The new radiocarbon laboratory was put into operation in January 1961 and has already produced dates that check well with those determined by other laboratories on the same samples.

"A new vacuum X-ray Spectrograph has been installed and has proved to be most valuable in extending the sensitivity of analyses for many elements, down to magnesium (No. 12), in the periodic table."

In petrology, important progress has been made in studies of granites in Canada (J.E. Reesor) and of ultrabasic rocks in Canada (C.H. Smith). Dr. Reesor reports as follows:

"The study of granites in Canada has included an area in southeastern British Columbia and the Anstruther batholith in eastern Ontario. Work has been largely concentrated toward understanding the tectonic and petrologic development of gneissic and granitic rocks in part of a well defined mountain belt in southern British Columbia. This mountain belt consists of a region of granitic gneisses, migmatites, and high grade metamorphic rocks (Shuswap terrain) along its western limits in southern Selkirk and Monashee Mountains and of discrete, post-tectonic granitic plutons along its eastern limits in Purcell and northern Selkirk Mountains. Work to date consists of detailed mapping in a number of critical localities by J.E. Reesor and three Ph.D. students.

"K.R. Dawson has commenced work on a deep-seated batholith in the Grenville of eastern Ontario. It is expected that a gravity survey of the batholith will be made by the Dominion Observatory as part of this study.

"The study of ultrabasic rocks has now been in progress for four years. Dr. Smith reports as follows:

"The objective of the Canadian ultrabasic rock study is to develop general interpretations on the origin, tectonic and economic significance of ultrabasic bodies based upon detailed mineralogical, petrographic, and chemical studies. Because of the widespread occurrences of the intrusions, certain areas have been chosen as "bench marks" to be studied in detail. Those currently under study include the Bay of Islands complex, Newfoundland (Smith, G.S.C. Memoir 290, 1958), Mount Albert, Gaspé (Smith and MacGregor, Bull G.S.A., Dec. 1960, p. 1978, Muskox complex, Coppermine River area, N.W.T. (Smith, in press), the Tulameen complex, B.C.

(Findlay, D.C., Ph.D. study, Queen's University). These studies deal with the primary features of ultrabasic intrusions and at a later date studies of serpentinization and asbestos deposits will be undertaken. The data will then be combined with that from reconnaissance and literature studies of other ultrabasic intrusions in Canada as a basis for more general syntheses.

"Laboratory studies, apart from those directly related to the above field work, also include a study of magnesium isotopes and their possible application to ultrabasic studies (Wanless, Smith, Loveridge, Maxwell), a study of the platinum group content of ultrabasic rocks and associated mineral deposits (in association with the Mines Branch), and a study of pyroxenes (MacGregor, I.D., Ph.D. thesis, Princeton University).

"The work to date has served to indicate the general lack of, and need for, quantitative data on igneous rock, and also the slow, tedious and not too precise methods currently available for supplying this data. Despite the great amount of information and interpretation that has been accumulated in igneous petrology, work on igneous intrusions is still very much at the reconnaissance level and in need of tuning up in order to provide the proper quantitative data necessary to develop fundamental theories that are statistically sound.

"K.R. Dawson and others published the first description of the Abee meteorite in December, 1960[1]. He is

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[1] Geochim. et Cosmochim. Acta, 1960, vol. 21, pp. 127-144.

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currently working on the Holman Island and Benton falls.

Mineralogical Projects include;

"(1) Compilation of data on Canadian minerals (R.J. Traill).

"The major task of extracting pertinent data from geological literature covering the period from 1915 to 1960 was completed in 1960. All data have been recorded in card files and analytical data rechecked with the original references. A considerable amount of reliable unpublished information provided by members of the Mineralogical Association of Canada and extracted from G.S.C. laboratory records has been incorporated. A start has been made on preparation of the manuscript for publication.

"(2) Studies of micas (J. Rimsaite).

"Good progress is being made on an extensive study of micas and mica-bearing rocks in conjunction with potassium-argon age determination studies.

"(3) Catalogue of X-ray diffraction patterns (A.P. Sabina and R.J. Traill).

"A catalogue of X-ray diffraction patterns and specimen mounts on file at the Geological Survey of Canada up to April 1, 1959, was published as Geol. Surv., Canada Paper 60-4.

"(4) X-ray spectrographic analysis of minerals and rocks (G.R. Lachance).

"The facilities of X-ray spectrography were expanded in 1960 with the installation of a Philips Universal Vacuum X-ray Spectrograph....

"(5) X-ray diffraction studies.

"Preliminary studies were made on the application of X-ray diffraction determinative schemes for olivines, pyroxenes and feldspars to the study of compositional variations within ultrabasic bodies....

"(6) Geological Survey collections of minerals and ores.

"Mr. H.R. Steacy joined the Mineralogy Section in 1960 as curator of the collections of minerals and ores. These extensive collections are now housed in a single building and are being re-catalogued and prepared for active use...

"In geochemistry the radiochemistry laboratory under Dr. R.A. Washington is now functioning. As part of the 'Roads to Resources' geological mapping program for a large area in northwestern Ontario, more than 10,000 rock samples were collected and analyzed for a number of trace elements. The results are not yet correlated."

Quebec

Dr. J.E. Gill of McGill University reported to the International Geological Congress on some interesting solid diffusion studies on sulphides[1]. This is part of a major study by Drs. Gill, Kranck and Saull on silicate and sulphide phase relationships of great mineralogic and geochemical significance.

[1] Gill, J.E., 1960, Solid diffusion of sulphides and ore formation: Rept. 21st. International Geol. Congress, Norden, Part 16, Genetic Problems of Ores, pp. 209-217.

At the Ecole Polytechnique Professor Perrault is studying the mineralogy of the Oka alkaline intrusions.

Dr. F.F. Osborne reports the following graduate student thesis projects underway at Laval University:

M.Sc. thesis projects

(1) L. Kiss is studying coronas developed in troctolites and gabbros in the cyanite grade and comparing the mineralogy with some coronas that have been metasomatized.

(2) A.Gagnon is working on the average composition of rocks of a region northwest of Abitibi using analyses of local clays and silts and thin sections collected from bedrock.

(3) N. Blouin is comparing the compositions of gneisses occurring in a belt southeast of the Keewatin-Timiskaming subprovince in Quebec.

D.Sc. thesis projects

(1) L. Robert is working on the structure and petrology of the gneisses of a part of the Grenville subprovince west of Témiscamingue Lake.

(2) P. St-Julien is studying the stratigraphy, structure, and petrology of an area near Magog, Quebec.

(3) G. Duquette has mapped, on a scale of 500 ft. to an in., the area about two new copper-zinc orebodies near Weedon and has made petrographic studies of pre- and post-Taconic metamorphic rocks and Taconic and Acadian intrusive rocks. An M.Sc. candidate, J. Lacasse, is making a petrographic study of the country rock and the alteration minerals. An undergraduate thesis is being prepared on the ore minerals.

Maritimes

Dr. R.F. Cormier, St. Francis Xavier University, reports on activities in petrology, mineralogy, and geochemistry at the Maritime universities as follows:

Active research in the fields of mineralogy, petrology, and geochemistry in the Maritime Provinces is being carried out primarily at the University of New Brunswick, Dalhousie University, and Saint Francis Xavier University, Nova Scotia.

At the University of New Brunswick, the work falls into two categories:

a. petrological investigations of intrusive rocks of economic significance based primarily on field work and thin section studies.

b. trace element studies of selected minerals from intrusive rock masses and based largely on field work and emission spectrographic analyses. For example, considerable work along these lines has been done on the plagioclase feldspars and the pyroxenes of the nickel bearing gabbros of the St. Stephen, New Brunswick area.

At Dalhousie University, in the near future, a study of the zeolites contained in the Triassic trap-rocks of North Mountain, Nova Scotia will be undertaken. At the same time, it is hoped that an investigation of the alteration products, particularly the clay minerals, contained in recent sediments will be initiated.

At St. Francis Xavier University, petrofabric studies of sphalerite-bearing, crystalline limestones of the George River group have been begun by B.J. Keating. Detailed analyses of the crystallographic orientation of the carbonate minerals will be made and possible techniques for orientation studies of the contained sphalerite will be studied. R.F. Cormier is setting up a mass-spectrometer (12" radius) for the measurement of isotope abundances and for isotope dilution analyses. Work on this instrument will be largely directed towards the absolute dating of sedimentary rocks. Initially, this will entail the Rb-Sr dating of glauconites, volcanic rocks, etc. Eventually it is intended that ages based upon the uranium decays and potassium-40 decay will also be measured. Facilities for the separation of pure mineral samples and for their chemical treatment prior to mass spectrometric analysis have been set up and are in operation.

With regard to his own work on rubidium-strontium dating, Dr. Cormier writes:

> "....my machine is still in the process of construction. If it is operating by next fall, I shall be happy. These things move very slowly here since facilities for instrument-making are practically nil and everything must be farmed out."

This bears on the problem of technicians that Dr. Shaw discussed in the Tenth Annual Report of the National Advisory Committee[1].

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[1] National Advisory Committee on Research in the Geological Sciences. Tenth Annual Report, 1969-60, p. 43.

CONCLUDING SUGGESTIONS

Dr. J.M. Harrison, in an account of his recent visit to geological establishments in the U.S.S.R., touches on a controversial problem, particularly to workers in geochemistry, when he comments that at one lecture he was asked through an interpreter why Canadians published all their good papers in United States publications. He did not know if his answer satisfied the Russians; it did not quite satisfy him. Is this not a topic that should be discussed and reported on by this Committee.

Dr. Robinson suggests calendar year coverage for the annual reports as reasonable, in view of the March submission date for subcommittee reports.

REPORT OF THE SUBCOMMITTEE ON STRATIGRAPHY, PALAEONTOLOGY, AND FOSSIL FUELS

Presented by F.H. Edmunds

Members of Subcommittee

F.H. Edmunds (Chairman)	- University of Saskatchewan, Saskatoon, Saskatchewan.
F.W. Beales	- University of Toronto, Toronto, Ontario.
J. Beland	- Department of Natural Resources, Quebec, Quebec.
J.F. Caley	- Geological Survey of Canada, Ottawa, Ontario.
S.J. Nelson	- University of Alberta, Edmonton, Alberta.
V.J. Okulitch	- University of British Columbia, Vancouver, British Columbia.
C.G. Winder	- University of Western Ontario, London, Ontario.

CURRENT RESEARCH

The number of research projects in stratigraphy, palaeontology and fossil fuels has increased considerably in the past year. In 1959-60, 120 projects were reported; this year the survey of current research (Pt. II, p. 97) lists about 188 projects. A classification of the projects follows:

Category	Number of Projects
Stratigraphy and Palaeontology	148
Sedimentary petrology and sedimentation	31
Petroleum	6
Coal	3
Total	188

These research projects are being carried out by the Geological Survey of Canada, by various provincial research councils, departments of mines and resources, and by university staff members and graduate students. A listing of the organizations in which this work

is being done, with corresponding data for 1959-60, follows:

Organization	Number of Projects 1960-61		1959-60	
Geological Survey	60		26	
National Museum	5		-	
Provincial Departments	20		20	
Universities Staff	46		40	
Ph.D. Candidates	13	103	9	74
Master Candidates	44		25	
Total	188		120	

The increase is substantial, particularly in the work being done at the universities, a result in part, of an increase in the number of graduate students. The increase in number of projects reported by the Geological Survey and National Museum is due in part to the listing of projects for the first time that have been in progress previously.

Stratigraphy

To indicate the scope of current stratigraphic studies, one hundred and forty-five projects listed under Stratigraphy and Palaeontology (Pt. II, p. 97) have been classified according to areal distribution and stratigraphic range (Table I). This table gives an indication of the interest being taken in the geology of a particular province but is not necessarily a measure of the volume or profundity of that interest because the extent and substance of individual projects are not equal. Eighty-nine of the studies deal with the geology of Western Canada; thirty with Eastern Canada; fifteen with the Northwest Territories and the Arctic; and eleven are classified as general. The last include projects such as the preparation of a 'Lexicon of Stratigraphic Names used in Canada' by T.E. Bolton and F.J.F. Wagner, and the 'Study of the Geological Survey Collection of Fossil Insects' by H.M.A. Rice which involves organization, arrangement and consideration of their stratigraphic significance.

Precambrian

Precambrian correlation in the northwest Canadian Shield is being studied by J.C. McGlynn, Geological Survey of Canada. At the University of Alberta the 'Structure and Stratigraphy of Precambrian Rocks in the Rocky Mountains' is being studied by H.A.K. Charlesworth et al.; R.A. Burwash et al. continues the study of the 'Subsurface Precambrian of Western Canada'.

Lower Palaeozoic

Studies of Lower Palaeozoic strata are about equally divided between Eastern and Western Canada, the Ordovician receiving slightly more attention in the west and the Silurian in the east. A general study of 'Cambrian Trilobites and Cambrian Stratigraphy' is underway by J.W. Kerr, Queen's University and J.E. Brindle, Saskatchewan Department of Mineral Resources, is studying 'Faunas of the Winnipeg and Deadwood Formations in the Subsurface of Saskatchewan'. The Deadwood and Winnipeg formations range from Upper Cambrian to Ordovician. In Eastern Canada H.D. Lilley, Memorial University of Newfoundland is studying Cambrian and Ordovician sediments between Bonne Bay and Humber River, Newfoundland; studies of Ordovician and Silurian strata by several graduate students at McGill University are in

TABLE I

Distribution of Research in Stratigraphy and Palaeontology

	N.W.T.	Arctic Islands	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.S.	N.B.	Nfld.	Canada General	West	East	Total
Tertiary			7										2		9
Cretaceous			1	13	10								3		27
Jurassic	1	2	1									1	2		7
Triassic			6												6
Permian	1		1												2
Carboniferous	2		2	5	2				1	4	1		1		18
Devonian	9			6	1	1						2	5	1	25
Silurian			1				5	3	2				1	1	13
Ordovician			3	2	2	2	4	3			1				17
Cambrian					1							1			2
Precambrian				1								1	2		4
General			2	1	1		2	1			1	6	1		15
Total	13	2	24	28	17	3	11	7	3	4	3	11	17	2	145

progress; and F.W. Beales, University of Toronto continues his work on the stratigraphy of the Black River group in southern Ontario and Quebec. In western Canada a number of surface and subsurface studies of the Ordovician of the Prairie Provinces are being made and B.S. Norford, Geological Survey of Canada is studying the 'Late Ordovician and Silurian Fauna of Southern British Columbia'.

Upper Palaeozoic

Of the forty-five projects underway, the majority are on Palaeozoic strata in Western Canada. Of these, twenty-five are of Devonian strata. These include faunal studies in the Northwest Territories by D.J. McLaren and K.W. Norris, Geological Survey of Canada; and by W.G.E. Caldwell and a number of graduate students at the University of Saskatchewan. D.M. Baird, University of Ottawa continues his work on the Carboniferous strata of Newfoundland; other studies of the Carboniferous are underway by graduate students at the University of New Brunswick. Carboniferous projects in Western Canada include those of S.J. Nelson, University of Alberta on Permo-Pennsylvanian faunas, and by W.R. Danner, University of British Columbia on the Devonian-Pennsylvanian-Permian palaeontology and stratigraphy of southwestern British Columbia and northwest Washington.

Mesozoic

Studies of Triassic strata are being carried out in British Columbia by the Department of Mines and Petroleum Resources and by W.R. Danner, University of British Columbia. The Jurassic faunas of the Canadian Arctic, southern Yukon and northeastern British Columbia are under study by H. Frebold, Geological Survey of Canada. Some 27 projects on the Cretaceous of Western Canada include palaeontological studies such as those by J.A. Jeletzky, Geological Survey on the G.S.C. collections of 'Scaphites Faunas from the Bearpaw Formation of Alberta and Saskatchewan and its Equivalent in Manitoba' and by J.H. Wall, Alberta Research Council on 'Cretaceous Foraminifera of Alberta'. A general stratigraphic investigation by C.F. Burk, Geological Survey, on 'Subsurface Upper Cretaceous Stratigraphy of West Central Alberta and British Columbia' includes regional correlation and stratigraphic analysis with special attention to oil and gas reservoirs such as the Cardium and Dunvegan formations. J.F. Lerbekmo, University of Alberta is studying the petrology of the Belly River, Edmonton and Brazeau formations of the Alberta Foothills with the objective of correlating these continental formations, and of differentiating between possible source areas.

Cenozoic

Among the Cenozoic projects are four by graduate students at University of British Columbia and one at McMaster University. L.S. Russell, National Museum, continues revision of certain fossil Unionidae of non-marine beds of the Cretaceous and Tertiary of Western Canada, and his studies of fossil mammals of Western Canada.

Palaeontological Research

About 80 palaeontological projects cover a wide field. They are included under the category Stratigraphy and Palaeontology in the table (Pt. I, p. 67) and most of them are included also in Table I (Pt. I, p. 69) which shows the distribution of projects.

The palaeontological projects may be classified as follows:

	1961	1960
Invertebrate Palaeontology ..	46	21
Vertebrate Palaeontology ...	5	1
Micropalaeontology	16	9
Palaeobotany	7	2
Palynology	7	3
Total	81	36

In comparison with last year there has been an increase in the number of investigations in all fields of palaeontological research. Many of the investigations are general faunal studies dealing with stratigraphic units, but a considerable number are specialized studies dealing with particular genera or groups of fossils. Groups of invertebrates receiving most attention are corals and brachiopods, each with nine special studies devoted to them. These are followed by ostracods (5), bryozoa (4), trilobites (3), cephalopods (3), stromotoporoids (2). Much of this research is being carried out by the Geological Survey but there is a marked increase in contributions from the universities, particularly from the Universities of Alberta, British Columbia, Toronto, and Saskatchewan.

Vertebrate palaeontological studies are restricted to four projects by the National Museum and one at the University of Ottawa by D.L. Dineley. Apparently, no other university has entered this specialized field.

Micropalaeontological and palaeobotanical studies as a means of stratigraphic dating and correlation are receiving increasing attention. Work in these fields is about equally divided between the east and west of Canada. Realization of the importance of fossil spores and pollen in stratigraphic correlation has resulted in an increase in the number of palynological projects. Projects in this field are being undertaken in the Geological Survey and the Universities of Alberta, British Columbia, New Brunswick and Saskatchewan. Three projects are underway at the latter institution where Margaret W. Steeves is studying the fossil pollen and spores of Jurassic and Cretaceous sediments to gain a stratigraphic and statistical record of vegetation changes.

Sedimentary Petrology

The Polar Continental Shelf Project of the Department of Mines and Technical Surveys under the leadship of E.F. Roots is a major integrated exploration of the geology of the Canadian Arctic continental shelf area with studies of the islands, straits and sounds associated with it. Much information is being obtained regarding sediments now forming in that region.

Eight studies of recent sediments are underway in other parts of Canada. In British Columbia W.H. Mathews in cooperation with F.P. Shepard is investigating sedimentation in the Fraser Delta, and in Newfoundland W.D. Brueckner of Memorial University is studying the carbonate content of some recent sediments. Sediments forming in lacustrine, alluvial and eolian environments are being examined. Sedimentary petrological studies of old sediments include many of specific stratigraphic units. The techniques used in these studies vary with the lithological type; clay mineral and heavy mineral analyses are commonly employed for the shales and sandstones

respectively. G.V. Middleton of McMaster University is developing techniques for the quantitative mineralogical, chemical, and textural study of indurated sandstones. Petrographic and chemical studies of a number of the carbonate rock units are being made.

Petroleum

Current research applied to the search for petroleum is extensive and many of the one hundred and forty-eight stratigraphy and palaeontology studies (Pt. II, p. 97) are directed toward the assessment of subsurface conditions that may lead to oil and gas accumulation. The six petroleum projects shown (Pt. II, p. 51) have no particular stratigraphic implications. Most of the many research projects related to petroleum geology being carried out by oil company geologists and consultants, are not recorded in the current list.

Coal

Three projects connected with the geology of coal are being carried out by the Geological Survey of Canada. They include the collection of data necessary for estimation of the coal reserves of Canada by B.A. Latour, research on petrology and the spore analysis of coal seams in Nova Scotia and Western Canada by P.A. Hacquebard and a study of the Cretaceous strata of the western Foothills by D.F. Stott with emphasis on their possibilities as a source of fossil fuels.

NOTES AND SUGGESTIONS

Various comments and suggestions have been submitted by members of the subcommittee. J.F. Caley forwards the following suggestion contributed by B.A. Liberty:

> "A detailed palaeontological study of Middle Ordovician and Upper Ordovician faunas in the Great Lakes area for the purpose of 1) delimiting, listing and describing the faunal zones within these strata, 2) determining the most valuable marker fossils, and 3) determining the natural faunas of Middle as compared with Upper to aid in delimiting the Middle-Upper Ordovician time line."

S.J. Nelson submits the following valuable suggestions dealing with the importance of Palaeozoic colonial corals, and methods that might be developed to enable field geologists to make use of fossils more easily. He writes:

> "The first suggestion is that more attention be paid to the various species of Palaeozoic colonial corals, and their stratigraphic distribution. Because of their aesthetic appeal these are one of the more common kinds of fossils collected by field parties and include such genera as Palaeophyllum, Hexagonaria, Billingsastraea, Diphyphyllum (s. l), Lithostrotion, Lithostrotionella, Catenipora, Halysites, Favosites, Coenites, Alveolites, and Syringopora. In a good many cases the palaeontologist is frustrated to find himself with a beautifully preserved specimen and yet be able to suggest only the approximate horizon because of ignorance of the species distribution.

"It has been my experience with Mississippian colonial corals such as Syringopora and Lithostrotionella that they are excellent guide fossils. For example one species of Lithostrotionella has a restricted vertical range, and appears to extend from northeastern British Columbia south to Mexico and east to Illinois. Although longer ranging, Syringopora also have a great lateral extent: one species extends from Virginia to the northern Yukon.

"A great deal of stress has been placed upon brachiopods in Palaeozoic correlations, and rightly so because they are the most abundant elements of the fauna. However, while colonial corals are nowhere near as common, their massive structure generally allows good preservation. In addition, the numerous corallites within a corallum allows the norm of the species to be determined with relative ease. With brachiopods, on the other hand, 25 to 50 specimens may be needed to find the norm and then there is often uncertainty because of their fragmentary nature.

"Thus I feel that more work should be devoted to the colonial corals, with less stress placed upon the assemblage and more upon the various species and their vertical occurrence within a system.

"Work along these lines is proceeding at the University of Alberta. This year we have a Ph.D. candidate who will examine Ordovician, Silurian, and Devonian Favosites with the primary aim of using this coral to distinguish the three systems. The results could have considerable economic significance, particularly for the Yukon and Northwest Territories. A Master's candidate is studying a rather extensive collection of western Canadian Silurian Halysitidae with a view to differentiating the various species. It is hoped that later workers will study the stratigraphic distribution of these species and thus give a means of recognizing Lower, Middle, and Upper Silurian (at present very uncertain) in the shelly facies.

"My second suggestion is concerned with the inability of many field geologists to use fossils for horizon identification, and the way in which this can be overcome.

"In this modern era of helicopters the geologist in a single day often runs the gamut of geological systems ranging from Cambrian to Mesozoic or Cenozoic. I have found that many of these men are well versed in morphology, being able to recognize graptolites, brachiopods and the like, but all too often are ignorant of their stratigraphic significance. Usually they prefer to wait for age identifications by professional palaeontologists rather than make their own rough determinations in the field where they will do the most good.

"In part, the blame for this situation can be laid on the palaeontology or stratigraphy courses of Canadian universities where the emphasis is on morphology and

memorization of genera and species rather than on the stratigraphic significance of the various fossil groups. For example, many geologists can recognize at a glance Tetragraptus or Climacograptus but how many know that the former indicates Lower Ordovician; and the latter (or the various biserial types) indicate Middle or Upper Ordovician, if in abundance? How many are inclined to call the first chain coral they see Halysites without realizing that there is a very abundant fauna of related but easily differentiated genera in the Upper Ordovician? I know of many similar examples.

"I think this ignorance can be counteracted in two ways. The first is that the palaeontology and stratigraphy collections of the universities should contain much more fragmentary material such as tiny pieces of generically unidentifiable graptolites, productid shells, belemnites, etc. with instructions on how to use this material. After all, this is often the way fossils are preserved in the field!

"The second is that a pamphlet with suitable illustrations should be prepared, describing, with a minimum of technical languaged, how to use fossils for horizon identification throughout the Phanerozoic. It was with this in mind that I prepared the Alberta Society of Petroleum Geologists reports on field identification of the Ordovician-Silurian interval (1959) and of the Yukon Permo-Carboniferous (1961), only covering the entire Phanerozoic Eon. Tips such that branched Favosites are likely Middle Devonian; graptolite fragments Ordovician or Silurian; colonial corals with a lonsdaleoid dissepimentarium are probably Permo-Carboniferous (and almost always Mississippian) in western Canada; and that belemnite fragments suggest Jurassic strata could be included, along with more specific information."

Dr. Beales has submitted the following comment with regard to the danger of overspecializing and the desirability of maintaining a close relationship between palaeontology, stratigraphy, and other related earth sciences:

"An Institute of Earth Sciences has recently been formed at Toronto under the chairmanship of Dr. Tuzo Wilson. Its express aim is to promote inter-departmental and inter-disciplinary research within the scope of geology, physics, chemistry, and biology. From a humble beginning without staff or accommodation, the Institute hopes to broaden and integrate the scope of Earth Sciences research. It is an attempt to face up to the restricted and compartmentalized research that is becoming more and more prevalent. Specialization is tending to become over-specialization, which, as every palaeontologist knows, commonly leads to extinction. Within the more limited field of stratigraphy similar trends should be fostered. Palaeontology and stratigraphy have tended to drift apart in recent years. They should be brought closer together again along with isotope geology, geochemistry, and any other field of related effort that can be brought to bear on stratigraphic problems."

Dr. Gordon Winder stresses the importance of contacts between university geology departments and the Geological Survey by visits of Survey personnel to the universities during the academic session and by university personnel to visiting Survey field parties.

Dr. A.D. Baillie submits the following comments on research needs and current research activity in the Alberta area.

> "Basic and applied research in the wide field of petroleum geology is being done by most major oil companies in Alberta but, due to the competitive nature of the industry very little of this work is published. Consultant geologists in Alberta are doing a fair amount of research, much of which is being published. No attempt has been made to obtain information on research underway by the oil companies but the areas of research being investigated by consultants are, in general, an indication of research being done by industry.
>
> "In recent years there has been an increased emphasis on aspects of carbonate rock research. In part this emphasis has been dictated by a specific need of the industry. Discovery and successful development of carbonate reservoirs requires a thorough understanding of the tectonic control intitiating the deposit, the depositional environment, a knowledge of the shape and lithologic variations to be expected in the reservoir and the actual textural variations that affect the porosity and permeability of various parts of the reservoir. To achieve this understanding, studies of sedimentation, depositional environment, sedimentary tectonics, petrology, palaeoecology, micro-facies and secondary alteration in carbonate rocks are all significant. Selections of techniques and methods for secondary recovery programs can be assisted materially if the variations and geometry of the void space in a reservoir are understood.
>
> "Observation and interpretation of cored and outcrop sections of reef and other bio-constructed carbonate facies are essential to studies of this nature. Material for research problems on carbonate rocks is abundant and accessible both in outcrop and in core storage buildings throughout Canada. No doubt the industry would cooperate fully in making cores and other basic data available.
>
> "Outlined below are some of the research projects currently in progress by consultants in Calgary.
>
> "Mr. A. McGugan, consultant in palaeontology and stratigraphy, is engaged in the following research projects:
>
> "Detailed field mapping and fossil collecting in the Permo-Carboniferous Rocky Mountain Group has been done in the outcrop area of western Alberta. The results of this study will be published shortly in the Journal of the Alberta Society of Petroleum Geologists

under the title 'The Stratigraphy of the Permo-Carboniferous Rocky Mountain Group Banff Area, Alberta'. It is hoped to continue the field work on this group.

"A study of the Upper Cretaceous foraminifera on Vancouver Island has been underway for several years. Many of the forms have been specifically identified and the work is continuing.

"Studies of Upper Cretaceous foraminifera from type localities in Germany and the Gulf Coast, obtained by exchange, are being studied and type material for zonal purposes in Northern Canada is being prepared.

"Andrichuk and Edie, consulting geologists, have been doing research on Mississippian and Devonian carbonate rocks for several years. Emphasis has been on petrography and palaeoecology. The studies are mainly directed towards developing criteria for recognition of various environments of deposition in prediction of permeable banks and reefs suitable as reservoirs for hydrocarbons. Some of the recent findings in these studies are as follows:

1) Additional documentary evidence to demonstrate that dolomitization and calcite cementation are environmentally controlled.

2) Additional stratigraphic evidence to emphasize the importance of basement fault block movements as a fundamental cause of reef growth[1].

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[1] Edie, Ralph W.; Devonian Limestone Reef Reservoir, Swan Hills Oil Field, Alberta: Bull. Can. Inst. Mining and Metallurgy, Vol. 54, No. 590, June 1961, p. 447-454.

"Mr. G.E. Thomas, consulting geologist, is engaged currently in research on carbonate reservoirs and the relationship of their textural properties to porosity and permeability. The effectiveness of a carbonate reservoir is directly related to grain size, sorting, presence or absence of matrix and cement, and other textural factors. Mapping of these variables demonstrates the sedimentation processes within and adjacent to reef bodies and can be used in exploration and exploitation of reef and other carbonate reservoirs.

"J.C. Sproule and Associates, Limited are conducting several research projects as follows:

1) Dr. John L. Usher of J.C. Sproule and Associates and Dr. R.G. Greggs of Shell Oil Company are making a field study of the Ghost River formation and the sub-Devonian unconformity. The type section and its northern and southern extension will be described. This

work is a follow-up of a paper to be published shortly by Dr. Greggs on the redefinition, age and stratigraphic relationships of the Ghost River formation.

2) Dr. J.L. Usher and Mr. R.H. Workum are engaged in a population and specific variability study of Atrypella spp. from Silurian rocks of Cornwallis Island. This involves external and internal studies of four recognized species of Atrypella.

3) Usher and Workum are also engaged in an ontogenetic study (by serial section) of Streptelasma trilobatum Whiteaves from the Cornwallis formation and from Ordovician rocks of the Great Bear Lake area.

4) Mr. T. Campbell is conducting a regional geological study of post-Palaeozoic and post-Jurassic erosional surface of Central Alberta. The palaeotopographic land surface and its effect on the sedimentation of the overlying Lower Cretaceous rocks will be investigated."

Research in the Universities

Current research in stratigraphy, palaeontology, and sedimentation at the universities is significant in amount and varied in scope. The following table gives the number of projects in each of the main fields of investigation and the total number under investigation at each university.

University Research

In Stratigraphy, Palaeontology, and Sedimentation

University	Stratigraphy	Palaeontology		Sedimentary		Total
		Micro.	Macro.	Old	Recent	
Alberta	4	1	5	5	1	16
British Columbia	6	4	7	2	1	20
Carleton	-	3	-	-	1	4
McGill	2	-	1	3	1	7
McMaster	-	-	4	3	-	7
Manitoba	1	-	-	1	-	2
Newfoundland	1	-	-	1	1	3
New Brunswick	2	-	-	-	-	2
Ottawa	4	1	1	1	-	7
Queen's	2	-	1	-	-	3
Saskatchewan	4	4	5	2	-	15
Toronto	3	-	3	5	3	14
Western	-	1	1	1	-	3
TOTALS	29	14	28	24	8	103

The greatest handicap to geological research at the universities is the lack of money. It is a perennial problem and has been brought up again this year by two members, Drs. Beales and Okulitch. Dr. Beales has this to say:

> "One of our most pressing needs in Canada at the present time is for more scholarship money to promote post-graduate research. Here at Toronto we are constantly, in effect, turning down very desirable applicants, because we cannot offer them sufficient financial assistance to carry them through their first year. Provincial and National Research funds often do not touch these cases and only rarely do the applicants manage to come 'under their own steam'. Many of these applications come from Commonwealth countries and represent potential immigrants; others come from inside North America. Yet others come from countries to which friendship in the form of scholarships would be a desirable form of external aid. Present scholarship machinery does not meet the need of many applicants and a more liberal policy is required even though it will involve mistakes from time to time."

Dr. Okulitch comments as follows:

> "It should be emphasized that the problem of financing field work remains with us and is the greatest single factor preventing or slowing down research. It is my belief that funds for graduate research in the field will have to be found, and that the administration and application of such funds should be in the hands of the teaching departments at the universities."

As Dr. Beales has stated, many applicants for graduate assistance have to be turned down because of the inability of the universities to offer financial aid. Columbo Plan and Commonwealth Scholarships and Fellowships are not adequate to meet the needs of a number of overseas applicants who have good academic records. It is not only funds for students that are in short supply. Some universities have problems of lack of space, shortage of equipment and of library facilities, for all which they need money. There are, however, some brighter aspects of the financial picture and it is a pleasure to record that the Shell Oil Company, realizing the difficulty of graduate students in financing field work, are offering $7,500 for this purpose. The sum is to be divided between ten universities. It is hoped that this example will be followed by other companies.

REPORT OF THE SUBCOMMITTEE ON SCHOLARSHIP AND RESEARCH TRAINING

Presented by A. L. McAllister

Members of Subcommittee

A.L. McAllister (Chairman)	- University of New Brunswick, Fredericton, New Brunswick.
P.E. Auger	- Department of Natural Resources, Quebec, Quebec.
I.C. Brown	- Geological Survey of Canada, Ottawa, Ontario.
J.B. Mawdsley	- University of Saskatchewan, Saskatoon, Saskatchewan.
K.C. McTaggart	- University of British Columbia, Vancouver, British Columbia.
P.A. Peach	- University of Toronto, Toronto, Ontario.
C.W. Stearn	- McGill University, Montreal, Quebec.

The report of this Subcommittee in 1960 contained a recommendation designed to help alleviate the partial "isolation" of many university geology departments from research centres and general geological activity. The report suggested the arrangement of "a series of lecture tours—whereby specialists in various fields could visit universities for a series of two or three lectures. It is specifically suggested that the Geological Survey of Canada arrange tours for members of its staff"[1].

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[1] National Advisory Committee on Research in the Geological Sciences, Tenth Annual Report, 1959-60, p. 31.

This suggestion was discussed at the April, 1960 meeting of the National Advisory Committee and, to quote from the minutes of that meeting:

> "It was agreed that the Subcommittee on Scholarship and Research Training should review further the whole matter of visiting lecturers, including:
>
> 1) The need for such a series of visiting lecturers and the likelihood of their success,
>
> 2) from what organizations the lecturers might be chosen,

3) how and by what organizations such a series might be initiated and sponsored, and

4) to what extent, if any, and by what means such a series should be subsidized."

The above four points, which are discussed in order below, are the basis for this report, in the hope that means may be found of inaugurating such a series.

Need for Lecture Series

To find out the need, the geology departments of most Canadian universities were asked their opinion of the desirability of such a series. All thought such a series should be arranged; no university suggested it would not wish to participate.

As an interim measure in 1961 the Maritime universities requested that a member of the Geological Survey staff visit each of their respective geology departments. As a result Dr. Robert W. Boyle spent approximately two weeks in New Brunswick and Nova Scotia visiting Dalhousie, Acadia, St. Francis Xavier, Mount Allison and the University of New Brunswick. He spent about two days at each university, giving a series of lectures and seminars at each. The tour was most successful. The participating universities concerned are enthusiastic and anxious that a similar lecture series be arranged for 1961-62.

The enthusiasm with which this limited lecture tour was received suggests that if a regular series were instituted, it would prove successful.

Choice of Lecturers

Lecturers could be chosen from any organization including the universities, Federal and Provincial geological surveys, and mining, oil or exploration companies. The prime qualifications should be the lecturer's ability, and his acquaintance with a suitable phase of geological research. Presumably, selection of the lecturer would be left to a small committee. This committee would consider suggestions from any of the participating universities.

Sponsorship

It was the general feeling of the Subcommittee that either the Geological Association of Canada or the Geology Division, Canadian Institute of Mining and Metallurgy were logical groups to organize and sponsor such a project.

The Geological Association of Canada was asked by this Subcommittee to consider the organization and sponsorship of such a lecture series and this was considered at a meeting of Council of the Association late in 1960. The Council of the Geological Association decided at this meeting that the administrative load, particularly the secretarial work, involved in the sponsorship of such series could not be handled by the Association for at least two or three years.

On learning of this decision the Geology Division of the Canadian Institute of Mining and Metallurgy was asked by this Subcommittee to consider sponsorship of such a lecture series.

If the Geology Division of the C.I.M. does not wish to sponsor the lecture series, the Subcommittee on Scholarship and Research Training should do so, at least on a limited scale, until the project is on its feet.

Financing

Similar lecture series are now sponsored by other scientific societies such as the Chemical Institute of Canada and the American Association of Petroleum Geologists. In both instances the bulk of the financial burden is borne by interested companies with incidental expenses covered by the host universities. Such an arrangement seems to most feasible for the suggested series. One or two big companies might be interested in having their name attached to the project as a matter of public relations. The amount of financial aid necessary obviously depends on the scale of the project. It is suggested that, to begin with, the series be limited to one visit to each university. This may or may not involve more than one lecturer. The cost of a series carried out on this scale should not exceed $2,000 and would be considerably less if the "on-the-spot" expenses were paid by the universities concerned.

Recommendation

This Subcommittee requests that the National Advisory Committee make every effort to have the lecture series instituted during the 1961-62 academic year.

APPENDIX I

GEOLOGICAL SURVEY OF CANADA RESEARCH GRANTS

SUMMARY REPORTS ON PROJECTS

Brief reports are given below on projects completed or that have achieved results of interest in 1960-61.

Project 26-53- Enthalpy Changes in Metamorphic Reactions and their Geologic Significance

Under direction of Dr. V.A. Saull, McGill University.

Minor mechanical improvements have been made in the calorimeter apparatus, and new calorimeter heaters and heater seals have been designed and are in use.

In 1960-61, the principal determinations of enthalpy changes were made on the iron minerals grunerite, specularite and hematite. The results indicate that the breakdown of grunerite to olivine or to pyroxene is strongly exothermic with an adiabatic temperature rise of more than 1000°C. In the metamorphism of iron formation this is significant; it is also of interest because the reactions represent dehydrations that are exothermic. The change from specularite to hematite would produce an adiabatic temperature rise of about 350°C, and the converse change (which is probably the more common in regional metamorphism) would be endothermic to the same extent. Details are presented in D.F. Sangster's thesis "Thermochemical Experiments on Certain Iron Minerals" (M.Sc. thesis, McGill University, 1961).

Samples of albite, microcline, labradorite, and standard clays have been obtained and chemically analysed. Measurements on clay to gneiss transformations are planned.

Project 1-54- Silicate and Sulphide Phase Relationships

Under direction of Professors J.E. Gill, V.A. Saull, and E.H. Kranck.

The investigations underway include:

(1) Study of the oxidation potential of certain sulphides—an empirical study of some fundamental chemical processes occurring during oxidation and secondary enrichment of sulphide minerals.

(2) Experimental study of the melting of rocks under high temperature and water pressures—a continuation of earlier work by R.V. Oja and A.R. Philpotts. During 1960-61, twenty experiments were made on samples of Morin anorthosite and syenite and the melting curves of the rocks were roughly determined.

(3) Growth of copper sulphide crystals in a temperature gradient.

(4) Experimental investigation of intergrowths of bornite and chalcopyrite.

(5) Experiments on the growth of authigenic albite in which albite (high temperature form) was synthetized in 62 days at 210°C.,

12,000 p.s.i. from a mixture of kaolinite, sodium carbonate and quartz.

(6) Deformation of quartzite at high temperatures and pressures.

(7) Experiments on thermochemical methods of producing high temperatures and pressures, in which high temperatures were obtained from thermite placed in open and sealed holes drilled in diabase boulders.

(8) Study of isotope ratios in natural and synthetic minerals.

The results of some of the studies are reported in the following:

MacDougall, J.F., B.K. Meikle, J.V. Guy-Bray, V.A. Saull, and J.E. Gill. Experimental Investigation of Solid Diffusion and Volatilization of Certain Metallic Sulphides, Economic Geology, Vol. 56, pp. 362-391, 1961.

Chagnon, J.Y.; Experimental Study of the Growth of Feldspar in Sediments; M.Sc. thesis, McGill University, 1961.

Philpotts, J.A.; Thermochemical Methods of Producing High Temperatures and Pressures; M.Sc. thesis, McGill Univ., 1961.

Project 2-54- Geochemical Studies

Under direction of Dr. D.M. Shaw, McMaster University.

During 1960-61 the following papers were published recording results of completed projects:

Shaw, D.M.; Spectrochemical Analysis of Silicates Using the Stallwood Jet; Canadian Mineralogist, Vol. 6, p. 467-482 (1960).

Shaw, D.M., O.C. Wickremasinghe and J.N. Weber; Spectrochemical Determination of Lithium, Sodium, Potassium and Rubidium in Rocks and Minerals Using the Stallwood Air-jet; Anal. Chem. Acta., Vol. 22, p. 398-400 (1960).

Shaw, D.M.; The Geochemistry of Scapolite, Pt. I—Previous Work and General Mineralogy, and Pt. 2—Trace Elements, Petrology and General Geochemistry; Jour. Petrology, Vol. 1, p. 218-285, (1960).

Pearson, G.R. and D.M. Shaw; Trace Elements in Kyanite, Sillimanite and Andalusite; Amer. Mineralogist, Vol. 45, p. 808-817, (1960).

Shaw, D.M.; Rare Elements as a Key to the Past; New Scientist, Vol. 9, no. 225, p. 618-619.

Moxham, R.L.; Minor Element Distribution in Metamorphic Pyroxenes; Canadian Mineralogist, Vol. 6, p. 522-545, (1960).

Weber, J.N. and G.V. Middleton; Geochemistry of the Turbidites of the Normanskill and Charny Formations; Geo. et Cosmo. Acta., Vol. 22, p. 200-288, (1960).

A thesis by P.S. Simony (M.Sc. thesis, McMaster Univ., 1961) entitled "Origin of the Apsley Paragneiss" is in part a Grenville Province geochemical study.

Project 4-54- Spectrographic and Geochemical Research on Rocks and Minerals

Under direction of Dr. J.E. Hawley, Queen's University.

In the study of Grenville granites of southeastern Ontario with H.R. Wynne-Edwards and J.G. Macdonald, complete analyses for both major constituents and trace elements are now available for 130 granitic rocks. Normative and model analyses of each have been made, full petrographic descriptions of 162 thin sections prepared, and a geological map of the area compiled. A comprehensive paper is planned in which the rocks will be described and classified and their origin discussed in the light of experimental science and regional structure.

Seven projects with graduate students are in progress that involve spectrochemical research on rocks and minerals. The following four additional projects have been completed.

(1) Origin of the Sullivan Lead-Zinc Silver Deposit, British Columbia, Ph.D. thesis by H.T. Carswell, Queen's University, 1961.

(2) Geochemistry of Cobalt in Ores of the Sudbury District, Ontario, M.Sc. thesis by A.J. Naldrett, Queen's University, 1961.

(3) Experimental Investigation of Some Textures of Massive Sulphide Ores, M.Sc. thesis by A.Y. Smith, Queen's University, 1961.

(4) The Geochemistry of Certain Precambrian Carbonate Rocks, M.Sc. thesis by R.K. Laakso, Queen's University, 1961.

Publications in 1961 include:

Hawley, J.E. and Ian Nichol; Trace Elements in Pyrite, Pyrrhotite and Chalcopyrite of Some Canadian Ores; Econ. Geol., Vol. 56, May, 1961.

Hawley, J.E., R.L. Stanton and A.Y. Smith; Pseudo-eutectic Intergrowths in Arsenical Ores of Sudbury; Canadian Mineralogist, Vol. 6, Pt. 5, p. 555-581 (1961).

Project 5-54- Studies of Precambrian Sediments

Under direction of Dr. W.W. Moorhouse, University of Toronto.

During the past year considerable time was devoted to determination of the optics of an amphibole and hypersthene in metamorphosed iron formations and to the study of the textures of taconites and associated iron bearing sediments from the Gunflint Iron Range. Additional chemical data were also obtained regarding taconite and shaly silicate rock and on evidences of life in the Animikie.

A paper was presented on textures and chemistry of the Gunflint Iron Formation at the meeting of the Lake Superior Institute, Port Arthur, April, 1961.

Project 5-55- X-ray Spectrographic Analyses of Minerals and Rocks

Under direction of Dr. L.G. Berry, Queen's University.

The X-ray spectrographic analysis equipment is being used for solving analytical problems arising from graduate thesis programs and other research projects in the Department of Geological Sciences, Queen's University. At times the equipment is converted to diffractometry for the identification of certain minerals in rocks and for precision measurements of lattice constants in olivine, sphalerite and pyrrhotite.

Analytical work for 13 research projects was carried out in 1960-61, many of which form parts of Project 4-54 (Pt. I, p. 84).

Project 4-56- Trace Element Content of Rocks in Western Canada

Under direction of Dr. H.V. Warren, University of British Columbia.

A summary of recent work on this project was presented in a paper by Harry V. Warren and Robert A. Delavault and entitled "Aqua Regia Extractable Lead and Molybdenum in Eruptive Rocks" which was presented to Section IV, Royal Society of Canada, June 1961. The abstract of this paper follows:

"Various bodies of eruptive rock in southern British Columbia were sampled and analyzed for lead and molybdenum, as well as copper and zinc. The results indicate that each eruptive body tends to have a characteristic assemblage of trace elements, and that these trace element assemblages may be useful both in correlating rock masses and in determining which areas are most attractive for prospecting. In this type of work, chemical methods seem, at present, to be more applicable than either spectroscopic or X-ray fluorescence techniques."

Publications in 1960-61 include:

Warren, Harry V. and Robert E. Delavault: Observations on the Biogeochemistry of lead in Canada; Trans. Royal Society of Canada, III Series, Vol. LIV, Sect. IV, p. 11-20, 1960.

Warren, Harry V.: Some Aspects of the Relationships between Health and Geology; Canadian Jour. Public Health, April, 1961, p. 157-164.

Project 1-57- Problems in Nuclear Geochronology

Under direction of Dr. R.E. Folinsbee, University of Alberta.

Construction of a second mass spectrometer in cooperation with the Department of Physics is well advanced. This solid source machine will be used in the program of rubidium-strontium dating. An X-ray fluorescence survey of samples indicates that the potassium-argon date of most biotites can be checked by the strontium-rubidium method, but that common strontium in the feldspars, including the bentonitic sanidines, would make it impossible to date these minerals accurately.

It is planned to make further collections of bentonites from the Cretaceous-Tertiary boundary zone, and other critical horizons,

in an attempt for further define the post-Cambrian time scale.

The following papers were published in 1961:

Baadsgaard, H., R.E. Folinsbee, and J. Lipson: Potassium Argon Age of Biotites from Cordilleran Granites; Bull. Geol. Soc. America, Vol. 72, No. 5, p. 689-702, May, 1961.

Folinsbee, R.E., H. Baadsgaard, and J. Lipson: Potassium-Argon Dates of Upper Cretaceous Ash Falls, Alberta, Canada: Annals New York Acad. Science, Vol. 91, Art. 2, Geochronology of Rock Systems, Pt. III, The Phanerozoic Time Scale, 352-363, 1961.

Lipson, J., R.E. Folinsbee, and H. Baadsgaard: Periods of Orogeny in the Western Cordillera; Annals New York Acad. Science, Vol. 91, Art. 2, Geochronology of Rock Systems, Pt. IV, The Age of the Basement Rocks of the World: North America, p. 459-463, 1961.

Smith, D.G.W., H. Baadsgaard, R.E. Folinsbee, and J. Lipson: Potassium Argon Age of Lower Devonian Bentonites of Gaspé, Quebec; Bull. Geol. Soc. America, Vol. 72, No. 1, p. 171-174, 1961.

Bystrom-Asklund, A.M., H. Baadsgaard, and R.E. Folinsbee: Potassium Argon Age of Biotite, Sanidine and Illite from Middle Ordovician Bentonites at Kinnekulle, Sweden; Geol. Foren. Forh (in press).

Project 3-58- Terrestrial Thermal Gradient in St. Lawrence Lowlands of Quebec

Under direction of Drs. T.H. Clark and V.A. Saull, McGill University.

More than 77 boreholes in the Montreal area have been examined to check their usefulness for heat flow determinations. Only four of the boreholes were found to be useable. The thermal gradients in these holes were measured and approximately 100 determinations of thermal conductivity were made on samples of the core from the holes. From these data, heat flow values for the holes were determinated, the 95 per cent confidence limits for the mean of these values being $0.790 \pm 0.053 \times 10^{-6}$ calories per square centimetre per second.

In the course of the work a new type of probe was designed for temperature detection. This probe contains a temperature sensitive oscillator and can be used with virtually any supporting cable. The results of the 1960-61 work are embodied in a thesis by R. Doig entitled "Further Study of Terrestrial Heat Flow in St. Lawrence Lowlands" (M.Sc. thesis, McGill University, 1961).

Project 11-58- Stratigraphic Correlation of Glacial Deposits between Lake Huron and the St. Lawrence Lowland

Under direction of Professor A. Dreimanis, University of Western Ontario.

Field examinations and collection of samples in 1960 were restricted mostly to the area around Lake Ontario and south of the St. Lawrence Lowlands in order to (a) fill gaps for a step-by-step lithologic correlation between St. Lawrence Lowland and southwestern Ontario and (b) find out what heavy minerals could have been carried into the Lake

Ontario and Erie basins and the area south of them by glacial flows from the Adirondacks and Green Mountains. Some field work was done also south of Lakes Erie and Huron for correlation with recent Pleistocene stratigraphic studies in the United States.

The carbonate content of till matrix, the heavy minerals (with emphasis on garnets) and the pebbles have been studied in more than 100 of the samples collected. Testing of the gasometric method for quantitative determination of calcite and dolomite has been completed, and a paper prepared for publication.

Publications in 1960-61 include the following:

Dreimanis, A.: Preclassical Wisconsin in the Eastern Portion of the Great Lakes Region, North America; Int. Geol. Congress, 21 Norden, 1960, Pt. 4, 108-119 (with a supplement, 5 pages, published by Geology Dept., University of Western Ontario).

Dreimanis, A.: The Early Wisconsin in the Eastern Great Lakes Region, North America; Abh. Stock. Akad. Wiss. Berlin, Kl. III H. 1, p. 196-205, 1960.

Dreimanis, A.: Tills of Southern Ontario; Soils of Canada, Royal Society of Canada, Spec. publication No. 3, 1961.

Project 1-59- Direct Numerical Interpretation of Resistivity Measurements

Under direction of Dr. Keeva Vozoff, University of Alberta.

A summary of results during 1960-61 is given in the following abstract of a thesis by S.A. Bukhari entitled "An Application of Linear Programming Methods to Earth Resistivity Analysis" (M.Sc. thesis, University of Alberta, 1961):

"The problem of direct interpretation of earth resistivity data was attacked by Ness using a method of least squares. The same problem is considered here, using linear programming methods for its solution. These methods were tried because they allow data fitting in other than a least square sense.

Two sets of model data were analyzed, and the results are comparable with those obtained by Ness, both in quality of fit and in computation time required. It appears that both methods reduce errors to within the range of the accuracy of the measurements and of the approximations.

The linear programming methods possess a decided advantage in their flexibility, which allows subjective control where desired, and which would also allow the use of information from other sources with little modification of the programs."

The results of earlier work on this project have been published in the following paper:

Vozoff, K.: Numerical Resistivity Interpretation; General Inhomogeneity; Geophysics, Vol. XXV, No. 6, p. 1184-1194, December 1960.

Project 8-59- Structural Investigation of Canoe Lake Fault and Related Structures

Under direction of Dr. J.W. Ambrose, Queen's University.

The results of this project are embodied in a thesis by D.D. Brown entitled "The Canoe Lake Wrench Fault and Associated Structures (M.Sc. thesis, Queen's University, 1961). The abstract follows:

"An investigation of the structural geology of the Canoe-Desert Lake fault, 35 miles north of Kingston, Ontario, was carried out by mapping an area covering 55 square miles of Precambrian Grenville-type metamorphic rocks. Quantitative and qualitative analysis of attitudes of fault surfaces, slickensides and complementary drag folds indicate the Canoe-Desert Lake fault and subsidiary faults are wrench faults. Trans-current movement of the Canoe-Desert Lake fault has been almost certainly left-handed. The magnitude of strike separation is not known. North striking left-hand second order wrench faults and east to southeast striking right-hand second order wrench faults, subsidiary to the Canoe-Desert Lake fault, define a system which agrees with the theoretical mechanics of second order wrench faults. Northeast striking left-hand splay faults diverge from the Canoe-Desert Lake wrench fault at acute angles.

"Statistical analysis of the axes of folds indicates two generations of folds, a first generation of gently northeast plunging regional folds and a second generation of folds which plunge more steeply in a direction more east of north than the shallow folds. The second generation folds are drag folds, up to one mile wide, which are restricted to local apical areas lying between the intersection of the Canoe-Desert Lake fault and subsidiary faults. The geometry of the second generation folds, as defined by the attitudes of fold axes, agrees with the theoretical geometrical transformations of "s" planes and "b" lineations resulting from the superimposition of one generation of folds on another by axial plane shear folding. The axial plane shear movements are intimately related to the same regional left-hand shear movements which resulted in the formation of the Canoe-Desert Lake fault."

Project 10-59- Palynological Investigations in Western Canada

Under direction of Professors F.H. Edmunds, W.O. Kupsch and W.G.E. Caldwell, University of Saskatchewan.

A study of a flora of Blairmore and Jurassic age represented by spores and pollen in samples from the Esterhazy Potash Shaft will be completed shortly. The Cretaceous Blairmore section from the Patience Lake (Saskatoon) Potash Shaft has been studied. More than 50 species have been described and the work promises to have important stratigraphic significance.

A collection of fossil Cretaceous spores and pollen, largely from the Atlantic States, and of modern representatives of these groups is being made for use for comparison and identification. Since the Jurassic-Cretaceous boundary is critical in the evolution of angiosperms, it is important to obtain accurate identifications of plants having biological significance. The only reliable way to do this is to correlate the microfossil flora with macrofossils from the same

strata because commonly, macrofossils can be assigned to taxa having biological significance. The ideal occurs when spores and pollen can be isolated from identifiable fruiting bodies and any sporomorph thus isolated can be identified subsequently with confidence, wherever found. Collections from the type section of the Blairmore will be made to obtain such a correlation and with the hope of collecting fruiting material so that these sporomorphs may be identified in terms of biological taxa.

Spores and pollen from muskeg sections in Northern Saskatchewan will be examined to find out more about the floral changes that followed the disappearance of ice from the region.

Project 11-59- Genesis of Sulphide Ores and Studies of Metamorphism

Under direction of A.R. Byers and J.R. Smith, University of Saskatchewan.

The grant has been spent, along with other funds, to supplement X-ray diffraction and analytical equipment. The use of the equipment is shared with the Saskatchewan Research Council who have done much of the field work on projects currently in progress. Several of these relate to the study of the Coronation Mine area.

The equipment has been used to date for analytical work in connection with the following thesis projects:

(1) Temperature of Formation of the Coronation Sulphide Orebody, Flin Flon Area, Saskatchewan, M.Sc. thesis by C.S. Ferris, 1961. The temperature of formation of pyrrhotite by Fe/S ratio was determined by X-ray diffraction techniques and compared with temperatures determined by Zn/Fe ratio in sphalerite.

(2) Plagioclase Composition in Metamorphosed Igneous Rocks of Mink Lake Area, Saskatchewan, M.A. thesis by D.R. Pyke, 1961. Includes refined curves for determination of plagioclase composition by X-ray diffraction techniques.

(3) Trace Elements Related to Sulphide Deposits, Ph.D. thesis by E.L. Faulkner, 1961. A detailed investigation of trace elements in the ore and wall rocks at the Coronation Mine as compared with barren iron sulphide bodies in the Flin Flon area.

In addition to these studies the X-ray equipment has greatly accelerated a study of trace metals in bedrock in an area of about 100 square miles around the Coronation and Birch Lake Mines—a cooperative project of the Saskatchewan Research Council and University of Saskatchewan.

Project 13-59- Measurement of Induced and Remanent Magnetism of Rocks in Situ

Under direction of Dr. R.J. Uffen, University of Western Ontario.

A combined electromagnetic, magnetometer and resistivity survey was carried out over a "negative" anomaly near Wilberforce, Ontario (Geol. Surv., Canada, Aeromagnetic Map 31E/1). No evidence was found for a massive body of negatively polarized rock, such as ilmenite, from either the electromagnetic or ground magnetic survey. The results indicate that the observed negative

anomaly is caused by the combined effect of very rapid variations in the permanent magnetization of the surface rock. From laboratory measurements of the direction and intensity in specimens collected from the surface rock it has been demonstrated that the size of the magnetized particles is too small to produce an observable electromagnetic response with the equipment used (Ronka). From studies of thin sections it is concluded that the observed inverse remanent magnetism is caused by very finely disseminated magnetite and ilmenite in the rock, which is predominantly a highly metamorphosed impure dolomite limestone. The results of this work are included in a thesis by C.S. Mason entitled "Geophysical Investigations of Inversely Magnetized Rocks near Wilberforce, Ontario" (M.Sc. thesis, University of Western Ontario, 1959).

A trial model of an instrument suitable for use, ultimately, in a bore hole has been constructed. It employs a rotating coil driven by compressed air for measuring the combined remanent and induced magnetic field in the bore hole. The same coil will be used with an audio frequency alternating current to measure the magnetic susceptibility.

Project 8-60- Quantitative Petrology of Sandstones

Under direction of Dr. G.V. Middleton, McMaster University.

Publications in 1960-61 include:

Weber, J.N. and G.V. Middleton: Geochemistry of Turbidites of the Normanskill and Charny Formations (Parts I and II); Geochim. et Cosmochim. Acta., Vol. 22, p. 200-288, 1960.

Smoor, P.B.: Dimensional Grain Orientation Studies of Turbidite Greywackes; Canadian Mining Journal, Vol. 82, No. 3, p. 104, March 1961 (abstract of M.Sc. thesis).

Work will be continued on the Normanskill and Charny Formations, with particular attention to composition and petrofabrics.

APPENDIX II

GEOLOGICAL SURVEY OF CANADA RESEARCH

GRANTS TO CANADIAN UNIVERSITIES

1961-62

UNIVERSITY OF ALBERTA

Fundamental Research in Geochronology

Applicant - Halfdan Baadsgaard — Amount - $3,000.00

Includes a comparative study of Argon^{40} diffusion in feldspars and the partition coefficients and diffusion of Strontium^{87} in rocks and minerals, in order to evaluate some of the factors causing discordant "radioactivity" dates and thus aid in the interpretation of absolute dates.

Stratigraphy, Structure and Metamorphism of Old Fort Point Formation, Jasper, Alberta

Applicant - H.A.K. Charlesworth — Amount - $ 950.00

A study of the nature of the rocks of this formation and in particular the conditions under which they were deposited, the style of their deformation, and the age of their metamorphism.

Palaeozoic Syringopora and Speciation of the Genus Favosites

Applicant - Samuel J. Nelson — Amount - $1,320.00

The corallite diameter and spacing in the Genus Syringopora are apparently diagnostic for each species and it is hoped to establish a system by which the different species may be identified by this means in the field.

The Genus Favosites will be studied so that it may be used in correlation and determination of the age of strata containing it in Western Canada.

Petrography and Depositional Environments of Basal Cretaceous Clastics of Southwestern Canadian Sedimentary Basin

Applicant - T.A. Oliver — Amount - $1,500.00

A study of the lithology and petrography of the basal Cretaceous sediments to find out more about their origin, source and depositional environment.

UNIVERSITY OF BRITISH COLUMBIA

Isotope Geology

Applicant - R.D. Russell — Amount - $1,500.00

This project involves study of the origin of sulphide deposits, using isotopic ratios of lead in minerals, to find out more

about the relations of the different rocks; it will also provide isotopic evidence on mantle-crust relationships.

Trace Element Relationships on Soils, Rocks and Plants

Applicant - H.V. Warren Amount - $4,000.00

A study of trace elements in soils, rocks and plants involving development of special chemical techniques, supplemented by spectroscopy. One phase of the study suggests a relation between high content of lead in limestones and the incidence of multiple sclerosis among inhabitants of areas underlain by these rocks, or covered by soils formed from them (See also Pt. I, p. 85).

CARLETON UNIVERSITY

Heavy Metal Dispersion through Podzolic Soil Profiles

Applicant - J.E. Riddell Amount - $1,500.00

A study to determine the sites of concentration of selected heavy metals in podzolic soil profiles developed in glacial soils when (a) the source of the heavy metals is at the top of the profile as in the case of contaminated surface run off water and (b) the source is at the base of profile as in the case of oxidizing sulphide deposits.

Tungsten and Related Elements in Relation to Structural Development of the Appalachians

Applicant - J.E. Riddell Amount - $1,500.00

Field experience suggests a relation between various stages in the orogenic cycle and specific types of mineralization. In this project the possibility of a relation between concentrations of certain characteristic metallic and non-metallic mineral assemblages and primary and secondary structures of the Appalachian orogenic province will be investigated.

Geochemical Study of Austin Brook Iron Formation and Isotopic Investigation of Sulphide Deposits in Bathurst Area, N.B.

Applicant - William M. Tupper Amount - $2,000.00

The objective of the geochemical study is to determine the origin of the magnetite-hematite iron formation and associated pyritic zinc-lead sulphide deposit. The isotopic study will determine the behaviour and distribution of sulphur isotopes in the Bathurst deposits and host rocks thereby obtaining basic information necessary for a better understanding of the processes involved in the formation of sulphide deposits.

Geological Study of Brent Crater, Algonquin Park, Ont.

Applicant - William M. Tupper Amount - $ 600.00

The work will include field mapping of the crater and surrounding Precambrian gneisses, and petrographic, X-ray, and chemical study of material from surface exposures and drill cores to obtain structural and other data as to its origin.

DALHOUSIE UNIVERSITY

Chemistry of an Inland Sea

Applicant - W.R. Trost Amount - $2,500.00

Sediments and sedimentary processes are being studied in a laboratory model of an inland sea. Simulated leaching processes bring rocks into solution and disgorge the solution laden 'river' into the inland sea, with sedimentation occurring at places and in forms dependant on the chemical equilibria involved, and flow and evaporation rates in the 'sea'.

ECOLE POLYTECHNIQUE

Mineralogy and Petrography of the Oka Alkaline Intrusions and Study of Amphibole Minerals

Applicant - Guy Perrault Amount - $2,000.00

The objectives are to obtain a more thorough understanding of the distribution and composition of the niobium-bearing minerals at Oka, Quebec and of the petrography of the alkaline intrusions. A study of the amphibole minerals, including precise determination of their properties, is also underway.

UNIVERSITY OF MANITOBA

Gravity Studies at Coronation Mine, Manitoba

Applicant - William C. Brisbin Amount - $1,270.00

This project includes completion of field work, reduction of the surface readings, and complete interpretation of both the surface and subsurface data.

Quantitative Study of Ore Minerals at Coronation Mine, Manitoba

Applicant - G.M. Brownell Amount - $1,700.00

This forms part of a cooperative, comprehensive study of the Coronation copper deposit initiated by the National Advisory Committee on Research in the Geological Sciences. Several hundred samples of the ore have been collected for study.

Interpretation of Paragenesis of Ore Deposits

Applicant - H.D.B. Wilson Amount - $1,320.00

A study of the mineralogical and textural changes that take place during heating and cooling of ore specimens under controlled temperatures and pressures, ranging from room temperature to 1,100°C. Structural changes such as recrystallization, grain growth, precipitation, replacement and phase transformation in both ore and gangue will be studied visually at the temperatures at which they occur.

McGILL UNIVERSITY

Terrestrial Heat Flow in St. Lawrence Lowlands of Quebec

Applicants - T.H. Clark and V.A. Saull — Amount - $2,500.00

The objectives are to determine (1) depth-temperature curves for a number of bore-holes recently drilled in the vicinity of Montreal, and (2) the lithology and thermal properties of the strata penetrated by the holes by examination and testing of the drill cores. The results will be studied with particular reference to terrestrial heat flow, artesian water flow, and local and regional rock structure. (See also Pt. I, p. 86).

Silicate and Sulphide Phase Relationships

Applicants - J.E. Gill, E.H. Kranck, V.A. Saull — Amount - $5,000.00

This is a long term project involving experiments on the behaviour of silicates and sulphides at high temperatures and pressures to find out more about the formation of ores and the metamorphism of rocks. (See also Pt. I, p. 82).

Enthalpy Changes in Metamorphic Reactions

Applicant - V.A. Saull — Amount - $2,500.00

This project involves basic research on the changes (metamorphism) that rocks undergo when deeply buried in the earth's crust. Apparatus has been constructed to measure the heat developed in any solution process that can be made to occur in a closed system. These data are being used to obtain the heats of reactions, surface and strain energy of geologic materials. (See also Pt. I, p. 82).

Devonian Stromatoporoids from Canadian West and Arctic

Applicant - Colin W. Stearn — Amount - $ 550.00

A study of the stromatoporoid fauna from collections of the Geological Survey of Canada by microscopic examination of thin sections to find out if these animals can be used to correlate reefal sequences and to interpret the palaeoecology.

A Petrological-Geochemical Study of Mount Yamaska, Quebec

Applicant - G.R. Webber — Amount - $ 300.00

A study of the igneous rocks of Mount Yamaska with emphasis on the petrography and chemical composition of the rocks and constituent minerals.

McMASTER UNIVERSITY

Mineralogical and chemical studies of Basic and Ultrabasic Rocks

Applicant - T.N. Irvine — Amount - $1,500.00

This project includes field studies, chemical and spectrographic analysis for major and trace elements, X-ray studies, isotopic analysis and optical investigations. It is an attempt to classify ultrabasic rocks according to their chemical and mineralogical characteristics and petrologic associations, and to evaluate the factors involved in their evolution.

Sulphur Isotope Studies in Sulphide and Sulphate minerals of Niagara Escarpment

Applicant - R.E. Jones Amount $1,500.00

The project involves study of the distribution of sphalerite, galena, marcasite, pyrite, gypsum and barocelestite, both stratigraphically and regionally, in Silurian rocks exposed in the Niagara escarpment, and the collection of a suite of sulphide and sulphate minerals for determination of their sulphur isotope and minor element distribution. It is hoped the results of the study will suggest the origin and mode of deposition of the sulphide and sulphate minerals.

Statistical Geochemical Studies

Applicant - D.M. Shaw Amount $3,000.00

The general objective of these studies is to develop criteria for the origin of rock types, based on statistical studies of their trace element contents. Current work will include study of trace elements in Silurian shales, in the Glamorgan granite of southeastern Ontario, and in para- and ortho-amphibolites.

MEMORIAL UNIVERSITY

Cambrian Rocks of Western St. Mary's Bay Area, Avalon Peninsula, Nfld.

Applicant - W.D. Brueckner Amount - $2,000.00

A study of the Cambrian stratigraphy, conditions of sedimentation, palaeontology and structure of the area.

UNIVERSITY OF NEW BRUNSWICK

Palaeozoic Fishes and Fish Zones of Maritime Provinces

Applicant - H.R. Greiner Amount - $ 400.00

The collection and identification of fossil fishes of Silurian to Pennsylvanian age, principally in New Brunswick, to establish their morphologies and stratigraphic zonation.

Acidic Volcanics of Bourinot Group, Cape Breton Island

Applicant - A.L. McAllister Amount - $1,320.00

A detailed study of the stratigraphy of the Bourinot Group and the relation of the tuffs of this group to others in the northern Appalachians with which several massive sulphide deposits are associated.

Nickel Bearing Gabbros of the Miramichi Area, N.B.

Applicant - A.L. McAllister Amount - $1,320.00

A detailed field and petrographic study of a body or bodies of gabbro currently being explored for nickel. Much information including drill core, has been made available for this study.

UNIVERSITY OF OTTAWA

Conodont Faunas of Ottawa Limestone and other Palaeozoic Limestones

Applicant - David L. Dineley Amount - $2,300.00

No research of this type has been carried out on the limestones of Eastern Canada, but conodont studies in the United States and Europe have been remarkably successful. The immediate objective is to locate, describe and assess the stratigraphical value of conodont faunas in the St. Lawrence Lowlands.

QUEEN'S UNIVERSITY

Publication of Canadian Mineralogist (M.A.C.).

Applicant - L.G. Berry, Editor Amount - $1,600.00

The Mineralogical Association of Canada publishes the Canadian Mineralogist annually (the first number was published in 1957). Mineralogical studies are of interest to a relatively small group, and this necessitates financial support until the membership has built up. (See also Pt. I, p. 8).

Publication of "Mineralogy and Origin of Sudbury Ores" (M.A.C.).

Applicant - L.G. Berry, Editor Amount - $3,500.00

This grant will support the Mineralogical Association of Canada in publishing the major work of an outstanding Canadian mineralogist - the culmination of many years study made in collaboration with many graduate students. The study deals with the ores of Canada's most famous mining camp - one which is unique and known internationally. It is desirable that a work of this character be published in Canada.

Gravity and Magnetic Survey of Southern Quebec Serpentine Belt

Applicant - M.M. Fitzpatrick Amount - $ 800.00

The purpose is to find out if a combined magnetic and gravity survey can be used to determine the degree and depth of serpentinization of ultramafic masses. Between 500 and 600 gravity stations will be established between Thetford Mines and Asbestos. Where suitable gravity features are found, detailed magnetic studies will be carried out, accompanied by surface sampling of the ultramafic rocks of the area.

Distribution of elements in rocks and minerals

Applicant - Hugh R. Wynne-Edwards Amount - $2,000.00

A geochemical study of partition of elements between co-existing minerals in metamorphic rocks in the granulite and upper amphibolite facies. Preliminary work has been carried out on the compositions of co-existing cordierite, garnet and biotite from gneisses of the Westport area. The study will be extended to co-existing hypersthene, clinopyroxene and hornblende, and to garnet-hypersthene assemblages from this and other Canadian localities.

ST. FRANCIS XAVIER UNIVERSITY

Construction of Absolute post-Precambrian Time Scale by Rubidium-Strontium Dating of Glauconite and other Minerals

Applicant - R.F. Cormier — Amount - $1,000.00

Dating of glauconite found in sedimentary rocks holds considerable promise as a means of establishing an absolute time scale as opposed to the purely relative palaeontologic time scale. More than twenty palaeontologically well dated glauconites have been obtained and microgram quantities of rubidium and strontium have been separated for isotopic analysis and calculation of age.

UNIVERSITY OF SASKATCHEWAN

Trace Elements in Sulphides and Associated Wall-rocks Coronation Mine, Manitoba

Applicant - A.R. Byers — Amount - $ 320.00

A study of the amount and distribution of trace elements in the ore and wall-rocks. This study forms part of an overall investigation of the Coronation orebody which it is hoped will provide a better understanding of the genesis of such deposits.

Cretaceous Foraminifera from Saskatchewan

Applicants - F.H. Edmunds and W.O. Kupsch — Amount - $2,000.00

A study of the Late Cretaceous foraminifera and the establishment of microfaunal zones for the Montana beds underlying Saskatchewan.

Palaeontology and Palaeoecology of Pleistocene and Postglacial Invertebrates in Saskatchewan

Applicant - W.O. Kupsch — Amount - $2,000.00

Involves collection and study of Pleistocene and early Postglacial invertebrate fossils, including stratigraphic and geomorphic studies at the sites. The objective is a better understanding of the environment prevailing during Pleistocene and early Postglacial times.

Palynological Studies

Applicants - W.G.E. Caldwell, W.O. Kupsch, and F.H. Edmunds — Amount - $2,000.00

This project involves systematic analyses of Pleistocene, Cretaceous and Jurassic sediments for fossil pollen and spores in an attempt to gain a stratigraphic and statistical record of vegetation changes, both climatic and evolutionary. (See also Pt. I, p. 88).

Evaporite and Carbonate Deposits of Saskatchewan

Applicant - N.C. Wardlaw — Amount - $ 400.00

A petrologic and stratigraphic study of potash bearing beds and associated carbonate and related sedimentary rocks of the Middle Devonian evaporite formation in part of south-central Saskatchewan.

UNIVERSITY OF TORONTO

Analysis of Methods used in Structural Cross-sections

Applicant - John B. Currie Amount - $1,500.00

An investigation and development of improved methods for preparing interpretive cross-sections and subsurface geologic structures with particular reference to fold and fault structures in sedimentary strata.

Age Determinations and Isotope Studies of a Keewatin Greenstone Belt

Applicants - J.T. Wilson and M.A. Farquhar Amount - $4,000.00

The purpose is to determine if rubidium - strontium , uranium-lead, and possibly potassium-argon age determination techniques are useful in establishing the time sequence and metamorphic history of the rocks in a selected greenstone belt in the Keewatin geological province of the Canadian Shield.

UNIVERSITY OF WESTERN ONTARIO

Stratigraphic correlation of Glacial Deposits between Lake Huron and St. Lawrence Lowlands

Applicant - A. Dreimanis Amount - $ 750.00

This work includes lithologic investigation of tills and studies of leaching of soils so that stratigraphic correlations may be made. Results of recent studies related to this project have been published in 1960 and 1961 in four papers by Professor Dreimanis. (See also Pt. I, p. 86).

Repose Slopes of Pleistocene Material in Southwestern Ontario

Applicant - R.W. Packer Amount - $ 980.00

A study of the stable angle for slopes in river valleys and road cuts to prevent excessive bank erosion.

Geophysical Prospecting Methods

Applicant - R.J. Uffen Amount - $1,300.00

This project includes two projects supported previously. The first involves application of the method of 'Operations Research' in the study of problems such as optimum spacing of diamond drill holes, of airborne magnetometer flight lines and probability of success in prospecting based on past statistical data. The second is an investigation of the possibility of measuring the induced and remanent magnetism of rocks by combined use of electromagnetic, magnetic, and resistivity methods. (See also Pt. I, p. 59).

CURRENT RESEARCH IN THE GEOLOGICAL SCIENCES IN CANADA, JUNE, 1960 - MAY, 1961

Compiled by J.F. Henderson

CONTENTS

INTRODUCTION

The lists of research projects in the bibliography have been obtained from the universities, federal and provincial departments of mines, and other non-industrial institutions carrying on research in geological sciences in Canada. With the exception of a few projects, mostly in micropalaeontology, they do not include research by mining and oil company geologists. The survey was made from December 1960 to April 1961 and the bibliography records research in progress for about the period June 1960 to May 1961.

The bibliography is useful in indicating lines of geological research receiving the greatest attention, and by inference, those being neglected; and in enabling research workers to see who are working in similar fields and on similar problems. It also serves as a record of the large number of research projects undertaken as graduate student theses in our universities, many of which are available only in manuscript form in university libraries.

Success in assembling project titles for a bibliography such as this depends on the response of institutions and individual research workers. Acknowledgement is made in particular to those who assembled and forwarded data on research projects in institutions under their direction. However, in spite of general excellent cooperation, many projects on which no information was received have not been recorded. So that succeeding compilations may be more complete, any reader doing research projects or knowing of projects that have been omitted, is requested to send information of them to the Secretary, National Advisory Committee on Research in the Geological Sciences, 601 Booth Street, Ottawa.

Use of the Bibliography

In the bibliography projects are grouped under main headings that cover the different branches of the geological sciences. The reader can thus find out readily the research in progress in any field in which he is interested. Many projects that seem to fall equally well under more than one heading will be found repeated under those headings. An author index lists after each author the numbers of projects, as listed in the bibliography, on which he is currently engaged. Thus by reference to the author index, the fields of research and projects of any worker can be found readily.

AREAL GEOLOGY

Alberta

1. Price, R.A., Geol. Surv., Canada:
   Fernie Map-area (East Half), British Columbia and Alberta, 1 inch to 4 miles, 1958-60.

2. Mountjoy, E.W., Geol. Surv., Canada:
   Mount Robson Southeast Map-area, 1 inch to 4 miles, 1959-61.
   Includes study of Cambrian units in sufficient detail to make positive correlations; fossil collections for future Cambrian palaeontological studies; study of Devonian Ancient Wall reef and facies relations with surrounding strata; mapping of Front Range thrust sheets, Pyramid thrust and Main Range structure. See Mount Robson Southeast Prel. Paper, Geol. Surv., Canada (in press).
   Geology of Miette Area, Jasper National Park, 1956-60; Ph.D. thesis, Univ. of Toronto, 1960.
   Study of stratigraphy and carbonate petrography of a small Devonian reef is continuing. Significant correlations of carbonate facies can be demonstrated.

3. Tremblay, L.P., Geol. Surv., Canada:
   West Border of Canadian Shield, Alberta and Saskatchewan, 1 inch to 4 miles, 1960-61.

British Columbia

4. Brown, A. Sutherland, British Columbia Dept. Mines and Petroleum Resources:
   Geological Mapping, Queen Charlotte Islands, 1957-61.
   The work is mainly in the southern part of Moresby Island, and between Cumshewa and Skidegate Inlets, but includes reconnaissance on Graham Island. See Prel. Map of Southern Queen Charlotte Islands; B.C. Dept. Mines and Petroleum Resources.

5. Campbell, R.B., Geol. Surv., Canada:
   Quesnel Lake Map-area, 1 inch to 4 miles, 1959-61.
   The structure, stratigraphy and metamorphism of the Lower Palaeozoic and Proterozoic rocks, including the problem of the Cambrian-Precambrian boundary and the stratigraphy of the Triassic and Jurassic volcanic and sedimentary rocks included in the Quesnel River group; and the extension of the Pinchi Lake fault zone.

6. Carr, J.M., British Columbia Dept. Mines and Petroleum Resources:
   Craigmont Mine and Promontory Hills, Detailed Geological Mapping, 1958-60.
   A further study of mine geology, including logging of diamond drill cores, and the study of structure of Nicola group rocks, Promontory Hills. See Note on Craigmont Mine; Report of the Minister of Mines, B.C., 1959, pp. 31-34.

7. Danner, Wilbert R., Univ. of British Columbia:
   Geology of the San Juan Islands, 1958-60.

8. Eastwood, G.E.P., British Columbia Dept. Mines and Petroleum Resources:
A Study of Nicola Group Rocks by Detailed Mapping in the Vicinity of Lawless Creek, Tulameen River, 1960.

9. Gabrielse, H., Geol. Surv., Canada:
Kechika and Rabbitt River Map-area, 1 inch to 4 miles, 1957-61.
Data have been collected on the stratigraphy and structure of Proterozoic and Lower Palaeozoic strata on both sides of the Rocky Mountain Trench. Information has also been obtained on facies changes in Cambrian strata from southwest to northeast in the Cassiar and Rocky Mountains. See Geol. Surv., Canada, Map 57-1959.

10. Hughes, J.E., McGill Univ.:
Field Studies of the Geology of the Peace and Pine River Foothills, 1958-61; Ph.D. thesis.

11. Irish, E.J.W., Geol. Surv., Canada:
Halfway River Map-area, British Columbia, 1 inch to 4 miles, 1959-61.
Special attention will be given to oil and gas potentialities.

12. Jeffery, W.G., British Columbia Dept. Mines and Petroleum Resources:
Mapping in Vicinity of Mannix Coast Copper Mines, Port McNeil Area, Vancouver Island, 1/2 inch to 1 mile, 1960-62.

13. Leech, G.B., Geol. Surv., Canada:
Fernie Map-area, 1 inch to 4 miles, 1956-60.

14. McTaggart, K.R., and Thompson, R.M., Univ. of British Columbia:
Areal Geology of the Southeast Corner of the Hope Area, 1957-61.

15. Muller, J.E., Geol. Surv., Canada:
Pine Pass Map-area, 1 inch to 4 miles, 1959-61.

16. Price, R.A., Geol. Surv., Canada:
Fernie Map-area (East Half), British Columbia and Alberta, 1 inch to 4 miles, 1958-60.

17. Souther, J.G., Geol. Surv., Canada:
Sumdum (Chutine), and Tulsequah Map-areas, 1 inch to 4 miles, 1958-60.
See Geol. Surv., Canada Maps 7-1959, 6-1960.

18. Taylor, G.C., Geol. Surv., Canada:
McDonald River Map-area, 1 inch to 1 mile, 1960-61.
With special attention to oil and natural gas potentialities.

19. Tipper, H.W., Geol. Surv., Canada:
Prince George Map-area, 1 inch to 4 miles, 1954-61.

20. Wheeler, J.O., Geol. Surv., Canada:
Rogers Pass Map-area, 1 inch to 4 miles, 1959-61.
Will provide information on geology of the Selkirk Mountains, Rocky Mountain Trench, and part of the Rocky Mountains to the Continental Divide.

Manitoba

21. Barry, George S., Manitoba Mines Branch:
Geology of God's Narrows Area, 1960-61.

22. Bell, C.K., Geol. Surv., Canada:
Cross Lake Map-area, 1 inch to 4 miles, 1960.

23. Burwash, R.A., Manitoba Mines Branch (part time), Univ. of Alberta:
Geology of Rusty Lake Area, 1960-61.

24. Currie, K.L., Geol. Surv., Canada:
Whiskey Jack Lake Map-area, 1 inch to 4 miles, 1960.

25. Patterson, J.M., Manitoba Mines Branch:
Geology of Thompson - Moak Lake Area, 1958-.
A joint project with the Univ. of Manitoba.

26. Pollock, G.D., Manitoba Mines Branch:
Geology of Duval - Kipihigan Lakes Area, 1960; Ph.D. thesis, Univ. of Manitoba.

27. Rousell, D.H., Manitoba Mines Branch:
Geology of Cross Lake Area, 1960; Ph.D. thesis, Univ. of Manitoba.

28. Williams, H., Geol. Surv., Canada (part time):
Detailed Mapping of the Chisel Lake Map-area, 1958-59; Ph.D. thesis, Univ. of Toronto.
See Geol. Surv., Canada Map 27-1960.

New Brunswick

29. Poole, W.H., Geol. Surv., Canada:
Hayesville Map-area, 1 inch to 1 mile, 1959-60.
This area in central New Brunswick contains mainly Middle Ordovician quartzite, greywacke, slate and volcanic rocks; Middle Silurian greywacke and slate; at least two ages of granitic rocks; and undeformed Carboniferous strata. Some of the younger granitic stocks contain quartz veins with wolframite, molybdenite, fluorite and beryl. These stocks control in part the location of the Burnt Hill Tungsten Mine.
See Geol. Surv., Canada Paper 60-15, 1960.

Newfoundland and Labrador

30. Anderson, F.D., Geol. Surv., Canada:
Paradise Map-area, Newfoundland, 1 inch to 4 miles, 1960.

31. Baragar, W.R.A., Geol. Surv., Canada:
Wakuach Lake Map-area, Quebec and Labrador, 1 inch to 4 miles, 1958-60.
History of development of Labrador geosyncline and its subsequent orogenic phase; analysis of structural cross-section through Labrador Trough; delineation of zones of regional metamorphism. See Petrology of Basaltic Rocks of Labrador Trough, Geol. Soc. Amer. Bull., vol. 71, pp. 1589-1644, 1960.

32. Fahrig, W.F., Geol. Surv., Canada:
Shabogamo Lake Map-area (East Half), Quebec and Newfoundland, 1959.
See Geol. Surv., Canada Paper 60-19.

33. Greene, B., Memorial Univ. of Newfoundland:
Geology of Area around Cape St. Mary's (Avalon Peninsula), Eastern Part, 1960-62; M.Sc. thesis.
Includes study of stratigraphy and structure of Cambrian formations and petrography of basic intrusive rocks.

34. Jackson, G.D., Geol. Surv., Canada:
Geology of an Area West of Wabush Lake, Labrador, with Special Reference to Iron Deposits, 1958-61; Ph.D. thesis, McGill Univ.

35. Mullins, Jack, Memorial Univ. of Newfoundland:
Geology of that Part of the Noel Paul River Area between Tally Pond and Lake Ambrose, Central Newfoundland, with Special Reference to Petrography, 1959-61; M.Sc. thesis.

36. Nash, W.A. Neale, E.R.W., Larochelle, A., and Black, R.F., Geol. Surv., Canada:
Sandy Lake Map-area, Newfoundland, 1 inch to 4 miles, 1960-61.
Recent work suggests the unfossiliferous Devonian(?) Springdale group may include rocks of two ages. To test this hypothesis oriented specimens were collected for palaeomagnetic analysis. Preliminary results suggest that there are indeed two ages represented. Further specimens will be collected in the 1961 field season.

37. Neale, E.R.W., Geol. Surv., Canada:
Kings Point and Hampden Map-areas, Newfoundland, 1 inch to 1 mile, 1959-60.
See Geol. Surv., Canada Map 35-1960.

38. Wynne-Edwards, H.R., Geol. Surv., Canada (part time) Queen's Univ.:
Ossokmanuan Map-area, Quebec and Newfoundland, 1 inch to 4 miles, 1960.

Northwest Territories

39. Blackadar, R.G., Geol. Surv., Canada:
Hobart Island, White Bear Bay and Cape Dorset Map-areas, District of Franklin, 1 inch to 4 miles and 1 inch to 1 mile (Cape Dorset), 1958-60.
See Geol. Surv., Canada Maps 11-1959 and 55-1959.

40. Christie, R.L., Geol. Surv., Canada:
Exploration of Southeast Ellesmere Island, 1 inch to 8 miles, 1960-.

41. Heywood, W.W. (in charge), Davison, W.L., Tremblay, M., Aitken, J.D., and Blanchard, J.L., Geol. Surv., Canada:
Operation Back River, 1 inch to 8 miles, 1960.
Geological reconnaissance mapping with helicopter support of an area bounded by latitude 66 degrees and the Arctic Coast and the western boundary of Keewatin District east to about longitude 90 degrees.

42. McGlynn, J.C., Geol. Surv., Canada:
Regional Correlation of the Northwest Canadian Shield, 1960-.
The purpose is to provide data for better correlation of Precambrian rocks in the northwest Canadian Shield by studying key areas.

43. Morse, Stearns A., Arctic Institute of North America:
Bedrock Geology of Kiglapait - Manvers Area, 1960-62; Ph.D. thesis, McGill Univ.

44. Thorsteinsson, R., Christie, R.L., Tozer, E.T., and Fyles, J.G., Geol. Surv., Canada:
Banks and Victoria Islands, District of Franklin, 1 inch to 8 miles, 1959-.
Areal mapping with special attention to stratigraphic-palaeontological studies and surficial geology.

Nova Scotia

45. Benson, D.G., Geol. Surv., Canada:
Geology of the Hopewell Map-area, Nova Scotia, 1 inch to 1 mile, 1960-61.
Special attention will be given to the Carboniferous stratigraphy.

46. Kelley, D.G., Geol. Surv., Canada:
Cheticamp, Margaree and Lake Ainslie Map-areas, 1 inch to 1 mile, 1960.

47. Schiller, E., Geol. Surv., Canada (part time):
Guysborough Map-area, Nova Scotia, 1 inch to 1 mile, 1959-60; Ph.D. thesis.

48. Taylor, F.C., Geol. Surv., Canada:
Shelbourne Map-area, 1 inch to 4 miles, 1959-60.
Annapolis Map-area, 1 inch to 4 miles, 1960-61.

Ontario

49. Card, K.D., Ontario Dept. Mines (part time), Princeton Univ.:
Hyman and Drury Townships, District of Sudbury, 1 inch to 1/2 mile, 1960-61.

50. Duffell, S. (in charge), Prest, V.K., MacLaren, A.S., Donaldson, J.A., Kranck, S., Jackson, G.D., Elmslie, R.F., and Carruthers, C.A., Geol. Surv., Canada:
Geological Mapping in Northwestern Ontario (Roads to Resources Project), 1 inch to 4 miles, 1959-61.
A cooperative project with Ontario Department of Mines to provide data on an area of 50,000 square miles between Lat. 51 and 53 degrees north and Long. 86 and 94 degrees west. Investigations include an aeromagnetic survey, mapping of bedrock and surficial geology, geochemical reconnaissance and examination of certain aeromagnetic anomalies indicated by the aeromagnetic survey. See Geol. Surv., Canada Map 58-1959, and maps of North Spirit Lake, North Caribou Lake and Mininiska Areas (in press).

51. Ferguson, S.A., Ontario Dept. Mines:
Dome Township, District of Kenora, 1 inch to 1,000 feet, 1960.

52. Frarey, M.J., Geol. Surv., Canada:
Wakwekobi Map-area, Ontario, 1 inch to 1 mile, 1959-63.
Part of a programme of revision and extension of earlier mapping in the original Huronian area, with emphasis on Huronian stratigraphy and structure.

53. Ginn, R.M., Ontario Dept. Mines:
Clergue and Dundonald Townships, District of Cochrane, 1 inch to 1,350 feet, 1960-61.

54. Grant, J.A., Ontario Dept. Mines (part time), California Institute of Technology:
Vogt, Hobbs and Pardo Townships, District of Nipissing, 1 inch to 1/2 mile, 1959-60.

55. Hay, R.E., Geol. Surv., Canada (part time):
Sault Ste. Marie Map-area, 1 inch to 1 mile, 1959-60; Ph.D. thesis, McGill Univ.

56. Hewitt, D.F., Ontario Dept. Mines:
Madoc-Gananoque Area, 1 inch to 2 miles, 1960-61.

57. Hudec, P.P., Ontario Dept. Mines (part time):
Big Trout Lake Area, District of Kenora, 1 inch to 1 mile, 1960-61; Ph.D. thesis, McGill Univ.

58. Irvine, T.N., Ontario Dept. Mines (part time), McMaster Univ.:
Lac des Mille Lacs, District of Thunder Bay, 1 inch to 1 mile, 1960-61.

59. Liberty, B.A., Geol. Surv., Canada:
Palaeozoic Rocks of Southeastern Ontario, 1 inch to 4 miles, 1959-60.
Includes study of stratigraphy and sedimentation of Palaeozoic rocks in Ontario eastward to the Frontenac Axis. See Geol. Surv., Canada Paper 60-14 and 60-31.

60. Lumbers, S.B., Ontario Dept. Mines (part time), Princeton Univ.:
Sargeant, Hepburn and Adair Townships, District of Cochrane, 1 inch to 1/2 mile, 1960.

61. Milne, V.G., Ontario Dept. Mines (part time), Univ. of Toronto:
Flanders Lake Area, District of Thunder Bay, 1 inch to 1 mile, 1960.

62. Puskas, F.P., Ontario Dept. Mines (part time), Lehigh Univ.:
Port Coldwell Area, District of Thunder Bay, 1 inch to 1/2 mile, 1959-60.

63. Pye, E.G., Ontario Dept. Mines:
Big Duck Lake Area, District of Thunder Bay, 1 inch to 1,320 feet, 1960.

64. Robertson, J.A., Ontario Dept. Mines (part time), Univ. of Toronto:
McGiverin and Long Townships, District of Algoma, 1 inch to 1/2 mile, 1960.

65. Simony, P.S., Ontario Dept. Mines (part time), Imperial College, London, Eng.:
Phyllis, Joan, Belfast, Cynthia and Le Roch Townships, District of Nipissing, 1 inch to 1 mile, 1960.

66. Wright, G.M., Geol. Surv., Canada:
Deep River Map-area (West Half), Ontario, 1 inch to 4 miles, 1959-63.
Grenville, Region, Ontario and Quebec, 1960-.
Reconnaissance and development of techniques for 1 inch to 4 mile mapping of the Grenville rocks.

Prince Edward Island

67. Frankel, L., Geol. Surv., Canada (part time):
Mapping of the Surficial and Bedrock Formation of Prince Edward Island, 1 inch to 1 mile, 1953-61.

Quebec

68. Ayrton, W.G., Quebec Dept. Mines (part time), Northwestern Univ.:
Chandler - Port Daniel Area, Gaspé South County, 1 inch to 1 mile, 1960-62; Ph.D. thesis.

69. Baragar, W.R.A., Geol. Surv., Canada:
Wakuach Lake Map-area, Quebec and Labrador, 1 inch to 4 miles, 1958-60.
Problems include a history of development of Labrador geosyncline and its subsequent orogenic phase; analysis of structural cross-section through Labrador Trough; delineation

of zones of regional metamorphism. See Petrology of Basaltic Rocks of Labrador Trough, Geol. Soc. Amer. Bull., vol. 71, pp. 1589-1644, 1960.

70. Beland, J., Quebec Dept. Mines:
Reconnaissance of Matapedia River, Temiscouata Lake Area, 1 inch to 2 miles, 1958-61.

71. Benoit, F.W., Quebec Dept. Mines:
Condé - Bourbon Area, Roberval County, 1 inch to 1 mile, 1960-61.

72. Bérard, Jean, Quebec Dept. Mines:
Cartier - Tracy Area, Joliette County, 1 inch to 1 mile, 1960-61.

73. Chagnon, J.-Y., Quebec Dept. Mines (part time):
Brodeur -Caire Area, Témiscamingue and Rouyn-Noranda Counties, 1 inch to 1 mile, 1960-62; Ph.D. thesis.

74. Chown, E.H., Quebec Dept. Mines (part time), Johns Hopkins Univ.:
Shigami Mountains Area, Mistassini Territory, 1 inch to 1 mile, 1959-61; Ph.D. thesis.
See Papachouésati River Area, Que. Dept. Mines, Prel. Rept., No. 415, 1960.

75. Clark, T.H., Quebec Dept. Mines (part time), McGill Univ.:
Granby Area, West Half, Shefford and Rouville Counties, 1 inch to 1 mile, 1960-62.

76. Clarke, P.J., Quebec Dept. Mines (part time), Univ. of Manitoba:
Gras Lake Region, Saguenay County, 1 inch to 1 mile, 1960-62; Ph.D. thesis.
See Prel. Rept. on the Normanville Area, Que. Dept., Mines, P.R. No. 413, 1960.

77. Duquette, Gilles, Quebec Dept. Mines (part time), Laval Univ.:
Lake Aylmer and Stratford Areas, Wolfe and Frontenac Counties, Quebec, 1 inch to 1,000 feet, 1960-61; Ph.D. thesis.

78. Eakins, P.R., Quebec Dept. Mines (part time), McGill Univ.:
Natel Lake - Casey Lake Area, Mistassini Territory, 1 inch to 1 mile, 1960-61.

79. Fahrig, W.F., Geol. Surv., Canada:
Shabogamo Lake Map-area (East Half), Quebec and Newfoundland, 1 inch to 4 miles, 1959.
See Geol. Surv., Canada Paper 60-19.

80. Gélinas, Léopold, Quebec Dept. Mines:
Watts Lake Area, New Quebec, 1 inch to 1 mile, 1960-62.

81. Gilman, W.J., Univ. of Toronto:
Geology of Desmeloizes and Part of Lareine Townships, Quebec, 1958-61; Ph.D. thesis.
A study of the regional geology with particular reference to the diabase dykes.

82. Gorman, W. Alan, Queen's Univ.:
Geology of the Estcourt - Baker Lake Area, Temiscouata County, Quebec, 1956-61.
This forms part of a mapping programme in southern Quebec by the Que. Dept. Mines.

83. Hashimoto, T., Quebec Dept., Mines (part time), McGill Univ.:
Hippocampe Lake Area, Mistassini Territory, 1 inch to 1 mile, 1960-61.

84. Hogarth, D.D., Univ. of Ottawa:
A Guide to the Geology of the Gatineau - Lievre Region, Quebec, 1960-61.
This report will include geological maps and descriptions of mineral occurrences within a radius of about 30 miles of Ottawa. The text is intended for use of geologists, students and naturalists.

85. Hogg, Wm. A., Quebec Dept. Mines:
Compilation of the Geology of Duprat and Clericy Townships, Quebec, 1959-60.

86. Jurkus, R.A., McGill Univ.:
The Geology of Part of Hippocampe Lake Area, Quebec, 1959-61; M.Sc. thesis.

87. Lajoie, J., Quebec Dept. Mines (part time), McGill Univ.:
Grénier - Varin Area, Rimouski County, 1 inch to 1 mile, 1960-62; Ph.D. thesis.

88. Laurin, A.F., Quebec Dept. Mines:
Cabonga Reservoir Area (Southern Part), 1 inch to 1 mile, 1959-60.

89. Lee, S.M., Quebec Dept. Mines (part time):
Port Harrison - Hopewell Point Area, New Quebec, 1 inch to 1 mile, 1959-61; Ph.D. thesis.

90. McGerrigle, J.I., Quebec Dept. Mines:
Degrosbois Area, Beresford Township, Terrebonne and Montcalm Counties, Quebec, 1 inch to 1,000 feet, 1960-61.

91. McPhee, D.S., Quebec Dept. Mines (part time), Univ. of London:
Michaud Lake Area, 1 inch to 1 mile, 1959-62; Ph.D. thesis.

92. Morin, M., and others, Quebec Dept. Mines:
Compilation of the Geology of the Province of Quebec, 1 inch to 4 miles and 1 inch to 16 miles, 1959-61.

93. Moyer, P.T., Quebec Dept. Mines (part time), Univ. of Michigan:
Boisvert Lake Area, Mistassini Territory, 1 inch to 1 mile, 1960-62; Ph. D. thesis.

94. Newham, W.D., Quebec Dept. Mines (part time), McGill Univ.:
Chaumont - Borgia Area, Quebec and Laviolette Counties, 1 inch to 1 mile, 1960-62; Ph. D. thesis.

95. Ollerenshaw, N., Quebec Dept. Mines (part time), Univ. of Toronto:
Cuoq - St. Vianney Area, Matane and Matapedia Counties, 1 inch to 1 mile, 1959-61; Ph.D. thesis.

96. Papezik, V.S., Quebec Dept. Mines (part time), McGill Univ.:
Glen Almond Area, Papineau County, Quebec, 1 inch to 1,000 feet, 1960-61; Ph.D. thesis.

97. Philpotts, Anthony R., Quebec Dept. Mines (part time), McGill Univ.:
Southeastern Part of Grenville Township, Argenteuil County, Quebec, 1 inch to 1,000 feet, 1960-61; Ph.D. thesis.

98. Pollock, D.W., Quebec Dept. Mines (part time), Michigan College of Mining and Technology:
Nominingue Area, Labelle County, 1 inch to 1 mile, 1960-61.

99. Pouliot, Gaston, Quebec Dept. Mines (part time), McGill Univ.:
Southwest Quarter McCorkill Township, Abitibi East County, Quebec, 1 inch to 1,000 feet, 1960-61; Ph. D. thesis.

100. Remick, J.H., Quebec Dept Mines:
Harricana - Obamska Lake Area, Abitibi West County and Abitibi Territory, 1 inch to 1 mile, 1959-62.

101. Robert, J.-L., Quebec Dept. Mines (part time), Laval Univ.:
Kipawa Area, Témiscamingue County, 1 inch to 1 mile, 1960-62; Ph.D. thesis.

102. Rondot, J., Quebec Dept. Mines:
Langelier - La Croche Area, Laviolette and Quebec Counties, 1 inch to 1 mile, 1960-62.

103. Sabourin, R., Quebec Dept. Mines (part time), Laval Univ.:
Denys and Fagnant Lakes Area, New Quebec, 1 inch to 1 mile, 1960-61.

104. St. Julien, Pierre, Quebec Dept. Mines (part time), Laval Univ.:
Montjoie Lake Area, Stanstead, Sherbrooke and Richmond Counties, Quebec, 1 inch to 1,000 feet, 1960-61; Ph. D. thesis.

105. Sanschagrin, R.J., Quebec Dept. Mines (part time), Univ. of Ottawa:
Geology of Magdalen Islands, 1960-61.

106. Sauvé, P., Quebec Dept. Mines:
Lower Manicouagan River Area, Saguenay County, 1 inch to 1 mile, 1960-61.

107. Sharpe, John I., Quebec Dept. Mines (part time), McGill Univ.:
South Half Figuery Township and Southwest Quarter Landrienne Township, Abitibi East County, Quebec, 1 inch to 1,000 feet, 1960-61.
Geology of Mattagami Lake Area, Quebec, 1960-62; Ph.D. thesis.

108. Sinclair, A.J., Quebec Dept. Mines (part time), Univ. of British Columbia:
Peppler Lake (West) and Cailletoux Lake (West) Area, Saguenay County, 1 inch to 1 mile, 1959-61.

109. Skidmore, W. B., Quebec Dept. Mines:
Carleton-Pilote Area, Bonaventure County, 1959-61.

110. Stevenson, I. M., Geol. Surv., Canada:
Operation Ungava (Quebec West of Labrador Trough), 1 inch to 8 miles, mapping by helicopter, 1960-61.
Work in 1960 involved preliminary reconnaissance and preparation for 1961 operation.

111. Thibault, Camille, Quebec Dept. Mines (part time), McGill Univ.:
Northwest Quarter of Montbray Township, Rouyn-Noranda County, Quebec, 1 inch to 1,000 feet, 1960-61; Ph. D. thesis.

112. Wolhuter, Louis E., Quebec Dept. Mines (part time), McGill Univ.:
Southeast Quarter Daubrée Township, Abitibi East County, Quebec, 1 inch to 1,000 feet, 1960-61; Ph. D. thesis.

113. Wright, G. M., Geol. Surv., Canada:
Grenville Region, Ontario and Quebec, 1960-.
Reconnaissance and development of techniques for 1 inch to 4 miles mapping of the Grenville rocks.

114. Wynne-Edwards, H. R., Geol. Surv., Canada (part time), Queen's Univ.:
Ossokmanuan Map-area, Quebec and Labrador, 1 inch to 4 miles, 1960.

Saskatchewan

115. Colborne, G. L., Saskatchewan Dept. Mineral Resources:
Geology of the Clut Lakes Area, 1 inch to 1 mile, 1959-60.
See Summary of Geological Surveys Conducted in the Precambrian Area of Saskatchewan, 1960; Saskatchewan Dept., Mineral Resources, 1960.

116. Hall, D. D., and Kupsch, W. O., Univ. of Saskatchewan:
Relation between Geophysics, Bedrock Geology, and Surficial Geology of Churchill River Area, Saskatchewan, 1960-62.

117. Johnston, F. J., Saskatchewan Dept. Mineral Resources:
Geology of the Astrolabe Lake Area, 1 inch to 1 mile, 1959-60.
See Summary of Geological Surveys conducted in the Precambrian Area of Saskatchewan, 1960; Saskatchewan Dept. Mineral Resources, 1960.

118. Koster, F., Saskatchewan Dept. Mineral Resources:
Geology of the Thainka Lake Area (West Half), 1 inch to 1 mile, 1960-61.
See Summary of Geological Surveys conducted in the Precambrian Area of Saskatchewan, 1960; Saskatchewan Dept. Mineral Resources, 1960.

119. Money, P., Saskatchewan Dept. Mineral Resources:
Geology of the Barnett Lake Area (West Half), 1 inch to 1 mile, 1960-61.
See Summary of Geological Surveys conducted in the Precambrian Area of Saskatchewan, 1960; Saskatchewan Dept. Mineral Resources, 1960.

120. Morris, A., Saskatchewan Dept. Mineral Resources:
Geology of the Trout Lake Area (East Half), 1 inch to 1 mile, 1959-60.
Geology of the Settee Lake Area (West Half), 1 inch to 1 mile, 1960-61.
See Summary of Geological Surveys conducted in the Precambrian Area of Saskatchewan, 1960; Saskatchewan Dept. Mineral Resources, 1960.

121. Padgham, W.A., Saskatchewan Dept. Mineral Resources:
The Geology of the Otter Lake Area, 1 inch to 1 mile, 1959-60; Ph.D. thesis, Univ. of Wisconsin.
See Summary of Geological Surveys conducted in the Precambrian Area of Saskatchewan, 1960; Saskatchewan Dept. Mineral Resources, 1960.

122. Pyke, M.W., Saskatchewan Dept. Mineral Resources:
Geology of the Wapus Bay Area (East Half), 1 inch to 1 mile, 1959-60.
See Geology of the Wapus Bay Area (East Half); Saskatchewan Dept. Mineral Resources (in press).

123. Shklanka, R., Saskatchewan Dept. Mineral Resources:
The Geology of the Oliver Lake Area (East Half) 1 inch to 1 mile, 1959-61.
Geology of the Deception Lake Area (East Half), 1 inch to 1 mile, 1960-61.
See Summary of Geological Surveys conducted in the Precambrian Area of Saskatchewan, 1960; Saskatchewan Dept. Mineral Resources, 1960.

124. Tremblay, L.P., Geol. Surv., Canada:
West Border of Canadian Shield, Alberta and Saskatchewan, 1 inch to 4 miles, 1960-61.

Yukon Territory

125. Roddick, J.A., Green, L.H., and Wheeler, J.O., Geol. Surv., Canada:
Operation Pelly, Yukon Territory, 1 inch to 4 miles, (with air support), 1958-60.
The project has provided much new information on Palaeozoic stratigraphy and structure in southeastern Yukon. The structure of the Pelly Mountains is characterized by low angle thrusts unlike that of the Cassiar Mountains to the south. The Tintina Trench marks a major structural break separating Palaeozoic rocks of different facies and metamorphic grade. See Geol. Surv., Canada Maps 7-1960, 8-1960 and 10-1960.

ENGINEERING GEOLOGY

126. Bozozuk, M., Division of Building Research, National Research Council:
Swelling and Shrinkage of Clays, 1954-.
See Shrinking and Swelling of Two Canadian Clays; a paper prepared for presentation to the Fifth Conference of the International Society of Soil Mechanics and Foundation Engineering, Paris 1961.

127. Brandon, L.V., Geol. Surv., Canada:
Ground-water Geology of Permafrost Areas, Mackenzie District, N.W.T. 1960-.
The purpose is to provide information on ground-water conditions in areas of permafrost.

128. Brink, V.C., and Mackay, J.R., Univ. of British Columbia:
Needle Ice, 1960-.
A study of the effect of needle ice on frost heaving and plants.

129. Brown, R J.E., Division of Building Research, National Research Council:
Permafrost Distribution in Canada; Permafrost Boundary in Canada; Energy Exchange at Ground Surface in Relation to Permafrost Distribution, 1953-.
In addition to recording information on the occurrence of permafrost in Canada by direct observation, this project has now been directed towards an analysis of the various components of energy exchange at the earth's surface as a means of improving the understanding of and the ability to predict the distribution and occurrence of permafrost. See Distribution of Permafrost and Its Relation to Air Temperature in Canada and the U.S.S.R.; Arctic, vol. 13, No. 3, September 1960, pp. 163-177.

130. Burn, K.N., Bozozuk, M., Crawford, C.B., Eden, W.J., and Hamilton, J.J., Division of Building Research, National Research Council:
Geotechnical Properties of Eastern Marine Clay, 1951-.
Attempts are being made to collect and correlate geotechnical data on the Eastern Marine clay. Laboratory investigations include studies of behaviour of the clays in triaxial and consolidation tests. Field work includes measurements of settlement of two heavy earth embankments and case record studies of landslides. See Influence of Rate of Strain of Effective Stresses in Sensitive Clay; Special Tech. Pub. No. 254, ASTM, 1960, and Improved Determination of Preconsolidation Pressure of a Sensitive Clay; Special Tech. Pub. No. 254, ASTM, 1960.

131. Chapman, L.J., Ontario Research Foundation and Brown, R.J.E., Division of Building Research, National Research Council:
Evapotranspiration Studies - Norman Wells, Northwest Territories, 1953-.
This field study of evapotranspiration is being carried out by the staff of the Division of Building Research, National

Research Council for the Ontario Research Foundation under the direction of Mr. L. J. Chapman.

132. Hutcheon, N. B., Gold, L. W., and Penner, E., Division of Building Research, National Research Council:
Ground Temperatures and Frost Action, 1948-.
See Use of Waste Sulphide Liquor to Reduce Frost Heaving in Soils; Transactions, Engineering Institute of Canada, vol. 3, No. 4, December 1959, pp. 107-109.

133. Johnston, G. H., Division of Building Research, National Research Council:
Kelsey Generating Station - Dyke Studies, 1958-.
The study of dyke construction in a sporadic area of permafrost at the Kelsey Generating Station of the Manitoba Hydro-Electric Board on the Nelson River in northern Manitoba. Observations of ground temperature, dyke movement and climate are being taken to follow the performance of the dykes.
Observations at Inuvik, Northwest Territories (new location of townsite of Aklavik), 1954-.
Observations on the performance of various engineering facilities were continued by means of soil temperature and foundation movement measurements. Additional movement reference points were established on a number of buildings. A precise level survey was run to tie in all major Bench Marks used for observations of foundation movement and to evaluate the performance of these Bench Marks. Observations on the depth of thaw occurring under various soil conditions and vegetation cover resulting from general construction activity were continued by means of ground temperature measurement.
See The New Aklavik: Search for the Site; Journal Engineering Institute of Canada, vol. 43, No. 1, January, 1960; see also Technical Paper No. 89, Division of Building Research (N.R.C. 5573) February, 1960.

134. Jones, J. F., Research Council of Alberta:
Geology and Hydrology, Alluvial Terraces, Peace River District, Alberta, 1960-62.
Relationship of Rainfall, Run-off, Evapotranspiration, etc., to Groundwater Recharge and Discharge in the Peace River District, Alberta, 1960-62.
Permeability Studies of Some Bedrock Aquifers in the Peace River District, Alberta, 1960-.

135. MacFarlane, Ivan C., Division of Building Research, National Research Council:
Muskeg Research, 1954-.
See Evaluation of Road Performance over Muskeg in Ontario; Canadian Good Roads Association, Proceedings, 40th Convention, September, 1959, pp. 396-405.

136. Mackay, J. R., and Mathews, W. H., Univ. of British Columbia;
Snow Creep and Its Influence on Soil Movement, 1958-.

137. Packer, R. W., Univ. of Western Ontario:
Repose Slopes of Pleistocene Material in Southwestern Ontario, 1961-.

GEOCHEMISTRY

138. Anderson, D. T., Univ. of Manitoba:
Distribution of Copper, Cobalt, Nickel and Iron in Silicate and Sulphide Phases, 1959-62; Ph. D. thesis.

139. Anderson, G. M., Univ. of Toronto:
Solubility of Lead Sulphide in H_2S - H_2O Solutions, 1958-61; Ph. D. thesis.

140. Baadsgaard, H., Univ. of Alberta;
Argon Leakage from Feldspars, 1958-.
The mechanism of argon loss from feldspars, in particular between various sanidines, is being investigated with regard to structural and crystal-chemical factors. The possibility of using argon loss as an indicator of structural or compositional rearrangement in feldspar is also being actively considered.

141. Baadsgaard, H., Davis, A., Tedrick, R., and Stelmach, A., Univ. of Alberta:
Geochemical Indicators, Analytical Methods in Geochemistry, 1959-.
Geochemical indicators for marine and continental environment are being evaluated. Investigations in the analysis of geologic materials include: (1) potassium in minerals (wet chemical + titration), (2) rubidium by wet chemical + x-ray fluorescence, and (3) boron by short direct colorimetric procedure, without distillation.

142. Berry, L. G., and Reynolds, R. L., Queen's Univ.:
The Hydrothermal Synthesis and Recrystallization of Mica, 1961-62.
The purpose is to explore the effect of an argon atmosphere on the crystallization or recrystallization of mica under conditions simulating those extant during thermal metamorphism.

143. Belyea, H. R., Maxwell, J. A., and Wanless, R. K., Geol. Surv., Canada:
Isotopic Studies of Sulphur from Canadian Petroleum Deposits, 1955-.
To determine whether variations in the isotopic composition of sulphur derived from petroleum, from oil field waters and from petroleum-bearing strata can be used to aid in correlation and dating of strata at and near petroleum-bearing horizons and in determining the source rocks from which petroleum in various fields was originally derived.

144. Boyle, R. W., Geol. Surv., Canada:
Barymin Barite deposits, Walton, Nova Scotia, 1957-60.
A geochemical study of the barium in the deposit and adjacent strata.
Geochemistry of the Bathurst-Newcastle District, New Brunswick, 1957-64.
A study of the geochemistry of the gossans, supergene, and primary phases of the base metal deposits of the district, and an evaluation of geochemical prospecting techniques used in that district by mining and exploration companies.

145. Boyle, R.W., and Wanless, R.K., Geol. Surv., Canada:
Lead and Sulphur Isotope Geology of Keno and Galena Hills, Yukon, 1958-.
The purpose is to determine the isotopic abundances of lead and sulphur in the lead-zinc-sulphur deposits and their host rocks, and from the data to determine, if possible, the source of the elements in the deposits and the processes which have led to their concentration.

146. Boyle, R.W., Wanless, R.K., and Lowdon, J.A., Geol. Surv., Canada:
Isotope Chemistry of Sulphur in Rocks and Ore Deposits, 1955-.
See Sulphur Isotope Investigation of the Gold-quartz Deposits of the Yellowknife District; Economic Geology, Vol. 5, No. 8, 1960, pp. 1591-1621.

147. Byers. A.R., Univ. of Saskatchewan:
Geology of Sulphide Ore Bodies, 1958-.
Work to date involves obtaining data on temperature, depths of formation, and trace element constituents of naturally occurring bodies of ore and non-ore grade.
Trace Elements in Sulphides and Associated Wallrocks, 1961-.

148. Cameron, E.M., Geol. Surv., Canada:
Geochemistry of Sandstones, 1958-.
A study of the geochemical characteristics of sandstones that may be of importance in the petroleum industry.

149. Candy, G., Shaw, D.M., and Middleton, G.V., McMaster Univ.:
Geochemistry of Shales, 1960-.
A trace element study of Silurian shales in the Niagara peninsula in relation to sedimentary environment.

150. Chagnon, J.Y., McGill Univ.:
Experimental Studies on the Growth of Minerals in Sediments, 1959-61; M.Sc. thesis.

151. Clark, Lloyd A., McGill Univ.:
Phase Equilibrium Studies in Synthetic Sulphide Systems, 1957-.
This involves thorough and systematic laboratory determination of the phase relations in a number of relatively simple sulphide systems to gain the groundwork of basic knowledge necessary for quantitative approach to the problems of ore transport, localization and deposition. See The Fe-As-S System: Phase Relations and Applications; Economic Geology, vol. 55, No. 7, pp. 1345-1381.

152. Cruft, E.D., McMaster Univ.:
Trace Element Study of the Sudbury Irruptive, 1959-; Ph.D. thesis.
A study of trace element distribution in relation to initial petrology and alteration processes.

153. Davies, J.L., Carleton Univ.:
Geochemistry of the Austin Brook Iron Deposit, Bathurst, New Brunswick, 1960-63; Ph.D. thesis.
The deposit appears to be an iron formation of Ordovician age and consists of interbanded magnetite, hematite and chert. It is associated with a large pyritic zinc-lead ore deposit. Elucidation of the iron formation - sulphide relationship, may provide significant data on the conditions under which each formed. The work may also have practical significance, since other economic sulphide deposits in the district are associated with iron formation.

154. Dibbs, H.P., Mines Branch, Dept. of Mines and Technical Surveys:
Activation Analysis of Minerals and Concentrates, 1960-61.
The determination of beryllium and precious metals in natural ores and concentrates by gamma and neutron activation.

155. Delavault, Robert E., Univ. of British Columbia:
A Comparison of the Suitability of Various Analytical Methods in Geochemistry, 1959-.
See Trace Element Variations in Related Rocks; International Geol. Cong., 21 Norden, 1960, pt. 2, pp. 57-64.

156. Eichholz, G.G., Mines Branch, Dept. of Mines and Technical Surveys:
Radiometric Measurement of Radium and Radon Content in Water, 1960-61.
Adaptation of flow counting methods to routine analysis of radium and radon in natural waters.

157. Elson, J.A., Yong, R., and Frenkel, O.J., McGill Univ.:
The Effect of Chemical Additives on the Permeability of Soils, 1960-61.
The spacing of oriented, purified clay particles is controlled in a specially built permeameter through which flow under pressure can be induced either parallel or perpendicular to the particles. Rates of flow and chemical changes in the water can be measured under various pressures.

158. Folinsbee, R.E., Baadsgaard, H., and Campbell, F.A., Univ. of Alberta;
Bruderheim Meteorite, 1960-61.
Description and analysis of Bruderheim meteorite, a grey chondrite which fell on March 4, 1960, near Bruderheim, Alberta. Three hundred kilograms of this meteorite have been collected and catalogued. Detailed study of rare gas content, mineralogy, and cosmogenic spallation products of this meteorite is underway at the Univ. of Alberta and at other laboratories in Europe and North America.

159. Frenkel, O.J., McGill Univ.:
The Flow of Water and Ions through Clays, 1959-61; M.Sc. thesis.

160. Froese, Edgar, Queen's Univ.:
Petrology and Metamorphic Geology of Wall-rocks at Coronation Mine, Saskatchewan, 1960-62; Ph.D. thesis.
This forms part of a major project involving the complete study of a mineral deposit initiated on the recommendation of the National Advisory Committee on Research in the Geological Sciences, with participation by several organizations including a number of Canadian universities. The adjacent area was mapped on a scale of 400 feet to the inch, and samples from the surface and from underground are being studied. Particular attention is being paid to composition and properties of co-existing garnets and amphiboles and trace element distribution in rocks adjacent to ore.

161. Frueh, Alfred J. Jr., McGill Univ.:
Crystal Chemistry of Sulphides, 1959-.
See Use of Zone Theory in Problems of Sulphide Mineralogy, part III; Polymorphism of Ag_2Te and Ag_2S; American Mineralogist (in press).

162. Gill, J.E., and Thorniley, B.H., McGill Univ.:
Solid Diffusion in Sulphides, 1955-.

163. Godfrey, John D., Research Council of Alberta:
Hydrogen Isotopes (stable) in Hydrous Silicate Minerals, 1952-61.

164. Govett, G.J., Gravenor, C.P., and Rigg, T., Research Council of Alberta:
Dissolution of Naturally Occurring Silicates in Aqueous Solution, 1958-.

165. Hansuld, J.A., McGill Univ.:
Oxidation Potential of Certain Sulphides, 1959-61; Ph.D. thesis.

166. Hawley, J.E., Wynne-Edwards, H.R., and MacDonald, J.G., Queen's Univ.:
Granitic Rocks of the Grenville Sub-province, South-eastern Ontario, 1959-61.
One hundred and twenty-five new analyses for major and trace elements of samples from about sixty granitic bodies are now complete, together with modes, norms and full petrographic descriptions. These rocks, and previously published analyses, fall into four major groups which are separable both mineralogically and chemically. Zircon studies further emphasize this classification. The groups are characteristic of different regions. The data are being compared with Tuttle and Bowen's experimental studies of the hydrous granite system and preliminary work shows that two of the groups fall near the minimum melting composition of hydrous granite and another group lies near the thermal valley leading to this point from the binary Or-Ab minimum.

167. Hickie, G. Hewson, Lake, R.H., and Bright, N.F.H., Mines Branch, Dept. of Mines and Technical Surveys:
Fayalite-Forsterite Olivines, 1960.

A range of intermediate materials in the fayalite-forsterite ($2FeO.SiO_2$-$2MgO.SiO_2$) solid solution series has been made for use as X-ray and optical standards in the Geological Survey of Canada.

168. Hogarth, D.D., Univ. of Ottawa:
Carbonate Rocks in the Meach Lake Area, Quebec, 1959-61.
A geochemical and petrographical study of rocks that are possibly carbonatites. Detailed geological mapping was undertaken in the fall of 1960.

169. Holman, R.H.C., Geol. Surv., Canada:
Reconnaissance Geochemical Survey in Northwestern Ontario (Roads to Resources Project), 1960-61.
Includes map-areas 42 M, 43 D, 52 N, O, P, 53 A, B, C, of Nat. Top. Series.

170. Ibrahim, M., Bright, N.F.H., Jongejan, A., and Rowland, J.F., Mines Branch, Dept. of Mines and Technical Surveys:
High-Temperature Phase Equilibrium Studies in the System CaO-Nb_2O_5-SiO_2, 1956-61.
The quench technique for silicate equilibria studies is being used to find the fields of primary crystallization in a substantial portion of this system. A phase having crystal properties similar to those of natural niocalite has been encountered in this system. Work on the binary systems is complete.

171. Jolliffe, A.W., and Laakso, R., Queen's Univ.:
Element Associations in Ore Deposits and their Significance, 1950-60.
Geochemistry of Precambrian Carbonate Rocks, 1958-60.

172. Jones, R.E., McMaster Univ.:
Sulphur Isotope Studies of Sulphide and Sulphate Minerals of the Niagara Escarpment, Ontario, 1960-62.
The project involves a study of sulphur isotope distribution in sphalerite, galena, marcasite, pyrite, gypsum and baro-celesite occurring in the Silurian rocks of the Niagara escarpment across the northern extension of the Cincinnati axis in the Hamilton area. Study of the geological environment of the samples mineralogically, stratigraphically, and structurally is an important part of the project.

173. Jongejan, A., and Bright, N.F.H., Mines Branch, Dept. of Mines and Technical Surveys:
Magnesia - Ferric Oxide - Alumina Spinels, 1957-61.
A high temperature phase equilibrium study of magnesia-rich refractory compositions.
Iron-bearing Gehlenites, 1957-61.
A high temperature phase equilibrium study undertaken to investigate the constitution of complex basic refractory compositions.
Study of Portions of the CaO-Fe_2O_3-Al_2O_3-SiO_2 Quaternary System, 1960-61.
An extension of the work on iron-bearing gehlenites that relates to the chemistry of basic refractory clinkers.

174. Jongejan, A., Bright, N.F.H., and Rao, M.K., Mines Branch, Dept. of Mines and Technical Surveys:
High-temperature Phase Equilibrium Studies in the System $MgO-Fe_2O_3-TiO_2-SiO_2$, 1955-61.
This study is related to basic refractory materials, particularly to the effect of TiO_2 on forsterite ($2MgO.SiO_2$) and on magnesite clinkers. See Melting Points and Certain Phase Relationships in the System Magnesium Orthosilicate, Magnesium Orthotitanate, Magnesioferrite by M. Ramakrishna Rao, Jour. Sci. Ind. Res. (India), 16B, (1957), 444.

175. Jongejan, A., Lake, R.H., and Bright, N.F.H., Mines Branch, Dept. of Mines and Technical Surveys:
Algoma Siderite Treatment, 1960-61.
A study of the composition of the ore and of the materials formed when it is decomposed to oxide under various conditions is being made in order to determine optimum processing data.

176. Kramer, J.R., Univ. of Western Ontario:
Chemistry of Lake Erie, 1958-61.
Carbonate Minerals at Low Temperature, Phase II
Composition of Salina Carbonates, 1958-.
Carbonate Minerals at Low Temperature, Phase III
Organics in Calcite-dolomite, 1960-.
A study of amino acids and their chelating of alkaline earth metals.
Liquid Inclusions in Ancient Sediments, 1959-.

177. Kramer, J.R., McGrath, P., and McCallum, S., Univ. of Western Ontario:
Solubility of $CaSO_4$ - $CaSO_4$, $2H_2O$ in Brines, 1960-61.

178. Kretz, R., Geol. Surv., Canada:
Geochemistry of Metamorphic and Pegmatitic Rocks, 1960-.
Studies in the Beaulieu-Yellowknife area of the Northwest Territories, Flin Flon area of Manitoba and in the Grenville sub-province, to provide information on the geochemistry of metamorphic and pegmatitic rocks. It is hoped that the studies will aid in understanding their genesis and history. See Distribution of Certain Elements Among Coexisting Pyroxenes, Calcic Amphiboles and Biotites in Skarns, Geochem. of Cosmochem. Acta, vol.20, pp. 161-191, 1960.

179. Kudo, A., and Shaw, D.M., McMaster Univ.:
Geochemistry of Amphibolites, 1960-.
A study of major, minor and trace elements in various amphibolites, with the aim of finding criteria for igneous or sedimentary origin.

180. La Rush, P., and Shaw, D.M., McMaster Univ.:
Geochemistry of Skarn Minerals, 1960-.
A continuation of previous trace element studies on Grenville skarn minerals, with present emphasis on phlogopites.

181. Le Breton, Gordon E., Research Council of Alberta:
Chemistry of Alberta Groundwaters.

Examination of data so far indicates much similarity in the chemistry of groundwaters in bedrock and drift aquifers in the above area. The most striking differences occur in the hardness and nitrate contents. Groundwater from bedrock aquifers is normally soft, apart from an area extending from township 49 to the North Saskatchewan River and from the Alberta-Saskatchewan border to Range 8. The nitrate content in the water wells of the area appears to be a direct result of faulty well completion practices. This study emphasizes the principal that recharge is by local precipitation. In areas of recharge, the total mineralization of groundwater is lower, and in the sulphate chloride relationship, the former is high and the latter is low, whereas in discharge areas, the total mineralization is higher, the sulphate content is low and the chloride content is high.

182. Maxwell, J.A., Geol. Surv., Canada:
Cooperative Evaluation of Methods of Fluorine Determination, 1958-60.

The purpose is to evaluate methods of fluorine determination by interlaboratory cooperation.

183. Maxwell, J.A., Geol. Surv., Canada and Moore, J.M., Carleton Univ.:
Investigation Into Recent Methods for the Determination of Ferrous Iron in Rocks and Minerals, 1960.

184. Meloche, Marvin J., Queen's Univ.:
Comparative Study of Copper and Copper-Nickel Ores in Granitic Rocks and in Adjacent Wallrocks, 1959-61.

A mineralographic and spectrographic study of individual ore minerals in each type of deposit, one in Quebec and the other in Ontario. Copper ores in granite and in adjacent wallrocks show slight differences; the nickel-copper ores on the other hand, are quite dissimilar in many respects.

185. Montgomery, D.S., and Goodspeed, F., Mines Branch, Dept. of Mines and Technical Surveys:
The Intra-red Absorption Spectra of Bituminous Substances, 1951-.

186. Moore, J.M., Carleton Univ.:
Application of Thermodynamic Principles to Metamorphism, 1960-62.

An investigation of compositional relationships among solid solutions (primarily Fe-Mg) in metamorphic rocks of pelitic composition by physical and chemical analytical methods in the light of physico-chemical models.

187. Naldrett, A.J., Queen's Univ.:
Cobalt Distribution in Ore Minerals of the Sudbury Area, 1958-61.

Separation of individual ore minerals, sulphides, sulpharsenides and arsenides has been made from many different deposits and over various depths in some individual deposits. Determinations of cobalt distribution are being made by spectrographic and X-ray methods.

188. Newham, W.D., McGill Univ.:
Experimental Investigation of Intergrowths of Chalcopyrite and Bornite, 1959-61; Ph.D. thesis.

189. Northcote, K.E., Univ. of British Columbia:
Distribution of Metals in the Sediments of Boundary Bay, British Columbia, 1960-61; M.Sc. thesis.
A study of the distribution of copper, zinc, molybdenum, lead, iron and sulphur with respect to the shoreline. Chemical and X-ray fluorimeter methods of analysis will be used.

190. Papezik, V.S., McGill Univ.:
Trace Elements in Anorthosites, 1959-61; Ph.D. thesis.

191. Philpotts, J.A., McGill Univ.:
Experiments on Thermochemical Methods of Producing High Temperatures and Pressures, 1959-61; M.Sc. thesis.

192. Pollak, H., Univ. of Toronto:
Partition of Cerium between Silicate and Aqueous Fluids, 1959-61; Ph.D. thesis.

193. Riddell, John E., Carleton Univ.:
Continuation of Studies on Cation Migrations in Natural Solutions: Distribution of Metals in Recent Marine Sediments of Chaleur Bay, 1958-61.
General Studies of Distribution of Heavy Metals in Glacial Soils of Canada, 1957-.
Distribution of Copper in Soils of Allumette Island, Quebec, 1959-60.

194. Riddell, John E., and Potter, R.R., Carleton Univ.:
Study of Tungsten and Related Elements in Relation to Structural Development of the Appalachians, 1961-.

195. Riddell, John E. and Presant, E., Carleton Univ.:
Study of Heavy Metal Dispersion through Podzolic Soil Profiles, 1961-.

196. Roscoe, S.M., Geol. Surv., Canada:
Origin of Sulphides in Radioactive Conglomerates, 1960-.
A comparison of the isotopic composition of sulphur in the sulphides of these rocks with those whose origin is better understood.

197. Russell, R.D., Stacey, J.S., Ulrych, T.J., Kanasewich, E., and Ostic, R., Univ. of British Columbia:
Isotopic Studies in Geophysics, 1958-.
The project consists of the measurement and interpretation of lead isotope abundances, with the principal objectives of (a) distinguishing the contaminations of lead by radiogenic isotopes according to their occurrence in crustal or sub-crustal regions and correlating these results with possible theories of continental growth, and (b) tracing the development of certain lead ores.

198. Sangster, D.F., McGill Univ.:
Thermochemical Studies of Certain Iron Minerals, 1959-61; M.Sc. thesis.

199. Saull, V.A., and Sangster, D.F., McGill Univ.:
Enthalpy Changes in Metamorphic Reactions, 1953-62.

200. Saull, V.A., Gill, J.E., Kranck, E.H., Chagnon, J.Y., and Philpotts, J.A., McGill Univ.:
Silicate and Sulphide Phase Relationships, 1954-.
See Solid Diffusion of Sulphides and Ore Formation; International Geol. Cong., 21 Norden, 1960, Part 16, pp. 209-217.

201. Shaw, D.M., McMaster Univ.:
Statistics of Sampling and Analysis Errors in Geochemistry, 1960-.
A theoretical and experimental study of error variances with regard to the distribution laws of elements in geochemical populations.

202. Smith, A.Y., Geol. Surv., Canada (part time), Carleton Univ.:
Geochemical Studies in Southeastern New Brunswick, 1959-60; Ph.D. thesis.
To provide information on the geochemistry of stream sediments, etc. and on copper in the Pennsylvanian sandstones; See Geol. Surv., Canada Paper 59-12.

203. Smith, F.G., Univ. of Toronto:
Solid Solution Equilibria as Geological Thermometers, 1960-65.

204. Thode, H.G., McMaster Univ., and Gross, W.H., Univ. of Toronto:
Sulphur Isotope Studies, 1958-61.

205. Thomas, J.F.J., Mines Branch, Dept. of Mines and Technical Surveys:
Chemical Quality of Ground Waters, 1948-.
Water Quality Surveys of Canadian Drainage Basins with Special Reference to Heavy Metals, 1957-.

206. Thompson, R.M., and Drummond, A.D., Univ. of British Columbia:
Pyrosyntheses in the Lead, Bismuth, Copper, Silver, Sulphur System, 1960-61.

207. Thorniley, B.H., McGill Univ.:
Experiments with Copper Minerals at High Temperatures, 1959-61; M.Sc. thesis.

208. Traill, R.J., Abbey, S., Wanless, R.K., Paris, J.C., and Robinson, S.C., Geol. Surv., Canada:
Age Determinations of Rocks and Minerals, 1954-.
The purpose is to make concentrations of minerals from bulk samples of rocks and ores; to analyse these concentrations for specific elements and make chemical concentrations of specific elements for isotope analyses. By means of the mass spectrometer to make isotope analyses of the above and to compute the age of the minerals and enclosing rocks from this data. See Geol. Surv., Canada Paper 61-17.

209. Trost, W.R., Dalhousie Univ.:
Chemistry of an Inland Sea, 1959-.

210. Tupper, W.M., Carleton Univ.:
Thermodynamic and Laboratory Investigation of the Distribution of Sulphur Isotopes in Nature, Particularly as Applied to Processes of Sulphide Genesis in Sulphide Ore Deposits, 1958-.
Geochemical and Geological Study of the Bourinot Group, Cape Breton, Nova Scotia, 1960.

211. Vincent, J.S., McGill Univ.:
Studies in Rheomorphism,. 1960-62; M.Sc. thesis.

212. Wanless, R.K., Lowdon, J.A., and Leech, G.B., Geol. Surv., Canada:
Isotopic Study of Canadian Ore Leads, 1956-.
The purpose is to determine the lead (and possibly sulphur) isotope distribution in lead ores, to investigate possible isotope variations with geological environment, to determine the direction and magnitude of isotopic fractionation of lead isotopes as a result of chemical and physical processes in nature and when applicable, to establish the age, employing the "common lead" method of dating. See Lead Isotope and Potassium Argon Studies in East Kootenay District, Southeastern British Columbia; Geol. Soc. America (in press).

213. Wanless, R.K., Maxwell, J.A., and Smith, C.H., Geol. Surv., Canada:
Magnesium Isotopes, 1957-.
A survey of the variations in abundance of magnesium isotopes from different geological environments, to determine if a fractionation of isotopes takes place and whether distinctive abundances are indicative of distinctive environments.

214. Warren, Harry V., Delavault, Robert E., Boyle, S., and Bullman, A.H., Univ. of British Columbia:
Biogeochemical Prospecting, 1947-.
The establishment of normal and anomalous metal content of various trees and lesser plants requires a large number of analyses of a wide range of species from various geological and geographical backgrounds. Further publication of background material may be anticipated before long. See Observations on the Biogeochemistry of Lead in Canada; paper presented sec. IV, Roy. Soc., Canada, June 1960 (abstract).
Lead in Rocks, Soils, and Food Plants, 1959-62.
Because lead, in some forms, may present a health hazard, it seems desirable to establish as many facts as possible concerning the normal and anomalous amounts of lead in rocks, soils, and various food products. See Trace Element Variation in Related Rocks; International Geol. Cong., 21, Norden, 1960, Pt. 2, pp. 57-64.

215. Weber, J.N.E., Univ. of Toronto:
Composition of Carbonate Minerals and Rocks, 1959-61; Ph.D. thesis.

216. Webster, A.H., and Bright, N.F.H., Mines Branch, Dept. of Mines and Technical Surveys:
High Temperature Study of the System Fe-Ti-O, 1954-60.
The ranges of stability, with variations of temperature, oxygen partial pressure and composition, of the compounds obtainable from the system Fe-Ti-O, such as $2FeO.TiO_2$, $FeO.TiO_2$, $FeO.2TiO_2$, $Fe_2O_3.TiO$, and the various solid solution systems involved, were investigated. This system is of interest because of its bearing on the reactions occurring in the thermal decomposition of ilmenite ores. See A Study of the Iron-Titanium-Oxygen System at 1200°C. and Oxygen Partial Pressures between 1 Atm. and 2×10^{-14} Atm.; Journ. Amer. Ceram. Soc. (in press).

217. Wesemeyer, H., Geol. Surv., Canada:
Development of Magnetic Resonance Apparatus for Laboratory Chemical Analyses, 1958-62.
To develop apparatus for the qualitative and quantitative analysis of rocks and minerals by means of magnetic resonance techniques. Both nuclear paramagnetic and electron paramagnetic resonances are to be employed.

218. Wilson, J.T., and Farquhar, M.A., Univ. of Toronto:
Age Determinations and Isotope Studies of a Keewatin Greenstone Belt, 1961-.

219. Wynne-Edwards, H.R., Queen's Univ.:
Distribution of Elements in Rocks and Minerals.

220. Wynne-Edwards, H.R., and Hay, P.W., Queen's Univ.:
Co-existing Cordierite and Garnet from the Westport Area, Ontario, 1960-61.
Bulk chemical analysis and analyses of ferromagnesian minerals are being used to investigate the factors controlling the stability of cordierite with and without co-existing garnet in regional metamorphism. See Westport Map-area. Geol. Surv., Canada, Map 28-1959 with descriptive notes.

GEOCHRONOLOGY

221. Baadsgaard, H., Univ. of Alberta:
Argon Leakage from Feldspars, 1958-.
The mechanism of argon loss from feldspars, in particular between various sanidines, is being investigated with regard to structural and crystal-chemical factors. The possibility of using argon loss as an indicator of structural or compositional rearrangement in feldspar is also being actively considered.

222. Baadsgaard, H., Steen, G., Stauffer, M.R., and Evans, C.R., Univ. of Alberta:
Use of Absolute Dating in Provenance Studies and in Delineating Metamorphic Events, 1959-.
The investigation involves such problems as the effect of sedimentary transport, diagenesis, and metamorphism on the radioactive systems. It is hoped that measurement of daughter-parent ratios will provide evidence of environment, and history of the materials concerned. See Potassium-Argon Age of Biotites from Cordilleran Granites of Central British Columbia; Bull. Geol. Soc. Amer., Vol. 72, No. 5, May 1961, 689-702.

223. Berry, L.G., and Reynolds, P.L., Queen's Univ.:
The Hydrothermal Synthesis and Recrystallization of Mica, 1961-62.
The purpose of the research is to explore the effect of an argon atmosphere on the crystallization or re-crystallization of mica under conditions simulating those extant during thermal metamorphism.

224. Boyko, W.O., McGill Univ.:
Structure and Absolute Ages across Superior-Churchill Boundary, 1960-62; Ph.D. thesis.

225. Cormier, R.F., St. Francis Xavier Univ.:
Construction of an Absolute Post Pre-Cambrian Time Scale by the Rubidium-Strontium Dating of Glauconite - a continuing project.

226. Cumming, G., and Crouse, R., Univ. of Alberta:
Mass Spectrographic Age Determinations, 1957-.
A mass spectrometer for potassium argon age determinations has been operated in the Physics Department since 1958. A second instrument, which will be used for strontium-rubidium and lead isotope measurements, is now under construction. The work in geochronology is being carried out in cooperation with the Dept. of Geology.

227. Folinsbee, R.E., and Baadsgaard, H., Univ. of Alberta:
Potassium-Argon Dating, 1954-.
See Potassium-Argon Time Scale: International Geological Congress, 21 Norden, 1960, Pat 3, pp. 7-17.

228. Mathews, W.H., and Rouse, G.E., Univ. of British Columbia:
Isotope Age Dating of Cenozoic Volcanic Rocks in British Columbia, 1959-61.
Isotopic analyses made at the Univ. of Alberta.

229. Sinclair, A.J., Univ. of British Columbia:
Mineralization and Lead Isotopes in the Kootenay Arc, 1960-; Ph.D. thesis.

230. Traill, R.J., Abbey, S., Wanless, R.K., Paris, J.C., and Robinson, S.C., Geol. Surv., Canada:
Age Determinations of Rocks and Minerals, 1954-.
The purpose is to make concentrations of minerals from bulk samples of rocks and ores; to analyse these concentrations for specific elements and make chemical concentrations of specific elements for isotope analyses.

By means of the mass spectrometer to make isotope analyses of the above and to compute the age of the minerals and enclosing rocks from this data. See Geol. Surv., Canada Paper 61-17.

231. Wilson, J.T., and Farquhar, M.A., Univ. of Toronto:
Age Determinations and Isotope Studies of a Keewatin Greenstone Belt, 1961-.

GEOMORPHOLOGY

232. Ambrose, J.W., Queen's Univ.:
Precambrian - Palaeozoic and sub-Proterozoic Erosion Surfaces in Canada, 1957-61.
A study of the extent and character of ancient erosion surfaces, now partially or largely exhumed on the Canadian Shield.

233. Bostock, H.S., Geol. Surv., Canada:
Physiography of Canadian Cordillera, 1959-61.
A revision of Geological Survey of Canada Memoir 247 to extend its scope and describe the physiography of the entire Canadian cordillera.

234. Brisbin, W.C., Univ. of Manitoba:
Relationship of Buried Rock Topography to Geology at the Coronation Mine, Manitoba, 1960-61.

235. Clark, T.H., and Elson, J.A., McGill Univ.:
Formation of Ventifacts, 1958-61.

236. Loken, O., McGill Univ.:
Studies of Glacial Geology and Geomorphology in the Northern Torngate Mountains, Labrador, 1960-62; Ph.D. thesis, McGill Univ.

237. Mackay, J.R., Univ. of British Columbia:
Geomorphology of the Mackenzie Delta and Adjoining Areas, 1954-62.
The work is being carried out for the Geographical Branch, Dept. of Mines and Technical Surveys, Ottawa. Field investigations have been carried out on the Mackenzie Delta and the unconsolidated deposits of the Liverpool Bay area. See Glacier Ice-Thrust Features of the Yukon Coast; Geographical Bull. No. 13, Ottawa, 1959, pp. 5-21.
Origin of Pingos and Oriented Lakes, Northwest Territories, 1954-62.
Includes study of size, depth, and general type of lake in which pingos grow; quantitative treatment of changes in climatic-permafrost regime as they effect pingo formation; and study of transverse wind theory of oriented lakes in Liverpool Bay and Baffin Island areas. The work is supported partly by the Geographical Branch, Mines and Technical Surveys, Ottawa. See Notes on Oriented Lakes of the Liverpool Bay Area, N.W.T; Revue Canadienne de Geographie, vol. 10, 1956, pp. 169-173.

Harmonic Analysis of Meandering in the Mackenzie River and Deltaic Channels, 1960-61.

Fourier (harmonic) analysis, carried out with the aid of a high speed electronic computer, is being used to study meandering of the Mackenzie River. Variance spectra (a kind of Fourier analysis applied to autocorrelation functions derived from a series) analysis has been started for the distributary system of the Delta.

238. Marsden, M., Arctic Institute of North America:
The Submarine Morphology of the Queen Elizabeth Archipelago, Northwest Territories, 1960-62; Ph.D. thesis, McGill Univ.
Hydrographic Work in Queen Elizabeth Island to Evaluate the Geomorphic History, 1960-62.

239. Muller-Battle, F., Bird, J. Brian, Adams, P., and Maag, H., McGill Univ.:
Jacobsen-McGill Arctic Research Expedition, 1959-62.

A preliminary expedition visited Axel Heiberg Island in 1959 and a party of 22 scientists returned in 1960. Integrated studies in botany, geomorphology, geophysics, geology, glaciology, hydrology, meteorology and permafrost will be made by scientists from McGill Univ. and other institutions. Members of the expedition contributing to the geomorphological programme are listed above.

240. Parry, J.T., McGill Univ.:
A Study of the Landforms and Surficial Deposits in the North River Valley, Quebec, 1960-63; Ph.D. thesis.

GEOPHYSICS

Electrical and Magnetic

241. Blanchard, J.E., Dalhousie Univ. and Nova Scotia Research Foundation:
Theoretical Studies of Electromagnetic Methods of Geophysical Prospecting, 1956-.

An attempt is being made to determine the effect of overburden on the resolving power of the various types of electromagnetic prospecting equipment presently in use.

242. Bower, M.E., Geol. Surv., Canada:
Typical Aeromagnetic Anomalous Patterns, 1955-.

The assembly of a series of typical aeromagnetic anomalous patterns from published one mile aeromagnetic maps to illustrate some common rock structures.

243. Garland, G.D., Vozoff, K., Surkan, A.J., Ellis, R., and Rankin, D., Univ. of Alberta:
Investigation of Structures by Means of Natural Alternating Magnetic Fields, 1957-.

Oscillations of the earth's magnetic field occur with a wide range of frequencies. These induce electric currents within the earth, and these currents produce fields measurable at the earth's surface. Because of the wide

range of frequencies, measurements of these fields can give information on a wide range of geological structures, from orebody size up to crustal dimensions. Work is in progress on both the instrumentation for the measurements and on the interpretation. See Investigations of Natural Electric and Magnetic Fields; J. Research, U. S. Nat. Bur. of Standards.

244. Gross, W. H., and Strangway, D. M., Univ. of Toronto:
Remanent Magnetism as a Guide to the Origin of Hard Hematites in Precambrian Iron Formations, 1957-60.
The study of magnetism in iron formations will be continued.

245. Hall, D. H., Univ. of Saskatchewan:
Rock Magnetism, Aeromagnetic Anomalies, and Regional Structure, 1960-62.
Includes study of relation between geological history and the geological (particularly tectonic) setting of various formations, and the magnetization of the rocks, as well as ore, if present. Also expression of the magnetization in aeromagnetic anomalies is being compared.

246. Larochelle, A., Black, R. F., and Sopher, S. R., Geol. Surv., Canada:
Palaeomagnetic Studies, 1955-.
Includes collection and preparation of rock samples and measurement of the direction of remanent magnetism, to accumulate data expected to reveal the direction of the earth's magnetic field during geologic history and thus throw light on age and structural relations of rock formations.

247. MacLaren, A. S., Geol. Surv., Canada:
Preparation of 4 mile to 1 inch Aeromagnetic Composites, 1958-.
The purpose is to prepare a 4 mile aeromagnetic composite map for all areas completely covered by surveys and to prepare marginal notes with geological map references and a general interpretation of the magnetic data. See Geol. Surv., Canada Maps 1073A and 1080A.
Investigation and Interpretation of Aeromagnetic Anomalies in Northwestern Ontario (Roads to Resources Project), 1960-61.
Includes map-areas 42 M, 43 D, 52 N, O, P, 53 A, B, C, of Nat. Top. Series.

248. MacLaren, A. S., and Larochelle, A., Geol. Surv., Canada:
Relations of Bedrock Geology to Aeromagnetic Anomalies, 1955-.
The purpose is to enhance ability to make geological interpretations of aeromagnetic maps; to explain aeromagnetic anomalies; and to associate and correlate aeromagnetic anomalies with economic geology.

249. Madill, R. G., and Dawson, E., Dominion Observatory:
Regional Magnetic Charts of Canada - a continuing project.
The provision of regional magnetic charts for survey, mapping, and prospecting purposes involves the estimation of secular variation and the collection and reduction of ground and airborne observations. Chart revisions are

made from time to time, and machine handling of the data is now being introduced. See Isogonic Chart for Canada, 1960, showing lines of equal magnetic declination and equal annual change.

250. Nash, W.A., Neale, E.R.W., Larochelle, A. and Black, R.F., Geol. Surv., Canada:
Sandy Lake Map-area, Newfoundland, 1 inch to 4 miles, 1960-61.
Recent work suggests the unfossiliferous Devonian(?) Springdale group may include rocks of 2 ages. To test this hypothesis oriented specimens were collected for palaeomagnetic analysis. Preliminary results suggest that there are indeed 2 ages represented. Further specimens will be collected in the 1961 field season.

251. Niblett, E.R., and Cooke, A.B., Dominion Observatory:
Magneto-Telluric Investigations, 1955-.
The investigation of the spectrum of the earth current and magnetic temporal variations provides information on sub-surface conductivity: the depth of penetration depends on the region of the spectrum investigated.

252. Owens, K.H., Essex, F., Redeler, D., Kempt, J., and Derouin, E., Geol. Surv., Canada:
Aeromagnetic Surveys by the Geological Survey of Canada, 1960.
Includes surveys in the Sudbury-North Bay district of Ontario; an area between lat. 59°45' and 60° and long. 107°30' and 112° in the Northwest Territories; and an area about the Coronation Mine in Saskatchewan. Flight lines in surveys in Ontario and the Northwest Territories are at 1/2 mile spacing and 1,000 foot altitudes; at the Coronation Mine they are 1/4 mile spacing and 500 foot altitudes.

253. Roy, J., Dominion Observatory:
Magnetic Properties of Rocks, 1955-.
The magnetic properties of drill cores from geological features of possible meteoritic origin have been measured. Apparatus has been developed suitable for many different types of palaeomagnetic measurement.

254. Uffen, R.J., and Hammond, R.M., Univ. of Western Ontario:
Optimization of Line Spacing in Aeromagnetic Surveys, 1959-60.
In this project the methods of operational research are applied to determining the line spacing required in aeromagnetic surveys to produce optimum results.

255. Uffen, R.J., Carmichael, C.M., Law, L.K., and Irwin, G.J., Univ. of Western Ontario:
Palaeomagnetic Studies, 1957-.
The magnetic properties of the exsolved phases of ilmenite and hematite have been investigated using natural and heat treated crystals of the Allard Lake

hemo-ilmenite. This study is being extended to naturally occurring magnetite-ilmenite mixtures which are reversed. A method of measuring the magnetic properties of rocks "in situ" is also being investigated. See Remanent Magnetism of the Allard Lake Ilmenites; Nature, 183, pp. 1239-1241 (1959).

256. Uffen, R.J., and Tikkanen, G.D., Univ. of Western Ontario:
Interpretation of Airborne Magnetic and Electromagnetic Data, 1960-61.
An integrated interpretation using airborne geophysical data, air photos and geological maps in the Lac La Ronge area of Saskatchewan.

257. Vozoff, K., and Bukhari, S.A., Univ. of Alberta:
Numerical Interpretation of Electrical Resistivity Data, 1959-61.
Interpretative techniques to date have employed least squares methods of fitting predicted to measured data. These have the disadvantage that regional trends, or one erroneous data point, very strongly influence the result. The feasibility of absolute-value fitting by means of a linear programming technique is being investigated. This approach has been used successfully on gravity and magnetic data by other groups. See Numerical Resistivity Interpretation: General Inhomogeniety; Geophysics, December 1960.

258. Wesemeyer, H., Geol. Surv., Canada:
Development of Magnetic Resonance Apparatus for Laboratory Chemical Analyses, 1958-62.
To develop apparatus for the qualitative and quantitative analysis of rocks and minerals by means of magnetic resonance techniques. Both nuclear paramagnetic and electron paramagnetic resonances are to be employed.
Electron Spin Resonance at Very Low Fields, 1958-.
An investigation of the feasibility of using the principle of electron spin resonance at very low magnetic fields for prospecting purposes.
Magnetically Shielded Hut, 1960-.
This involves construction of a magnetically shielded hut against electromagnetic noise at low frequencies, the direct current component of the earth's field, and the gradient in the earth's field.
Magneto-Absorption in Rocks at Low Magnetic Fields, 1960.

Gravity

259. Fitzpatrick, M.M., Queen's Univ.:
A Gravity Study of the Monteregian Hills, 1959-60.
Approximately 1300 gravity stations were established in the area bounded by latitudes 45°15' and 45°45' and longitudes 72°30' and 75°00'. The purpose of the study is: (1) to see if there is any connection between the Monteregian Hills and the Ottawa Valley Graben; (2) to see if any Hills existed unexposed beneath the Palaeozoic rocks of the Lowlands; (3) to locate the common source of the material forming the Hills; and (4) to establish the vertical extent of the Hills.
Gravity and Magnetic Survey of Southern Quebec Serpentine Belt, 1961-.

260. Innes, M. J. S., Dominion Observatory:
Gravity and Isostasy in Northern Ontario and Manitoba.
Regional gravimeter surveys in northern Canada were first initiated in 1947 by the Dominion Observatory using aircraft transportation. The results of measurements for 1,220 stations established in northern Ontario and Manitoba to the end of 1950 are given in the form of Bouguer and Hayford isostatic anomaly maps and in tables of principal facts. The principal variations in the anomalies are examined in the light of the surface geology and larger crustal structures. See Publication of Dominion Observatory, vol. 21, No. 6, 1960.
Study of the Gravity Field in Northern Alberta and Saskatchewan.
During 1960 about 1,900 regional gravity stations were established at 6 to 8 mile intervals in northern Saskatchewan and northeastern Alberta. The results may be of considerable value in tracing major structural features of the basement rocks and their extension to the southwest into northeastern Alberta.

261. Riley, Colin, Univ. of Manitoba:
Gravity Studies in the Kenora District, Ontario, 1960-61; M. Sc. thesis.

262. Sobczak, L., and Hornal, R., Dominion Observatory:
Polar Continental Shelf Gravity Work.
In conjunction with the Polar Continental Shelf Project about 400 stations were established at 8 mile intervals on both land and sea ice in the vicinity of Ellef Rignes, Amund Rignes, Lougheed and Borden Islands. In addition about 300 gravity stations at much shorter intervals were observed to supplement geological studies of ring dykes gypsum piercement domes and to provide detailed information concerning the ice thickness of the Meighen Island Glacier.

263. Tanner, J.G., Dominion Observatory:
Gravity Anomalies in the Gaspé Peninsula, Quebec.
Bouguer anomalies are presented for 600 gravity stations established in the Gaspé Peninsula and isostatic anomalies computed for about 50 of these stations. See Publication of Dominion Observatory, vol. 21, No. 5, 1960.

264. Tanner, J.G., Sobczak, L., and Rottenberg, J., Dominion Observatory:
Studies of the Vertical Gradient of Gravity.
Theoretical studies have been completed to facilitate the calculation of the gravitational field at various heights above the earth from a knowledge of gravity at its surface. This work, coupled with detailed gravity measurements in the vicinity of Ottawa is intended primarily to provide a suitable means of testing airborne gravity measuring instruments when their development work has been completed.

265. Uffen, R.J., Beck, A.E., and McGrath, P., Univ. of Western Ontario:
An Investigation of the Effect of Changes in Superficial Deposits in Gravity Exploration, 1960-61.
Gravity, shallow refraction seismic and resistivity profiles are being made over a reef near Thedford, Ontario, in an attempt to improve the interpretation of gravity anomalies.

266. Uffen, R.J., Beck, A.E., and Valliant, H.D., Univ. of Western Ontario and Dominion Observatory:
Improvements in the Accuracy of Gravity Measurements using a Pendulum Apparatus, 1960-61.
This project is devoted mainly to improving the accuracy of timing pendulums in a pendulum apparatus. Once this is done it should be possible to determine, and possibly eliminate, other sources of error in the measurements. See Evaluation of the Dominion Observatory Bronze Pendulum Apparatus - a paper presented at the Twelfth General Assembly of the I.U.G.G. (Helsinki) 1960.

Radioactivity

267. Eichholz, G.G., Mines Branch, Dept. of Mines and Technical Surveys:
Radiometric Measurement of Radium and Radon Content in Water, 1960-61.
Adaptation of flow counting methods to routine analysis of radium and radon in natural waters.

268. Gregory, A.F., Geol. Surv., Canada and Horwood, J., Mines Branch:
Gamma Ray Spectrometer Studies, 1959-.
Previous work established that distinct contrasts in gamma ray spectra may exist between various lithologic sources. Proposed research includes a laboratory study of thick source emission spectra to be followed, if feasible, by in situ measurements on rocks. Continuing research will investigate the degradation of energy spectra with increasing air distance, and the significance of diurnal variations in the gamma field of the earth. These data will allow evaluation of a potential technique for aerial mapping of geology in which radioactive contrasts exist. Suitable in situ measurements would be useful in stratigraphic and petrogenic correlations.
Evaluation of Aeroradiometric Surveying as an Aid to Geological Mapping, 1958-.
To evaluate the possibility of using aeroradiometric data as an aid to geological mapping and petrogenetic analysis.

269. Horwood, J.L., Mines Branch and Gregory, A.F., Geol. Surv., Canada:
Scattering of Gamma-rays in Air, 1959-61.
The effect of air scattering on energy spectrum from uranium, thorium and potassium sources with special application to airborne surveying.

Degradation of Gamma-ray Spectra from Uranium and Thorium Ores on Passage through Rocks and Soil, 1958-61.

Determination of changes in characteristic gamma-ray spectra from uranium and thorium ores as a result of absorption and scattering effects in overlying rocks and soils. This is expected to assist in developing improved methods for aerial radioactive surveys.

270. Traill, R.J., Abbey, S., Wanless, R.K., Paris, J.C., and Robinson, S.C., Geol. Surv., Canada:
Age Determinations of Rocks and Minerals, 1954-.

The purpose is to make concentrations of minerals from bulk samples of rocks and ores; to analyse these concentrations for specific elements and make chemical concentrations of specific elements for isotope analyses. By means of the mass spectrometer to make isotope analyses of the above and to compute the age of the minerals and enclosing rocks from this data. See Geol. Surv., Canada Paper 61-17.

271. Uffen, R.J., and Murty, Rama C., Univ. of Western Ontario:
Attenuation of Gamma Rays in Heterogeneous Materials, 1958-61.

Seismic

272. Bancroft, A.M., Sander, G., Milne, W.G., and White, W.R.H., Dominion Observatory:
Time Term Survey of Canada, 1950-.

The various filed surveys carried out, on the Polar Shelf and in more temperate latitudes, are being arranged to give a time-term which is related to the depth of the Mohorovicic discontinuity. When sufficient work has been completed, it will be possible to contour the time-terms in the same way that gravity data are contoured. The resulting map will be related to the structure.

273. Blanchard, J.E., Dalhousie Univ., and Nova Scotia Research Foundation:
Application of Seismic Methods of Geophysical Exploration to Geological Problems in Nova Scotia, 1956-.

Seismic reflection and refraction studies are being carried out in conjunction with gravity and magnetic surveys in the sedimentary basins of Nova Scotia to aid in the interpretation of the geology.

274. Brisbin, W.C., Univ. of Manitoba:
Relationship of Buried Rock Topography to Geology at the Coronation Mine, Manitoba, 1960-61.

275. Buchbinder, G.G.R., Martel, P., and Blanchard, J.E., Dalhousie Institute of Oceanography and Nova Scotia Research Foundation:
Seismic Refraction and Reflection Studies, Northumberland Strait, Gulf of St. Lawrence, 1960.

The purpose is to determine the geological structure, evaluate equipment and determine costs of such projects.

276. Hodgson, J. H., and Metzger, M. M., Dominion Observatory:
Fault Plane Project, 1950-.

The Observatory measures the mechanism of all earthquakes with a magnitude greater than 6.8. An attempt will be made to extend this to small earthquakes in the Mid-oceanic Ridges.

277. Hodgson, J. H., Halliday, R. J., and Lombardo, F., Dominion Observatory:
Expanded Seismic Network, 1959-64.

The Dominion Observatory is expanding the seismological network of Canada so that there will be a station at 500 mile intervals throughout the entire country. Each of these stations will be staffed by a trained technician and all will operate identical instruments. Data from the stations will be made available by radio communications to international organizations.

278. Hobson, G. D., Geol. Surv., Canada:
Seismic Studies in Southern Ontario, 1959-60.

By means of seismic refraction determination of depths to basement, to evaluate the capabilities and limitations of refraction and reflection methods as a means of interpreting geological features of the Palaeozoic assemblage. See A Reconnaissance Refraction and Reflection Survey in Southwestern Ontario; Canadian Mining Journal, April, 1960.

279. Kasahara, K., Dominion Observatory:
Use of S in Mechanism Studies, 1960-62.

Dr. Kasahara is studying the displacement in S waves in a number of deep focus earthquakes in order to throw light on the mechanism in the focus.

Programming of Fault Plane Studies, 1960.

The Dominion Observatory has a continuing project for studying the mechanism of earthquakes by determining the P Nodal planes. This has been done in the past by plotting on a particular projection and the solution by inspection. Dr. Kasahara is attempting to program the process for an I. B. M. 650.

280. Kollar, F., and Kasahara, K., Dominion Observatory:
Directional Seismograph, 1957-61.

Three identically calibrated seismometers are set up to form an orthogonal triad record on magnetic tape. The record may be analyzed for frequency content, or for the direction of approach of the seismic wave. This will allow the search for suspected phases by orienting the pickup to favour the direction of expected approach. This project was commenced by Dr. Willmore and is being continued by Dr. Kollar and Dr. Kasahara.

281. Lennox, D. H., Research Council of Alberta:
Earthquake Effects Observed in Alberta Wells, 1960-61.

Includes a review of the records from automatic water-level recorders throughout the province prompted by the observation, on a number of records, of the passage of shock waves from the Montana earthquake of August, 1959.

282. Morrison, H.F., McGill Univ.:
Seismic Investigations in the Sverdrup Basin, Queen Elizabeth Islands, Northwest Territories, 1959-61; M.Sc. thesis.

283. Redpath, B.B., McGill Univ.:
Seismic Studies on Axel-Heiberg Island, 1959-61; M.Sc. thesis.

284. Saull, V.A., and Redpath, B., McGill Univ.:
Seismic Studies on Axel Heiberg Island, 1960.

285. Uffen, R.J., Beck, A.E., and Mereu, Robert F., Univ. of Western Ontario:
Seismic Modelling Experiments, 1959-61.
A study of the partition of energy into plastic and elastic phases after an impulse is applied to a solid.

286. Uffen, R.J., and Carr, M.H., Univ. of Western Ontario:
Plastic Waves in Rocks, 1960-62.
Preliminary investigation of particle and wave volocities of plastic waves through heterogeneous media.

General Problems

287. Beals, C.S., Innes, M.J.S., and others, Dominion Observatory:
Fossil Crater Studies.
Gravity studies of the Holleford, Brent and Deep Bay craters have been completed. In 1960 preliminary gravity investigations were carried out at the New Quebec crater and a gravity survey on the ice is planned for this crater in March, 1961. See The Brent Crater, publication of Dominion Observatory, vol. 24, No. 1, 1960 and Search for Fossil Meteorite Craters, Dominion Observatory contribution, vol. 4, No. 4, 1960.

288. Beck, A.E., Univ. of Western Ontario:
An Investigation of the Physical Requirements for, and Consequences of, an Expanding Earth, 1959-.
The energy requirements for an expanding earth have been investigated and it is found that for small expansions of the radius, of the order of 100 km, no unknown sources of energy are required. The physical consequences of an expanding earth are now being investigated with particular reference to the thermal history of the earth. See An Expanding Earth with Loss of Gravitational Potential Energy; Nature, 185, pp. 677-678 (1960).

289. Beck, A.E., and Sass, J.H., Univ. of Western Ontario:
Terrestrial Heat Flow, with Particular Reference to Northern and Eastern Canada, 1958-.
The project consists of routine measurements of terrestrial heat flow together with the necessary work required to improve the methods. Methods are being developed for (1) the "in situ" measurement of the thermal conductivity of rocks; (2) continuously recording temperature gradients in boreholes;

(3) measuring the thermal conductivity of small crystals; and (4) simultaneous coring and temperature gradient measurements in the sediments of the Great Lakes. See On the Measurement of the Thermal Conductivity of Rocks by Observations on a Divided Bar Apparatus; A.G.U. Trans. 39, pp. 1111-1123, (1958).

290. Blanchard, J.E., Dalhousie Univ., and Nova Scotia Research Foundation:
Gravity and Magnetic Studies of the Sedimentary Basins of Nova Scotia, 1952-.
Because of the density contrasts in the Windsor section of the Mississippian, gravity has been found particularly useful in helping to solve structural problems in the sedimentary basins.

291. Blanchard, J.E., and Buchbinder, G.G.R., Dalhousie Univ.:
Measurement of Stress in the Crust of the Earth, 1960-62.

292. Bower, D.R., and Weber, J.R., Dominion Observatory:
Gravity Measurements in Hudson Bay.
During 1960 a number of gravity measurements were carried out in a submarine in cooperation with United States hydrographic service. Further measurements are planned in 1961.

293. Garland, G.D., and Kanasewich, E., Univ. of Alberta:
Studies of the Athabasca Glacier, 1959-61.
The complete project includes drilling through the ice, seismic and gravity measurements, determination of flow rate of the ice, and ice temperatures. An M.Sc. thesis by Mr. Kanasewich deals with the gravity measurements over the ice and the determination of the shape of the glacier floor from these measurements. Work is continuing on ice temperature measurements with thermocouples set in deep holes through the glacier. Work on ice flow and seismic measurements is being done at the Univ. of B.C. The Alberta Research Council investigated cable-tool drilling of the ice, and produced 3 holes by this method. Other holes were hot-point drilled. As an addition to the gravity work over the glacier, Mr. Kanasewich extended the gravity survey of the southern portion of the Rocky Mountain Trench, from Cranbrook to the International border, and a paper on the interpretation for this area is in preparation.

294. Garland, G.D., and Lennox, D., Univ. of Alberta:
Heat Flow Measurements in Western Canada, 1957-.
Measurements of heat flow are now available for the Leduc, Redwater and Norman Wells area. See Heat Flow Measurements in Western Canada; Proceedings of Helsinki Meeting, Int. Assoc., of Seismology, August 1960 (abstract)

295. Hall, D.H., and Kupsch, A.O., Univ. of Saskatchewan:
Relation Between Geophysics, Bedrock Geology and Surficial Geology of Churchill River Area, Saskatchewan, 1960-62.

296. Hattersley-Smith, G., Weber, J.R., and Sagar, R.B., Defence Research Board:
Lake Hazen Meteorology and Geophysics, 1957-60.
See The Ablation Season on the Gilman Glacier, Northern Ellesmere Island and Geophysical Studies on Gilman Glacier, Northern Ellesmere Island; papers presented at the 12th Gen. Assembly, I.U.G.G., Helsinki, 1960.

297. Jessop, A.M., Univ. of Western Ontario (N.R.C. Postdoctorate Fellow):
Theoretical Studies of Thermal Conditions in the Upper Mantle, 1960-61.

298. Lennox, D.H., Research Council of Alberta:
Near-surface Geophysical Investigations, 1957-.
Seismic and earth resistivity surveys of selected areas in Alberta being carried out as part of the ground-water exploration program.
Some Terrestrial Heat Flow Measurements in Alberta, 1958-60; M.Sc. thesis, Univ. of Alberta.
Includes heat flow measurements in two Alberta wells.

299. Roots, E.F. (in charge), Pelletier, B.R., Horn, D.R., (Submarine Geology), Roots, E.F., St.-Onge, D.A., Arnold, K. (Terrestrial Geology, Physiography, Glaciology), Hobson, G.D., Sander, G., Overton, A., Sobczak, L., McConnell, D. (Geophysics), and Collin, A.E. (Oceanography), Dept. of Mines and Technical Surveys:
Polar Continental Shelf Project - a continuing project initiated in 1958.
A general geological and geophysical investigation of the continental shelf area of Arctic Canada, with associated studies of the islands, straits and sounds, the ocean waters, the continental slope and deeper crustal structures. The Project comprises teams of scientific specialists from the appropriate units of the Department of Mines and Technical Surveys (Geological Surveys, Geographical Branch, Dominion Observatory, and Surveys and Mapping Branch) and individual aspects of the programme are integrated with the country-wide programmes of that respective unit (e.g. the gravity researches form part of the overall gravity study of Canada, conducted by the Dominion Observatory). The ultimate aim is to obtain a thorough and balanced understanding of the geological and physical characteristics of the region.

300. Russell, R.D., Stacey, J.S., Ulrych, T.J., Kanasewich, E., and Ostic, R., Univ. of British Columbia:
Isotopic Studies in Geophysics, 1958-.
The project consists of the measurement and interpretation of lead isotope abundances, with the principal objectives of (a) to distinguish the contaminations of lead by radiogenic isotopes according to their occurrences in crustal or sub-crustal regions and to correlate these results with possible theories of continental growth, and (b) to trace the development of certain lead ores.

301. Saull, V.A., Clark, T.H., Butler, R.A., and Doig, R., McGill Univ.:
Terrestrial Heat Flow in the St. Lawrence Lowland of Quebec, 1959-61.

302. Uffen, R.J., Jessop, A.M., and Gascoigne, W., Univ. of Western Ontario:
Theoretical Temperature Distribution Due to an Instantaneous Spherical Source Near a Plane Boundary Separating Media of Different Physical Properties, 1960-61.

303. Wilson, H.D.B., and Brisbin, W.C., Univ. of Manitoba:
Regional Gravity and Magnetic Study of the Boundary Between the Churchill and Superior Blocks of the Precambrian Shield, 1958-.
See Thompson - Moak Lake Nickel Belt, Econ. Geol. p. 1327, vol. 55 (abstract).
Ground Magnetic and Surface and Underground Gravity Surveys at the Coronation Mine, Manitoba, 1959-62.

INVENTORIES, ETC.

304. Alberta Society of Petroleum Geologists:
Supplement to Annotated Bibliography of Geology of the Sedimentary Basin of Alberta and Adjacent parts of British Columbia and the Northwest Territories.
The initial volume of this bibliography covers the years 1845-1955. It is hoped that the supplement to cover the years 1956-1960 will be published in 1961.
Geological Map of the Arctic.
This map on the scale of 1 to 7,500,000 will show the topography and geology of the Arctic, contours of the ocean floor and the Greenland ice-cap.

305. Bolton, T., Geol. Surv., Canada:
Maintenance of Geological Survey Palaeontological Collections.

306. Bolton, T.E., and Wagner, F.J.E., Geol. Surv., Canada:
Lexicon of Stratigraphic Names Used in Canada, 1958-60.

307. Dawson, K.R., Geol. Surv., Canada:
Meteorite Collection, 1957-.
The purpose is to catalogue, study, describe, and display the Geological Survey meteorite collection.
Petrological Collections, 1957-.
The purpose is to obtain and maintain representative suites of rocks from all areas mapped by the Geological Survey for future petrological, geochemical, and other scientific studies.

308. Dawson, K.R., and Maxwell, J.A., Geol. Surv., Canada:
Compilation of Canadian Rock and Mineral Analyses, 1957-.
To collect, evaluate, and publish in appropriate form and at appropriate intervals all Geological Survey of Canada rock and mineral analyses and, if and when practicable, to expand this task to include all similar data from other sources.

309. Johnston, A.G., Geol. Surv., Canada:
Economic Geology Files, 1940-.
The purpose is to file and cross-index all published authentic geological information and geological plans on Canadian occurrences of economic metals or minerals and to assist in preparing for publication maps and reports showing the distribution and mode of occurrence of specific minerals of metals.

310. McGregor, D.C., Geol. Surv., Canada:
Reference Slide Collection of Small Spores, 1960-.
The preparation of a reference slide collection and photographic record of small spores of known geological age to aid in the intelligent interpretation of spore assemblages and in dating submitted samples; and to provide material for exchange with other institutions.

311. Parsch, K.O., Texaco (Canada) Limited, Calgary, Alberta:
Micropalaeontological Bibliography for Canada.

312. Sanford, B.V., Geol. Surv., Canada:
Catalogue of Oil and Gas Wells in Sample Repository, Geological Survey of Canada, 1960.
A compilation of all wells drilled in southwestern Ontario for which sample cuttings are available at the Geol. Surv., Canada.

313. Traill, R.J., Geol. Surv., Canada:
A List of Canadian Mineral Occurrences, 1958-60.
The compilation of an up-to-date list of Canadian mineral occurrences, including all available analytical data.

MINERAL DEPOSITS

Base Metals

314. Archibald, Gary Marvyn, McGill Univ.:
Geology of the Geco Mine, Ontario, 1959-61; Ph.D. thesis.

315. Boyle, R.W., Geol. Surv., Canada:
Geochemistry of the Bathurst-Newcastle District, New Brunswick, 1957-64.
A study of the geochemistry of the gossans, supergene, and primary phases of the base metal deposits of the district and an evaluation of geochemical prospecting techniques used in that district by mining and exploration companies.

316. Boyle, R.W., and Wanless, R.K., Geol. Surv., Canada:
Lead and Sulphur Isotope Geology of Keno and Galena Hills, Yukon, 1958-.
The purpose is to determine the isotopic abundances of lead and sulphur in the lead-zinc-sulphur deposits and their host rocks, and from the data to determine, if possible, the source of the elements in the deposits and the processes which have led to their concentration.

317. Brett, Brian Dudley, McGill Univ.:
Geology of the Antoinette Lake Property, Chibougamau, Quebec, 1960-62; Ph.D. thesis.

318. Brisbin, W.C., Univ. of Manitoba:
Relationship of Buried Rock Topography to Geology at the Coronation Mine, Manitoba, 1960-61.

319. Brownell, G.M., Univ. of Manitoba:
Quantitative Study of Ore Minerals at Coronation Mine, Manitoba, 1961.

320. Byers, A.R., Univ. of Saskatchewan:
Geology and Mineral Deposits of the Flin Flon Area, Saskatchewan, 1953-61.
Geology of Sulphide Bodies, 1958-.
Work to date involves obtaining data on temperature, depths of formation, and trace element constituents of naturally occurring sulphide bodies of ore and non-ore grade. See Sulphide Deposits in Saskatchewan; Trans. Can. Inst. Min. Met., vol. LXIII, pp. 86-93.
Trace Elements in Sulphides and Associated Wallrocks, 1961-.

321. Campbell, F.A., Univ. of Alberta:
Geology of Quemont Mine, Quebec, 1959-61.

322. Carr, J.M., British Columbia Dept. Mines and Petroleum Resources:
Further Studies of Guichon Batholith, Highland Valley Area (Mainly of Porphyries), 1956-60.
Craigmont Mine and Promontory Hills, B.C., Detailed Geological Mapping, 1958-60.
A further study of mine geology, including logging of diamond drill cores, and study of structure of Nicola group rocks, Promontory Hills, See Note on Craigmont Mine; Report of the Minister of Mines, British Columbia, 1959, pp. 31-34.

323. Carswell, H.T., Queen's Univ.:
Origin of the Lead-zinc Deposits, Sullivan Mine, B.C., 1958-61; Ph.D. thesis.
The origin of the conformable Sullivan lead-zinc ores may be explained by accumulation of metals from source beds, by sedimentary deposition of metals with subsequent metamorphic mobilization, or by epigenetic mineralization. Detailed studies, including regional considerations and geothermometry, as well as spectrographic, mineralogic, and metal distribution investigations, favour an epigenetic origin.

324. Cooke, D.L., Univ. of Toronto:
Petrography and Paragenesis of Some Base Metal Veins, 1959-61; M.A. thesis.
A preliminary petrographic study of veins and vein structures to determine if there are significant features which might form the basis of more specific studies.

325. Cruft, E.D., McMaster Univ.:
Trace Element Study of the Sudbury Irruptive, 1959-; Ph.D. thesis.
A study of trace element distribution in relation to initial petrology and alteration processes.

326. Froese, Edgar, Queen's Univ.:
Petrology and Metamorphic Geology of Wall-rocks at Coronation Mine, Saskatchewan, 1960-62; Ph.D. thesis.
This forms part of a major project on the complete study of a mineral deposit initiated on the recommendation of the National Advisory Committee on Research in the Geological Sciences, with participation by several organizations including a number of Canadian Universities. The adjacent area was mapped on a scale of 400 feet to the inch, and samples from the surface and from underground are being studied. Particular attention is being paid to composition and properties of co-existing garnets and amphiboles and trace element distribution in rocks adjacent to ore.

327. Gates, W.G., Univ. of New Brunswick:
Structural Geology of the Opemiska Copper Mine, Quebec, 1960; M.Sc. thesis.

328. Hawley, J.E., and Stanton, R.L., Queen's Univ.:
The Mineralogy and Origin of the Sudbury Ores, 1955-61.
Manuscript in progress with several chapters, maps, photographs and figures completed. See Pseudoeutectic Intergrowths in Arsenical Ores from Sudbury, by J.E. Hawley, R.L. Stanton and A.Y. Smith; Canadian Mineralogist, Vol. 6, Pt. 5, 1961, pp. 555-575.

329. Jeffery, W.G., British Columbia Dept. Mines and Petroleum Resources:
Mapping in Vicinity of Mannix Coast Copper Mines, Port McNeil Area, Vancouver Island, 1/2 inch to 1 mile, 1960-62.

330. Kindle, E.D., Geol. Surv., Canada:
Copper Deposits of Canada, 1960-.
An investigation of the mode of occurrence, distribution, origin and classification of copper deposits in Canada.

331. MacDonald, Angus L.J., Univ. of British Columbia:
Geology and Mineralogy of the Hector and Calumet Mines, Yukon Territory, 1960-61; M.Sc. thesis.

332. Meloche, Marvin J., Queen's Univ.:
Comparative Study of Copper and Copper-Nickel Ores in Granitic Rocks and in Adjacent Wallrocks, 1959-61.
A mineralographic and spectrographic study of individual ore minerals in each type of deposit, one in Quebec and the other in Ontario. Copper ores in granite and in adjacent wall-rocks show slight differences; the nickel-copper ores on the other hand, are quite dissimilar in many respects.

333. Montgomery, J.H., Univ. of British Columbia:
The Copper Mountain Intrusions, British Columbia, 1960-62; Ph.D. thesis.

334. McNutt, James R.A., Univ. of New Brunswick:
Nickel Bearing Gabbros of the Miramichi Area, New Brunswick, 1960-62; M.Sc. thesis.

335. Newham, W.D., McGill Univ.:
Experimental Investigation of Intergrowths of Chalcopyrite and Bornite, 1959-61; Ph.D. thesis.

336. Patterson, J.M., Manitoba Mines Branch (part time), Univ. of Manitoba:
Regional Metamorphism of the Thompson - Moak Lake Area, Manitoba, 1957-62; Ph.D. thesis.

337. Sinclair, J.J., Univ. of British Columbia;
Mineralization and Lead Isotopes in the Kootenay Arc, B.C., 1960-; Ph.D. thesis.

338. Stevenson, John S., McGill Univ.:
Comprehensive Geological and Mineralogical Study of the Sudbury Nickel Irruptive, 1952-.

339. Thorniley, B.H., McGill Univ.:
Experiments with Copper Minerals at High Temperatures, 1959-61; M.Sc. thesis.

340. Wanless, R.K., Lowdon, J.A., and Leech, G.B., Geol. Surv., Canada:
Isotopic Study of Canadian Ore Leads, 1956-.
The purpose is to determine the lead (and possibly sulphur) isotope distribution in lead ores, to investigate possible isotope variations with geological environment, to determine the direction and magnitude of isotopic fractionation of lead isotopes as a result of chemical and physical processes in nature and when applicable, to establish the age, employing the "common lead" method of dating. See Lead Isotope and Potassium Argon Studies in East Kootenay District, Southeastern British Columbia; Geol. Soc., America (In press).

341. Whitmore, D.R.E., (coordinator) Geol. Surv., Canada:
Comprehensive Study of the Coronation Mine, Manitoba, 1960-.
A study of all geological aspects of the orebody to be coordinated by the Geol. Surv., Canada with cooperation of the Hudson Bay Mining and Smelting Co., universities, provincial governments and others.

342. Wilson, H.D.B., Univ. of Manitoba:
Sulphide Mineral Distribution in the Coronation Mine, Flin Flon, Area, Manitoba, 1960-62.

343. Wolhuter, L.E., McGill Univ.:
Geology of Part of Levy Township, Quebec, including the Opemiska Mine, 1959-61; Ph.D. thesis.

Ferrous Metals

344. Baldwin, Ben, and Gross, W.H., Univ. of Toronto:
The Origin of Iron Ores at Fort Gouraud, Mauritania, 1956-60.
This study has led to a revised classification of the origin of hematites in iron formation of Precambrian age.

345. Davies, J.L., Carleton Univ.:
Geochemistry of the Austin Brook Iron Deposit, Bathurst, New Brunswick, 1960-63; Ph.D. thesis.
The deposit appears to be an iron formation of Ordovician age and consists of interbanded magnetite, hematite and chert. It is associated with a large pyritic zinc-lead deposit. Elucidation of the iron formation - sulphide relationship may provide significant data on the conditions under which each formed. The work may also have practical significance since other economic sulphide deposits in the district are associated with iron formation.

346. Gross, G.A., Geol. Surv., Canada:
Iron Deposits of Canada, 1957-.
To provide information on the size, composition, mode of occurrence, origin, potentialities of the main known iron deposits of Canada. Special attention is being given to distribution of special facies of iron-formation in their geological setting with the purpose of showing significant metallogenetic characteristics. See Iron Formations and the Labrador Geosyncline, Geol. Surv., Canada Paper 60-30 and Metamorphism of Iron Formations and Its Bearing on their Beneficiation, Trans. Can. Inst. Mining and Metallurgy, v. LXIV, 1961, pp. 24-31.

347. Gross, W.H., and Strangway, D.M., Univ. of Toronto:
Remanent Magnetism as a Guide to the Origin of Hard Hematites in Precambrian Iron Formations, 1957-60.
The study of magnetism in iron formations will be continued.

348. Hashimoto, T., McGill Univ.:
A Mineralogical Study of the Iron Formation along the Povungnituk River, New Quebec, 1959-61; M.Sc. thesis.

349. Jackson, G.D., Geol. Surv., Canada:
Geology of an Area West of Wabush Lake, Labrador, with Special Reference to Iron Deposits, 1958-61; Ph.D. thesis, McGill University.

350. Mellon, George Harry, Research Council of Alberta:
Petrology and Geology of Sedimentary Magnetite Deposits of Southwestern Alberta, 1959-61.

351. Rose, E.R., Geol. Surv., Canada:
Investigation of Iron-titanium Bearing Anorthosites, 1958-.
A study of mineralogy and petrology of iron-titanium bearing anorthosites and associated mineral deposits. See Geol. Surv., Canada, Papers 60-11 and 61-7.

352. Sangster, D.F., McGill Univ.:
Thermochemical Studies of Certain Iron Minerals, 1959-61; M.Sc. thesis.

353. Squair, Hugh, Univ. of Saskatchewan:
The Forte-a-la Corne Iron Deposit, Saskatchewan, 1959-61; M.Sc. thesis.
A study of the petrology of the deposit, its origin and degree of metamorphism.

354. Suffel, G.G., and McCallum, S., Univ. of Western Ontario and Ontario Research Foundation:
Nature and Origin of Certain Sedimentary Banded Iron Formations of Ontario, 1960-62.

Radioactive Deposits

355. Allan, J.F.S., Queen's Univ.:
Geology of the Fay Mine, Eldorado, Sask., 1959-61; M.Sc. thesis.
A structural and petrological study of the orebody.

356. Gold, D.P., McGill Univ.:
Relationship between Limestones and Alkaline Rocks of Oka and St. Hilaire, Quebec, 1959-61; Ph.D. thesis.

357. Haycock, M.H., Mines Branch, Dept. of Mines and Technical Surveys:
The Mineralogy of the Uranium Deposits at the Eldorado Mine, Port Radium, Northwest Territories, 1959-61.
This investigation is intended to complete and bring up to date the description of the mineralogy of the uranium deposits at the Eldorado Mine. Collections have been made over the past few years in anticipation of the closing of the mine, which took place in 1960. A large quantity of material from the underground workings will be studied to supplement the early work, which was conducted on material from near the surface. See Mineralogy of the Ores of Great Bear Lake, Bull. G.S.A. vol. 46, pp. 879-960, 1935.
The Determination of Spectral Reflectivity of Ore Minerals, 1961-62.

358. Horwood, J.L., Mines Branch and Gregory, A.F., Geol. Surv., Canada:
Scattering of Gamma-rays in Air, 1959-61.
The effect of air scattering on energy spectrum from uranium, thorium and potassium sources with special application to airborne surveying.

Degradation of Gamma-ray Spectra from Uranium and Thorium Ores on Passage through Rocks and Soil, 1958-61.

Determination of changes in characteristic gamma-ray spectra from uranium and thorium ores as a result of absorption and scattering effects in overlying rocks and soils. This is expected to assist in developing improved methods for aerial radioactive surveys.

359. Kieller, B.J., Univ. of Alberta:
Geology of No. 2 Zone, Eldorado Mining and Refining Co., Northwest Territories, 1960-61; M.Sc. thesis.

360. Perrault, Guy, and Schilling, J.G., Ecole Polytechnique:
Petrography of the Oka Alkaline Intrusives, Quebec, 1960-61.
The main purpose of this work is to define mineralogically some of the alkaline intrusives in the neighbourhood of one of the columbium ore deposits. This petrographic work will serve as an introduction to other petrographic work on the alkaline intrusives.

361. Roscoe, S.M., Geol. Surv., Canada:
Origin of Sulphides in Radioactive Conglomerates, 1960-,
A comparison of the isotopic composition of sulphur in the sulphides of these rocks with those whose origin is better understood.

362. Trigg, C.M., McGill Univ.:
Geology of the Verna Uranium Deposit, Beaverlodge, Saskatchewan, 1960-62; Ph.D. thesis.

Other Metals

363. Dibbs, H.P., Mines Branch, Dept. of Mines and Technical Surveys:
Activation Analysis of Minerals and Concentrates, 1960-61.
The determination of beryllium and precious metals in natural ores and concentrates by gamma and neutron activation.

364. Drummond, A.D., Univ. of British Columbia:
Geology of Alice Arm Molybdenum Prospect, British Columbia, 1960-61; M.A. Sc. thesis.

365. Gill, Frederick David, Univ. of Toronto:
Petrography of Molybdenite Bearing Gneisses, Makkovik Area, Labrador, 1960-61; M.A. thesis.
The investigation of a series of highly altered meta-sediments carrying disseminated molybdenite.

366. Grant, Richard H., Univ. of New Brunswick:
Geology of the Tetagouche Falls Manganese Deposits, New Brunswick, 1954-; M.Sc. thesis.

367. Hutton, D.A., Univ. of Manitoba:
Geology of the Wilmar Gold Mine, Ontario, 1959-;
M. Sc. thesis.

368. Johnston, D., and McKillop, J.H., Newfoundland Dept. Mines and Resources:
Chromite in Newfoundland, 1961-.
An economic reassessment of chromite occurrences employing detailed geological mapping, geophysical surveys and sampling, which will be supplemented, as warranted, by diamond drilling.

369. Lowes, B.E., Queen's Univ.:
The Cobalt-Silver Ore Deposit of the Old Casey Mine, Ontario 1959-61; M. Sc. thesis.
A study of the structure and mineralogy of the ore.

370. Malcolm, T., and Gorman, D.H., Univ. of Toronto:
Mineralogy of Scandium, 1960-61; B. Sc. thesis,
A study of the geochemistry, mineralogy, extraction, and uses of scandium.

371. Milne, G.V., Univ. of Toronto:
Petrography and Alteration of some Spodumene Pegmatites near Beardmore, Ontario, 1959-61; Ph.D. thesis.
A field and laboratory investigation of a number of lithium bearing pegmatites, in connection with field work for the Ont. Dept. Mines.

372. Mulligan, R., Geol. Surv., Canada;
Geological Study of the Lithium-beryllium Pegmatites of Canada, 1953-60.
An investigation of the distribution, nature, age, and origin of the pegmatites and of the concentrations of lithium and beryllium minerals of possible economic importance contained in them.

373. Naldrett, A.J., Queen's Univ.:
Cobalt Distribution in Ore Minerals of the Sudbury Area, 1958-61.
Separation of individual ore minerals, sulphides, sulpharsenides and arsenides has been made from many different deposits and over various depths in some individual deposits, and determinations of cobalt distribution are being made by spectrographic and X-ray methods.

374. Nickel, E.H., Mines Branch, Dept. of Mines and Technical Surveys:
A Study of Niobium Minerals, 1957-.
Special attention is currently being given to the niobium minerals from Oka, Quebec. Investigation includes a study of variations in composition and physical properties of pyrochlore and niobium perovskite. See Composition and Crystallography of Niocalite, Can. Mineralogist, vol. 6, pt. 2, 1958, pp. 264-272.

Mineralogist, vol. 6, pt. 2, 1958, pp. 264-272.
The Mineralogy of Beryllium Ore from Seal Lake, Labrador, 1960-61.
The mineralogy of this ore is unusual and extremely complex. The investigation is being conducted by microscopy, X-ray diffraction analysis and chemical analysis.
Mineralogy of the Pollucite Deposit at Bernic Lake, Manitoba, 1960-61.
A study conducted by means of microscopy, X-ray.

375. Pollak, H., Univ. of Toronto:
Partition of Cerium between Silicate and Aqueous Fluids, 1959-61; Ph.D. thesis.

376. Renault, Jacques, R., Univ. of Toronto:
Studies of the Petrography of Molybdenite Deposits, 1960-62.
A series of molybdenite deposits will be studied in an attempt to correlate wall-rock alteration and neomineralization with deposition of the molybdenite.

377. Riddell, John E., and Potter, R.R., Carleton Univ.:
Study of Tungsten and Related Elements in Relation to Structural Development of the Appalachians, 1961-.

378. Robinson, R.E., Univ. of Toronto:
The Molybdenite Occurrence at the Bain Property, Masham Township, Quebec, 1960-61; M.A. thesis.
A petrographic study of a pegmatitic molybdenite occurrence.

Industrial Minerals

379. Baird, D.M., Geol. Surv., Canada (part time), Univ. of Ottawa:
Carboniferous Strata of Newfoundland, 1957-61.
Includes general description, consideration of palaeophysiography responsible for present Carboniferous strata, relation to through-going structures and successive renewals of movement along them and relation of deposits of gypsum and anhydrite to various late physiographic changes.
Geology and Origin of Gypsum-Anhydrite in Canada 1959-61.
An investigation of the geology of calcium sulphate evaporites in each of the occurrences in Canada with a view to a better understanding of their mode of origin and the general palaeostratigraphic and palaeophysiographic conditions at the time of their formation.
See Development of Gypsum Deposits in Southwestern Newfoundland; Can. Inst. of Min. and Met., Trans. vol. LXII, 1959, pp. 257-264.

380. Bannatyne, Barry B., Manitoba Mines Branch:
Clay, Shale, and Bentonite in Manitoba, 1959-60.
Description of deposits of clay and shale and of tests on suitability for various clay products; description of deposits of non-swelling bentonite, and test results of semi-swelling bentonite and possible uses.

381. Boyle, R.W., Geol. Surv., Canada:
Barymin Barite Deposits, Walton, Nova Scotia, 1957-60.
A geochemical study of the barium in the deposit and adjacent strata.

382. Bourret, P.E., Quebec Dept. Mines:
Industrial Minerals Investigation.
A continuing programme of investigation, with the purpose of advising owners as to the value of industrial mineral deposits and to furnish information regarding the developing, mining, milling and marketing of their product.

383. Brady, J.G., Buchanan, R.M., Sadler, A.G., Mines Branch, Dept. of Mines and Technical Surveys:
Mineralogical Constitution and Physical and Chemical Properties of Canadian Clays, 1958-.

384. Danner, Wilbert R., Univ. of British Columbia:
Limestone Deposits of West Washington State, U.S.A., 1959-60.

385. Gillain, P.R., McGill Univ.:
Dykes and Sills in the Canadian Cement Quarry, Montreal East, 1959-61; M.Sc. thesis.

386. Gillespie, C.R., and Johnston, D., Newfoundland Dept. of Mines and Resources:
Manuels Pyrophyllite Deposit, Conception Bay, Newfoundland, 1956-61.
An investigation of the nature, extent and ore deposition controls of the pyrophyllite deposit based upon the evidence of extensive diamond drilling.
Vari-coloured Brick Material of Eastern Newfoundland, 1959-61.
Includes detailed mapping, sampling and laboratory testing of Cambro-Ordovician shales and additives suitable to produce light and dark coloured brick.

387. Govett, G.J., Research Council of Alberta:
Occurrence and Stratigraphy of some Anhydrite and Gypsum Deposits in Alberta, 1959-60.

388. Govett, G.J., and Kidd, D.J., Research Council of Alberta:
Beneficiation of Silica Sand, 1959-61.

389. Hewitt, D.F., Ontario Dept. of Mines:
Salt Deposits of Southwestern Ontario, 1960.

390. Hoen, E.L.W.B., McGill Univ.:
Gypsum Domes on Axel Heiberg Island, Northwest Territories, 1960-62; Ph.D. thesis.

391. Keating, B. J., St. Francis Xavier Univ.:
Petrofabric Analysis of Mineralized Crystalline Limestone from Lime Hill, Inverness County, Nova Scotia, 1960-61.

392. McCammon, J. W., British Columbia Dept. Mines and Petroleum Resources:
Search for and Study of Limestone Occurrences, Shuswap Lake - Okanagan Lake Area, and Roch Creek - Grand Forks Area, B. C., 1960.

393. McCartney, W. D., Geol. Surv., Canada:
Barium, Fluorine, and Strontium in Canada, 1960-61.
To provide information on the mode of occurrence, distribution, origin and the classification of the deposits and principal occurrences of barium, fluorine, and strontium.

394. Paquet, Raymond, Quebec Dept. Mines:
Building Stones.
A continuing program of investigation, with the purpose of advising owners as to the value of deposits of building stones and to furnish information regarding the developing, extracting and marketing of their products.

395. Paré, Conrad, Quebec Dept. Mines:
Mineral Aggregates.
A continuing program of investigation, with the purpose of helping in the production and marketing of mineral aggregates.

396. McKillop, H. H., Newfoundland Dept. Mines and Resources:
Limestones in Newfoundland, 1958-61.
The compilation and analysis of the results of extensive diamond drilling, including thin section studies and spectrographic analyses, with particular attention to zones of low magnesium limestone.

397. Pearson, W. J., Saskatchewan Dept. of Mineral Resources:
Industrial Minerals - continuing programme of studies.
Includes mineralogical and stratigraphical studies of potash in the province of Saskatchewan and studies of potentially economic deposits of ceramic clay, silica, sand, bentonite, including local mapping projects. See Developments in Potash in Saskatchewan; Trans. C. I. M. M., vol. LXIII, 1960, pp. 509-514.

398. Soles, James A., Mines Branch, Dept. of Mines and Technical Surveys:
The Properties of Rocks, relating to their Use as Construction Materials.

399. Wardlaw, Norman C., Univ. of Saskatchewan:
Evaporite and Carbonate Deposits of Saskatchewan, 1960-65.
A petrologic and stratigraphic study of potash bearing beds, and associated carbonate and related sediments of the Middle Devonian Prairie Evaporite formation in part of south central Saskatchewan.

Petroleum

400. Belyea, H.R., Maxwell, J.A., and Wanless, R.K., Geol. Surv., Canada:
Isotopic Studies of Sulphur from Canadian Petroleum Deposits, 1955-.
To determine whether variations in the isotopic composition of sulphur derived from petroleum, from oil field waters and from petroleum-bearing strata can be used to aid in correlation and dating of strata at and near petroleum-bearing horizons and in determining the source rocks from which petroleum in various fields was originally derived.

401. Burk, C.F., Geol. Surv., Canada:
Subsurface Upper Cretaceous Stratigraphy of West Central Alberta and Adjacent British Columbia, 1960-62.
A regional correlation and stratigraphic analysis of a selected interval consisting mainly of Upper Cretaceous rocks, with special attention to potential oil and gas reservoirs such as the Cardium and Dunvegan formations. The basic stratigraphic data will be obtained from electric logs and well samples.

402. Caley, J.F., and Sanford, B.V., Geol. Surv., Canada:
Studies of Drift Thickness and Bedrock Topography in Southern Ontario, 1948-.
The purpose is to determine by means of bore-hole data the pre-Pleistocene bedrock topography, and the drift thickness and to deduce the pre-glacial drainage and probable location of reservoirs of ground water. As the pre-Pleistocene topography may reflect the underlying structure of the bedrock, this knowledge will assist in the search for oil and natural gas. See Geol. Surv., Canada, Paper 55-20.

403. Cameron, E.M., Geol. Surv., Canada:
Geochemistry of Sandstones, 1958-.
A study of the geochemical characteristics of sandstones that may be of importance in the petroleum industry.

404. Cumming, L.M., Geol. Surv., Canada:
Basement Rock Features in the Canadian Appalachians, 1960-61.
To summarise published and unpublished information concerning the rocks which are considered to be 'basement' for oil and gas exploration in the Appalachian region.

405. Douglas, R. J. W., and Herr, R. L., Geol. Surv., Canada:
Quaich Structure, Gap and Adjacent Map-area, Alberta, 1960.
To explain the structure by interpretation of results of drilling, examination of samples, and some re-mapping.

406. Irish, E. J. W., Geol. Surv., Canada:
Halfway River Map-area, British Columbia, 1 inch to 4 miles, 1959-61.
Special attention will be given to the oil and gas potentialities.

407. Jones, H. Llewelyn, Saskatchewan Dept. of Mineral Resources:
The Viking Formation in West-central Saskatchewan, 1959-61.
Involves the study of the stratigraphy, structure, conditions of deposition, and economic considerations of the Lower Cretaceous Viking formation in this area.

408. Kent, Donald M. J., Univ. of Alberta:
Stratigraphy and Sedimentation of the Upper Devonian Nisku and Duperow Formations of Southern Saskatchewan, 1960-62; Ph. D. thesis.
It is hoped that by a detailed study of the stratigraphy and sedimentation of this area, stratigraphic hydrocarbon traps may be outlined. A new stratigraphic tool, pseudochitinous microfossils called Tasmanites, are being used as an aid in unraveling the stratigraphy of the area under study. See Preliminary Report on Stratigraphy of the Upper Devonian Nisku and Duperow Formation, Southwestern Saskatchewan; Saskatchewan Dept. of Mineral Resources (in press).

409. Kirmani, Khalil-Ullah, Univ. of Alberta:
Detailed Study of Duhamel Reef, 1960-61; M. Sc. thesis.

410. McCabe, Hugh R., Manitoba Mines Branch:
Oil Fields of Southwestern Manitoba, 1959-61.

411. Price, L. L., Geol. Surv., Canada:
Subsurface Study of the Lower Cretaceous Formations of Southern Saskatchewan, 1954-.
The purpose is to describe and illustrate the character, distribution, structure, and correlation of the principal Lower Cretaceous formations by study of electric logs and samples from oil and gas wells and thereby assist exploration for oil and gas.

412. Pugh, D. C., Geol. Surv., Canada:
Subsurface Study of the Pennsylvanian and/or Permian, Triassic and Jurassic Formations in Northeastern British Columbia, 1954-.
To correlate, describe, and determine facies changes of Pennsylvanian-Permian, Triassic, and Jurassic formations by study of samples, cores, and electric and radioactivity logs of oil and gas wells. See Geol. Surv., Canada, Paper 60-1.

Insoluble Residues, Devonian Carbonate Rocks of Western Canada, 1959-.

It is hoped this study will contribute to an understanding of the source and conditions of deposition of the rocks and of the conditions favouring formation of reefs and organic carbonates. Initial work may include study of Redwater reef and surrounding strata, study of source sands of the Red Earth area, and of the effects of the Peace River land mass during Devonian time.

413. Sanford, B.V., Geol. Surv., Canada:
Sub-surface Studies of Each of the Palaeozoic Systems of Southwestern Ontario (Cambrian, Ordovician, Silurian and Devonian), 1958-61.

By the study of samples and data obtained from wells drilled for oil and gas, to describe and interpret the geological features of the formations of each system, and to assess their economic potentialities. See Geol. Surv., Canada Papers 58-12 and 60-26.

414. Stott, D.F., Geol. Surv., Canada:
Cretaceous Stratigraphy between Smoky and Pine Rivers, Rocky Mountain Foothills, Alberta and British Columbia, 1958-61.

Stratigraphic Studies of the Upper Cretaceous Smoky group have been directed to the pronounced facies changes from marine to transitional sediments and to correlations of these beds with the type Smoky section and Alberta group of the Alberta Foothills. In the Fort St. John Group, the relation of the flora to the Lower Cretaceous Blairmore-Luscar flora and its relation to dated marine rocks are being investigated. The lithology of these rocks is being studied in detail to determine environments of deposition, their potentialities as sources of oil and gas and suitability as reservoirs.

415. Taylor, G.C., Geol. Surv., Canada:
McDonald River Map-area, British Columbia, 1 inch to 1 mile, 1960-61.

With special attention to oil and natural gas potentialities.

Coal and Peat

416. Eydt, R., McMaster Univ.:
Fossilized Tissues in Peats as a Means of Comparing Different Kinds of Peat; Ph.D. thesis.

417. Hacquebard, P.A., Geol. Surv., Canada:
Research on the Petrography and Spore Analysis of Coal, 1948-.

Investigations of the character and correlation of various coal seams in Nova Scotia and Western Canada such as will aid their development. See Geol. Surv., Canada, Bulletins 19 and 40.

418. Latour, B.A., Geol. Surv., Canada:
Coal Reserves of Canada, 1950-.
The collection of data necessary for an estimation of Canada's coal reserves and the collection of coal samples for qualitative spectrographic analysis.

419. Stewart, J., McMaster Univ.:
Significance of Cuticles in Peat as a Means of Interpreting the Origin and Evolution of Vegetal Composition; Ph.D. thesis.

420. Tibbetts, T.E., Mines Branch, Dept. of Mines and Technical Surveys and Hacquebard, P., Geol. Surv., Canada:
Study of Coking Characteristics on Laboratory Scale of Coal Seams and Sections in Relation to Petrographic Constituents, 1956-.
See Practical Significance of Coal Petrography to Coking, Dominion Provincial Coal Research Conference, Ottawa, September 1960.

General Problems

421. Anderson, G.M., Univ. of Toronto:
Solubility of Lead Sulphide in H_2S - H_2O Solutions, Ph.D. thesis.

422. Anderson, D.T., Univ. of Manitoba:
Distribution of Copper, Cobalt, Nickel and Iron in Silicate and Sulphide Phases, 1959-62; Ph.D. thesis.

423. Assad, J.R., Quebec Dept. Mines:
Examination of Mining Properties and Development in Chibougamau District, Quebec.
A continuing programme of investigation of mining properties and development work being carried out from year to year in the Chibougamau District.

424. Boyle, R.W., Wanless, R.K., and Lowdon, J.A., Geol. Surv., Canada:
Isotope Chemistry of Sulphur in Rocks and Ore Deposits, 1955-.
See Sulphur Isotope Investigation of the Gold-quartz Deposits of the Yellowknife District; Economic Geology Vol. 5, No. 8, 1960, pp. 1591-1621.

425. Bristol, C.C., and Wilson H.D.B., Univ. of Manitoba:
Textural Studies of Sulphide Ores when Heated, 1960-61.

426. Clark, Lloyd A., McGill Univ.:
Phase Equilibrium Studies in Synthetic Sulphide Systems, 1957-.
This involves thorough and systematic laboratory determination of the phase relations in a number of relatively simple sulphide systems to gain the groundwork of basic knowledge necessary for quantitative approach to the problems of ore transport, localization and deposition.
See The Fe-As-S System: Phase Relations and Applications; Econ. Geol., vol. 55, No. 7, pp. 1345-1381.

427. Clark, T.H., McGill Univ.:
Stratigraphy, Structure and Economic Products of the St. Lawrence Lowland, 1938-.
See Stratigraphy of the Trenton Group St. Lawrence Lowland, Quebec; Proceedings Geol. Assoc., of Canada, vol. II, December, 1959.

428. Deland, André, Quebec Dept. Mines:
Examination of Mining Properties and Development in Montreal District, Quebec.
A continuing programme of investigation of mining properties and development work being carried out from year to year in the Montreal district.

429. Delavault, Robert E., and Stanley, A.D., Univ. of British Columbia:
Determination of Copper and Magnetite in the Host Rock of an Orebody, 1960-61.

430. Dugas, Jean, Quebec Dept. Mines:
Examination of Mining Properties and Development in Rouyn-Noranda District, Quebec.
A continuing program of investigation of mining properties and development being carried out from year to year in the Rouyn-Noranda District.

431. Frueh, Alfred J. Jr., McGill Univ.:
Crystal Chemistry of Sulphides, 1959-.
See Use of Zone Theory in Problems of Sulphide Mineralogy, part III; Polymorphism of Ag_2Te and Ag_2S; American Mineralogist (in press).

432. Gill, J.E., and Thorniley, B.H., McGill Univ.:
Solid Diffusion in Sulphides, 1955-.

433. Hansuld, J.A., McGill Univ.:
Oxidation Potential of Certain Sulphides, 1959-61; Ph.D. thesis.

434. Hughes, O.L., and McLeod, C.R., Geol. Surv., Canada:
Surficial Geology of the Klondike, Yukon Territory, 1960-.
To provide information on surficial formations, with special attention to the conditions favouring placer deposits.

435. Jolliffe, A.W., and Laakso, R., Queen's Univ.:
Element Associations in Ore Deposits and their Significance, 1950-60.

436. Johnston, A.G., Geol. Surv., Canada:
Economic Geology Files, 1940-.
The purpose is to file and cross-index all published authentic geological information and geological plans on Canadian occurrences of economic metals or minerals and to assist in preparing for publication maps and reports showing the distribution and mode of occurrence of specific minerals or metals.

437. Jones, R.E., McMaster Univ.:
Sulphur Isotope Studies of Sulphide and Sulphate Minerals of the Niagara Escarpment, Ontario, 1960-62.
The project involves a study of sulphur isotope distribution in sphalerite, galena, marcasite, pyrite, gypsum and baro-celesite occurring in the Silurian rocks of the Niagara escarpment across the northern extension of the Cincinnati axis in the Hamilton area. Study of the geological environment of the samples mineralogically, stratigraphically, and structurally is an important part of the project.

438. Kaiman, S., and Hughson, M.R., Mines Branch, Dept. of Mines and Technical Surveys:
Mineralogical Reports on Ore Samples.
These reports cover the mineralogical composition of ores and mill products. Their main purpose is to supply mineralogical information in connection with ore treatment investigations.

439. Latulippe Maurice, Quebec Dept. Mines;
Examination of Mining Properties and Development in Val d'Or District, Quebec.
A continuing programme of investigation of mining properties and development work being carried out from year to year in the Val d'Or district.

440. Mannard, G.W., McGill Univ.:
Geology of the Sungida Kimberlite Pipes, Tanganyika, 1959-62; Ph.D. thesis.

441. Marleau, Raymond A., Quebec Dept. Mines:
Examination of Mining Properties and Development in Quebec District, Quebec.
A continuing programme of investigation of mining properties and development work being carried out from year to year in the Appalachian and North Shore Regions.

442. McCartney, W.D., and others, Geol. Surv., Canada:
Metallogenic Maps of Canada, 1957-62.
The preparation of a composite map illustrating Canadian metallogenic provinces for all major metals and as many minor ones as practical and at the same time to prepare individual metallogenic maps. See Geol. Surv., Canada Maps 1045-A, M2, M3, M4, and M5.

443. McKechnie, N.D., British Columbia Dept. of Mines and Petroleum Resources:
Study of Ultrabasic Rocks in Mineralized Areas, B.C., 1958-.

444. McLeod, C.R., Geol. Surv., Canada:
Heavy Minerals of Beach and other Placer Deposits in Canada, 1957-.
The purpose is to provide data concerning the occurrence in beaches, beach placers, and similar deposits of minerals of commercial or possible commercial importance; and to test and improve

techniques for detecting and evaluating such occurrences. See Geol. Surv., Canada, Paper 59-7.

445. Northcote, K.E., Univ. of British Columbia:
Distribution of Metals in the Sediments of Boundary Bay, British Columbia, 1960-61; M.Sc. thesis.
A study of the distribution of copper, zinc, molybdenum, lead, iron and sulphur with respect to the shoreline. Chemical and X-ray fluorimeter methods of analysis will be used.

446. Russell, R.D., Stacey, J.S., Ulrych, T.J., Kanasewich, E., and Ostic, R., Univ. of British Columbia:
Isotopic Studies in Geophysics, 1958-.
The project consists of the measurement and interpretation of lead isotope abundances (a) to distinguish the contaminations of lead by radiogenic isotopes according to their occurrence in crustal or sub-crustal regions and to correlate these results with possible theories of continental growth, and (b) to trace the development of certain lead ores.

447. Saull, V.A., Gill, J.E., Kranck, E.H., Chagnon, J., and Philpotts, J., McGill Univ.:
Silicate and Sulphide Phase Relationships, 1954-.
See Solid Diffusion of Sulphides and Ore Formation; International Geol. Cong., 21 Norden, 1960, Part 16, pp. 209-217.

448. Smith, A.Y., Geol. Surv., Canada (part time), Carleton Univ.:
Geochemical Studies in Southeastern New Brunswick, 1959-60; Ph.D. thesis.
To provide information on the geochemistry of stream sediments, etc., and on copper in the Pennsylvania sandstones. See Geol. Surv., Canada, Paper 59-12.

449. Thompson, R.M., and Drummond, A.D., Univ. of British Columbia:
Pyrosyntheses in the Lead, Bismuth, Copper, Silver, Sulphur System, 1960-61.

450. Tupper, W.M., Carleton Univ.:
Thermodynamic and Laboratory Investigation of the Distribution of Sulphur Isotopes in Nature, Particularly as Applied to Processes of Sulphide Genesis in Sulphide Ore Deposits, 1958.

MINERALOGY

X-Ray, Crystal Structure, Specific Minerals

451. Berry, L.G., and Reynolds, P.L., Queen's Univ.:
The Hydrothermal Synthesis and Recrystallization of Mica, 1961-62.
The purpose of the research is to explore the effect of an argon atmosphere on the crystallization or recrystallization of mica under conditions simulating those extant during thermal metamorphism.

452. Coleman, Leslie C., Univ. of Saskatchewan:
Investigation of the Relation Between Atomic Substitutions in Monoclinic Pyroxenes and their Unit Cell Dimensions and Optical Constants, 1959-63.
A study of synthetic monoclinic pyroxenes which it is hoped will solve some of the problems encountered in assessing compositional effects in naturally occurring species.

453. Courville, S., Dawson, K.R., and Maxwell, J.A., Geol. Surv., Canada.
Rapid Fusion Technique for Determining Composition of Plagioclase Feldspars, 1958-.
To determine the loss of sodium and potassium in plagioclase feldspar glasses and thus evaluate the accuracy of this technique in determining the composition of feldspars. See Identification of Plagioclase by Fusion Technique; Canadian Mineralogist, vol. 6, Pt. 3, 1959, pp. 390-394.

454. Hogarth, D.D., Univ. of Ottawa:
Datolite in Mica Veins of the Ottawa Region, Ontario and Quebec, 1960-61.
A mineralogical study of "botryoidite" from mica veins of the Gatineau - Lievre district.

455. Hughson, M.R., Mines Branch and Maxwell, J.A., Geol. Surv., Canada:
Britholite from Oka, Quebec, 1957-61.
Includes determination of the chemical composition and some physical properties.

456. Kudo, A., and Shaw, D.M., McMaster Univ.:
Geochemistry of Amphibolites, 1960-.
A study of major, minor and trace elements in various amphibolites, with the aim of finding criteria for igneous or sedimentary origin.

457. Malcolm, T., and Gorman, D.H., Univ. of Toronto:
Mineralogy of Scandium, 1960-61; B.Sc. thesis.
A study of the geochemistry, mineralogy, extraction, and uses of scandium.

458. Nash, W.A., Univ. of New Brunswick:
A Study of the Amphiboles in St. Stephen Gabbro, New Brunswick, 1959-61; M.Sc. thesis.

459. Nuffield, E.W., Harris, D., and Waddington, J., Univ. of Toronto:
X-ray Spectrographic Analysis of Rocks, 1959-62.

460. Perrault, Guy, and Bertrand, Claude, Ecole Polytechnique:
X-ray Diffraction Data for Pyroxene, 1960-61.
An attempt to gather from the mineralogical literature all data pertaining to pyroxene and compiling them in such a fashion that the X-ray powder diffraction pattern may be a guide to identification. Some new diffraction data for individual pyroxene species may be added.

461. Sangster, D.F., McGill Univ.:
Thermochemical Studies of Certain Iron Minerals, 1959-61; M.Sc. thesis.

462. Trembath, Lowell, and Ferguson, R.B., Univ. of Manitoba:
Study of Potash Feldspars from the Moak Lake Area, Manitoba, 1960-61.

463. Wynne-Edwards, H.R., and Hay, P.W., Queen's Univ.:
Co-existing Cordierite and Garnet from the Westport Area, Ontario, 1960-61.
Bulk chemical analysis and analyses of ferromagnesian minerals are being used to investigate the factors controlling the stability of cordierite with and without co-existing garnet in regional metamorphism. See Westport Map-area, Geol. Surv., Canada, Map 28-1959 with descriptive notes.

General Problems

464. Brady, J.G., Buchanan, R.M., Sadler, A.G., Mines Branch, Dept. of Mines and Technical Surveys:
Mineralogical Constitution and Physical and Chemical Properties of Canadian Clays, 1958-.

465. Bristol, C.C., and Wilson, H.D.B., Univ. of Manitoba:
Textural Studies of Sulphide Ores when Heated, 1960-61.

466. Chagnon, J.Y., McGill Univ.:
Experimental Studies on the Growth of Minerals in Sediments, 1959-61; M.Sc. thesis.

467. Clark, George S., Univ. of New Brunswick:
Mineralogical Study of the Gabbroic Rocks of the St. Stephen Area of New Brunswick, 1960-62; M.Sc. thesis.

468. Dell, Carol, I., Ontario Research Foundation:
Mineralogical Composition of Sand in Ontario, 1956-61.
Soil samples from northern Ontario are being studied. See Methods of Study of Sand and Silt from Soils; Canadian Mineralogist, vol. 6, Part 3, pp. 363-371, 1959 and A Study of the Mineralogical Composition of Sand in Southern Ontario; Can. J. Soil Sci., vol. 39, pp. 185-196, 1959.

469. Folinsbee, R.E., Baadsgaard, H., and Campbell, F.A., Univ. of Alberta:
Bruderheim Meteorite, 1960-61.
Description and analysis of Bruderheim meteorite, a grey chondrite which fell on March 4, 1960, near Bruderheim, Alberta. Three hundred kilograms of this meteorite have been collected and catalogued. Detailed study of rare gas content, mineralogy, and cosmogenic spallation products of this meteorite is underway at the Univ. of Alberta and at other laboratories in Europe and North America.

470. Hamilton, W.N., Univ. of Saskatchewan:
Mineralogy of the Cretaceous Bearpaw Formation in the South Saskatchewan River Valley, 1960-62; M. Sc. thesis.

471. Halferdahl, L.B., Research Council of Alberta:
Alluvial Deposits in Alberta with Special Emphasis on Heavy Minerals, 1957-.
The bulk of the heavy minerals presently being transported in rivers in Alberta consist of siderite, garnet, magnetite, and ilmenite. In certain parts of some rivers interesting amounts of gold have been found.

472. Hashimoto, T., McGill Univ.:
A Mineralogical Study of the Iron Formation along the Povungnituk River, New Quebec, 1959-61; M. Sc. thesis.

473. Hawley, J.E., and Stanton, R.L., Queen's Univ.:
The Mineralogy and Origin of the Sudbury Ores, 1955-61.
Manuscript in progress with several chapters, maps, photographs and figures completed. See Pseudo-eutectic Intergrowths in Arsenical Ores from Sudbury, by J.E. Hawley, R.L. Stanton and A.Y. Smith; Can. Mineralogist, Vol. 6, pt. 5, 1961, pp. 555-575.

474. Haycock, M.H., Mines Branch, Dept. of Mines and Technical Surveys:
The Mineralogy of the Uranium Deposits at the Eldorado Mine, Port Radium, Northwest Territories, 1959-61.
This investigation is intended to complete and bring up to date the description of the mineralogy of the uranium deposits at the Eldorado Mine. Collections have been made over the past few years in anticipation of the closing of the mine, which took place in 1960. A large quantity of material from the underground workings will be studied to supplement the early work, which was conducted on material from near the surface. See Mineralogy of the Ores of Great Bear Lake, Bull. G.S.A. vol. 46, pp. 879-960, 1935.
The Determination of Spectral Reflectivity of Ore Minerals, 1961-62.

475. Heidecker, Eric I., Queen's Univ.:
Geology of an Area West of Mt. Isa, Australia, 1960-61; M. Sc. thesis.
A study of certain amphibolites on either side of the Mt. Isa Fault, and of the geology of the fault itself, with the particular aim of solving the character and amount of displacement.

476. Irvine, T.N., McMaster Univ.:
Mineralogical Studies of the Ultramafic Complex of Duke Island, Southeastern Alaska, 1959-61.

477. Kaiman, S., and Hughson, M.R., Mines Branch, Dept. of Mines and Technical Surveys:
Mineralogical Reports on Ore Samples.
These reports cover the mineralogical composition of ores and mill products. Their main purpose is to supply mineralogical information in connection with ore treatment investigations.

478. La Rush, P., and Shaw, D.M., McMaster Univ.:
Geochemistry of Skarn Minerals, 1960-.
A continuation of previous trace element studies on Grenville skarn minerals, with present emphasis on phlogopites.

479. Lowes, B.E., Queen's Univ.:
The Cobalt-Silver Ore Deposit of the Old Casey Mine, Ontario, 1959-61; M.Sc. thesis.
A study of the structure and mineralogy of the ore.

480. Meloche, Marvin J., Queen's Univ.:
Comparative Study of Copper and Copper-Nickel Ores in Granitic Rocks and in Adjacent Wallrocks, 1959-61.
A mineralographic and spectrographic study of individual ore minerals in each type of deposit, one in Quebec and the other in Ontario. Copper ores in granite and in adjacent wallrocks show slight differences; the nickel-copper ores on the other hand, are quite dissimilar in many respects.

481. Naldrett, A.J., Queen's Univ.:
Cobalt Distribution in Ore Minerals of the Sudbury Area, 1958-61.
Separation of individual ore minerals, sulphides, sulpharsenides and arsenides has been made from many different deposits and over various depths in some individual deposits and determinations of cobalt distribution are being made by spectrographic and X-ray methods.

482. Nickel, E.H., Mines Branch, Dept. of Mines and Technical Surveys:
A Study of Niobium Minerals, 1957-.
Special attention is currently being given to the niobium minerals from Oka, Quebec. Investigation includes a study of variations in composition and physical properties of pyrochlore and niobium perovskite. See Composition and Crystallography of Niocalite, Can. Mineralogist, vol. 6, pt. 2, 1958, pp. 264-272.
The Mineralogy of Beryllium Ore from Seal Lake, Labrador, 1960-61.
The mineralogy of this ore is unusual and extremely complex. The investigation is being conducted by microscopy, X-ray diffraction and chemical analysis.
Mineralogy of the Pollucite Deposit at Bernic Lake, Manitoba, 1960-61.
A study conducted by means of microscopy, X-ray diffraction and chemical analysis that includes a

determination of the composition of the pollucite, compositional variations of the lithium micas, and a study of the tin and tantalum mineralization.

483. Ostry, R., Univ. of Toronto:
Mineralogical Studies of Some Tills in Scarborough Township, Ontario, 1960-61; M.A. thesis.

484. Perrault, Guy, Ecole Polytechnique:
Mineralogy of the Oka Alkaline Intrusives, Quebec, 1957-.
See Determination de la Composition Chimique du Pyrochlore d'Oka; L'Ingenieur, 1958.
X-ray Diffraction Data for the Amphibole Minerals, 1959-.
Single crystal X-ray diffraction work has been done on two amphiboles, and powder diffraction data obtained on a number of others. One of the amphiboles completely studied is from Oka while the other is from the southern part of the Labrador Trough.
Structure of Feldspar Minerals, 1957-62.
Work is being concentrated on the study of some microcline perthites. See La Structure Atomique des Feldspaths; L'Ingenieur, 1958.

485. Petruk, William, Mines Branch, Dept. of Mines and Technical Surveys:
Refinement of Semi-quantitative X-ray Diffraction Methods of Mineralogical Analysis, 1960-62.
The purpose is to establish a method for determining the amounts of minerals in mixtures, especially in ores and mill products. It is hoped to develop a rapid method that will not reqire the addition of an internal standard.

486. Pouliot, Gaston, McGill Univ.:
Thermal History of the Monteregian Intrusives, Based on a Study of the Feldspars, 1959-61; Ph.D. thesis.

487. Smith, C.H., and MacGregor, I.D., Geol. Surv., Canada:
Study of Mineralogical, Petrographical, and Chemical Variations in the Mount Albert Ultrabasic Intrusion, Quebec, 1957-60.
The purpose is to test the chemical homogeneity of the intrusion and to set up techniques for the study of ultrabasic bodies. See Ultrabasic Intrusive Conditions Illustrated by the Mount Albert Ultrabasic Pluton, Gaspe, Quebec; Bull. Geol. Soc. America, vol. 71, No. 12, Pt. 2, p. 1978, 1960 (abstract).

488. Stevenson, John, S., McGill Univ.:
Comprehensive Geological and Mineralogical Study of the Sudbury Nickel Irruptive, 1952-.

489. Traill, R.J., Geol. Surv., Canada:
A List of Canadian Mineral Occurrences, 1958-60.
The compilation of an up-to-date list of Canadian mineral occurrences, including all available analytical data.

490. Traill, R.J., and Sabina, A.P., Geol. Surv., Canada:
Reference Collection of X-ray Powder Photographs of Minerals, 1949-.
The collection of X-ray photographs of material identified accurately by chemical or other means and development of new techniques in powder photography. See Geol. Surv., Canada Paper 60-4.

491. Tweedy, N., Univ. of Manitoba:
An X-ray Study of Some Pegmatite Minerals from Southeast Manitoba, 1959-61; M.Sc. thesis.

492. Weber, J.N.E., Univ. of Toronto:
Composition of Carbonate Minerals and Rocks, 1959-61; Ph.D. thesis.

PALAEONTOLOGY

493. Bate, Raymond H., McMaster Univ.:
Lower Bathonian Ostracoda of Rutland, England, 1960-61.
Middle Bajocian Ostracoda of Yorkshire and Lincolnshire, England, 1957-61.
The ostracods studied fall into the single order Podocopide of which the majority belong to the suborder Podocopina; only three genera belonging to the suborder Platycopina have been described. Of the three superfamilies represented in the Podocopina, the Cytheracea contains the bulk of the genera described. Two new families, the Kirtonellidae and the Pneumatocytheridae are introduced as well as three new subfamilies; Homocytherideinae, Pneumatocytherinae and Kirtonellinae. The subfamilies Progonocytherinae and Schulerideinae are emended to fit in with the classification adopted. Twenty-two new genera and 78 new species are also described.

494. Bartlett, G., Carleton Univ.:
Foraminifera of the Scotian Shelf, 1960-62; M.Sc. thesis.

495. Beales, F.W., Univ. of Toronto:
Shallow Water Limestone Ecology, 1957-.

496. Best, R.V., Univ. of British Columbia:
Dalmanites and Acanthopyge from the Lockport of Ontario, 1960-61.
A continuation of study of late Mid-Silurian trilobites from Hamilton, Ontario. See Intraspecific Variation in Encrinurus urnatus; J. Palaeont., (in press).

497. Bolton, Thomas L., Geol. Surv., Canada:
Silurian Bryozoa from Anticosti Island, Quebec, 1959-.
An investigation and description of the bryozoa fauna found in the Silurian formations of Anticosti Island, Quebec, and comparison with European and Central North American faunas.

Silurian Bryozoa from Arisaig, Nova Scotia, 1960.

An investigation and description of the bryozoa found in the Upper Silurian Stonehouse and Moidart formations at Arisaig, Nova Scotia, and their comparison with bryozoa collected from the Upper Silurian strata of the Arctic. This study is associated with ostracod studies being carried out by Dr. Copeland.

Silurian Coralline Faunas of Canada, 1952-.

An investigation and description of the coral fauna found in the Silurian strata of Anticosti and Manitoulin Islands, and Western Canada. It is proposed to take one group of corals at a time and trace their distribution and specific relationship.

Maintenance of Geological Survey Palaeontological Collections.

498. Brindle, John E., Saskatchewan Dept. of Mineral Resources:

Faunas of the Winnipeg and Deadwood Formations in the Subsurface of Saskatchewan, 1960-61.

This research involves the study of a collection of Cambrian and Ordovician invertebrate fossils, principally brachiopods, from Saskatchewan well cores. The results will be published as a Departmental report. The results of a similar study of fossils from the Ordovician and Silurian carbonate rocks of the province, are in press.

499. Caldwell, W.G.E., Univ. of Saskatchewan:

Middle Devonian Faunas of Northern Canada, 1959-65.

A study of the various groups of brachiopods, corals and molluscs in these rocks, mainly in the Mackenzie River Valley.

Stratigraphy of the Late Cretaceous Bearpaw Formation in South Saskatchewan River Valley, 1959-62.

A study of the field relations, megafossils, microfossils, fossil spores and pollen, and the light, heavy and clay minerals.

500. Chamney, T.P., Shell Oil Co., of Canada Ltd., Edmonton, Alberta:

Micropalaeontological Investigations in Western Canada, 1953-.

501. Cockbain, A.E., Institute of Oceanography, Univ. of British Columbia:

Distribution of Foraminifera in the Juan de Fuca, Georgia, and Queen Charlotte Straits.

502. Copeland, M.J., Geol. Surv., Canada:

Jurassic Microfauna of the Prairies and Foothills, 1957-.

A study with special emphasis on Jurassic ostracod occurrences.

Ordovician Ostracoda, Lake Temiskaming, Ontario, 1959-60.

A description of new ostracods from the above area, and of the strata with which they are associated.

Canadian Fossil Arthropoda II: Ostracoda, Conchostraca, 1960-61.

Includes examination of some leperditiid ostracods from northern Canada, Ordovician ostracoda from Healey Falls, Ontario, some Silurian ostracoda from the

Canadian Arctic, Silurian ostracoda from Anticosti Island, Quebec, Upper Silurian Beyrichiid ostracods from New Brunswick, a Devonian Conchostracan fauna from Melville Island, Canadian Arctic, and ostracoda from the Silurian Rochester Shale, southern Ontario.

503. Cox, Raymond, Univ. of British Columbia:
Biostratigraphy of a Portion of the Sooke Formation of Vancouver Island, British Columbia, 1960-62; M. Sc. thesis.
Includes identification of megafossils of marine origin and plant microfossils.

504. Danner, Wilbert R., Univ. of British Columbia:
Palaeontology of the Nicola and other Triassic Formations of Southwestern British Columbia, 1960-.
Palaeontology and Stratigraphy of the Chilliwack, Cache Creek and Sicker Groups of Southwestern British Columbia, 1957-.

505. Dineley, David L., Univ. of Ottawa:
Re-examination and Study of Devonian Fishes in the Collections of the National Museum of Canada, 1960-.
The large Devonian fish collections in the National Museum have not been critically examined for many years and new material has been accumulating at a rapid rate. Work on similar fossils in Europe has shown that many are of stratigraphical importance but that many problems of morphology and lineage remain. The Canadian material shows many new and undescribed features.
Devonian Conodont Studies, 1952-.
Micropalaeontological zoning, using conodonts, has now been applied to the Devonian formations of Europe and should be useful for similar rocks in Canada.
Stratigraphy, Palaeontology and Sedimentology of Devonian Continental Formations, 1960-.
This project is a continuation of studies carried out on similar formations in Europe and Spitsbergen during the last 10 years. New techniques of vertebrate fossil preparation are to be employed.
Conodont Faunas of Ottawa Limestone and Other Palaeozoic Limestones, 1961-.

506. Ferguson, Laing, Univ. of Alberta, (N.R.C. Postdoctorate Fellow):
Zonation and Palaeoecology of Permian Waagenoconcha from the Yukon and Northwest Territories, 1960-61.

507. Frebold, Hans, Geol. Surv., Canada:
The Jurassic System in Canada:
A long term project involving comprehensive description of the geology of the Canadian Jurassic, particularly its index-faunas, stratigraphy, correlation and palaeogeography. See Marine Jurassic Rocks in the Nelson and Salmo Areas; Geol. Surv., Canada, Bull. 49 (1959) and Jurassic Faunas of the Canadian Arctic; Geol. Surv., Canada, Bull. 59 (1960).

The Lower Jurassic System of Southern Yukon and Northwestern British Columbia, 1960-61.
A description of the index fossils, stratigraphy and correlation of the beds with other Lower Jurassic occurrences in Canada and elsewhere; palaeogeography of the area during Early Jurassic time.

508. Frison, E.H., Univ. of Saskatchewan:
Mid Devonian Ceroid Rugose Corals from Northern Canada, 1960-61; M.A. thesis.

509. Fritz, Madeleine A., Univ. of Toronto:
Ordovician Bryozoa from Quebec, 1960-61.
Bryozoan Fauna from the Rocky Mountain Group, Alberta, 1960-61.
New Coral Fauna from Lake Temiskaming, 1960-61.

510. Green, Robert, Research Council of Alberta:
Ostracodes of the Banff Formation of Alberta, 1956-61.
A study of ostracodes of the type section of the Banff formation, supplemented by other Banff formation microfaunal collections.

511. Greiner, H.R., Univ. of New Brunswick:
Palaeozoic Fish and Fish Zones of the Maritime Provinces, 1961-.

512. Hamilton, J.B., New Brunswick Dept. of Lands and Mines;
Correlation of Pennsylvanian Rocks of Eastern New Brunswick by Palynological Methods, 1958-61; M.Sc. thesis, Univ. of New Brunswick.

513. Hills, Leonard, Univ. of British Columbia:
Stratigraphy and Fossil Flora of the Princeton Basin, British Columbia, 1960-61; M.Sc. thesis.

514. Hooper, Kenneth, Carleton Univ.:
Microfaunal Investigations in the Gulf of St. Lawrence and Atlantic Shelf, 1959-.
A study of distribution of foraminifera, benthic and planktonic; relationship of physical and chemical factors to foraminiferal distribution; vertical distribution of successive foraminifera populations.
Microradiography of Foraminifera, 1955-.
See X-ray Absorption Techniques Applied to Statistical Studies of Foraminifera Populations; Jour. Pal., vol. 33, No. 4, 1959.

515. Hubert, C.M., McGill Univ.:
The Silurian Stromatoporoids and Favosites of Matapedia and Temiscouata Counties, Quebec; M.Sc. thesis.

516. Jansonius, J., Imperial Oil Ltd., Calgary, Alberta:
Microfloral Assemblages of Permian and Triassic Age in Alberta and British Columbia.

517. Jeletzky, J.A., Geol. Surv., Canada:
A Study of Geological Survey Collections of Scaphites Faunas from the Bearpaw Formation of Alberta and Saskatchewan and its Equivalents in Manitoba, 1949-.
The purpose is to zone the Bearpaw formation and its equivalent formations, using their Scaphites faunas; and to correlate these formations throughout the Prairie Provinces.
Cretaceous Marine Zones of the Western Interior of Canada, 1956-.
Includes comprehensive description of the palaeontology and stratigraphy of the marine Cretaceous strata of the western interior of Canada.
Monograph on Canadian Buchia, 1948-.
Monograph on Canadian Belemites, 1959-.

518. Jull, Robert K., Univ. of Alberta:
Silurian Halysitidae of Western Canada, 1960-61; M. Sc. thesis.
The project involves a fairly detailed morphological study of the colonial chain coral Genus Halysites. The collection was made from areas in northern British Columbia and the Yukon and Northwest Territories. It is hoped that some specific age determinations may be made.

519. Kupsch, W.O., Univ. of Saskatchewan:
Palaeontology and Palaeoecology of Pleistocene and Postglacial Invertebrates in Saskatchewan, 1961.

520. Langston, Wann, Nat. Mus. of Canada:
Study of the Lower Vertebrates of the St. Mary River Beds of Southern Alberta, 1957-61.
Study of an Elasmosaurid Plesiosaur from the Lower Member of the Edmonton Formation, Alberta, 1959-61.
Study of a Fossil Skate from the Oldman Formation of Alberta, 1960-61.

521. Mason, David, Univ. of Western Ontario:
Radiolarian Fauna of the Kettle Point Shale, Ontario, 1960-61; M. Sc. thesis.

522. McGill, P.C., Imperial Oil Ltd., Calgary, Alberta:
Ostracods of the Beaverhill Lake Formation (Devonian, Taghanician Age) of Alberta.

523. McGregor, D.C., Geol. Surv., Canada:
Reference Slide Collection of Small Spores, 1960-.
The preparation of a reference slide collection and photographic record of small spores of known geological age to aid in the intelligent interpretation of spore assemblages and in dating submitted samples and to provide material for exchange with other institutions.
Microfossils from the Ordovician Red River Formation, 1960.
Botanic (Morphologica and Taxonomic) Study of Early Devonian Floras of Eastern Canada, 1960-64.

524. McGregor, D.C., Geol. Surv., Canada, Greggs, R.D., Shell Oil Co. of Canada, Rouse, G.E., Univ. of British Columbia:

Description and Evaluation of Plant Mega- and Microfossils from the Type Section of the Ghost River Formation of Alberta, 1960-61.

A reassessment of the type section of the Ghost River formation in the light of récent stratigraphic and palaeontological discoveries.

525. McGugan, A., Calgary, Alberta:

Upper Cretaceous Foraminifera of Vancouver Island.

526. McKay, M.W., and Green, Robert, Research Council of Alberta:

Mississippian Foraminifera of Bow Valley and Jasper Areas, Alberta, 1959-61.

Members of the following genus have been found in Mississippian limestone sequences: Endothyra, Plectogyra, Granuliferella, Archaediscus, Glomrapira, Involutina, Palaeotextularia and (?) Endothyranella. Evolution of the Endothyridal was rapid during the Mississippian, and stratigraphic correlations based on this fauna have been extended successfully from the U.S. Cordillera (Utah, Montana) to southwestern Alberta.

527. McLaren, D.J., Geol. Surv., Canada:

Monograph of the Camarotoechiid Brachiopods of the Middle and Early Upper Devonian of Western Canada, 1959-60.

Includes description of the genera and species of this family of rhynchonellids from Western Canada and study of their use for detailed and accurate long-range correlation.

Rugose Corals of Middle Devonian of Great Slave Lake, Northwest Territories, 1960-.

To describe and figure corals collected during 'Operation Mackenzie' and from earlier Survey collections from Middle Devonian rocks of Great Slave Lake, with the objective of correlating within the area and with the Middle Devonian of the Mackenzie Valley.

528. McLaren, D.J., and Norris, A.W., Geol. Surv., Canada:

Illustration of Fossils from Devonian of Alberta and Upper Mackenzie Region, Northwest Territories, 1960-61.

The fauna of each major formation will be illustrated in a series of plates with detailed legend describing horizon and locality of each specimen.

Age and Fauna of a late Middle Devonian Reef on Horn Plateau, Northwest Territories, 1960-61.

The description of an unusual fauna associated with a reef developed in the Middle Devonian rocks of the Horn Plateau. The faunal assemblage should lead to an exact dating of the formation. Collection was made on 'Operation Mackenzie'.

529. Miedema, O., Univ. of Saskatchewan:
Eifelian Solitary Rugose Corals from Northern Canada, 1959-61; M.A. thesis.

530. Mensah, M.K., Univ. of Toronto:
Ecology of the Trenton Limestones in the Vicinity of Kirkfield, Ontario, 1960-62; M.A. thesis.

531. Nelson, S.J., Univ. of Alberta:
Palaeozoic Syringopora, 1958-63.
See Mississippian Syringopora of Western Canada; J. Alberta Soc. Petrol. Geol., vol. 7, No. 4, 1959.
Permo-Pennsylvanian Brachiopods of the Northern Yukon Territory, 1958 65.
See Permo-Carboniferous of the Northern Yukon Territory; Jour. Alta. Soc. Petrol. Geol., (in press).
Permo-Carboniferous Corals, 1960-61.
See Mississippian Lithostrotionid Zones of the Southern Canadian Rocky Mountains; J. Palaeont., vol. 34, No. 1, 1960.

532. Norford, B.S., Geol. Surv., Canada:
Late Ordovician and Silurian Fauna of Southern British Columbia, 1960-.
A study of past collections made from the Beaverfoot and Brisco units of the southern Rocky Mountains. This study will allow revision of taxonomic nomenclature and will lay the groundwork for future collecting and stratigraphic analysis.
Cirrus Mountain "Halysites" Beds, Banff National Park, Alberta, 1960.
A section measured at Cirrus Mountain in 1960 spans the interval between the Cairn and Mount Wilson formations. Silicified fossils suggest an Ordovician age for the sub-Devonian rocks rather than the Silurian suggested by many past workers.

533. Norris, A.W., Geol. Surv., Canada:
Atrypacea of Western Canada, 1953-.
To monograph the Devonian Atrypids of Western Canada to be followed by a study of Ordovician and Silurian forms, mainly from the Survey collections of atrypids from the front ranges of the Canadian Rocky Mountains, northeast Alberta, Upper Mackenzie basin, and Arctic Archipelago. This project is a continuation of a Ph.D. project, University of Toronto, which was completed in 1955.

534. North, Beatrice Ruth, Univ. of Saskatchewan:
Foraminifera from the Cretaceous Bearpaw Formation in the South Saskatchewan River Valley, 1959-61; M.Sc. thesis.

535. Parsch, K.O., Texaco (Canada) Limited, Calgary, Alberta:
Palaeozoic Microfaunas and Stratigraphic and Environmental Problems in the Mesozoic Rocks of Alberta and the Northwest Territories.
Micropalaeontological Bibliography for Canada.

536. Pocock, S.A., Imperial Oil Ltd., Calgary, Alberta:
Palynological Study of the Jurassic-Cretaceous Boundary in Canada and Europe.

537. Pocock, S.A., and Crickmay, C.H., Imperial Oil Ltd., Calgary, Alberta;
Cretaceous Eocene Boundary of the Vancouver Area.

538. Rice, H.M.A., Geol. Surv., Canada:
Study of Geological Survey Collection of Fossil Insects, 1955-.
Includes organization and arrangement of collection, identification of orders, genera, and species, and consideration of stratigraphic significance of the collections. See Geol. Surv., Canada, Bulletin 55, 1959.

539. Roed, M.A., Univ. of Saskatchewan:
Some Mid-Devonian Productoids and Chonetoids from Northern Canada, 1960-61; M.A. thesis.

540. Rouse, G.E., Univ. of British Columbia:
Cenozoic Flora of British Columbia - a continuing project.

541. Russell, Loris S., Nat. Mus., of Canada:
Fossil Mammals of the Cretaceous and Tertiary of Western Canada - a continuing project.
See Horse Astragalus from the Hand Hills Conglomerate of Alberta; Nat. Mus., of Canada, Nat. Hist., Paper No. 1, 1958. Current work is on the study of mammal teeth from the St. Mary River formation (Upper Cretaceous) of Alberta.
Fossil Non-Marine Molluscs of the Cretaceous and Teriary of Western Canada-a continuing project.
Current work is on the revision of certain fossil Unionidae. See Mollusca from the Tertiary of Princeton, British Columbia; Ann. Rept. Nat. Mus., 1955-56 and Nat. Mus., Bull. 147, pp. 84-95, 1958.

542. Sartenaer, P., Geol. Surv., Canada (N.R.C. post-doctorate fellow):
Upper Devonian Faunas of the Upper Mackenzie River, 1959-60.

543. Singh, Chaitanya, Univ. of Alberta:
Palynology of Mannville Formation in Central Alberta, 1960-62; Ph.D. thesis.

544. Smith, Roberta, Univ. of British Columbia:
Pleistocene Foraminifera of the British Columbia Coastal Region, 1960-62; Ph.D. thesis.

545. Sproule, H., Carleton Univ.:
Foraminifera of Chaleur Bay, Quebec and New Brunswick, 1960-62; M.Sc. thesis.

546. Staplin, F.L., Imperial Oil Ltd., Calgary, Alberta:
Pleistocene Freshwater Ostracoda of Illinois.
Reef-controlled Distribution of Devonian Microplankton.

547. Stearn, C.W., McGill Univ.:
Stromatoporoids of the Waterways Formation (Devonian) of Northeastern Alberta, 1960-61.

548. Steeves, Margaret Wolfe, Univ. of Saskatchewan:
A Palynological Analysis of Jurassic and Cretaceous Deposits in Saskatchewan, 1960-.
An analysis of Jurassic and Cretaceous sediments for fossil pollen and spores in an attempt to gain a stratigraphical and statistical record of vegetational changes both climatic and evolutionary. An analysis of the Lower Cretaceous Blairmore formation is in progress. A revision of and an examination of the botanical affiliations and geological distribution of the Mesozoic genus, Deltoidosporo, is near completion. The study is being extended into Upper Cretaceous sediments with a preliminary survey of the Belly River, Eastend and Whitemud formations. Ultimately this will overlap with work on Tertiary and Pleistocene deposits, some of which has been initiated already, to provide a picture of the evolution of the flora of Saskatchewan.

549. Steeves, Margaret Wolfe, and Maini, Jagmohan Singh, Univ. of Saskatchewan:
A Palynological Analysis of Post-glacial Sediments from Three Bogs in Northern Saskatchewan, 1960-.
An analysis of post-glacial deposits from Lac la Ronge, Cree Lake and Stoney Rapids for fossil pollen and spores. To aid in the identification of these sporomorphs, a reference collection of modern pollen of plants of Saskatchewan is being compiled. The goal of this study is an interpretation of climatic and vegetational changes in the area in glacial and post-glacial times.

550. Steeves, Margaret Wolfe and Rainsberry, Lois Eileen, Univ. of Saskatchewan:
Pollen and Spores of Cretaceous Sediments from Saskatchewan, 1959-61.
A systematic analysis of Cretaceous sediments, more specifically the Colorado Group and Blairmore Formation, for fossil pollen and spores to gain a stratigraphical and statistical record of vegetational changes both climatic and evolutionary.

551. Suguitan, Lynda, McMaster Univ.:
Comparative Study of Spores and Pollen in Peat; Ph.D. thesis.

552. Sykes, D.W., Univ. of Saskatchewan:
Mid-Devonian Smooth Speriferoids from Northern Canada, 1959-61; M.A. thesis.

553. Teeter, J.W., McMaster Univ.:
The Ostracod Fauna from the Eramosa Member of the Lockport Formation (Mid-Silurian) in the Hamilton Area, Ontario, 1960-62; M.Sc. thesis.

554. Trettin, H., Univ. of British Columbia:
Fusulinids from the Cache Creek Group, Lillooet, B.C.

555. Wagner, F.J.E., and Terasmae, J., Geol. Surv., Canada:
Identification of Organic Remains from Off-shore Dredged Samples, 1960-.
Identification of material collected by the Hydrographic Service from Exeter Bay, Baffin Island, to provide information about depth of occurrence and geographic distribution of recent species found in dredged samples as an aid in interpretation of fossil assemblages from Pleistocene deposits.

556. Wall, J.H., Research Council of Alberta:
Cretaceous Foraminifera of the Foothills and Peace River Area of Alberta, 1958-.
A number of outcrop sections of the Wapiabi formation along the Foothills, extending from the Waterton area in the south to the Wapiti River area in northern Alberta, are currently being analyzed for their microfaunal content. The assemblages recovered to date indicate that the microfossils will be useful in determination of stratigraphic position within this thick marine sequence and in interpretation of ecological conditions. See Upper Cretaceous Foraminifera from the Smokey River Area, Alberta; Research Council of Alberta, Geol. Div. Bull, No. 6, 1961,

557. Westermann, G.E.G., McMaster Univ.:
The Occurrence of Spiriferina stracheyi Salter at the Base of the Mid-Triassic in the Canadian Rocky Mountain Foothills, 1959-61.
This species is the common index fossil of the thin "Horizon of Sp. st." in the Himalayas of Mid-Anisian age and is now known to exist in a similar horizon of approximately identical age through 500 miles of the B.C. and Alberta Foothills.
Quantitative Study on Dimension-ornament Correlation in Spiriferina stracheyi Salter, 1959-61.
It is shown statistically that the plication of the Spiriferina valve probably was functionally correlated with its dimensional proportions as if to give maximal stability to a corrugated membrane surface. This is compared with the structure of the ammonite septum. See The Significance of Septa and Sutures in Jurassic Ammonite Systematics, Geol. Mag., vol. XCV. No. 6. pp. 441-55, 1958.
A Lower Bajocian Ammonite Fauna from the Alaska Peninsula, 1960-62.

558. Whiton, Geoffrey, Univ. of British Columbia:
Palaeobotany of the Hazelton Group, British Columbia, 1960-61; M.Sc. thesis.

559. Williams, Michael, Univ. of British Columbia:
Upper Palaeozoic Fauna from Keremeos, British Columbia, 1959-61; M.Sc. thesis.

560. Winder, C.G., Univ. of Western Ontario:
Conodont Fauna of Kettle Point Shore, Ontario, 1957-61.

561. Yole, R.W., Univ. of British Columbia:
Upper Palaeozoic Fauna, Vancouver Island, 1960-62; Ph.D. thesis.

PETROLOGY AND PETROGRAPHY

Alberta

562. Alcock, R.A., Univ. of Toronto:
A Petrographic Study of the Tazin-like Sediments of the Fort Fitzgerald Area, Alberta; 1959-61; M.A. thesis.
A mineralogical and quantitative petrographic study of a series of cordierite-bearing gneisses.

563. Carrigy, M.A., Research Council of Alberta:
Sedimentary Petrology of the McMurray Formation (Athabasca Oil Sands), 1957-.
See The Athabasca Oil Sands; Oil Fields of Alberta, published by the Alberta Soc. of Pet. Geol.

564. Crook, Keith A.W., Univ. of Alberta, (N.R.C. Research Fellow):
Petrology and Diagenesis of the Crowsnest Volcanics, Alberta, 1959-61.

565. Lerbekmo, John F., Univ. of Alberta:
Petrology of the Belly River, Edmonton, and Brazeau Formations of the Alberta Foothills, 1957-61.
A detailed study of the mineralogy is being undertaken with the hope of correlating these continental formations, and of differentiating possible source areas.

566. MacKenzie, W.S., Univ. of Toronto:
Petrographic Studies of a Devonian "Reef" in Jasper Park, Alberta, 1959-61; M.A. thesis.

567. Mellon, George Barry, Research Council of Alberta:
Stratigraphy and Petrology of Lower Cretaceous Sediments of Alberta, 1956-61.
Petrology and Geology of Sedimentary Magnetite Deposits of Southwestern Alberta, 1959-61.

568. Oliver, T.A., Univ. of Alberta:
Petrography and Depositional Environments of the Basal Cretaceous Clastics of the Southwestern Canadian Sedimentary Basin, 1961.

569. Scott, Darcy L., Univ. of British Columbia:
Stratigraphy and Palaeogeography of the Etherington and Rocky Mountain Formations in the Southern Alberta Rocky Mountains, 1959-63; Ph.D. thesis.
This project will include a detailed petrographic examination of many stratigraphic sections of uppermost Palaeozoic sediments in the southern Alberta Rocky Mountains.

570. Taylor, Donald A., Univ. of Alberta:
Petrology of the St. Mary River Formation, Southern Alberta, 1960-61; Ph.D. thesis.

571. Watanabe, Roy Y., Univ. of Alberta:
Waugh Lake Metasedimentary Complex, Northeastern Alberta, 1960-61; M.Sc. thesis.

572. Wilkins, A. A., Univ. of Alberta:
A Compositional Comparison of the Paddy and Cadotte Sandstones of Northwestern Alberta, 1960-61; M. Sc. thesis.
A heavy mineral and thin section study of the mineralogy of the Cadotte and Paddy members of the Peace River formation.

British Columbia

573. Carr, J. M., British Columbia Dept. of Mines and Petroleum Resources:
Further Studies of Guichon Batholith, Highland Valley Area (Mainly of Porphyries), 1956-60.

574. Campbell, F. A., Univ. of Alberta:
Ice River Complex, British Columbia, 1959-61.

575. Church, Neil B., McMaster Univ.:
Petrology of the Early Tertiary Midway Volcanic Rocks of South-Central British Columbia, 1959-61; M. Sc. thesis.
Major and minor element composition, mineralogy, and stratigraphy of the Midway rocks are being studied by rapid analytical, fused glass, spectrochemical, X-ray, and field methods in an attempt to understand their petrogenesis.

576. Findlay, D. C., Queen's Univ.:
Petrology of the Tulameen Ultrabasic Complex, Yale District, B. C., 1959-62; Ph. D. thesis.
This project is being carried out under the auspices of the Geological Survey of Canada, as part of a continuing study of ultrabasic rocks in Canada. The program involves detailed mapping of the complex on a scale of 1" = 1000' along with laboratory studies to determine mineralogical and chemical variations within the rocks of the complex. One aspect of these studies will be the investigation of the distribution pattern of platinum group metals. To date, mapping of most of the northern part of the intrusion has been completed.

577. Hunt, Graham H., Univ. of Alberta:
Purcell Igneous Rocks, 1957-61; Ph. D. thesis.
See Time of Intrusion of Purcell Sills, B. C.; Geol. Soc. Amer., Program 1960 Annual Meeting (Abstract).

578. McKechnie, N. D., British Columbia Dept. Mines and Petroleum Resources:
Study of Ultrabasic Rocks in Mineralized Areas, B. C., 1958-.

579. Montgomery, J. H., Univ. of British Columbia:
The Copper Mountain Intrusions, British Columbia, 1960-62; Ph. D. thesis.

580. Nicholson, H. P., Univ. of British Columbia:
Petrology of Burrard and Kitsilano Formations, British Columbia, 1960-61; M. Sc. thesis.

Manitoba

581. Patterson, J.M., Univ. of Manitoba:
Regional Metamorphism of the Thompson - Moak Lake Area, Manitoba, 1957-62; Ph.D. thesis.

582. Smith, D.L., Univ. of Manitoba:
Sedimentary Petrology of the Stony Mountain Formation, Manitoba, 1960-61; M.Sc. thesis.

583. Tweedy, N., Univ. of Manitoba:
An X-ray Study of Some Pegmatite Minerals from Southeast Manitoba, 1959-61; M.Sc. thesis.

584. Williams, H., Univ. of Toronto:
A Petrographic Study of the Metamorphic Rocks of the Chisel Lake Area, Manitoba, 1958-61; Ph.D. thesis.
A study of the origin and relationships of the "quartz-eye granite" in this area, and of the associated metamorphic sedimentary and igneous rocks, based on field work for Geological Survey of Canada.

New Brunswick and Nova Scotia

585. Clark, George S., Univ. of New Brunswick:
Mineralogical Study of the Gabbroic Rocks of the St. Stephen Area of New Brunswick, 1960-62; M.Sc. thesis.

586. Cooper, Gordon Evans, Univ. of New Brunswick:
Petrology and Petrography of the Benton Granitic Stock, 1960-61; M.Sc. thesis.

587. Gordon, Kenneth R., Univ. of New Brunswick:
Devonian Granites of Northern Charlotte County, New Brunswick, 1958-61; M.Sc. thesis.

588. Keating, B.J., St. Francis Xavier Univ.:
Petrofabric Analysis of Mineralized Crystalline Limestone from Lime Hill, Inverness County, Nova Scotia, 1960-61.

589. McNutt, James R.A., Univ. of New Brunswick:
Nickel Bearing Gabbros of the Miramichi Area, N.B., 1960-62; M.Sc. thesis.

590. Nash, W.A., Univ. of New Brunswick:
A Study of the Amphiboles in St. Stephen Gabbro, N.B., 1959-61; M.Sc. thesis.

591. Wilband, John Truax, Univ. of New Brunswick:
Acid Volcanics of the Bourinot Group - Cape Breton, 1960-62; M.Sc. thesis.

Newfoundland and Labrador

592. Gill, Frederick David, Univ. of Toronto:
Petrography of Molybdenite Bearing Gneisses, Makkovik Area, Labrador, 1960-61; M.A. thesis.
The investigation of a series of highly altered metasediments carrying disseminated molybdenite.

593. Glaister, J.T.D., Univ. of Toronto:
A Comparative Petrographic Study of Basic Dykes from Aillik, Labrador, 1960-61; M.A. thesis.
A description of the dykes and comparison of similar dykes in Sweden and Norway.

594. Mullins, Jack, Memorial Univ. of Newfoundland:
Geology of that Part of the Noel Paul River Area between Tally Pond and Lake Ambrose, Central Newfoundland, with special Reference to Petrography, 1959-61: M.Sc. thesis.
Area consists of steeply dipping interbedded volcanic sedimentary rocks, supposedly of Ordovician age. A detailed petrographic study of the rock types is being made.

Ontario

595. Crufft, E.D., McMaster Univ.:
Trace Element Study of the Sudbury Irruptive, 1959-; Ph.D. thesis.
A study of trace element distribution in relation to initial petrology and alteration processes.

596. Hawley, J.E., Wynne-Edwards, H.R., and MacDonald, J.G., Queen's Univ.:
Granitic Rocks of the Grenville Sub-province, South-eastern Ontario, 1959-61.
One hundred and twenty-five new analyses for major and trace elements of samples from about sixty granitic bodies are now complete, together with modes, norms and full petrographic descriptions. These rocks, and previously published analyses, fall into four major groups which are separable both mineralogically and chemically. Zircon studies further emphasize this classification. The groups are characteristic of different regions. The data are being compared with Tuttle and Bowen's experimental studies of the hydrous granite system and preliminary work shows that two of the groups fall near the minimum melting composition of hydrous granite and another group lies near the thermal valley leading to this point from the binary Or-Ab minimum.

597. Hodgkinson, J.M., Univ. of Manitoba:
Metamorphic Petrology of the Kenora Area, Ontario, 1960-61; M.Sc. thesis.

598. Milne, V.G., Univ. of Toronto:
Petrography and Alteration of some Spodumene Pegmatites near Beardmore, Ontario, 1958-61; Ph.D. thesis.

A field and laboratory investigation of a number of lithium bearing pegmatites, in connection with field work for the Ont. Dept. of Mines.

599. Moorhouse, W.W., Univ. of Toronto:
Studies of Precambrian Sediments, 1950-,
Studies of the petrography, trace element composition, mineralogy and sedimentation features of the Animikie iron formations. See Gunflint Iron Range in the Vicinity of Port Arthur; Ont. Dept. of Mines, vol. LXIX, pt. 7, 1960.

600. Robinson, G.D., Univ. of New Brunswick:
Basic and Ultrabasic Rocks, Timmins District, Ontario, 1960-; M.Sc. thesis.

601. Rogers, D.P., Univ. of Toronto:
A Petrographic Reconnaissance of Granitic Rocks in the Biscotasing Area, Ontario, 1959-60; M.A. thesis.
Includes micrometric studies of granites and granitic rocks, based on field work for the Ont. Dept. of Mines.

602. Watkinson, David H., McMaster Univ.:
Petrology of the Ultramafic Rocks of the Quetico-Shebandowan Area, District of Thunder Bay, Ontario, 1960-61; M.Sc. thesis.

603. Wynne-Edwards, H.R., and Hay, P.W., Queen's Univ.:
Co-existing Cordierite and Garnet from the Westport Area, Ontario, 1960-61.
Bulk chemical analysis and analyses of ferromagnesian minerals are being used to investigate the factors controlling the stability of cordierite with and without co-existing garnet in regional metamorphism. See Westport Map-area, Geol. Surv., Canada, Map Map 28-1959 with descriptive notes.

Quebec

604. Baragar, W.R.A., Geol. Surv., Canada:
Wakuach Lake Map-area, Quebec and Labrador, 1 inch to 4 miles, 1958-60.
Problems include history of development of Labrador geosyncline and its subsequent orogenic phase; analysis of structural cross-section through Labrador Trough; and delineation of zones of regional metamorphism. See Petrology of Basaltic Rocks of Labrador Trough, Geol. Soc. Amer. Bull., vol. 71, pp. 1589-1644, 1960.

605. Dean, R.S., McGill Univ.:
The Shales of the St. Lawrence Lowland of Quebec, 1959-61; Ph.D. thesis.

606. Gillain, P.R., McGill Univ.:
Dykes and Sills in the Canada Cement Quarry, Montreal East, 1959-61; M.Sc. thesis.

607. Gold, D. P., McGill Univ.:
Relationship between Limestones and the Alkaline Rocks of Oka and St. Hilaire, Quebec, 1959-61; Ph.D. thesis.

608. Guy-Bray, J.V., McGill Univ.:
Petrology of La Liever Area, Roberval, Quebec, 1959-61; Ph.D. thesis.

609. Hogarth, D.D., Univ. of Ottawa:
Carbonate Rocks in the Meach Lake Area, Quebec, 1959-61.
A geochemical and petrographical study of rocks that are possibly carbonatites. Detailed geological mapping was undertaken in the fall of 1960.

610. Perrault, Guy, and Schilling, J.G., Ecole Polytechnique:
Petrography of the Oka Alkaline Intrusives, Quebec, 1960-61.
The main purpose of this work is to define mineralogically some of the alkaline intrusives in the neighbourhood of one of the columbium ore deposits. This petrographic work will serve as an introduction to other petrographic work on the alkaline intrusives.

611. Pouliot, Gaston, McGill Univ.:
Thermal History of the Monteregian Intrusives, Quebec, Based on a Study of the Feldspars, 1959-61; Ph.D. thesis.

612. Reid, Arch. M., Univ. of Western Ontario:
Petrology of the Mount Megantic Igneous Complex, Quebec, 1959-61; M.Sc. thesis.

613. Robinson, R.E., Univ. of Toronto:
The Molybdenite Occurrence at the Bain Property, Masham Township, Quebec, 1960-61; M.A. thesis.
A petrographic study of a pegmatitic molybdenite occurrence.

614. Smith, C.H., and MacGregor, I.D., Geol. Surv., Canada:
Study of Mineralogical, Petrographical, and Chemical Variations in the Mount Albert Ultrabasic Intrusion, Quebec, 1957-60.
The purpose is to test the chemical homogeneity of the intrusion and to set up techniques for the study of ultrabasic bodies. See Ultrabasic Intrusive Conditions Illustrated by the Mount Albert Ultrabasic Pluton, Gaspe, Quebec; Geol. Soc. America, Program 1960 Annual Meetings, p. 210 (abstract).

615. Vaughan, W.S., McGill Univ.:
The Anorthosite at Oka, Quebec, 1959-61; M.Sc. thesis.

616. Webber, G.R., McGill Univ.:
Petrological-Geochemical Study of Mount Yamaska, Quebec, 1961-.

Saskatchewan

617. Allan, J.F.S., Queen's Univ.:
Geology of the Fay Mine, Eldorado, Sask., 1959-61; M.Sc. thesis.
A structural and petrological study of the orebody.

618. Froese, Edgar, Queen's Univ.:
Petrology and Metamorphic Geology of Wall-rocks at Coronation Mine, Saskatchewan, 1960-62; Ph.D. thesis.
This forms part of a major project on the complete study of a mineral deposit initiated on the recommendation of the National Advisory Committee on Research in the Geological Sciences, with participation by several organizations including a number of Canadian Universities. The adjacent area was mapped on a scale of 400 feet to the inch, and samples from the surface and from underground are being studied. Particular attention is being paid to composition and properties of co-existing garnets and amphiboles and trace element distribution in rocks adjacent to ore.

619. Kaufmann, W.L.M., Univ. of Saskatchewan:
The Mississippian Ratcliff and Midale Beds of Southeastern Saskatchewan, 1960-61; M.Sc. thesis.
Detailed petrographic study of well cores from an area south of the Weyburn-Midale oilfields.

620. Wardlaw, Norman C., Univ. of Saskatchewan:
Evaporite and Carbonate Deposits of Saskatchewan, 1960-65.
A petrological and stratigraphic study of potash-bearing beds and associated carbonate and related sediments of the Middle Devonian Prairie Evaporate formation in part of south central Saskatchewan.

General Problems

621. Chagnon, J.Y., McGill Univ.:
Experimental Studies on the Growth of Minerals in Sediments, 1969-61; M.Sc. thesis.

622. Courville, S., Dawson, K.R., and Maxwell, J.A., Geol. Surv., Canada:
Rapid Fusion Technique for Determining Composition of Plagioclase Feldspars, 1958-.
To determine the loss of sodium and potassium in plagioclase feldspar glasses and thus evaluate the accuracy of this technique in determining the composition of feldspars. See Identification of Plagioclase by Fusion Technique; Canadian Mineralogist, vol. 6, Pt. 3, 1959, pp. 390-394.

623. Dawson, K.R., and Maxwell, J.A., Geol. Surv., Canada:
Compilation of Canadian Rock and Mineral Analyses, 1957-.
To collect, evaluate, and publish in appropriate form and at appropriate intervals all Geological Survey of Canada rock and mineral analyses and, if and when practicable, to expand this task to include all similar data from other sources.

624. Dawson, K.R., Geol. Surv., Canada:
Petrological Collections, 1957-.
The purpose is to obtain and maintain representative suites of rocks from all areas mapped by the Geological Survey for future petrological, geochemical, and other scientific studies.
Meteorite Collection, 1957-.
The purpose is to catalogue, study, describe, and display the Geological Survey meteorite collection.

625. Dence, Michael R., Carleton Univ.:
Lithology of Some Precambrian Conglomerates, 1960-61; M.A. thesis.
Various conglomerates from the Keewatin, Temiskaming, Huronian, and Grenville terrains are being examined to find out if they have been deposited by volcanic or water-borne processes. Particular emphasis is being placed on petrographic and chemical examination of the matrices. The possible stratigraphic and structural implications are being investigated.

626. Dusing, Constantin, McGill Univ.; (Research Associate):
Structural Investigations on Anorthosites and Related Rocks in the Grenville Province, 1960-63.
The application of petrofabric studies to the structure of the rocks of the Grenville province.

627. Hacquebard, P.A., Geol. Surv., Canada:
Research on the Petrography and Spore Analysis of Coal, 1948-.
Investigations of the character and correlation of various coal seams in Nova Scotia and Western Canada such as will aid their development. See Geol. Surv., Canada Bulletins 19 and 40.

628. Hutchison, W.W., Univ. of Toronto:
Conditions of Metamorphism of Certain Rocks, 1959-61; Ph.D. thesis.
A study devoted chiefly to decrepitation studies of metamorphic rocks and minerals.

629. Irvine, T.N., McMaster Univ.:
Mineralogical Studies of the Ultramafic Complex of Duke Island, Southeastern Alaska, 1959-61.

630. Kranck, E.H., McGill Univ.:
Ultrametamorphism.
See Experimental Studies of Anatexis; International Geol. Cong., 21 Norden, 1960, Pt. 16, pp. 209-217.

631. Kretz, R., Geol. Surv., Canada:
Geochemistry of Metamorphic and Pegmatitic Rocks, 1960-.
Studies in the Beaulieu-Yellowknife area of the Northwest Territories, Flin Flon area of Manitoba and in the Grenville sub-province, to provide information on the geochemistry of metamorphic and pegmatitic rocks. It is hoped that this will aid in understanding their genesis and history. See Distribution of Certain Elements Among

Coexisting Calcic Pyroxenes, Calcic Amphiboles and Biotites in Skarns, Geochim. et Cosmochim. Acta vol. 20, p. 161-191, 1960.

632. Mannard, G.W., McGill Univ.:
Geology of the Sungida Kimberlite Pipes, Tanganyika, 1959-62; Ph.D. thesis.

633. Middleton, G.V., McMaster Univ.:
Quantitative Petrology of Sandstones, 1957-63.
The aim is to develop techniques for quantitative mineralogical, chemical and textural study of indurated sandstones, and to study selected sandstone formations using these techniques. Special attention will be paid to turbidite formations. See Petrography of Two Turbidite Formations (abstract); a paper read at the spring, 1960 Meeting of Soc. Econ. Mineralogists and Palaeontologists.

634. Moore, J.M., Carleton Univ.:
Application of Thermodynamic Principles to Metamorphism, 1960-62.
An investigation of compositional relationships among solid solutions (primarily Fe-Mg) in metamorphic rocks of pelitic composition by physical and chemical analytical methods in the light of physico-chemical models.

635. Mulligan, R., Geol. Surv., Canada:
Geological Study of the Lithium-beryllium Pegmatites of Canada, 1953-60.
An investigation of the distribution, nature, age, and origin of the pegmatites and of the concentrations of lithium and beryllium minerals of possible economic importance contained in them.

636. Papezik, V.S., McGill Univ.:
Trace Elements in Anorthosites, 1959-61; Ph.D. thesis.

637. Reavely, G.H., Univ. of Western Ontario:
Detrital and Detrital Forming Minerals in Palaeozoic and Precambrian Rocks, in Ontario and Parts of Quebec, 1959-62.
Many Palaeozoic rocks contain detrital minerals derived from Precambrian terrains which may yield information on their source.

638. Reesor, J.E., Geol. Surv., Canada:
Granitic Bodies of Canada, 1957-.
The detailed mapping of representative granitic bodies with special attention to providing comprehensive geological information concerning their scientific and economic aspects.

639. Renault, Jacques, R., Univ. of Toronto:
Studies of the Petrography of Molybdenite Deposits, 1960-62.
A series of molybdenite deposits will be studied in an attempt to correlate wall-rock alteration and neo-mineralization with deposition of the molybdenite.

640. Rose, E.R., Geol. Surv., Canada:
Investigation of Iron-titanium Bearing Anorthosites, 1958-.
A study of mineralogy and petrology of iron-titanium bearing anorthosites and associated mineral deposits. See Geol. Surv., Canada Papers 60-11 and 61-7.

641. Saull, V.A., and Sangster, D.F., McGill Univ.:
Enthalpy Changes in Metamorphic Reactions, 1953-62.

642. Smith, C.H., Geol. Surv., Canada:
Ultrabasic Intrusions of Canada, 1957-.
The detailed mapping of representative ultrabasic intrusions with special emphasis on their scientific and economic features. See Ultrabasic Intrusive Conditions Illustrated by the Mount Albert Ultrabasic Pluton, Gaspe, Quebec; Geol. Soc. America, Program 1960 Annual Meetings, p. 210 (abstract).

643. Vincent, J.S., McGill Univ.:
Studies in Rheomorphism, 1960-62; M.Sc. thesis.

PLEISTOCENE AND GROUNDWATER

Alberta

644. Bayrock, L.A., Research Council of Alberta:
Pleistocene Mapping of Sheet 73D (Nat. Top. Sys.), 1954-61.
The mapping of sheets 73D 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16 has been completed. See Glacial Geology of the Alliance-Brownfield District, Prelim. Rept. (73D, 5, 6,) and Glacial Geology of the Galahad-Hardisty District, Prelim. Rept. (73D 11, 12), Research Council of Alberta.

645. Eweida, Ahmed Farag, Univ. of Saskatchewan:
An Aquifer Study of the Ponoka Area, Alberta, 1960-61; M.Sc. thesis.

646. Garland, G.D., and Kanasewich, E., Univ. of Alberta:
Studies of the Athabasca Glacier, 1959-61.
The complete project includes drilling through the ice, seismic and gravity measurements, determination of flow rate of the ice, and ice temperatures. An M.Sc. thesis by Mr. Kanasewich deals with the gravity measurements over the ice and the determination of the shape of the glacier floor from these measurements. Work is continuing on ice temperature measurements with thermocouples set in deep holes through the glacier. Work on ice flow and seismic measurements are being done at the Univ. of B.C. The Alberta Research Council investigated cable-tool drilling of the ice, and produced 3 holes by this method. Other holes were hot-point drilled. As an addition to the gravity work over the glacier, Mr. Kanasewich extended the gravity survey of the southern portion of the Rocky Mountain Trench, from Cranbrook to the International border, and a paper on the interpretation for this area is in preparation.

647. Geophysics Group at Univ. of British Columbia:
Athabaska Glacier Project, 1959-.

648. Jones, J.F., Research Council of Alberta:
Geology and Groundwater Resources, Peace River District, Northwestern Alberta, 1960-61.
Surficial Geology and Related Problems, Beaverlodge District, Alberta, 1960-61; M.Sc. thesis.
See Groundwater Geology Beaverlodge District, Alberta, Preliminary Report, 59-2.
Geology and Hydrology, Alluvial Terraces, Peace River District, Alberta, 1960-62.
Relationship of Rainfall, Run-off, Evapo-transpiration, etc., to Groundwater Recharge and Discharge in the Peace River District, Alberta, 1960-62.
Permeability Studies of Some Bedrock Aquifers in the Peace River District, Alberta, 1960-.

649. Kunkle, G., Research Council of Alberta:
Groundwater Geology and Hydrology of Southeastern Alberta, 1960-.
Use of Baseflow Depletion Curves in Determining Groundwater Use, 1960-61.
Increases in the rate of baseflow depletion may be directly related to increases in groundwater use.
Vertical Components of Groundwater Movement in Alberta, 1960-61.

650. Le Breton, E. Gordon, Research Council of Alberta:
Groundwater Geology of the Lloydminster Area, Alberta.
Groundwater Geology of the Andrew Area, Alberta.
Groundwater Geology of the Lamont Area, Alberta.
Water supplies other than those for domestic purposes are difficult to locate. Unconsolidated deposits appear to be the only likely source for small municipal supplies of groundwater.
Groundwater Geology of the Two Hills Area, Alberta.
Results to date indicate the possibility of developing groundwater supplies for industrial purposes. Municipal supplies are already obtained, and only locally where geologic factors are unfavourable are domestic supplies of water difficult to obtain.
Chemistry of Alberta Groundwaters.
Examination of data so far indicates much similarity in the chemistry of groundwaters in bedrock and drift aquifers. The most striking differences occur in the hardness and nitrate contents. Groundwater from bedrock aquifers is normally soft apart from an area extending from township 49 to the North Saskatchewan River and from the Alberta-Saskatchewan border to Range 8. The nitrate content in the water wells of the area appears to be a direct result of faulty well completion practices. This study emphasizes the principal that recharge is by local precipitation. In areas of recharge, the total mineralization of groundwater is lower, and in the sulphate chloride relationship, the former is high and the latter is low, whereas in discharge areas, the total mineralization is higher, the sulphate content is low and the chloride content is high.

651. Lennox, D. H., Research Council of Alberta:
Near-surface Geophysical Investigations, 1957-.
Seismic and earth resistivity surveys of selected areas in Alberta being carried out as part of the ground-water exploration program.
Earthquake Effects Observed in Alberta Wells, 1960-61.
Includes a review of the records from automatic water-level recorders throughout the province prompted by the observation, on a number of records, of the passage of shock waves from the Montana earthquake of August, 1959.
Mechanical Drilling in the Athabasca Glacier, Alberta; 1960-61.
Investigation of the feasibility of cable-tool drilling.

652. Meneley, W. A., Research Council of Alberta:
Hydrogeology of the Edmonton Formation at Stettler, Alberta, 1957-60.
Part of a continuing investigation of permeability variations in the Edmonton formation, and the long term evaluation of the effects of production on a typical Alberta aquifer.
The Elasticity of the Bearpaw Formation at Throne, Alberta, 1961-.

653. Meyboom, P., Research Council of Alberta:
Groundwater Resources of Calgary and Vicinity, Alberta, 1960-61.
Geological and hydrological aspects of groundwater resources with special emphasis on industrial and municipal potential.
Estimating Groundwater Recharge from Stream Hydrographs, 1960.
An attempt has been made to derive a mathematical expression for river baseflow. Results of mathematical analysis enable determination of the entities that make up the basic hydrologic equation; groundwater recharge = groundwater discharge ± change in groundwater storage.

654. Stalker, A. M., Geol. Surv,, Canada:
Fernie Map-area, East Half, 1 inch to 4 miles, 1959-60.
Mapping of surficial deposits east of the Rocky Mountains.
Surficial Deposits of the Windermere Map-area (East Half), Alberta, 1 inch to 4 miles, 1960-61.

655. Toth, J., Research Council of Alberta:
Groundwater Resources in Red Deer River Drainage Basin, Alberta, 1960-62.

656. Westgate, John Arthur, Univ. of Alberta:
Pleistocene Geology of the Cypress Hills Region of South-eastern Alberta, 1960-63; Ph. D. thesis.

British Columbia, Manitoba and Saskatchewan

657. Charron, J., Geol. Surv., Canada:
Ground-water Survey of Red River Basin, Manitoba, 1959-.
See Geol. Surv., Canada Paper 60-22.

658. Fulton, R.J., Geol. Surv., Canada (part time):
Surficial Formations of the Nicola Map-area, British Columbia, 1 inch to 4 miles, 1960-61; Ph.D. thesis.

659. Hall, D.D. and Kupsch, W.O., Univ. of Saskatchewan:
Relation between Geophysics, Bedrock Geology, and Surficial Geology of Churchill River Area, Saskatchewan, 1960-62.

660. Hall, S.E., Geol. Surv., Canada:
Reconnaissance Study of Groundwater of Souris River Basin, Southeastern Saskatchewan, 1958-59.
See Geol. Surv., Canada, Water Supply Paper No. 329.

661. Halstead, E.C., Geol. Surv., Canada:
Groundwater Survey of East Coast of Vancouver Island between Nanaimo and Campbell River, 1959-60.

662. Johnston, G.H., Division of Building Research, National Research Council:
Kelsey Generating Station - Dyke Studies, 1958-.
The study of dyke construction in a sporadic area of permafrost at the Kelsey Generating Station of the Manitoba Hydro-Electric Board on the Nelson River in northern Manitoba. Observations of ground temperature, dyke movements and climate are being taken to follow the performance of the dykes.

663. Kupsch, W.O., Univ. of Saskatchewan:
Palaeontology and Palaeoecology of Pleistocene and Postglacial Invertebrates in Saskatchewan, 1961-.

664. Russell, G.A., Univ. of Manitoba:
Surficial Geology of the Winnipeg Area, 1960-62.

665. Scott, J.S., Geol. Surv., Canada:
Surficial Geology of Elbow, Hawarden and Outlook Map-areas, Saskatchewan, 1 inch to 1 mile, 1958-60.

666. Steeves, Margaret Wolfe and Maini, Jagmohan Singh, H., Univ. of Saskatchewan:
A Palynological Analysis of Post-glacial Sediments from Three Bogs in Northern Saskatchewan, 1960-.
An analysis of post-glacial deposits from Lac la Ronge, Cree Lake and Stoney Rapids for fossil pollen and spores. A reference collection of modern pollen of plants of Saskatchewan is being completed to aid in identification of these sporomorphs. The goal of this study is an interpretation of climatic and vegetational changes in the area in glacial and post-glacial times.

667. Toth, A.M., Geol. Surv., Canada:
Ground-water Survey of Saskatoon Area, Saskatchewan, 1959-.
See Geol. Surv., Canada Paper 60-25.

New Brunswick, Newfoundland and Prince Edward Island

668. Carr, P.A., Geol. Surv., Canada:
Ground-water Survey of Moncton Area, New Brunswick, 1960-61.

669. Frankel, L., Geol. Surv., Canada (part time):
Mapping of the Surficial and Bedrock Formations of Prince Edward Island, 1 inch to 1 mile, 1953-61.

670. Henderson, E.P., Geol. Surv., Canada:
Reconnaissance Mapping of Glacial and Post-glacial Shorelines and Associated Deposits Along the Northeast Coast of Newfoundland between White Bay and Trinity Bay, 1960-.

671. Lee H.A., Geol. Surv., Canada:
Surficial Formations of St. John River Valley from Edmundston to Fredericton, 1 inch to 1 mile, 1953-61.
See Geol. Surv., Canada Paper 34-1959.

672. Loken, O., Arctic Institute of North America:
Studies of Glacial Geology and Geomorphology in the Northern Torngate Mountains, 1960-62; Ph.D. thesis, McGill Univ.

Ontario

673. Brandon, L.V., Geol. Surv., Canada:
Groundwater Study of Ottawa-Hull Region, Ontario and Quebec, 1958-59.
See Geol. Surv., Canada Paper 60-23.

674. Caley, J.F., and Sanford, B.V., Geol. Surv., Canada:
Studies of Drift Thickness and Bedrock Topography in Southern Ontario, 1948-.
The purpose is to determine by means of bore-hole data the pre-Pleistocene bedrock topography, and the drift thickness and to deduce the pre-glacial drainage and probable location of reservoirs of ground water. As the pre-Pleistocene topography may reflect the underlying structure of the bedrock, this knowledge will assist in the search for oil and natural gas. See Geol. Surv., Canada Paper 55-20.

675. Dell, Carol I., Ontario Research Foundation:
Mineralogical Composition of Sand in Ontario, 1956-61.
Soil samples from northern Ontario are being studied. See Methods of Study of Sand and Silt from Soils; Canadian Mineralogist, vol. 6, Part 3, pp. 363-371, 1959 and A Study of the Mineralogical Composition of Sand in Southern Ontario; Can. J. Soil Sci., vol. 39, pp. 185-196, 1959.

676. Dell, Carol. I., and Chapman, L. J., Ontario Research Foundation:
A Revised Version of the First Split of the Wisconsin Glacier in Southwestern Ontario, Resulting from Analyses of Calcite and Dolomite in Sands, 1959-61.

677. Gadd, N.R., Geol. Surv., Canada:
Surficial Formations of the Ottawa Map-area, 1 inch to 1 mile, 1956-61.

678. Hoare, James, McMaster Univ.:
Delineation of Glacial Lake Beaches in Wentworth County, Ontario, 1960-61.

679. Karrow, P.F., Ontario Dept. of Mines:
Pleistocene Geology of the Brantford Area, Ontario, 1 inch to 1/2 mile, 1960.

680. Lajtai, E.A., Univ. of Toronto:
A Study of Pleistocene Sediments along the University Subway Line, Toronto, Ontario, 1960-61; M.Ap.Sc. thesis.

681. Mirynech, E., Geol. Surv., Canada:
Surficial Geology of Trenton Map-area, Ontario, 1 inch to 2 miles, 1960-61.

682. Murphy, D.K., Univ. of Toronto:
Littoral Drift Studies of Scarborough Bluffs, 1960-61; M.Ap.Sc. thesis.

683. Ostry, R., Univ. of Toronto:
Mineralogical Studies of Some Tills in Scarborough Township, Ontario, 1960-61; M.A. thesis.

684. Packer, R.W., Univ. of Western Ontario:
Repose Slopes of Pleistocene Material in Southwestern Ontario, 1961-.

685. Prest, V.K., Geol. Surv., Canada:
Surficial Deposits of Northwestern Ontario (Roads to Resources Project), 1960-61.
Includes map-areas 42 M, 43 D, 52 N, O, P, 53 A, B, C.

686. Terasmae, J., Geol. Surv., Canada:
Pleistocene Palynology and Stratigraphy in the Area Between the Lower Great Lakes and James Bay, 1956-60.
A study of Pleistocene palynology from samples of bog and lake deposits as an aid in determining the glacial history and correlating glacial deposits. See Geol. Surv., Canada Bulletins 46, 56.
Surficial Geology of the Cornwall Map-area, 1 inch to 1 mile, 1959-60.
See Geol. Surv., Canada Paper 60-28.

Deglaciation and Post-glacial Events in Ontario, between Lake Erie and James Bay, 1956-62.

An attempt to establish the chronological sequence of events in late and post-glacial time in Ontario by palynological studies, radiocarbon dating and stratigraphic observations. See A Palynological and Geological Study of Pleistocene Deposits in the James Bay Lowland, Geol. Surv., Canada, Bull. 62, 1960.

Quebec

687. Brandon, L.V., Geol. Surv., Canada:
Groundwater Study of Ottawa-Hull Region, Ontario and Quebec, 1958-59.
See Geol. Surv., Canada Paper 60-23.

688. Parry, J.T., McGill Univ.:
A Study of the Landforms and Surficial Deposits in the North River Valley, Quebec, 1960-63; Ph.D. thesis.

689. Tremblay, J.J.L., Geol. Surv., Canada:
Ground-water Survey of St. Jean Map-area, Quebec, 1955-61.
Ground-water Survey of Vaudreuil Map-area, Quebec, 1960-61.

Yukon and Northwest Territories

690. Brandon, L.V., Geol. Surv., Canada:
Ground-water Geology of Permafrost Areas, Mackenzie District, N.W.T., 1960-.

The purpose is to provide information on ground-water conditions in areas of permafrost.

691. Chapman, L.J., Ontario Research Foundation and Brown, R.J.E., Division of Building Research, National Research Council:
Evapotranspiration Studies - Norman Wells, Northwest Territories, 1953-.

This field study of evapotranspiration is being carried out by the staff of the Division of Building Research, National Research Council for the Ontario Research Foundation under the direction of Mr. L.J. Chapman.

692. Craig, B.G., Geol. Surv., Canada:
Operation Coppermine, 1 inch to 8 miles, supported by helicopter, 1959.

Reconnaissance mapping of surficial formations.
See Geol. Surv., Canada Paper 60-18.
Reconnaissance Mapping of Surficial Formations of an Area in the Northwest Territories bounded by Lat. 66° and the Arctic Coast and the Western Boundary of Keewatin District East to about Long. 90° (Operation Back River), 1960.

693. Craig, B.G., Fyles, J.G., and Lee, H.A., Geol. Surv., Canada:
Surficial Geology of Parts of Districts of Keewatin and Mackenzie, 1958-60.
See Geol. Surv., Canada Paper 60-10.

694. Hattersley-Smith, G., Weber, J.R., and Sagar, R.B., Defence Research Board:
Lake Hazen Meteorology and Geophysics, 1957-60.
See The Ablation Season on the Gilman Glacier, Northern Ellesmere Island and Geophysical Studies on Gilman Glacier, Northern Ellesmere Island; papers presented at the 12th Gen. assembly, I.U.G.G., Helsinki, 1960.

695. Hughes, O.L., and McLeod, C.R., Geol. Surv., Canada:
Surficial Geology of the Klondike, Yukon Territory, 1960-.
To provide information on surficial formations, with special attention to the conditions favouring placer deposits.

696. Johnston, G.H., Division of Building Research, National Research Council.
Observations at Inuvik, Northwest Territories (new location of townsite of Aklavik), 1954-.
Observations on the performance of various engineering facilities were continued by means of soil temperature and foundation movement measurements. Additional movement reference points were established on a number of buildings. A precise level survey was run to tie in all major Bench Marks used for observations of foundation movement and to evaluate the performance of these Bench Marks. Observations on the depth of thaw occurring under various soil conditions and vegetation cover resulting from general construction activity were continued by means of ground temperature measurement. See The New Aklavik: Search for the Site; Journal Engineering Institute of Canada, vol. 43, No. 1, January, 1960; see also Technical Paper No. 89, Division of Building Research (N.R.C. 5573) February, 1960.

697. Mackay, J.R., Univ. of British Columbia:
Geomorphology of the Mackenzie Delta and Adjoining Areas, 1954-62.
The work is being carried out for the Geographical Branch, Dept. of Mines and Technical Surveys, Ottawa. Field investigations have been carried out on the Mackenzie Delta and the unconsolidated deposits of the Liverpool Bay area. See Glacier Ice-Thrust Features of the Yukon Coast; Geographical Bull. No. 13, Ottawa, 1959, pp. 5-21.
Harmonic Analysis of Meandering in the Mackenzie River and Deltaic Channels, 1960-61.
Fourier (harmonic) analysis, carried out with the aid of a high speed electronic computer, is being used to study meandering of the Mackenzie River. Variance spectra (a kind of Fourier analysis applied to autocorrelation functions derived from a series) analysis has been started for the distributary system of the Delta.
Origin of Pingos and Oriented Lakes, Northwest Territories, 1954-62.
Includes study of size, depth, and general type of lake in which pingos grow; quantitative treatment of

changes in climatic-permafrost regime as they effect pingo formation; and study of transverse wind theory of oriented lakes in Liverpool Bay and Baffin Island areas. The work is supported partly by the Geographical Branch, Mines and Technical Surveys, Ottawa. See Notes on Oriented Lakes of the Liverpool Bay Area, N.W.T., Revue Canadienne de Geographie, vol. 10, 1956, pp. 169-173.

698. Owen, E.B., Geol. Surv., Canada:
Yukon Territory Dam Sites, 1959-60.
Study of engineering geology of possible dam sites, mainly along the Yukon River.

699. Roots, E.F. (in charge), Pelletier, B.R., Horn, D.R., (Submarine Geology), Roots, E.F., St-Onge, D.A., Arnold, K. (Terrestrial Geology, Physiography, Glaciology), Hobson, G.D., Sanders, G., Overton, A., Sobczak, L., McConnell, K. (Geophysics), and Collin, A.E. (Oceanography), Dept. of Mines and Technical Surveys:
Polar Continental Shelf Project - a continuing project initiated in 1958.
A general geological and geophysical investigation of the continental shelf area of Arctic Canada, with associated studies of the islands, straits and sounds, the ocean waters, the continental slope and deeper crustal structures. The Project comprises teams of scientific specialists from the appropriate units of the Department of Mines and Technical Surveys (Geological Surveys, Geographical Branch, Dominion Observatory, and Surveys and Mapping Branch) and individual aspects of the programme are integrated with the country-wide programmes of that respective unit (e.g. the gravity researches form part of the overall gravity study of Canada, conducted by the Dominion Observatory). The ultimate aim is to obtain a thorough and balanced understanding of the geological and physical characteristics of the region.

700. Wagner, F.J.E., and Terasmae, J., Geol. Surv., Canada:
Identification of Organic Remains from Off-shore Dredged Samples, 1960-.
Identification of material collected by the Hydrographic Service from Exeter Bay, Baffin Island, to provide information about depth of occurrence and geographic distribution of recent species found in dredged samples as an aid in interpretation of fossil assemblages from Pleistocene deposits.

General Problems

701. Bozozuk, M., Division of Building Research, National Research Council:
Swelling and Shrinkage of Clays, 1954-.
See Shrinking and Swelling of Two Canadian Clays; a paper prepared for presentation to the Fifth Conference of the International Society of Soil Mechanics and Foundation Engineering, Paris, 1961.

702. Brink, V.C., and Mackay, J.R., Univ. of British Columbia:
Needle Ice, 1960-.
A study of the effect of needle ice on frost heaving and plants.

703. Brown, R.J.E., Division of Building Research, National Research Council:
Permafrost Distribution in Canada; Permafrost Boundary in Canada; Energy Exchange at Ground Surface in Relation to Permafrost Distribution, 1953-.
In addition to recording information on the occurrence of permafrost in Canada by direct observation, this project has now been directed towards an analysis of the various components of energy exchange at the earth's surface as a means of improving the understanding of and the ability to predict the distribution and occurrence of permafrost. See Distribution of Permafrost and Its Relation to Air Temperature in Canada and the U.S.S.R.; Arctic, vol. 13, No. 3, September, 1960, pp. 163-177.

704. Brown, J.C., McGill Univ.:
The Deglaciation of the St. Lawrence Lowland, 1958-62.

705. Burn, K.N., Bozozuk, M., Crawford, C.B., Eden, W.J., and Hamilton, J.J., Division of Building Research, National Research Council:
Geotechnical Properties of Eastern Marine Clay, 1951-.
Attempts are being made to collect and correlate geotechnical data on the Eastern Marine clay. Laboratory investigations include studies of behaviour of the clays in triaxial and consolidation tests. Field work includes measurements of settlement of two heavy earth embankments and case record studies of landslides. See Influence of Rate of Strain of Effective Stresses in Sensitive Clay; Special Tech. Pub. No. 254, ASTM, 1960, and Improved Determination of Preconsolidation Pressure of a Sensitive Clay; Special Tech. Pub. No. 254, ASTM, 1960.

706. Clark, T.H., and Elson, J.A., McGill Univ.:
Formation of Ventifacts, 1958-61.

707. David, P.P., McGill Univ.:
A Study of Roundness of Windblown Sands from Hungary and the Canadian Plains, 1960-62; M.Sc. thesis.

708. Dreimanis, A., Univ. of Western Ontario:
Quantitative Carbonate Determinations in Till Matrix, 1950-61.
The amount of dolomite is determined separately from the amount of calcite, by difference in the rate of reaction of these minerals with 20 per cent hydrochloric acid. The Chittick gasometric apparatus is used for measuring the volume of CO_2 evolved. This rapid and simple method makes it possible to analyze great numbers of samples. In some areas the results of such analyses have assisted in distinguishing tills of different glaciers, different lobes, even different moraines of one lobe, and different stratigraphic horizons.

Stratigraphic Correlations of Glacial Deposits in the Region between Lake Huron and St. Lawrence Lowland, 1953-65.

See Pre-classical Wisconsin in the Eastern Portion of the Great Lakes Region, North America; International Geol. Cong., 21 Norden, 1960, pt. IV, pp. 108-119.

709. Elson, J.A., Yong, R., and Frenkel, O.J., McGill Univ.:
The Effect of Chemical Additives on the Permeability of Soils, 1960-61.

The spacing of oriented, purified clay particles is controlled in a specially built permeameter through which flow under pressure can be induced either parallel or perpendicular to the particles. Rates of flow and chemical changes in the water can be measured under various pressures.

710. Frenkel, O.J., McGill Univ.:
The Flow of Water and Ions Through Clays, 1959-61; M.Sc. thesis.

711. Hutcheon, N.B., Gold, L.W., and Penner, E., Division of Building Research, National Research Council:
Ground Temperatures and Frost Action, 1948-.

See Use of Waste Sulphide Liquor to Reduce Frost Heaving in Soils; Transactions, Engineering Institute of Canada, vol. 3, No. 4, December 1959, pp. 107-109.

712. Klassen, R.W., and Taylor, R.S., Univ. of Alberta:
Photogeologic Comparitive Study of Areas Designated as Ground Moraine, 1959-60.

See A Photogeologic Study of Selected Ground Moraine Areas: Surface Features and Their Significance: unpublished M.Sc. thesis by R.W. Klassen, Univ. of Alberta.

713. Kupsch, W.O., Univ. of Saskatchewan:
Early Postglacial Ground Wind Circulation as Determined from Anchored Dunes in North America, 1960-62.

714. MacFarlane, Ivan C., Division of Building Research, National Research Council:
Muskeg Research, 1954-.

See Evaluation of Road Performance over Muskeg in Ontario; Canadian Good Roads Association, Proceedings, 40th Convention, September 1959, pp. 396-405.

715. Mackay, J.R., and Mathews, W.H., Univ. of British Columbia:
Snow Creep and Its Influence on Soil Movement, 1958-.

716. Meyboom, P., Research Council of Alberta:
The Role of Groundwater in Landslides, 1959-61.

717. Mathews, W.H., and Morrison, B.L., Univ. of British Columbia:
Statistical Analysis of Discharge of a Glacial Stream, 1959-60.

718. Riddell, John E., Carleton Univ.:
General Studies of Distribution of Heavy Metals in Glacial Soils of Canada, 1957-.
Distribution of Copper in Soils of Allumette Island, Quebec, 1959-60.

719. Taylor, R.S., Univ. of Alberta:
Pleistocene History of Western Canada, 1956-.
Current works is on the phenomena of deleveling associated with the drainage of western Pleistocene lakes. See Some Pleistocene Lakes of Northern Alberta and Adjacent Areas (revised); J. Alberta Soc. Petrol. Geol., vol. 8, No. 6, pp. 167-185, 1960.

SEDIMENTATION

720. Baadsgaard, H., Steen, G., Stauffer, M., and Evans, C., Univ. of Alberta:
Use of Absolute Dating in Provenance Studies and in Delineating Metamorphic Events, 1959-.
The investigation involves such problems as the effect of sedimentary transport, diagenesis, and metamorphism on the radioactive systems. It is hoped that measurement of daughter-parent ratios will provide evidence of environment, and history of the materials concerned. See Potassium-Argon Age of Biotites from Cordilleran Granites of Central British Columbia; Bull. Geol. Soc. Amer., vol. 72, No. 5, 1961, pp. 689-702.

721. Brueckner, W.D., Memorial Univ. of Newfoundland:
Carbonate Content of some Recent Sediments and its Variation with Grain Size, 1959-61.
Carbonate containing unconsolidated sediments of various origins (beach and shelf, stream and river, moraine and glaciofluvial outwash) are divided into size fractions, and the carbonate content of the fractions is determined. It is hoped to find relationships between the carbonate distribution and the environment of deposition.

722. Candy, G., Shaw, D.M., and Middleton, G.V., McMaster Univ.:
Geochemistry of Shales, 1960-.
A trace element study of Silurian shales in the Niagara peninsula in relation to sedimentary environment.

723. Carrigy, M.A., Research Council of Alberta:
Sedimentary Petrology of the McMurray Formation (Athabasca Oil Sands), 1957-.
See The Athabasca Oil Sands; Oil Fields of Alberta, published by the Alberta Soc. of Pet. Geol.

724. David, P.P., McGill Univ.:
A Study of Roundness of Windblown Sands from Hungary and the Canadian Plains, 1960-62; M.Sc. thesis.

725. Dean, R.S., McGill Univ.:
The Shales of the St. Lawrence Lowland of Quebec, 1959-61; Ph.D. thesis.

726. Dineley, David, L., Univ. of Ottawa:
Stratigraphy, Palaeontology and Sedimentology of Devonian Continental Formations, 1960-.
This project is a continuation of studies carried out on similar formations in Europe and Spitsbergen during the last 10 years. New techniques of vertebrate fossil preparation are to be employed.

727. Forgeron, F., Carleton Univ.:
Sedimentation in the Bay of Fundy, 1959-61; M.Sc. thesis.

728. Halferdahl, L.B., Research Council of Alberta:
Alluvial Deposits in Alberta with Special Emphasis on Heavy Minerals, 1957-.
The bulk of the heavy minerals presently being transported in rivers in Alberta consist of siderite, garnet, magnetite, and ilmenite. In certain parts of some rivers interesting amounts of gold have been found.

729. Jones, H. Llewelyn, Saskatchewan Dept. of Mineral Resources:
The Viking Formation in West-central Saskatchewan, 1959-61.
Involves the study of the stratigraphy, structure, conditions of deposition, and economic considerations of the Lower Cretaceous Viking formation in this area.

730. Kent, Donald M.J., Univ. of Alberta:
Stratigraphy and Sedimentation of the Upper Devonian Nisku and Duperow Formations of Southern Saskatchewan, 1960-62; Ph.D. thesis.
It is hoped that by detailed study of the stratigraphy and sedimentation of this area, stratigraphic hydrocarbon traps may be outlined. A new stratigraphic tool, pseudochitinous microfossils called Tasmanites, are being used as an aid in unraveling the stratigraphy of the area under study. See Preliminary Report on Stratigraphy of the Upper Devonian Nisku and Duperow Formation, Southwestern Saskatchewan: Saskatchewan Dept. of Mineral Resources (in press).

731. Kick, J.F., Univ. of Toronto:
An Analysis of the Bottom Sediments of Lake Erie, Ontario, 1960-61; M.A. thesis.

732. Fyson, W.K., Saskatchewan Dept. of Mineral Resources:
Deadwood and Winnipeg Stratigraphy in Southwest Saskatchewan, 1960-61.
A study of the sedimentation and correlations within the Cambro-Ordovician clastics of southwest Saskatchewan.

733. Lajoie, J., McGill Univ.:
Origin of the Val Brillant and Sayabec Formation, Quebec, 1959-61; M.Sc. thesis.

734. Lajtai, E. A., Univ. of Toronto:
A Study of Pleistocene Sediments along the University Subway Line, Toronto, Ontario, 1960-61; M. Ap. Sc. thesis.

735. Lawson, David Edward, Univ. of New Brunswick:
Some Aspects of the Carboniferous Sediments of the Moncton Basin, New Brunswick, 1960-62; M. Sc. thesis.

736. Lerbekmo, John F., Univ. of Alberta:
Petrology of the Belly River, Edmonton, and Brazeau Formations of the Alberta Foothills, 1957-61.
A detailed study of the mineralogy is being undertaken with the hope of correlating these continental formations, and of differentiating possible source areas.

737. Lewis, C. F. M., Univ. of Toronto:
Determination of Lake Bottom Sediments from Echo Sounder Profiles, 1960-62; M. A. thesis.

738. Lilly, Hugh D., Memorial Univ. of Newfoundland:
Cambrian-Ordovician Sedimentation in Newfoundland, 1959-61; M. Sc. thesis.
An attempt to outline the relationships between the Cambrian and Ordovician in the area between Bonne Bay and the Humber River. The problem of major facies changes along with structural relationships is little understood and an attempt will be made to solve some of these problems on the basis of detailed work in the Goose Arm area of the Bay of Islands.

739. Mathews, W. H., and Morrison, B. L., Univ. of British Columbia:
Statistical Analysis of Discharge of a Glacial Stream, 1959-60.

740. Mathews, W. H., Univ. of British Columbia, and Shepard, F. P., Scripps Inst. of Oceanography:
Sedimentation of the Fraser River Delta, British Columbia, 1958-61.

741. Middleton, G. V., McMaster Univ.:
Quantitative Petrology of Sandstones, 1957-63.
The aim is to develop techniques for quantitative mineralogical, chemical and textural study of indurated sandstones, and to study selected sandstone formations using these techniques. Special attention will be paid to turbidite formations. See Petrography of Two Turbidite Formations (abstract); a paper read at the spring 1960 Meeting of Soc. Econ. Mineralogists and Palaeontologists.

742. Moorhouse, W. W., Univ. of Toronto:
Studies of Precambrian Sediments, 1950-.
Studies of the petrography, trace element composition, mineralogy and sedimentation features of the Animikie iron formations. See Gunflint Iron Range in the Vicinity of Port Arthur; Ont. Dept. of Mines, vol. LXIX, pt. 7, 1960.

743. Oliver, T.A., Univ. of Alberta:
Petrography and Depositional Environments of the Basal Cretaceous Clastics of the Southwestern Canadian Sedimentary Basin, 1961-.

744. Murphy, D.K., Univ. of Toronto:
Littoral Drift Studies of Scarborough Bluffs, 1960-61; M.Ap. Sc. thesis.

745. Pugh, D.C., Geol. Surv., Canada:
Subsurface Study of the Pennsylvanian and/or Permian, Triassic, and Jurassic Formations in Northern British Columbia, 1954-60.
To correlate, describe, and determine facies changes of Pennsylvanian-Permian, Triassic, and Jurassic formations by study of samples, cores, and electric and radioactivity logs of oil and gas wells. See Geol. Surv., Canada Paper 60-1.
Insoluble Residues, Devonian Carbonate Rocks of Western Canada, 1959-.
It is hoped this study will contribute to an understanding of the source and conditions of deposition of the rocks and the conditions favouring formation of reefs and organic carbonates.

746. Reavely, G.H., Univ. of Western Ontario:
Detrital and Detrital Forming Minerals in Palaeozoic and Precambrian Rocks, in Ontario and Parts of Quebec, 1959-62.
Many Palaeozoic rocks contain detrital minerals derived from Precambrian terrains which may yield information on their source.

747. Scott, Darcy L., Univ. of British Columbia:
Stratigraphy and Palaeogeography of the Etherington and Rocky Mountain Formations in the Southern Alberta Rocky Mountains, 1959-63; Ph.D. thesis.
This project will include a detailed petrographic examination of many stratigraphic sections of uppermost Palaeozoic sediments in the southern Alberta Rocky Mountains.

748. Stott, D.F., Geol. Surv., Canada:
Cretaceous Stratigraphy between Smoky and Pine Rivers, Rocky Mountain Foothills, Alberta and British Columbia, 1958-61.
Stratigraphic studies of the Upper Cretaceous Smoky group have been directed to the pronounced facies changes from marine to transitional sediments and to correlations of these beds with the type Smoky section and Alberta group of the Alberta Foothills. In the Fort St. John Group, the relation of the flora to the Lower Cretaceous Blairmore-Luscar flora and its relation to dated marine rocks are being investigated. The lithology of the rocks is being studied in detail to determine environments of deposition, their potentialities as sources of oil and gas and suitability as reservoirs.

749. Roots, E.F. (in charge), Pelletier, B.R., Horn, D.R., (Submarine Geology), Roots, E.F., St-Onge, D.A., Arnold, K. (Terrestrial Geology, Physiography, Glaciology), Hobson, G.D., Sanders, G., Overton, A., Sobczak, L., McConnell, K. (Geophysics), and Collin, A.E. (Oceanography), Dept. of Mines and Technical Surveys:
Polar Continental Shelf Project - a continuing project initiated in 1958.
A general geological and geophysical investigation of the continental shelf area of Arctic Canada, with associated studies of the islands, straits and sounds, the ocean waters, the continental slope and deeper crustal structures. The Project comprises teams of scientific specialists from the appropriate units of the Department of Mines and Technical Surveys (Geological Survey, Geographical Branch, Dominion Observatory, and Surveys and Mapping Branch) and individual aspects of the programme are integrated with the country-wide programmes of that respective unit (e.g. the gravity researches form part of the overall gravity study of Canada, conducted by the Dominion Observatory). The ultimate aim is to obtain a thorough and balanced understanding of the geological and physical characteristics of the region.

750. Smith, D.L., Univ. of Manitoba:
Sedimentary Petrology of the Stony Mountain Formation, Manitoba, 1960-61; M.Sc. thesis.

751. Wardlaw, N.C., Univ. of Saskatchewan:
Evaporite and Carbonate Deposits of Saskatchewan, 1961-.

752. Wilkins, A.A., Univ. of Alberta:
A Compositional Comparison of the Paddy and Cadotte Sandstones of Northwestern Alberta, 1960-61; M.Sc. thesis.
A heavy mineral and thin section study of the mineralogy of the Cadotte and Paddy members of the Peace River formation.

STRATIGRAPHY AND PALAEONTOLOGY

Precambrian

753. Burwash, R.A., Peterman Z.E., and Baadsgaard, H., Univ. of Alberta:
Subsurface Precambrian of Western Canada, 1950-61.
See Pre-Beltian Basement in Southern Alberta and Adjacent British Columbia; Geol. Soc. Amer., Annual Meeting, November 1959 (Abstract).

754. Charlesworth, H.A.K., Univ. of Alberta:
Stratigraphy, Structure and Metamorphism of Old Fort Point Formation in Meadow Creek Anticlinorium, Jasper, Alberta, 1961-.

755. Charlesworth, H.A.K., Evans, C.R., and Stauffer, M.R., Univ. of Alberta:
Structure and Stratigraphy of Precambrian Rocks in the Rocky Mountains, 1959-.
See Precambrian Rocks in the Vicinity of Jasper, Alberta: Edmonton Geol. Soc., 2nd Annual Field Conference Guidebook, pp. 11-18, 1960.

756. Frarey, M.J., Geol. Surv., Canada:
Wakwekobi Map-area, Ontario, 1 inch to 1 mile, 1959-63.
Part of a program of revision and extension of earlier mapping in the "original" Huronian area, with emphasis on Huronian stratigraphy and structure.

757. McGlynn, J.C., Geol. Surv., Canada:
Regional Correlation of the Northwest Canadian Shield, 1960-.
The purpose is to provide data for better correlation of Precambrian rocks in the northwest Canadian Shield by studying key areas.

Cambrian to Silurian

758. Aitken, J.D., Geol. Surv., Canada:
Subsurface pre-Devonian, Northwest Territories, 1960-62.
The establishment of mappable subsurface units and where possible, relation of these to named and described surface units; construction of one or more regional stratigraphic cross-sections.

759. Brueckner, W.D., Memorial Univ. of Newfoundland:
Cambrian Rocks of Western St. Mary's Bay Area, Avalon Peninsula, Nfld., 1961-.

760. Burk, C.F., Geol. Surv., Canada:
A Regional Study of the Silurian Stratigraphy of Gaspe Peninsula, Quebec, 1957-59; Ph.D. thesis, Northwest Univ.
Involves the correlation of Silurian sections from almost all outcrop areas in Gaspe Peninsula. The emphasis is on the nature and distribution of lithologies, but significant conclusions are drawn on time-stratigraphic ranges of certain Siluro-Devonian fossils. See Lithofacies Maps, Map 20; John Wiley and Sons, (1960).

761. Copeland, M.J., Geol. Surv., Canada:
Palaeontology and Stratigraphic Distribution of Ostracods from the Stonehouse Formation, Nova Scotia, 1959-60.

762. Fyson, W.K., Saskatchewan Dept. of Mineral Resources:
Deadwood and Winnipeg Stratigraphy in Southwest Saskatchewan, 1960-61.
A study of the sedimentation and correlations within the Cambro-Ordovician clastics of southwest Saskatchewan.

763. Greggs, Robert G., Univ. of British Columbia:
Upper Cambrian of Southern Canadian Rocky Mountains, 1958-61; Ph.D. thesis.

764. Hofmann, H.J., McGill Univ.:
Chazy Group in the St. Lawrence Lowland, 1959-61; Ph.D. thesis.

765. Kerr, James William, Queen's Univ.:
Cambrian Trilobites and Cambrian Stratigraphy, 1960-.

766. Lajoie, J., McGill Univ.:
Origin of the Val Brillant and Sayabec Formation, Quebec, 1959-61; M.Sc. thesis.

767. Lilly, Hugh D., Memorial Univ. of Newfoundland:
Cambrian Ordovician Sedimentation in Newfoundland, 1959-61; M.Sc. thesis.
An attempt to outline the relationships between the Cambrian and Ordovician in the area between Bonne Bay and the Humber River. The problem of major facies changes along with structural relationships is little understood and an attempt will be made to solve some of these problems on the basis of detailed work in the Goose Arm area of the Bay of Islands.

768. Norford, B.S., Geol. Surv., Canada:
Late Ordovician and Silurian Fauna Study of Southern British Columbia, 1960-.
A study of past collections made from the Beaverfoot and Brisco units of the southern Rocky Mountains. This study will allow revision of taxonomic nomenclature and will lay the groundwark for future collecting and stratigraphic analysis.
Cirrus Mountain "Halysites" Beds, Banff National Park, Alberta, 1960.
A section measured at Cirrus Mountain in 1960 spans the interval between the Cairn and Mount Wilson formations. Silicified fossils suggest an Ordovician age for the sub-Devonian rocks rather than Silurian as suggested by many past workers.

769. Smith, D.L., Univ. of Manitoba:
Sedimentary Petrology of the Stony Mountain Formation, Manitoba, 1960-61; M.Sc. thesis.

Devonian to Permian

770. Baird, D.M., Univ. of Ottawa:
Carboniferous Strata of Newfoundland, 1957-61.

771. Belyea, H.R., and Norris, A.W., Geol. Surv., Canada:
Middle Devonian Nomenclature and Correlations, Southern Northwest Territories, Alberta, and British Columbia, 1959-61.

772. Benson, D.G., Geol. Surv., Canada:
Geology of the Hopewell Map-area, Nova Scotia, 1 inch to 1 mile, 1960-61.
Special attention will be given to the Carboniferous stratigraphy.

773. Christopher, James E., Saskatchewan Dept. of Mineral Resources:
The Three Forks Group of Saskatchewan, 1959-61.
A regional subsurface stratigraphic study of uppermost Devonian and Kinderhookian formations of Saskatchewan. The term Three Forks group for three formations is proposed, beginning with the oldest - Torquay (new name), Big Valley and Bakken. The Three Forks group is correlated with the type outcropping of the Three Forks formation of Montana as defined by A.C. Peale, 1893.

774. Danner, Wilbert R., Univ. of British Columbia:
Palaeontology and Stratigraphy of the Chilliwack, Cache Creek and Sicker Groups of Southwestern British Columbia, 1957-.

775. Dineley, David L., Univ. of Ottawa:
Stratigraphy, Palaeontology and Sedimentology of Devonian Continental Formations, 1960-.
This project is a continuation of studies carried out on similar formations in Europe and Spitsbergen during the last 10 years. New techniques of vertebrate fossil preparation are to be employed.

776. Hamilton, J.B., New Brunswick Dept. of Lands and Mines:
Correlation of Pennsylvanian Rocks of Eastern New Brunswick by Palynological Methods, 1958-61; M.Sc. thesis, Univ. of New Brunswick.

777. Kaufmann, W.L.M., Univ. of Saskatchewan:
The Mississippian Ratcliffe and Midale Beds of Southeastern Saskatchewan, 1960-61; M.Sc. thesis.
A detailed petrographic study of well cores from an area south of the Weyburn - Midale oilfields.

778. Kent, Donald M.J., Univ. of Alberta:
Stratigraphy and Sedimentation of the Upper Devonian Nisku and Duperow Formations of Southern Saskatchewan, 1960-62; Ph.D. thesis.
It is hoped that by a detailed study of the stratigraphy and sedimentation of this area, stratigraphic hydrocarbon traps may be outlined. A new stratigraphic tool, pseudochitinous microfossils called Tasmanites, are being used as an aid in unraveling the stratigraphy of the area under study. See Preliminary Report on Stratigraphy of the Upper Devonian Nisku and Duperow Formation, Southwestern Saskatchewan; Saskatchewan Dept. of Mineral Resources (in press).

779. Kirmani, Khalil-Ullah, Univ. of Alberta:
Detailed Study of Duhamel Reef, 1960-61; M.Sc. thesis.

780. Lane, David M., Saskatchewan Dept. of Mineral Resources:
The Souris River Formation, Southern Saskatchewan, 1960-61.

781. Lawson, David Edward, Univ. of New Brunswick:
Some Aspects of the Carboniferous Sediments of the Moncton Basin, 1960-62; M. Sc. thesis.

782. MacKenzie, W. S., Univ. of Toronto:
Petrographic Studies of a Devonian "Reef" in Jasper Park, Alberta, 1959-61; M. A. thesis.

783. MacLeod, Kenneth Arnold, Univ. of New Brunswick:
Lower Windsor Rocks near Lake Ainslie, Cape Breton, 1960-62; M. Sc. thesis.

784. McGregor, D. C., Geol. Surv., Canada, Greggs, R. D., Shell Oil Co. of Canada, Rouse, G. E., Univ. of British Columbia:
Description and Evaluation of Plant Mega- and Microfossils from the Type Section of the Ghost River Formation of Alberta, 1960-61.
A reassessment of the type section of the Ghost River formation in the light of recent stratigraphic and palaeontological discoveries.

785. McKennitt, B. B., Univ. of Manitoba:
Stratigraphy of the Elk Point Group (Devonian), Manitoba, 1959-60; M. Sc. thesis.

786. McLaren, D. J., Geol. Surv., Canada:
Monograph of the Camarotoechiid Brachiopods of the Middle and Early Upper Devonian of Western Canada, 1959-60.
Includes description of the genera and species of this family of rhynchonellids from Western Canada and study of their use for detailed and accurate long-range correlation.
Rugose Corals of Middle Devonian of Great Slave Lake, Northwest Territories, 1960-.
To describe and figure corals collected during 'Operation Mackenzie' and from earlier Survey collections from Middle Devonian rocks of Great Slave Lake, with the objective of correlating within the area and with the Middle Devonian of the Mackenzie Valley.

787. McLaren, D. J., and Belyea, H. R., Geol. Surv., Canada:
Upper Devonian Nomenclature and Correlations, Northwest Territories Alberta and British Columbia, 1960-61.
The purpose is to develop a nomenclature covering the correlation of the Upper Mackenzie outcrop areas with the subsurface to the south.

788. McLaren, D. J., and Norris, A. W., Geol. Surv., Canada:
Age and Fauna of a late Middle Devonian Reef on Horn Plateau, Northwest Territories, 1960-61.
The description of an unusual fauna associated with a reef developed in the Middle Devonian rocks of the Horn Plateau. The faunal assemblage should lead to an exact dating of the formation. Collection was made on 'Operation Mackenzie'.

Illustration of Fossils from Devonian of Alberta and Upper Mackenzie Region, Northwest Territories, 1960-61.

The fauna of each major formation will be illustrated in a series of plates with detailed legend describing horizon and locality of each specimen.

789. Procter, R.M., Geol. Surv., Canada:
Subsurface Study of the Mississippian, Pennsylvanian and Permian Systems of Northeastern British Columbia, 1960-62.

A study of data obtained from wells drilled for oil and gas, the description and interpretation of the geological features of each system, and the preparation of cross-sections to show correlations of adjacent areas.

790. Scott, Darcy L., Univ. of British Columbia:
Stratigraphy and Palaeogeography of the Etherington and Rocky Mountain Formations in the Southern Alberta Rocky Mountains, 1959-63; Ph.D. thesis.

This project will include a detailed petrographic examination of many stratigraphic sections of uppermost Palaeozoic sediments in the southern Alberta Rocky Mountains.

791. Smith, Clyde, Univ. of British Columbia:
Stratigraphy of the Pennsylvanian System of Northwestern Washington, 1960-61; M.Sc. thesis.

Project spensored in part by Washington State Div. of Mines and Geol.

792. Souther, J.G., Geol. Surv., Canada, and Rigby, J.K., Brigham Young Univ.:
Stratigraphy and Fauna of the Permian of Northern British Columbia, 1959-61.

A detailed study and description of the Permian formations of Northwestern British Columbia, particularly those of the Stikine Area.

Mesozoic

793. Burk, C.F., Geol. Surv., Canada:
Subsurface Upper Cretaceous Stratigraphy of West Central Alberta and Adjacent British Columbia, 1960-62.

A regional correlation and stratigraphic analysis of a selected interval consisting mainly of Upper Cretaceous rocks, with special attention to potential oil and gas reservoirs such as the Cardium and Dunvegan formations. The basic stratigraphic data will be obtained from electric logs and well samples.

794. Caldwell, W.G.E., Univ. of Saskatchewan:
Stratigraphy of Cretaceous Bearpaw Formation in South Saskatchewan River Valley, 1959-62.

A study of the field relations of the Bearpaw formation, the megafossils, microfossils, fossil spores and pollen, and the light, heavy and clay minerals.

795. Danner, Wilbert R., British Columbia Dept. Mines and Petroleum Resources (part time), Univ. of British Columbia:
Reconnaissance in Nicola Group, B.C., Directed Toward Appraisal of Prospects for Working out Stratigraphy and Structure, 1960.
The work was a preliminary reconnaissance to evaluate the prospects of finding markers, fossil horizons. Numerous fossiliferous beds and unfossiliferous sedimentary sequences were examined.

796. Eastwood, G.E.P., British Columbia Dept. Mines and Petroleum Resources:
A Study of Nicola Group Rocks by Detailed Mapping in the Vicinity of Lawless Creek, Tulameen River, British Columbia, 1960.

797. Edmunds, F.H., Univ. of Saskatchewan:
Stratigraphy of the Cretaceous Colorado Group in Saskatchewan, 1959-.

798. Evans, J.K., Univ. of Saskatchewan:
Biostratigraphy of the Cretaceous Bearpaw Formation in the South Saskatchewan River Valley, 1959-61.

799. Frebold, H., Geol. Surv., Canada:
The Jurassic System in Canada, 1959-66.
A comprehensive description of the geology of the Canadian Jurassic, particularly its index-faunas stratigraphy, correlation and palaeogeography. See Marine Jurassic Rocks in the Nelson and Salmo Areas; Geol. Surv., Canada Bull. 49 (1959) and The Jurassic Faunas of the Canadian Arctic, Geol. Surv., Canada Bull 59 (1960).
The Lower Jurassic System of Southern Yukon and Northwestern British Columbia, 1960-61.
A description of the index fossils, stratigraphy and correlation of the beds with other Lower Jurassic occurrences in Canada and elsewhere; palaeogeography of the area during Early Jurassic time.

800. Hughes, J.E., British Columbia Dept. Mines and Petroleum Resources:
Bullhead Sequence, Peace River Canyon Area and Pine River near Mt. Bickford, B.C.; 1960.

801. Lerbekmo, John F., Univ. of Alberta:
Petrology of the Belly River, Edmonton, and Brazeau Formations of the Alberta Foothills, 1957-61.
A detailed study of the mineralogy is being undertaken with the hope of correlating these continental formations, and of differentiating possible source areas.

802. Mellon, George Barry, Research Council of Alberta:
Stratigraphy and Petrology of Lower Cretaceous Sediments of Alberta, 1956-61.
Petrology and Geology of Sedimentary Magnetite Deposits of Southwestern Alberta, 1959-61.

803. Pelletier, B.R., Geol. Surv., Canada:
Triassic Rocks of Northeast British Columbia, 1959.
A stratigraphic palaeontological study with special attention to Triassic stratigraphy. See Geol. Surv., Canada Paper 60-2.

804. Singh, Chaitanya, Univ. of Alberta:
Palynology of Mannville Formation in Central Alberta, 1960-62; Ph.D. thesis.

805. Stott, D.F., Geol. Surv., Canada:
Cretaceous Stratigraphy between Smoky and Pine Rivers, Rocky Mountain Foothills, Alberta and British Columbia, 1958-61.
Stratigraphic studies of the Upper Cretaceous Smoky group have been directed to the pronounced facies changes from marine to transitional sediments and to correlations of these beds with the type Smoky section and Alberta group of the Alberta Foothills. In the Fort St. John Group, the relation of the flora to the Lower Cretaceous Blairmore-Luscar flora and its relation to dated marine rocks are being investigated. The lithology of these rocks is being studied in detail to determine environments of deposition, their potentialities as sources of oil and gas and suitability as reservoirs.

806. Taylor, Donald A., Univ. of Alberta:
Petrology of the St. Mary River Formation, Southern Alberta, 1960-61; Ph.D. thesis.

807. Tozer, E.T., Geol. Surv., Canada:
Stratigraphic Palaeontological Study of Triassic of British Columbia, 1960-.

808. Zederayko, Edward Eugene, Univ. of Saskatchewan:
The Cretaceous Colorado in Saskatchewan, 1959-61; M.Sc. thesis.
Lithological study of samples obtained from the Esterhazy and Patience Lake potash shafts and electric log correlation of the Colorado underlying eastern Saskatchewan to establish stratigraphic subdivisions.

Cenozoic

809. Church, Neil B., McMaster Univ.:
Petrology of the Early Tertiary Midway Volcanic Rocks of South-Central British Columbia, 1959-61; M.Sc. thesis.
Major and minor element composition, mineralogy and stratigraphy of the Midway rocks are being studied by rapid analytical, fused glass, spectrochemical, X-ray and field methods in an attempt to understand their petrogenesis.

810. Cox, Raymond, Univ. of British Columbia:
Biostratigraphy of a Portion of the Sooke Formation of Vancouver Island, British Columbia, 1960-62; M. Sc. thesis.
Includes identification of megafossils of marine origin and plant microfossils.

811. Hills, Leonard, Univ. of British Columbia:
Stratigraphy and Fossil Flora of the Princeton Basin, British Columbia, 1960-61; M. Sc. thesis.

812. Hopkins, W. S. Jr., Univ. of British Columbia:
Tertiary Stratigraphy of Western Skagit County, Washington, 1960-62; M. Sc. thesis.
A study of the Cenozoic rocks cropping out in the Skagit River delta and adjacent islands.

813. Nicholson, H. P., Univ. of British Columbia:
Petrology of Burrard and Kitsilano Formations, 1960-61; M. Sc. thesis.

General Problems

814. Alberta Society of Petroleum Geologists and Geological Society of Canada:
Regional Geological Cross-section of Western Canada, 1954-.
Four regional geological cross-sections of the western Canada sedimentary basin have been completed. It is hoped the cross-sections will be published in 1961.

815. Beales, F. W., Univ. of Toronto:
Upper Palaeozoic Stratigraphy, Southwestern Alberta, 1948-.
Stratigraphy of the Black River Group in Southern Ontario and Quebec, 1955-.

816. Bolton, T. E., and Wagner, F. J. E., Geol. Surv., Canada:
Lexicon of Stratigraphic Names used in Canada, 1958-60.

817. Campbell, R. B., Geol. Surv., Canada:
Quesnel Lake Map-area, 1 inch to 4 miles, 1959-61.
The structure, stratigraphy and metamorphism of Lava Palaeozoic and Proterozoic rocks, including the problem of the Cambrian - Precambrian boundary; stratigraphy of the Traissic and Jurassic volcanic and sedimentary rocks included in the Quesnel River group; and the extension of the Pinchi Lake fault zone.

818. Clark, T. H., McGill Univ.:
Stratigraphy, Structure and Economic Products of the St. Lawrence Lowland, 1938-.
See Stratigraphy of the Trenton Group St. Lawrence, Lowland, Quebec; Proceedings Geol. Assoc., of Canada, vol. II, December, 1959.

819. Cumming, L.M., Geol. Surv., Canada:
Lower Palaeozoic of the Appalachian Region, 1953-.
A stratigraphic palaeontological study of the Silurian and Devonian formations.
Basement Rock Features in the Canadian Appalachians, 1960-61.
To summarize published and unpublished information concerning the rocks which are considered to be 'basement' for oil and gas exploration in the Appalachian region.

820. Danner, Wilbert R., Univ. of British Columbia:
Limestone Deposits of West Washington State, U.S.A., 1959-61.

821. Dean, R.S., McGill Univ.:
The Shales of the St. Lawrence Lowland of Quebec, 1959-61; Ph.D. thesis.

822. Dineley, David L., Univ. of Ottawa:
Upper Palaeozoic Stratigraphy and Structures in Parts of North Central Vestspitsbergen, 1951-61.
This is work carried out on a number of expeditions from Great Britain and is concerned with Devonian to Triassic strata. The stratigraphical column shows similarity to that of the Arctic Islands of Canada and a useful comparative study should result. See The Old Sandstone of Eastern Ekmanfjorden, Vestspitsbergen. Geological Magazine, vol. XCII, pp. 18-32.

823. Fyles, J.T., British Columbia Dept. Mines and Petroleum Resources, and Clifford, Paul, British Columbia Dept. Mines and Petroleum Resources (part time), Memorial Univ. of Newfoundland:
Detailed Structural and Stratigraphic Studies of North Kootenay Lake Area, B.C., - A Phase of Studies in the Kootenay Area, 1960.

824. Gabrielse, H., Geol. Surv., Canada:
Kecheka and Rabbit River Map-area, 1 inch to 4 miles, 1957-61.
Data have been collected on the stratigraphy and structure of Proterozoic and Lower Palaeozoic strata on both sides of the Rocky Mountain Trench. Information has also been obtained on facies changes in Cambrian strata from southwest to northeast in the Cassiar and Rocky Mountains. See Geol. Surv., Canada, Map 57-1959.

825. Govett, G.J., Research Council of Alberta:
Occurrence and Stratigraphy of some Anhydrite and Gypsum Deposits in Alberta, 1959-60.

826. Hughes, Richard David, Memorial Univ. of Newfoundland:
Stratigraphy and Depositional Tectonics of the Island of Newfoundland, 1959-.
A compilation of published stratigraphic sections will be made and the data evaluated for use in the preparation of palaeogeographic, isochoric, lithologic and depositional tectonic maps. Later, field studies will be directed into critical areas.

827. Hutt, R.B., and Pfeffer, B.J., Saskatchewan Dept. of Mineral Resources:
Regional Cross-sections of the Sedimentary Rocks of Saskatchewan, 1960-61.

828. Kerr, James William, Queen's Univ.:
Palaeozoic Sequences in Thrust Slices of the Seetoya Mountains, Northern Independence Range, Elko County, Nevada, 1958-61.
See Palaeozoic Sequences in Thrust Slices of the Seetoya Mountains; Geol. Soc. Am., Program Annual Meetings, 1960, pp. 136-137 (Abstract).

829. Liberty, B.A., Geol. Surv., Canada:
Palaeozoic Outliers of the Canadian Shield, 1957-.
Palaeozoic Rocks of Southeastern Ontario, 1 inch to 4 miles, 1959-60.
Includes study of stratigraphy and sedimentation of Palaeozoic rocks in Ontario eastward to the Frontenac Axis. See Geol. Surv., Canada, Papers 60-14 and 60-31.

830. Mountjoy, E.W., Geol. Surv., Canada:
Mount Robson Southeast Map-area, 1 inch to 4 miles, 1959-61.
Includes study of Cambrian units in sufficient detail to make positive correlations; fossil collections for future palaeontological studies; study of Devonian Ancient Wall reef and facies relations with surrounding strata; mapping of Front Range thrust sheets, Pyramid thrust and Main Range structures. See Mount Robson Southeast, Prel. Paper, Geol. Surv., Canada (in press).
Geology of Miette Area, Jasper National Park, 1956-60; Ph.D. thesis, Univ. of Toronto, 1960.
Study of the stratigraphy and carbonate petrography of a small Devonian reef is continuing. Significant correlations of carbonate facies can be demonstrated. See Geol. Surv., Canada, Map 40-1959.

831. Pugh, D.C., Geol. Surv., Canada:
Subsurface Study of the Pennsylvanian and/or Permian, Triassic, and Jurassic Formations in Northeastern British Columbia, 1954-60.
To correlate, describe, and determine facies changes of Pennsylvanian-Permian, Triassic, and Jurassic formations by study of samples, cores, and electric and radioactivity logs of oil and gas wells. See Geol. Surv., Canada, Paper 60-1.

832. Roddick, J.A., Green, L.H., and Wheeler, J.O., Geol. Surv., Canada:
Operation Pelly, Yukon Territory, 1 inch to 4 miles, (with air support), 1958-60.
The project has provided much new information on Palaeozoic stratigraphy and structure in southeastern Yukon. The structure of the Pelly Mountains is characterized by low angle thrusts unlike that of the Cassiar Mountains to the south. The Tintina Trench marks a

major structural break separating Palaeozoic rocks of different facies and metamorphic grade. See Geol. Surv., Canada, Maps 7-1960, 8-1960.

833. Sanford, B.V., Geol. Surv., Canada:
Sub-surface Studies of the Palaeozoic Systems of Southwestern Ontario (Cambrian, Ordovician, Silurian and Devonian), 1958-61.
By the study of samples and data obtained from wells drilled for oil and gas, to describe and interpret the geological features of the formations of each system, and to assess their economic potentialities. See Geol. Surv., Canada, Papers 58-12 and 60-26.
Catalogue of Oil and Gas Wells in Sample Repository, Geological Survey of Canada, 1960.
A compilation of all wells drilled in southwestern Ontario for which sample cuttings are available at the Geol. Surv., of Canada.

STRUCTURAL

British Columbia, Alberta and Saskatchewan

834. Allan, J.F.S., Queen's Univ.:
Geology of the Fay Mine, Eldorado, Sask., 1959-61; M.Sc. thesis.
A structural and petrological study of the orebody.

835. Campbell, R.B., Geol. Surv., Canada:
Quesnel Lake Map-area British Columbia, 1 inch to 4 miles, 1959-61.
The structure, stratigraphy and metamorphism of Lower Palaeozoic and Proterozoic rocks, including the problem of the Cambrian - Precambrian boundary; stratigraphy of the Triassic and Jurassic volcanic and sedimentary rocks included in the Quesnel River group; and the extension of the Pinchi Lake fault zone.

836. Danner, W.R., British Columbia Dept. of Mines and Petroleum Resources (part time), Univ. of British Columbia:
Reconnaissance in Nicola Group, B.C., Directed Toward Appraisal of Prospects for Working out Stratigraphy and Structure, 1960.
The work was a preliminary reconnaissance to evaluate the prospects of finding markers and fossil horizons. Numerous fossiliferous beds and unfossiliferous sedimentary sequences were examined.

837. Douglas, R.J.W., and Herr, R.L., Geol. Surv., Canada:
Quaich Structure, Gap and Adjacent Map-area, Alberta, 1960.
To explain the structure by interpretation of results of drilling, examination of samples, and some re-mapping.

838. Fitzgerald, E. L., Univ. of Alberta:
Structure of the McConnell Thrust Sheet near Ghost River, Alberta, 1960-61; M. Sc. thesis.

839. Fyles, J. T., British Columbia Dept. of Mines and Petroleum Resources and Clifford, Paul, British Columbia Dept. of Mines and Petroleum Resources (part time), Memorial Univ. of Newfoundland:
Detailed Structural and Stratigraphic Studies of Northern Kootenay Lake Area, British Columbia - a Phase of Studies in the Kootenay Arc, 1960.

840. Gabrielse, H., Geol. Surv., Canada:
Kechika and Rabbit River Map-area British Columbia, 1 inch to 4 miles, 1957-61.
Data have been collected on the stratigraphy and structure of Proterozoic and Lower Palaeozoic strata on both sides of the Rocky Mountain Trench. Information has also been obtained on facies changes in Cambrian strata from southwest to northeast in the Cassiar and Rocky Mountains. See Geol. Surv., Canada, Map 57-1959.

841. Garland, G. D., and Kanasewich, E., Univ. of Alberta:
Studies of the Athabasca Glacier, 1959-61.
The complete project includes drilling through the ice, seismic and gravity measurements, determination of flow rate of the ice, and ice temperatures. An M. Sc. thesis by Mr. Kanasewich deals with the gravity measurements over the ice and the determination of the shape of the glacier floor from these measurements. Work is continuing on ice temperature measurements with thermocouples set in deep holes through the glacier. Work on ice flow and seismic measurements are being done at the Univ. of B. C. The Alberta Research Council investigated cable-tool drilling of the ice, and produced 3 holes by this method. Other holes were hot-point drilled. As an addition to the gravity work over the glacier, Mr. Kanasewich extended the gravity survey of the southern portion of the Rocky Mountain Trench, from Cranbrook to the International border, and a paper on the interpretation for this area is in preparation.

842. Hutt, R. B., and Pfeffer, B. J., Saskatchewan Dept. of Mineral Resources:
Regional Cross-sections of the Sedimentary Rocks of Saskatchewan, 1960-61.

843. Jones, H. Llewelyn, Saskatchewan Dept. of Mineral Resources:
The Viking Formation in West-central Saskatchewan, 1959-61.
Involves the study of the stratigraphy, structure, conditions of deposition, and economic considerations of the Lower Cretaceous Viking formation in this area.

844. Mountjoy, E. W., Geol. Surv., Canada:
Mount Robson Southeast Map-area Alberta, 1 inch to 4 miles, 1959-61.
Includes study of Cambrian units in sufficient detail to make positive correlations; fossil collections for future palaeontological studies; study of Devonian Ancient Wall reef and facies relations with surrounding strata; mapping of Front Range thrust sheets, Pyramid thrust and Main Range structures. See Mount Robson Southeast, Prel. Paper, Geol. Surv., Canada (in press).
Geology of Miette Area, Jasper National Park, 1956-60; Ph.D. thesis, Univ. of Toronto, 1960.
Study of the stratigraphy and carbonate petrography of a small Devonian reef is continuing. Significant correlations of carbonate facies can be demonstrated. See Geol. Surv., Canada, Map 40-1959.

Northwest Territories and Yukon

845. McGlynn, J. C., Geol. Surv., Canada:
Regional Correlation of the Northwest Canadian Shield, 1960-.
The purpose is to provide data for better correlation of Precambrian rocks in the northwest Canadian Shield by studying key areas.

846. Green, L. H., Geol. Surv., Canada and McTaggart, K. C., Univ. of British Columbia;
Structural Studies in the Mayo District Yukon Territory, 1948-.
See Paper by this title in Bull. Geol. Assoc. Canada, vol. 12, pp. 119-134, 1960.

847. Hoen, E. L. W. B., McGill Univ.:
Gypsum Domes on Axel Heiberg Island, Northwest Territories, 1960-62; Ph.D. thesis.

848. Roddick, J. A., Green, L. H., and Wheeler, J. O., Geol. Surv., Canada:
Operation Pelly, Yukon Territory, 1 inch to 4 miles, (with air support), 1958-60.
The project has provided much new information on Palaeozoic stratigraphy and structure in southeastern Yukon. The structure of the Pelly Mountains is characterized by low angle thrusts unlike that of the Cassiar Mountains to the south. The Tintina Trench marks a major structural break separating Palaeozoic rocks of different facies and metamorphic grade. See Geol. Surv., Canada, Maps 7-1960, 8-1960.

849. Roots, E. F. (in charge), Pelletier, B. R., Horn, D. R., (Submarine Geology), Roots, E. F., St-Onge, D. A., Arnold, K. (Terrestrial Geology, Physiography, Glaciology), Hobson, G. D., Sanders, G., Overton, A., Sobczak, L., McConnell, K. (Geophysics), and Collin, A. E. (Oceanography), Dept. of Mines and Technical Surveys:

Polar Continental Shelf Project - a continuing project initiated in 1958.

A general geological and geophysical investigation of the continental shelf area of Arctic Canada, with associated studies of the islands, straits and sounds, the ocean waters, the continental slope and deeper crustal structures. The Project comprises teams of scientific specialists from the appropriate units of the Department of Mines and Technical Surveys (Geological Surveys, Geographical Branch, Dominion Observatory, and Surveys and Mapping Branch) and individual aspects of the programme are integrated with the country-wide programmes of that respective unit (e.g. the gravity researches form part of the overall gravity study of Canada, conducted by the Dominion Observatory). The ultimate aim is to obtain a thorough and balanced understanding of the geological and physical characteristics of the region.

Ontario and Quebec

850. Baragar, W.R.A., Geol. Surv., Canada:
Wakuach Lake Map-area, Quebec and Labrador, 1 inch to 4 miles, 1958-60.

Problems include history of development of Labrador geosyncline and its subsequent orogenic phase; analysis of structural cross section through Labrador Trough; and delineation of zones of regional metamorphism. See Petrology of Basaltic Rocks of Labrador Trough, Geol. Soc. Amer. Bull. vol. 71, pp. 1589-1644, 1960.

851. Brown, D.D., Queen's Univ.:
Canoe Lake Fault, Southeastern Ontario, 1959-61; M.Sc. thesis.

A detailed investigation of the geometry, kinematics and dynamics of the fault.

852. Fitzpatrick, M.M., Queen's Univ.:
A Gravity Study of the Monteregian Hills, 1959-60.

Approximately 1300 gravity stations were established in the area bounded by latitudes 45°15' and 45°45' and longitudes 72°30' and 75°00'. The purpose of the study is: (1) to see if there is any connection between the Monteregian Hills and the Ottawa Valley Graben; (2) to see if any Hills existed unexposed beneath the Palaeozoic rocks of the Lowlands; (3) to locate the common source of the material forming the Hills; and (4) to establish the vertical extent of the Hills.

853. Frarey, M.J., Geol. Surv., Canada:
Wakwekobi Map-area, Ontario, 1 inch to 1 mile, 1959-63.

Part of a program of revision and extension of earlier mapping in the "original" Huronian area, with emphasis on Huronian stratigraphy and structure.

854. Gates, W.G., Univ. of New Brunswick:
Structural Geology of the Opemiska Copper Mine, Quebec, 1960-; M.Sc. thesis.

855. Jones, R.E., McMaster Univ.:
Sulphur Isotope Studies of Sulphide and Sulphate Minerals of the Niagara Escarpment, Ontario, 1960-62.
The project involves a study of sulphur isotope distribution in sphalerite, galena, marcasite, pyrite, gypsum and baro-celesite occurring in the Silurian rocks of the Niagara escarpment across the northern extension of the Cincinnati axis in the Hamilton area. Study of the geological environment of the samples mineralogically, stratigraphically, and structurally is an important part of the project.

856. Lowes, B.E., Queen's Univ.:
The Cobalt-Silver Ore Deposit of the Old Casey Mine, Ontario, 1959-61; M.Sc. thesis.
A study of the structure and mineralogy of the ore.

857. Thomson, J.E., Ontario Dept. of Mines:
Tectonics of the Sudbury-Espanola Area, Ontario, 1 inch to 2 miles, 1960-61.

Nova Scotia and Newfoundland

858. Blanchard, J.E., Dalhousie Univ. and Nova Scotia Research Foundation:
Application of Seismic Methods of Geophysical Exploration to Geological Problems in Nova Scotia, 1956-.
Seismic reflection and refraction studies are being carried out in conjunction with gravity and magnetic surveys in the sedimentary basins of Nova Scotia to aid in the interpretation of the geology.

859. Hughes, Richard David, Memorial Univ. of Newfoundland:
Stratigraphy and Depositional Tectonics of the Island of Newfoundland, 1959-.
A compilation of published stratigraphic sections will be made and the data evaluated for use in the preparation of palaeogeographic, isochoric, lithologic and depositional tectonic maps. Later, field studies will be directed into critical areas.

860. Keating, B.J., St. Francis Xavier Univ.:
Petrofabric Analysis of Mineralized Crystalline Limestone from Lime Hill, Inverness County, Nova Scotia, 1960-61.

861. Lilly, Hugh D., Memorial Univ. of Newfoundland:
Cambrian-Ordovician Sedimentation in Newfoundland, 1959-61; M.Sc. thesis.
An attempt to outline the relationships between the Cambrian and Ordovician in the area between Bonne Bay and the Humber River. The problem of major facies

changes along with structural relationships is little understood and an attempt will be made to solve some of these problems on the basis of detailed work in the Goose Arm area of the Bay of Islands.

862. Nash, W.A., Neale E.R.W., Larochelle, A. and Black, R.F., Geol. Surv., Canada:
Sandy Lake Map-area, Newfoundland, 1 inch to 4 miles, 1960-61.
Recent work suggests the unfossiliferous Devonian (?) Springdale group may include rocks of 2 ages. To test this hypothesis oriented specimens were collected for palaeomagnetic analysis. Preliminary results suggest that there are indeed 2 ages represented. Further specimens will be collected in the 1961 field season.

General Problems

863. Alberta Society of Petroleum Geologists and Geological Society of Canada:
Regional Geological Cross-sections of Western Canada, 1954-.
Four regional geological cross-sections of the western Canada sedimentary basin have been completed. It is hoped the cross-sections will be published in 1961.

864. Alberta Society of Petroleum Geologists, Geological Association of Canada and Geological Survey of Canada:
Tectonic Map of Canada, 1958-.
A joint project. Dr. C.H. Stockwell, Geol. Surv., Canada, is Chairman of Central Coordinating Committee. This map will form part of the World Tectonic Map to be published by the International Geological Congress.

865. Ambrose, J.W., Queen's Univ.:
Precambrian - Palaeozoic and sub-Proterozoic Erosion Surfaces in Canada, 1957-61.
A study of the extent and character of ancient erosion surfaces, now partially or largely exhumed on the Canadian Shield.

866. Beals, C.S., Innes, M.J.S., and others, Dominion Observatory:
Fossil Crater Studies.
Gravity studies of the Holleford, Brent and Deep Bay craters have been completed. In 1960 preliminary gravity investigations were carried out at the New Quebec crater and a gravity survey on the ice is planned for this crater in March, 1961. See The Brent Crater, publication of Dominion Observatory, vol. 24, No. 1, 1960 and Search for Fossil Meteorite Craters, Dominion Observatory contribution, vol. 4, No. 4, 1960.

867. Bell, Richard T., Univ. of Toronto:
Photoelastic Experiments Applied to Structural Geology, 1960-61; M.Sc. thesis.

868. Blanchard, J.E., and Buchbinder, G.G.R., Dalhousie Univ.:
Measurement of Stress in the Crust of the Earth, 1960-62.

869. Bower, D.R., and Weber, J.R., Dominion Observatory:
Gravity Measurements in Hudson Bay.
During 1960 a number of gravity measurements were carried out in a submarine in cooperation with United States hydrographic service. Further measurements are planned in 1961.

870. Bower, M.E., Geol. Surv., Canada:
Typical Aeromagnetic Anomalous Patterns, 1955-.
The assembly of a series of typical aeromagnetic anomalous patterns from published one mile aeromagnetic maps to illustrate some common rock structures.

871. Brown, A., Mines Branch, Dept. of Mines and Technical Surveys with the cooperation of the Geol. Surv., of Canada, Dominion Observatory, provincial mining departments and provincial research groups:
Ground Control in Mines, 1950-.
The purpose is to find out more about the phenomena of ground stress and ground deformations associated with mining, thus leading to better control and design of mine workings. See Development of Semi-Automatic Instrumentations for the Determination of Stress-Strain Characteristics of Geologic Materials up to Fracture, by G.E. Larocque, Mines Branch Investigation Report IR 60-42, 1960.

872. Boyko, W.P., McGill Univ.:
Structure and Absolute Ages across Superior-Churchill Boundary, 1960-62; Ph.D. thesis.

873. Buchbinder, G.G.R., Martel, P., and Blanchard, J.E., Dalhousie Institute of Oceanography and Nova Scotia Research Foundation:
Seismic Refraction and Reflection Studies, Northumberland Strait, Gulf of St. Lawrence, 1960.
The purpose is to determine the geological structure, evaluate equipment and determine costs of such projects.

874. Burwash, R.A., Peterman Z.E., and Baadsgaard, H., Univ. of Alberta:
Subsurface Precambrian of Western Canada, 1950-61.
See Pre-Beltian Basement in Southern Alberta and Adjacent British Columbia; Bulletin Geol. Soc. Amer., vol. 70, No. 12, Pt. 2, 1959, p. 1576 (abstract).

875. Charlesworth, H.A.K., Univ. of Alberta:
Stratigraphy, Structure and Metamorphism of Old Fort Point Formation in Meadow Creek Anticlinorium, Jasper, Alberta, 1961-.

876. Charlesworth, H.A.K., Evans, C.R., and Stauffer, M.R., Univ. of Alberta:
Structure and Stratigraphy of Precambrian Rocks in the Rocky Mountains, 1959-.
See Precambrian Rocks in the Vicinity of Jasper, Alberta; Edmonton Geol. Soc., 2nd Annual Field Conference Guidebook, pp. 11-18, 1960.

877. Currie, John B., University of Toronto:
Analysis of Methods used in Structural Cross-Sections, 1961-.
Photoelastic Study of the Mechanics of Folding, 1960-.

878. Dineley, David L., Univ. of Ottawa:
Upper Palaeozoic Stratigraphy and Structures in Part of North Central Vestspitsbergen, 1951-61.
This is work carried out on a number of expeditions from Great Britain and is concerned with Devonian to Triassic strata. The stratigraphical column shows similarity to that of the Arctic Islands of Canada and a useful comparative study should result. See The Old Sandstone of Eastern Ekmanfjorden, Vestspitsbergen. Geological Magazine, vol. XCII, pp. 18-32.

879. Dusing, Constantin, McGill Univ., (Research Associate):
Structural Investigations on Anorthosites and Related Rocks in the Grenville Province, 1960-63.
The application of petrofabric studies to the structure of the rocks of the Grenville province.

880. Garland, G.D., Vozoff, K., Surkan, A.J., Ellis, R., and Rankin, D., Univ. of Alberta:
Investigation of Structures by Means of Natural Alternating Magnetic Fields, 1957-.
Oscillations of the earth's magnetic field occur with a wide range of frequencies. These induce electric currents within the earth, and these currents produce fields measurable at the earth's surface. Because of the wide range of frequencies, measurements of these fields can give information on a wide range of geological structures, from orebody size up to crustal dimensions. Work is in progress on both the instrumentation for the measurements and on the interpretation. See Investigations of Natural Electric and Magnetic Fields; J. Research, U.S. Nat. Bur. of Standards.

881. Hall, D.A., Univ. of Saskatchewan:
Rock Magnetism, Aeromagnetic Anomalies, and Regional Structure, 1960-62.
Includes study of relation between geological history and the geological setting (particularly tectonic) of various formations; and the magnetization of the rocks as well as the ore, if present. Also, expression of the magnetization in aeromagnetic anomalies is being compared.

882. Heidecker, Eric I., Queen's Univ.:
Geology of an Area West of Mt. Isa, Australia, 1960-61; M. Sc. thesis.

A study of certain amphibolites on either side of the Mt. Isa fault, and of the geology of the fault itself, with particular aim of solving the character and amount of displacement.

883. Innes, M. J. S., Dominion Observatory:
Gravity and Isostasy in Northern Ontario and Manitoba.

Regional gravimeter surveys in northern Canada were first initiated in 1947 by the Dominion Observatory using aircraft transportation. The results of measurements for 1,220 stations established in northern Ontario and Manitoba to the end of 1950 are given in the form of Bouguer and Hayford isostatic anomaly maps and in tables of principal facts. The principal variations in the anomalies are examined in the light of the surface geology and larger crustal structures. See Publication of Dominion Observatory, vol. 21, No. 6, 1960.

Study of the Gravity Field in Northern Alberta and Saskatchewan.

During 1960 about 1,900 regional gravity stations were established at 6 to 8 mile intervals in northern Saskatchewan and northeastern Alberta. The results may be of considerable value in tracing major structural features of the basement rocks and their extension to the southwest into northeastern Alberta.

884. Kerr, James William, Queen's Univ.:
Palaeozoic Sequences in Thrust Slices of the Seetoya Mountains, Northern Independence Range, Elko County, Nevada, 1958-61.

See Palaeozoic Sequences in Thrust Slices of the Seetoya Mountains; Bulletin Geol. Soc. Am., vol. 71, No. 12, Pt. 2, p. 1904, 1960 (abstract).

885. Meyboom, P., Research Council of Alberta:
The Role of Groundwater in Landslides, 1959-61.

886. Riddell, John E and Potter, R. R., Carleton Univ.:
Study of Tungsten and Related Elements in Relation to Structural Development of the Appalachians, 1961-.

887. Russell, R. D., Stacey, J. S., Ulrych, T. J., Kanasewich, E., and Ostic, R., Univ. of British Columbia:
Isotopic Studies in Geophysics, 1958-.

The project consists of the measurement and interpretation of lead isotope abundances, with the principal objectives of (a) to distinguish the contaminations of lead by radiogenic isotopes according to their occurrence in crustal or sub-crustal regions and to correlate these results with possible theories of continental growth, and (b) to trace the development of certain lead ores.

888. Sobczak, L., and Hornal, R., Dominion Observatory:
Polar Continental Shelf Gravity Work;

In conjunction with the Polar Continental Shelf Project about 400 stations were established at 8 mile intervals on both land and sea ice in the vicinity of Ellef Ringnes, Amund Ringnes, Lougheed and Borden Islands. In addition about 300 gravity stations at much shorter intervals were observed to supplement geological studies of ring dykes gypsum piercement domes and to provide detailed information concerning the ice thickness of the Meighen Island Glacier.

889. Vincent, J.S., McGill Univ.:
Studies in Rheomorphism, 1960-62; M.Sc. thesis.

AUTHOR INDEX