NATIONAL ADVISORY COMMITTEE ON RESEARCH IN THE GEOLOGICAL SCIENCES

Fourteenth Annual Report 1963-64

(Including Survey of Current Research in the Geological Sciences in Canada, 1963-64)

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NATIONAL ADVISORY COMMITTEE ON RESEARCH

IN THE

GEOLOGICAL SCIENCES

FOURTEENTH ANNUAL REPORT

1963 - 64

(Including Survey of Current Research in the Geological Sciences in Canada, 1963-64)

601 Booth Street,
Ottawa, October 30, 1964.

The Honourable Wm M. Benidickson,
Minister of Mines and Technical Surveys,
Ottawa, Ontario.

Sir:

I have the honour to submit to you the Fourteenth Annual Report of the National Advisory Committee on Research in the Geological Sciences covering the period September 1, 1963 to August 31, 1964.

Respectfully submitted,

J.M. Harrison
J.M. Harrison,
Chairman.

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Meetings:

June 10, 1964, Charlottetown, Prince Edward Island

FOURTEENTH ANNUAL REPORT

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, 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, 1963, to August 31, 1964. This is followed by the reports of the subcommittees that cover the different fields of the geological sciences. They record developments in 1963-64 and suggest further problems for study. An appendix lists the research grants to Canadian universities for 1964-65 which are awarded by the Geological Survey of Canada on the basis of the National Advisory Committee's recommendations.

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 and research councils and foundations between June 1963 and May 1964.

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 on the basis of the Committee's recommendations.

For 1964-65, 74 applications were received (compared with 53 in 1963-64) and the total of the grants applied for was $206, 263 (compared with $134, 847 in 1963-64). Of the 74 applications 26, amounting in the aggregate to $75, 965, were for support of projects supported previously. The remaining 48 applications, aggregating $130, 298, were for support of new projects.

Fifty-two grants totalling $100, 000 were awarded to 16 universities. Of the 52 grants 24, totalling $47, 430, were for the support of projects that had been supported previously and 28, totalling $52, 570, were for support of new projects. Amounts of the grants and summary descriptions of the projects are given in Appendix I (Pt. 1, p.103).

Need for Increase in Grants. Since 1951 when grants by the Geological Survey to the universities were initiated, the number of applications and the aggregate amounts requested have increased each year; and the funds provided have been increased in several steps from the initial $10,000 in 1951 to 100,000 in 1964.

This year (1964-65) the applications, with but few exceptions, were deserving of support. However, because they totalled $206,263, which was more than double the amount available, more than one quarter of them were rejected with no support and in nearly all cases the grants to the remainder are much less than the amount requested. One result is that more than 20 graduate students in geology and geophysics will not be supported this year in their graduate research, at a time when there is a great demand for such men.

The National Advisory Committee has recommended to the Geological Survey that the amount provided for grants in aid to the universities for research in the geological sciences in 1965-66 be increased from the present $100,000 to $150,000.

The grants are helping to provide the facilities and financial support for graduate students to pursue their graduate studies in Canada and to resist the pull to graduate schools in the United States. They are also helping to provide a more stimulating environment (more graduate students and tools for research) for faculty members of our universities and thus to attract the best men and to keep them from accepting more remunerative employment elsewhere. As pointed out in last year's annual report of this Committee[1], the number of M.Sc. degrees in geology and geophysics awarded each year by Canadian universities almost doubled between 1952 and 1962. In this period also the number of our universities granting M.Sc. and Ph.D. degrees in geology has increased greatly. And in the 10-year period the total of teaching staff in departments of the geological sciences in our universities has more than tripled (72 to 249). Whereas, in 1952 there were practically no teaching fellows, research associates and research fellows, there were 60 of them in 1962. All these men are engaged mainly in research and much of the money provided by the grants goes to help the research of these men.

The grants are helping our universities to make important contributions to the geological sciences. This is good for Canada not only for prestige in international science but for the practical reason that research provides new concepts that will help us to maintain our position as a world leader in mineral exploration. As more easily found mineral deposits become exhausted we are turning more and more to the development and the use of new methods to find the buried and drift-covered deposits that cannot be found by prospecting with

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[1]National Advisory Committee on Research in the Geological Sciences, Thirteenth Annual Report, 1962-63, pp. 2-4.

pick and shovel alone. This means more research and the greater employment of highly trained geologists, geochemists and geophysicists. Canada has been a world leader in the development and use of these scientific methods as is attested by the success of our mining companies in mine-finding not only here in Canada but in other parts of the world. If we are to maintain this leadership we must make sure of an adequate supply of highly trained men. We must make sure that our universities and other research institutions receive adequate support. Applied scientists must have new concepts and they turn to their colleagues in the universities for new supplies of scientific knowledge.

The National Advisory Committee is confident that the recommended increase from $100,000 to $150,000 is fully warranted and that the money will be spent to the advantage of the geological sciences and for the good of Canada.

Coordination of National Research Council and Geological Survey Grants. The National Research Council of Canada also awards the universities grants in aid of research in the geological sciences on a substantial scale. This support amounts to about $400,000 in 1964-65 with an additional $90,000 for support of projects in geophysics that are closely allied and concerned with the solution of geological problems.

Applications for National Research Council grants in aid are received up to January 15th of each year and applicants are notified of awards in March or early April. Applications for Geological Survey of Canada grants are received up to May 1st of each year, the applications are reviewed in June and applicants notified at that time whether or not they have been recommended for grants.

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

Geological Survey grants are awarded mainly to support projects involving, in general, studies of rocks, minerals and fossils in field and laboratory that are directed toward the solution of specific geological problems, in contrast to more experimental projects 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. may be better directed to the National Research Council.

COMPREHENSIVE STUDIES OF CANADIAN ORE DEPOSITS

The cooperative, comprehensive study, or series of studies of the Coronation cupriferous pyrite orebody and enclosing rocks southeast of Flin Flon, Manitoba, which was initiated at the instigation of this Committee in 1960 is now almost completed. Some of the results have already been published[1]. The results of eight of the studies were presented at a symposium at the annual meeting of the Canadian Institute of Mining and Metallurgy in Montreal, April, 1964 (Pt. I, p. 89). It is hoped that the papers of this symposium will be published in two or more consecutive numbers of the bulletin of the Canadian Institute of Mining and Metallurgy and that, in addition to the symposium papers, a comprehensive paper will be prepared by Dr. D.R.E. Whitmore, the coordinator of the whole project in which the individual studies are synthesized and general conclusions arising out of them are reached.

[1]National Advisory Committee on Research in the Geological Sciences, Twelfth Annual Report, 1961-62, pp. 3-5 and Thirteenth Annual Report, 1962-63, pp. 4-5.

In January, 1964, Dr. A.P. Beavan, Managing Director of British Newfoundland Exploration Limited, in a letter to the Chairman of the National Advisory Committee suggested that the Whalesback Pond copper ore deposit in the Appalachian orogenic region near Springdale, Newfoundland, would be suitable for a cooperative comprehensive study similar to the Coronation Mine study. This deposit is being developed by British Newfoundland Exploration Limited, and Dr. Beavan has offered the cooperation of the company in such a study.

The Whalesback Pond ore zone is a steeply dipping structure in Ordovician volcanic rocks and consists of pods, stringer zones and disseminations of pyrite and chalcopyrite. A large amount of excellent geological, geophysical and geochemical work has been done already on the deposit including surface and underground geological mapping, 55,000 feet of diamond drilling, aeromagnetic and electromagnetic surveys, ground E.M., I.P., and S.P. surveys, geochemical studies of stream sediments, lake sediments and soils, and some petrographic studies of the rocks.

The National Advisory Committee discussed the proposed comprehensive study of the Whalesback Pond ore deposit at the annual meeting in April, 1964. Some members expressed disappointment in the similarity of the Whalesback Pond deposit to the Coronation deposit; they thought it would be preferable to turn to the study of a much younger, little altered ore deposit such as the Pine Point lead-zinc deposit southeast of Great Slave Lake. However, all agreed that the study of the Whalesback Pond deposit and enclosing volcanic rocks is desirable and will provide a valuable supplement to the Coronation Mine study. The National Advisory Committee will sponsor the project. Individuals or organizations interested in participating in the Whalesback Pond project or finding out more details about it should get in touch with Dr. D.R.E. Whitmore, Geological Survey of Canada, the coordinator of the project.

CANADIAN JOURNAL OF EARTH SCIENCES AND CANADIAN GEOTECHNICAL JOURNAL

The efforts[1] of the National Advisory Committee to demonstrate the need for a Canadian journal of the earth sciences have been successful. The National Research Council of Canada has announced the establishment of the new journal, the first number of which appeared in August, 1964. The new journal will be devoted to the primary publication of the results of research in the earth sciences including all branches of geology, geochemistry, geophysics, pedology, soil mechanics and glaciology. It will be published bi-monthly.

Subscription rate for volume 1, August to December, 1964 is $3.00; for volume 2, January to December, 1965, the rate is $6.00. Subscriptions should be sent to Division of Administration, National Research Council, Ottawa 2, Canada. Remittances should be made payable to the Receiver General of Canada, credit National Research Council.

Articles for submission may be written in English or French, as papers or notes. Equal consideration will be given to all manuscripts regardless of country of origin. A total of 100 reprints of each paper, without covers, will be supplied free to authors. Manuscripts for publication should be submitted to Dr. H.C. Gunning, Editor, 3192 West 44th Ave., Vancouver 13, British Columbia, Canada.

The Canadian Journal of Earth Sciences has been established in the hope that it will become a Canadian publication in the geological and allied earth sciences of world-wide reputation that will be a medium for speedy publication of many of the best Canadian papers which have, up to now, been published in the United States and elsewhere. As one of the National Research Council's Canadian Journals of Research, the new journal is assured of an international circulation with a place in the libraries of all leading scientific institutions in the world. In Canada, in addition to its regular subscribers, it will be received at a nominal charge by members of the Geological Association of Canada and of other associations and societies that choose to have the journal sent to their members.

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[1] National Advisory Committee on Research in the Geological Sciences, Thirteenth Annual Report, 1962-63, pp. 5-6.

The Canadian Geotechnical Journal was also launched successfully in 1964, under the joint sponsorship of the National Research Council and the Engineering Institute of Canada. This journal will provide a publication medium for papers in English or French that cover the general field of soil engineering, together with papers in the related disciplines of geology, soil science and snow and ice that relate to civil engineering.

Each volume of the Canadian Geotechnical Journal contains 4 issues and the subscription is $5.00 a year. Subscribers to the Canadian Geotechnical Journal may subscribe to the Canadian Journal of the Earth Sciences for an additional $2.00 a year.

Manuscripts for publication and all subscriptions should be sent to: The Editor, Canadian Geotechnical Journal, c/o Civil Engineering Department, University of Toronto, Toronto 5, Ontario.

INTERNATIONAL UPPER MANTLE PROJECT

The Upper Mantle Project is an international scientific investigation of the upper part of the earth's mantle and of its influence on the development of the crust. It was initiated by the International Union of Geodesy and Geophysics and later endorsed and supported by the International Union of Geological Sciences. Canada is an active participant in the project.

At the April, 1964, annual meeting of the National Advisory Committee, Dr. C.H. Smith, a member of the Canadian Scientific Committee for the Upper Mantle Project, gave an account of developments to date, particularly in regard to Canadian participation and as to how liaison between geologists and geophysicists may be maintained and improved. A summary of Dr. Smith's remarks follows:

"Relation between National Advisory Committee and Upper Mantle Project

The Upper Mantle program is one phase of earth science study not directly represented on the National Advisory Committee on Research in the Geological Sciences. The Canadian Scientific Committee for the Upper Mantle is a subcommittee of the National Research Council Associate Committee on Geodesy and Geophysics and reports to it. Although certain people are members of both the National Advisory Committee and the Associate Committee on Geodesy and Geophysics there is no formal line of communication between the two committees and for this reason I will present a few remarks on the Upper Mantle Project as it is related to the National Advisory Committee and geological research in general.

"I believe there are two reasons why geologists have not played as full a role in the Upper Mantle Project as they might:

1. The lack of routine channels of communication between the geological and geophysical administrative committee in Canada which I have mentioned.

2. The lack of understanding among many geologists of the role they might play. Some geologists take the attitude that it is a program developed by geophysicists for geophysicists. In actual fact, geology has an important role to play even though currently the leadership is coming from our geophysical associates, and geologists are reaping some benefits of their organization and planning.

"Perhaps the National Advisory Committee would like to consider these two problems, which might be tagged as:

(a) the communication situation (between committees)

(b) the involvement problem (what is the role of the geologist or the National Advisory Committee in the Upper Mantle Project?).

"Organization of the Upper Mantle Project

The proper name of the project is "The Upper Mantle and its Influence on the Development of the Earth's Crust". The latter phrase is of more direct significance to geological studies, since geologists must make their observations on the earth's crust and then extrapolate their interpretations to understand the nature of the mantle. Geologists can contribute most directly through studies in tectonics, petrology, geochemistry, and through experimental investigations.

The booklet "International Upper Mantle Project - Programs and International Recommendations, 1960-63" published by the Secretariat of the Upper Mantle Committee, Los Angeles, Jan. 1964 (pp. 268) summarizes the international and Canadian organization for the Project, as well as the geological and geophysical proposals of 37 countries that are now conducting Upper Mantle studies.

"An International Upper Mantle Bureau of 7 members under V.V. Beloussov has been established to coordinate international aspects of the program. Associated with it are 10 working groups in the fields of:

1. Seismology
2. Physics and chemistry of the Upper Mantle
3. Gravity
4. Magnetism
5. Theory and computers
6. Deep drilling
7. Petrology and volcanism
8. Tectonics
9. Submarine geology
10. Isotope and silicate geochemistry

"The names of the groups give a good idea of the disciplines involved in the Project. The groups held their first meetings in Moscow in May, 1964, and are to meet again in Ottawa in September, 1965. Canadian members of the international organization are: J.M. Harrison (Bureau, and Deep Drilling Group); R.J. Uffen (Physics and Chemistry of the Upper Mantle); J.T. Wilson (Tectonics); G.A. Garland, ex officio, as Secretary-General of International Union of Geodesy and Geophysics.

"What Use is the Upper Mantle Project?

The basic purposes of the Upper Mantle Project are, in many respects, similar to those of the National Advisory Committee. The Upper Mantle Project seeks to advance knowledge of the mantle by:

1. developing new research projects;

2. accelerating existing research projects;

3. coordinating geological and geophysical disciplines or facilities toward an attack on common problems.

The Upper Mantle Project is improving the climate for earth science research in the following ways:

1. It is drawing attention to the importance of the upper mantle. This is not something new, you might say, yet many earth scientists have grown so used to looking at the two-dimensional geological map on their wall that they have not stopped to consider what possible role the zone 20 miles below may have in the interpretation of their data. This is why we, as geologists, have difficulty in defining upper mantle projects. It seems a fair conclusion that the project has emphasized the third dimension in geology.

2. It is increasing the coordination and cooperation between geologists and geophysicists. The work of Brisbin, Hall and Wilson at the University of Manitoba is a good example of the type of coordinated study that is required to advance our knowledge of subcrustal tectonics. This is a trend in geological research that counterbalances the trend toward ultra-specialized and possibly uncoordinated studies involving the application of physical or chemical "prestige tools", to borrow a term from an earlier National Advisory Committee report. Certainly geological research will improve with a proper balance of both types of study.

3. It is increasing the international exchange of scientific information. This acceleration is only starting, but the fact that there is a booklet which reviews the current plans of 37 countries is a start. The meetings in Berkeley in August 1963 and Moscow in May 1964, and the continued

discussion on data centres, revision of physical tables, etc., allow specialists in tectonics, geochemistry, petrology, etc., to be more aware of the pertinent developments in other countries prior to formal publication and possible translation of the results.

4. It is increasing the planning of international projects. Since geological boundaries do not conform to political boundaries the need for international coordination in certain areas or disciplines is obvious. Some countries such as Kenya with its rift valleys or Switzerland with its nappe structures have geological problems of interest to many nations yet lack the money or, in the case of Kenya, the specialists to study them. In international areas such as the seas, an international group of scientists and equipment can often do much more than the attempts of individual nations. Closer to home, the combined United States-Canadian seismic shoot in Lake Superior last summer is an example.

5. It has increased the financial support for research in the earth sciences.

"Canadian progress to date

The Canadian program was initiated by preparation of the proposed contributions of the Department of Mines and Technical Surveys, published in 1961. These plans were discussed by the National Advisory Committee. When coupled with the university requirements they were presented to the Government for approval. An amount of 3 million dollars, spread over 3 years, was approved in principle, but much of this sum was subsequently eliminated through austerity measures. Certain new positions were created in the Department, and grants were made to universities for geophysical and geological equipment.

"The Canadian Progress Report[1], 1963, summarizes some

[1]International Upper Mantle Project, Canadian Progress Report, January 1962 - June 1963.

150 individual projects. Many are not funded directly from the Upper Mantle program but represent Canadian studies contributing to an understanding of the mantle. This book is in the process of revision to evaluate the scientific progress which has been made to date[1]. It will be ready for distribution at the Upper Mantle

[1]The second progress report for June 1963 - June 1964 was distributed in November 1964.

Symposium to be held in conjunction with the International Geological Congress in India in December, 1964.

"Planning is under way to hold a "workshop" in Ottawa in February, 1965, at which geologists and geophysicists working on specific problems related to the Upper Mantle program may get together and discuss their progress and future requirements.

"One aspect of the Canadian Upper Mantle Project that merits mention is the drilling of the Muskox Intrusion, which was discussed by the National Advisory Committee two years ago. The drilling was completed in the summer of 1963 using 3 vertical holes to drill a total of 10,089 feet, resulting in a complete set of cores of the intrusion from roof to floor. The core recovery was better than 98 per cent. A report dealing with the operational aspects of the drilling program is in press (G.S.C. Paper 64-44). It must be understood that drilling the intrusion was not an end in itself, but rather a means of sampling layers that do not outcrop, and testing the dips, thickness and other surface observations used to interpret the subsurface structure of the intrusion. The objectives were:

1. To provide a complete core section from roof to floor of the intrusion (many serpentinite sections do not outcrop). This has been done.

2. To provide complete core section across layer boundaries for studies of the origin of layering. This has been done.

3. To indicate whether additional rock units exist in the intrusion (economic or not) whose presence is important to interpretations of the chemical history of the magma. None were found.

4. To confirm structural interpretations of the intrusion, especially layer thicknesses. The estimate of overall thickness of the intrusion was reduced from 8,500 feet to 6,500 feet. The original high estimate was due to calculations based on surface dips which were 2° steeper than the average plunge of the intrusion at depth. In addition, two surface layers were eliminated from the thickness estimate because the drilling showed they were repeated by faulting.

The intrusion is now blocked out like an orebody with 40 different "petrographic" blocks of known relative volumes. Mineral, major and trace-element abundances are being determined to calculate its "grade" and, because the sequence of formation of blocks is known, to calculate the changes in concentration between rock and magma portions during solidification. This is only one of a number of studies now under way. Those concerned with the studies can readily appreciate the importance of the drilling in providing a proper geologic framework within which to interpret the results of their often laboriously precise measurements.

"Summary

To conclude I would point out that the Upper Mantle Project has an active program. It had been planned to encompass the period from January, 1962, to December, 1964. Canada got off to a good start, but since international working groups are only now meeting to coordinate the work, it is obvious that the program will continue to 1966 at least.

"The Upper Mantle Project coincides in many ways with the interests of the National Advisory Committee.

"The National Advisory Committee might consider whether they should become more directly involved in the operations of the Upper Mantle Project in Canada."

In discussion of the points raised in Dr. Smith's remarks it was noted that the Canadian Scientific Committee on the Upper Mantle Project is charged specifically with looking after Canadian participation in the Project. The National Advisory Committee is most anxious to facilitate Canadian participation in every way, particularly in the geological aspects, and discussed the need for appointment of a subcommittee from its members to work with the Canadian Scientific Committee on the Upper Mantle. However, because the Canadian Scientific Committee includes 4 geologists (R.E. Folinsbee, E.F. Roots, C.H. Smith and J.T. Wilson) it did not seem that such a subcommittee to work with a Committee on which geologists were well represented would be helpful. It was felt that the existing National Advisory Subcommittee on Physical Methods Applied to Geological Problems should ensure the desired liaison between the National Advisory Committee and the Canadian Scientific Committee on the Upper Mantle. Several other N.A.C. subcommittees including those in mineralogy, geochemistry and petrology, on structure and on mineral deposits are also interested in many aspects of the Upper Mantle Project; these subcommittees should be cognizant not only of progress on these projects but also on the alert to suggest other projects in their fields that should be initiated.

The National Advisory Committees recorded its appreciation of achievements to date in the Upper Mantle Project. In view of the importance of the results being obtained both to international scientific understanding and to the development of knowledge of the geology of Canada with consequent economic benefit, it is hoped that the already significant Canadian contribution will continue with all necessary scientific and financial support.

A symposium on the Upper Mantle Project will be held at the International Geological Congress in New Delhi, India, in December, 1964. The symposium will include sessions on: physical processes in the upper mantle and their influence on the crust; tectonics; and petrology and volcanism. The American Association for the Advancement of Science will also hold a symposium on the Upper Mantle at its annual meeting in Montreal, Canada, on December 30th, 1964.

DATA COMPILATION AND PROCESSING

The ever-increasing flow of quantitative measurements of rocks and minerals creates growing problems of how to store these data so that they are readily accessible, not only to the individual or organization that collects the data but to other individuals and organizations working in that particular field of research. At the 1963 meeting of the National Advisory Committee, the problem of how and by whom data compilation and processing should be undertaken was discussed. The pressing need seems to be for the development among compilers of some standard code, or several compatible codes that would make the data in the different compilations readily exchangeable and generally useful. It was agreed that action was needed to coordinate data processing and compiling of geological data in Canada. Each of the subcommittees that cover the different fields of the geological sciences was asked to find out what was being done in its field so that the Committee as a whole might discuss the problem and decide what appropriate action should be taken. Accordingly, this year each subcommittee has devoted a section of its report to data processing and compilation (Pt. I, p. 23) and the problem as a whole was discussed at length at the annual meeting of the National Advisory Committee in April, 1964.

The Geological Survey of Canada is greatly concerned with the problem of efficient storage and retrieval of the large amount of analytical data that is accumulating within its own organization, and at the annual meeting Dr. K.R. Dawson outlined plans for setting up an electronic analytical file that would place all the Survey's analytical data on rocks, minerals and other geological materials on I.B.M. cards. The file would consist of a control card file and a card file recording the results of each analytical procedure applied to geological materials within the Survey. The control cards would contain basic information about each specimen including the specimen number, geographical location, geological age, rock name, etc. The cards of the analytical file would contain the analytical results, etc. A provisional code book has been developed.

In discussion of the proposed Geological Survey analytical file it was noted that the emphasis was on recording data on Precambrian and crystalline rocks. Some members felt that means of recording data on sedimentary material should be added; several major oil companies have given much study to the data processing and retrieval of such data and have systems in operation. Might it not be possible to formulate a comprehensive system or several compatible systems for electronic storage and retrieval of geological and related data that might be widely adopted by geological organizations across Canada and thus greatly facilitate the exchange of data? It seems an opportune time to explore this possibility because many organizations are concerned with the problem and are considering adoption of electronic data compilation and retrieval systems.

It was agreed that a subcommittee should be set up to investigate the possibility of formulating a scheme of electronic storage and retrieval of geological, geophysical, geochemical and related data which might be widely adopted in Canada. As an initial step, the Geological Survey was asked to assess the possibility of establishing a method or methods of electronic cataloguing, retrieving and computing geological data so that organizations in Canada collecting such data might use the one system (or systems). It is hoped that this assessment will expedite the work of the proposed sub-committee of the National Advisory Committee. The Geological Survey, although in need of electronic data processing for its own operations, has deferred starting even a pilot operation until this assessment has been completed so that its file may conform to the requirements of the hoped-for more comprehensive system which may develop eventually into a national system or systems.

In July 1964, Dr. Y.O. Fortier, Director of the Geological Survey, appointed Dr. S.C. Robinson to carry out this assessment. His investigations will include the aspects of geology and related sciences that require or will benefit from the services of electronic processing; the feasibility of attempting to develop a unifying system, or systems, for electronic processing of geological data in Canada; and the categories of files which might have wide application and in which exchange of cards between different organizations may be desirable. Professor W.C. Krumbein of Northwestern University, an authority on data processing in the geological sciences, has been retained by the Geological Survey to advise on the general problem. Following a visit by Dr. Krumbein to the Geological Survey in October 1964 for general consultation, Dr. Robinson will visit organizations across Canada and in the United States to discuss with those most interested the more specific factors involved in the problem. Dr. Robinson will embody the results of these consultations and the advice received in a summary report that will be prepared for publication early in 1965.

PUBLICATION OF ABSTRACTS OF THESES IN THE GEOLOGICAL SCIENCES

In 1953, the Canadian Mining Journal agreed to publish, on behalf of the National Advisory Committee on Research in the Geological Sciences, abstracts of theses in the geological sciences by graduate students in Canadian universities as they were accepted for graduate degrees. In the 10-year period between 1953 and 1963 some 492 abstracts have been so published.

The theses record the results of the labor and thoughts of many bright young men and women, each for a period of a year or more, while working towards their M.Sc. and Ph.D. degrees. The results of their researches, except in the instances when published in part as a paper by student or supervising professor, are buried in university libraries across Canada. The publication of the abstracts of the theses in the Canadian Mining Journal served at the time they were written to let geologists know what research was being done in our universities and where the theses recording the results might be studied. However, in time, the published abstracts scattered through the volumes of the Canadian Mining Journal tend to be forgotten and are not readily found. For this reason the National Advisory Committee requested the Geological Survey of Canada to publish a compilation of the titles of the theses, each with a reference to the abstract published in the Canadian Mining Journal.

The Geological Survey has agreed to carry out this request. The compilation of the titles of the abstracts has been completed and will be published early in 1965.

SUMMARY STATEMENTS AND DISCUSSION OF REPORTS

The different fields in the geological sciences are covered by seven subcommittees that maintain a continuous survey of developments in their fields and of the problems most in need of investigation. The reports of these subcommittees and a report on recent developments in the Geological Survey, all of which were presented at the Annual Meeting in Ottawa in April, 1964, are given in full in this report (Pt. I, p. 23). Summaries of these reports, and of the discussions that followed their presentation, follow.

The report of the Subcommittee on Physical Methods Applied to Geological Problems (Pt. I, p. 23) notes increased activity over the year in this field and that more opportunities are open in research and applied geophysics than there are students graduating Current research in geophysics of interest to geologists is reviewed in some detail including regional and local gravity and seismological studies; geomagnetic and palaeomagnetic studies; terrestrial heat-flow studies; and rock-mechanics research in connection with rock burst and creep around mine openings. Data compilation and retrieval is discussed including the increasing use of computers in geophysics for data reduction and interpretation.

Suggestions from members of the subcommittee to assist research include establishment of a directory of geophysical computer programs; the organized consideration of geophysical prospecting by a committee formed for the purpose; and an ad hoc subcommittee of the National Advisory Committee on the Upper Mantle Project. Suggested research projects include seismological and other studies involving a systematic survey of crustal structure; further research to explain the regional differences (seismic velocity, electrical conductivity, etc.) of the mantle; determination of crustal movement in the vicinity of the Peace River Power Project; investigation of possible movement of Vancouver Island with respect to the mainland; investigation of the use of remote airborne sensing by radar, photography, infrared and ultraviolet scanning and, in fact, the whole electromagnetic spectrum; rock magnetism studies; several palaeomagnetic projects including research on the different processes through which the Red Beds become magnetized; further field studies to test the portable gamma ray spectrometer as a means of studying the genesis of rocks and ores and development of more refined and exact methods of radiometric prospecting; an expanded magneto-telluric mapping program; analyses of low-frequency electro-magnetic fields as a means of tracing geologic structure and study of the use of pulse electro-magnetic methods in solution of geological problems; investigation of the value, if any, of gravity studies in delineating salt boundaries and estimating thicknesses of the Prairie Evaporites; the running of seismic reflection profiles in southern Saskatchewan across the projection of the Moak Lake gravity trend; and increased use of statistical methods in the solution of geological problems.

Following presentation of the report, Professor Brisbin stressed the usefulness of gravity data in the interpretation of regional geology. The Dominion Observatory has covered large areas of the Canadian Shield and, in places, in addition to gravity data many seismological data are also available to support it. Geologists are not making as much use of this basic information as they should. He emphasized the need for more data on the densities of bedrock. Geologists in describing the rocks on an area should record their densities.

Professor Brisbin raised the problem of how to relay geophysical data on the upper mantle to geologists in terms that would interest them and which they would understand. Dr. Harrison suggested that the Geological Association of Canada might be interested in holding a symposium on the influence of the upper mantle on the development of the earth's crust in which geologists and geophysicists might participate and thus help in communication between these two groups.

The report of the Subcommittee on Pleistocene Geology (Pt. I, p. 39) divides the great diversity of current research projects that fall within the general reference of this subcommittee into several categories. From a table indicating the number in the different categories it appears that the number of stratigraphic and palaeontological projects is low in comparison with those listed under the other categories. The subcommittee covers a large number of rather diverse fields, and at some time in the near future it may be advisable to divide it into two or more parts.

Comments from subcommittee members on data compilation and processing are discussed. These include a summary of present means of collecting and handling data on groundwater. Since most groundwater data are collected by the provinces, the repositories in each province would seem to be the most practical data centres. It is suggested that data on Pleistocene Geology should be compiled and filed by the institutions doing the field work, but uniformity of presentation and filing should be attempted to facilitate exchange of information. The establishment of a "Till Library" is suggested in which till samples collected by federal and provincial field parties would be deposited.

Progress is reported by the "Committee on the Characterization of Till". A first draft of a manual on till characterization has been prepared; it is hoped that the first edition will be available for distribution in 1965.

Current research by federal and provincial government agencies and several universities is reviewed province by province with summaries of results achieved.

Recommendations include the institution of groundwater inventories by all provinces similar to the one used by the Prairie Provinces; that ways and means of establishing urban geology projects in various cities in Canada be considered; and that ways and means be considered of strengthening the teaching on both the technical and scientific level of Pleistocene geology, geohydrology, engineering geology and related fields concerned with surficial materials.

In discussion of the report, Dr. Kupsch noted that the International Association of Quaternary Research (INQUA) would meet in Boulder, Colorado, in September 1965. Several foreign scientists would be brought to America at that time and would be prepared to give lectures in their special fields of research. The meetings and excursions in connection with them would offer an unparalleled opportunity for Canadians to learn more about the Quaternary. Dr. Legget mentioned that an International Conference on Soil Mechanics will be held in Montreal at about the same time as the INQUA meetings.

With reference to urban geology (p. 58), Dr. Harrison said the federal administration tended to regard urban problems as municipal responsibilities, but municipalities rarely had either the means of the desire to undertake such studies. The lectures on urban geology by Dr. Legget (p. 58) will be published in the near future in the Canadian Geotechnical Journal. It was noted that a special Canadian Committee for the Hydrological Decade has been set up under the Chairmanship of General Hugh Young which would ensure that Canadian participation was well looked after.

<u>The report of the Subcommittee on Stratigraphy, Palaeontology and Fossil Fuels</u> (Pt. I, p. 65) reviews current research in these fields, noting that in addition to the 250 projects open to public scrutiny an estimated 500 projects are supported by the petroleum industry. Thinking and knowledge from the latter source becomes available slowly but surely and many of the advances of the last decade may be traced to the efforts of highly trained personnel in the oil industry. Current areas of interest beginning to crystallize into research are listed.

In a discussion of data processing and its present and potential use, it is concluded that at present it is not used to any extent in stratigraphy and palaeontology. However, several possible uses of data processing are suggested and discussed. The geological data-processing service scheme developed by Canadian Stratigraphic Service, Calgary, is described with an outline of the data recorded for stratigraphic units revealed in well drill cores; millions of feet of stratigraphy from cores are ready for coding in British Columbia, the Northwest Territories and Alberta. With reference to the planned analytical file of the Geological Survey, the subcommittee recommends that the code adopted for this file be published with the hope that it be accepted so far as possible by other public and private groups.

Museums and other organizations with collections of geological materials are noted and the Geological Survey of Canada is urged to continue to distribute fossil duplicates and plasto types to improve teaching collections and display museums.

Many research problems in stratigraphy in Western, Eastern and Northern Canada awaiting solution are listed with several additional stratigraphic problems of a more general nature.

In discussion of the report in regard to the recommendation that the Geological Survey of Canada continue to distribute fossil duplicates and plasto types to improve teaching collections across Canada (p. 71), Dr. Harrison said he was sure the Palaeontological Division of the Survey would do all it could to carry on and improve this service.

In further discussion of collections of geological material, it was noted that the cataloguing and indexing of the national collections of invertebrate fossils is the responsibility of the Geological Survey; the National Museum of Canada displays the collections. The same arrangement holds for the national mineral collection. However, the indexing and cataloguing of vertebrate fossils (and museum display) is the responsibility of the National Museum. Vertebrates are becoming increasingly important in stratigraphy, especially in the Pleistocene and in the Canadian Arctic, and it would seem more logical and useful to have the working collections of vertebrate fossils in the custody of the Geological Survey as is the case with the invertebrate and mineral collections. It was, therefore, recommended that the cataloguing and indexing of both vertebrate and invertebrate fossils for the national collections be the responsibility of the Geological Survey of Canada with display of these fossils the responsibility of the National Museum of Canada.

With reference to the recommendation (Pt. I, p. 74) that a large area in the Northwest Territories between the Canadian Shield and the Franklin Mountains should be geologically mapped and studied, Dr. Lord said the Geological Survey of Canada plans a large helicopter-supported operation in this region in the near future.

<u>The report of the Subcommittee on Scholarship and Research Training</u> discusses the replies to a series of questions directed to university departments of the earth sciences in Canada. Six questions deal with scholarships: Are more needed? Should they be larger? Should their recipients be required, or permitted, to assist in teaching? Would more or larger scholarships attract more students to the geological sciences? Should more foreign students be encouraged to carry out graduate studies in Canada and should the scholarships provided to them be large enough to pay all their expenses under Canadian living standards? Two additional questions deal with research training in the geological sciences: Are present facilities for research adequate? Are the funds for research adequate?

Following discussion of the replies to these questions a number of interesting conclusions and recommendations are presented.

In discussion of the report with reference to the suggestion (p. 79) that the National Advisory Committee set up a central clearing house where Canadian graduate schools could pool their experiences with graduate students from foreign universities and thus be better able to evaluate future applications from foreign students, it was felt that this was a problem that the deans of the graduate schools must solve; it was not the concern of the National Advisory Committee.

The value of geological field conferences and seminars and the means of promoting them were discussed. The recent conferences on "Sandstones" and "Carbonate Rocks" at Banff, Alberta, which were sponsored by the Alberta Society of Petroleum Geologists and run by the University of Alberta, were cited as most successful examples. The conferences were self-supporting through charges to participants; they were oversubscribed and the conference on sandstones was repeated. Most of those attending the conferences were from the petroleum industry; practically all were highly qualified specialists in the fields of the conferences. All agreed on the usefulness of such conferences for preventing technical obsolescence among professionals, both academic and industrial. In this respect they were more useful than large meetings of societies where many short, unrelated papers were presented. It was suggested that the National Research Council might give sympathetic consideration to support of specialist seminar conferences of this kind.

With reference to the recommendation regarding scholarship support for graduate students with second-class standings (p. 81), some thought such students not deserving of scholarships; at least no national agency was justified in supporting such men. A lengthy discussion followed about scholars with first-class versus those with second-class standing, the need for both and the great difficulty graduate schools had in seeing that all those that deserved support secured it.

In view of the number of interesting points raised in the discussion of this report, the subcommittee was asked to prepare a statement on scholars and scholarship in the geological sciences (including faculty and graduate students) and the financial assistance needed by the universities for the support of both.

The report of the subcommittee on Mineralogy, Geochemistry and Petrology (Pt. I, p. 83) briefly reviews current research in these fields and notes the growing use of rapid analytical methods which is leading to an ever increasing flood of numerical data. This, in turn, is leading to an increasing interest in statistical theory and methods. Geochronological studies are now under way at 8 universities in addition to the Geological Survey of Canada. There is a relative lack of projects in structural crystallography, experimental silicate-phase petrology, mineralogical thermochemistry and electron microprobe analysis.

Data processing and storage is discussed. Three areas of interest are apparent, including text retrieval by machine methods; the recording and cross-indexing of numerical data; and the cataloguing and exchange of computer programs. The National Advisory Committee is urged to set up a small liaison subcommittee of geologists conversant with statistical methods and computer systems for particular studies.

Last year's recommendation of the subcommittee for initiation of a cooperative program of preparation of reference samples and analytical standards has been accepted and implemented; considerable progress is reported. It is recommended that the Geological Survey continue to give every possible assistance in this worthwhile project.

Suggestions from subcommittee members include the need for the holding of special colloquia on mineralogical, geochemical and mineralogical topics, enlargement of the functions of the National Advisory Committee and consideration of the merit of the concept of an International Geochemical Year.

In discussion of the report, in regard to electron microprobe analysis (p. 84), it was pointed out that any university embarking on this work, in addition to securing the very costly instrument, must be prepared to appoint a specialist to run and look after it.

It was agreed that the subcommittee on mineralogy, geochemistry and petrology was the appropriate subcommittee to report on geochronology and isotope studies. This field is also covered by the subcommittee on isotope studies and geochronology of the National Research Council Associate Committee on Geodesy and Geophysics which reports annually in the Canadian Geophysical Bulletin.

The report of the Subcommittee on Mineral Deposits (Pt. I, p. 88) in a review of current research notes that the general pattern shows little change from year to year; a substantial proportion of current geological research in Canada has some economic connotation. The comprehensive study of the Coronation mineral deposit is drawing to a close, and 8 papers on the results, presented at the April 1964 meetings of the Canadian Institute of Mining and Metallurgy, are listed.

Advances in all sciences take place not only by acquisition of new data but by the discovery of the unifying principles whereby data already known are explained. There is compelling need for effective methods of working over the information already accumulated, and accumulating, so that meaningful repetitive patterns or regularities will be revealed. The present interest in data processing forces a closer scrutiny and re-assessment of our basic data. Comments received from subcommittee members reflect a general lack of agreement on what data are worth compiling and how they should be compiled. Some would stress the geological or structural setting, others mineral paragenesis, enriched element assemblage, and so on. It is suggested that chemical content of an ore deposit is more fundamental, more permanent and more economically important than the mineral assemblage and can be established readily and objectively; any data-compilation system applied to ore deposits should have elemental chemical composition as one of its prime parameters.

Any system for coding geological analytical data such as the one proposed for use by the Geological Survey of Canada should contain a category that includes ores and ore deposits. Such bodies are naturally occurring mineral assemblages just as much as "igneous extrusive rocks" or "non-clastic sedimentary rocks". Because future advances in analytical techniques are a certainty, element groupings based on present methods of analysis or on present frequencies of determinations should be avoided, if possible.

The report modifies the proposal in last year's report for the initiation of a broad project culminating in the publication of a volume on the chemistry, mineralogy and petrography of Canadian ore deposits to complement the two volumes on the structural geology of these deposits. A preliminary survey indicated that this project should be tried out first on a small scale and within a limited area. This may be started in the 1964 field season.

In discussion of the report, Dr. Derry suggested that no real advances had been made over the past thirty-five years in our knowledge of how and why ore deposits form, although we do know more about the structures that control their formation and are more proficient at finding them. There were some indications that a break-through may be in the offing that will give us the key to the origin of the valuable metals and to the manner in which they are concentrated. He had been sceptical about the success of the cooperative study of the Coronation ore deposit but on the whole the project had turned out well. Perhaps comprehensive studies of particular deposits such as this were one of the best ways of tackling the problem of origin.

Dr. McAllister agreed that the Coronation project had succeeded only to the extent of pointing out many unsolved problems. The Canadian Institute of Mining and Metallurgy had offered to publish the papers of the symposium on the Coronation deposit that was presented at the annual meeting of the Institute in April, 1964, in two consecutive issues of the C.I.M. Bulletin; the group of papers would also be available in re-print form. It was agreed to endorse this plan for publication of the symposium; it is hoped that Dr. H.C. Gunning, who originally suggested such comprehensive studies, will write an introductory note and that Dr. Whitmore, the coordinator of the project, will prepare a comprehensive paper in which the individual studies are synthesised and general conclusions arising out of them are reached.

<u>The report of the Subcommittee on Structural Geology</u> (Pt. I, p. 94) notes a marked increase in the number of current projects concerned mainly with structure. This may be due in part to the increasing interest in rock mechanics and the recent publication of several advanced treatises on structure. One of the most important Canadian structural projects is the compilation of a tectonic map of Canada which will be completed by the end of 1964, with plans for publication on a scale of about 1 inch to 80 miles. It will differ from

most geological maps in that the main units will indicate the time at which the rocks were involved in orogenies; hence the boundaries between the units will indicate angular unconformities.

Comments and suggestions from subcommittee members include a plea for greater emphasis on basic problems such as the controls exerted by non-hydrostatic stress on the crystallization of minerals and research into bending analysis and the study of the relation of fold wave-lengths to rock type and environment; the importance of basic stratigraphy in the solution of structural problems many of which arise solely from ignorance of the stratigraphy; and the need for better communication between structural specialists by the holding of more symposia and field conferences. The recently organized Canadian Advisory Committee on rock mechanics is described. This committee will provide advice on the distribution of federal grants for university research in this field, provide coordination of research activities and be a connecting link between those interested in this field. Particular emphasis is being given by this committee to the application of basic research to mining operations and other types of rock excavations.

Progress on the Cordilleran structural projects is reported. Field work started in 1964; 4 projects have been initiated including studies of the Cascade Mountains east of the Coquihalla serpentine belt; structure of the salient of the Shuswap metamorphic complex northeast of Revelstoke; study of structures on the western limb of the Illecillewait syncline in the Rogers Pass area; and study of the Shuswap metamorphic complex 12 miles northwest of Revelstoke at the River Jordan.

In discussion of the report, Dr. Brisbin asked if any geophysical work was planned as part of the Cordilleran structure project (p. 98) or if any geophysical groups, either university or governmental, had been invited to participate; university groups were recording the seismic effects of the Suffolk explosions along or near the line of section of the structure project. Dr. McTaggart said no geophysical work was under way or planned at present but he hoped it would be undertaken later on. Dr. Brisbin suggested that geological parties engaged in the structural project, and indeed all geological field parties, should collect the representative rock samples for determination of rock densities. Such information was extremely important in the interpretation of gravity data.

<u>The report on the Geological Survey of Canada</u> notes that field work, as usual, took most of the effort of the Survey in 1963; 105 parties were in the field, which was 11 more than in 1962. Many thousands of square miles of new territory were mapped. By the end of 1963 the Geological Survey had published geological maps of about 65 per cent of Canada. About 330,000 line-miles of aeromagnetic surveying was carried out under the joint federal provincial program.

The Geological Survey operates four offices outside Ottawa and has geologists attached to a fifth. Some statistics are given in respect to the activities carried out in these offices. Official approval has been given to the plan for a major western office of the Survey in Calgary which will entail a large expansion of the existing office. The build-up of the marine geology unit at the Bedford Institute, Nova Scotia, continues slowly. Some Regional Geology officers and other specialists are also being posted from Ottawa to the Bedford Institute.

In discussion of this report, Dr. Stelck hoped that the Survey would not over-emphasize special projects to the detriment of geological mapping and geological compilations which were useful and essential in teaching. Dr. Harrison pointed out that practically all the special projects were based on field work directed to solution of specific problems. Field investigations, whether "special" or areal mapping, will continue to be the prime role of the Survey, although as reconnaissance mapping of Canada nears completion, the ratio of special to areal mapping projects may increase.

Dr. Gunning mentioned the large areas in British Columbia that will be flooded soon by power developments. He hoped the geology of these areas would be recorded within the next two field seasons before the flooding.

CHANGES OF PERSONNEL OF COMMITTEE

David R. Francis, C.P. Gravenor, F.F. Osborne, Robert J. Uffen and H.D.B. Wilson retired from the Committee in 1963. All members join in expressing appreciation of the contribution of time and effort made by these men during their terms of office. We look forward to their continued support.

New members appointed to succeed those who have retired are: L.G. Berry, Professor of Mineralogy, Queen's University, W.C. Brisbin, Professor of Geology, University of Manitoba, Robert Sabourin, Professor of Geology, Universite Laval, and C.R. Stelck, Professor of Geology, University of Alberta.

J.M. Harrison, Assistant Deputy Minister (Research), Department of Mines and Technical Surveys, will retire as Chairman of the National Advisory Committee on December 31st, 1964. He will be succeeded by Y.O. Fortier, Director, Geological Survey of Canada.

SUBCOMMITTEE REPORTS

REPORT OF THE SUBCOMMITTEE ON PHYSICAL METHODS APPLIED TO GEOLOGICAL PROBLEMS

Presented by W.C. Brisbin

Members of Subcommittee

W.C. Brisbin (Chairman)	University of Manitoba, Winnipeg, Manitoba.
A.R. Barringer	Barringer Research Ltd., Toronto, Ontario.
A.E. Beck	University of Western Ontario, London, Ontario.
G.D. Garland	University of Toronto, Toronto, Ontario.
D.H. Hall	University of Manitoba, Winnipeg, Manitoba.
M.J. Keen	Dalhousie University, Halifax, Nova Scotia.
L.W. Morley	Geological Survey of Canada, Ottawa, Ontario.
R.D. Russell	University of British Columbia, Vancouver, British Columbia.
V.A. Saull	McGill University, Montreal, Quebec.
H.B. Sawatzky	Saskatchewan Department of Mineral Resources, Regina, Saskatchewan.
K. Vozoff	University of Alberta, Edmonton, Alberta.

INTRODUCTION

The year 1963-64 has been one of greatly increased activity for research in physical methods applied to geological problems. Not only have important experiments taken place concerning the properties and the structure of the earth's crust but there has been increased interest in the development of new geophysical tools for mineral and groundwater exploration.

Financial assistance for most of the university research has come from the National Research Council, the Geological Survey of Canada, the Defence Research Board, the Meteorological Service, the Department of Northern Affairs and National Resources and the Mines Branch. As well, a few universities have received substantial grants from United States government agencies for crustal seismic studies.

Several subcommittee members have reported more opportunities in research and applied geophysics than there are students graduating and have remarked that more students should be encouraged to pursue this branch of the earth sciences.

Dr. R.J. Uffen has completed his term as chairman of this subcommittee. The present chairman has found his reports and advice of great value during subcommittee deliberations. The subcommittee as it is now constituted wishes to acknowledge his service.

A REVIEW OF CURRENT RESEARCH

The following brief review of current research on applied physical methods should be read in conjunction with the survey of current research in Canada (Pt. II). In this survey projects of interest are tabulated under the heading "Geophysics" (Pt. II, p. 48). Some of these projects under the heading of "Structural Geology" (Pt. II, p.169) are also of interest. Readers are also referred to the Canadian Geophysical Bulletin, Vol. 16, Dec. 1963 (published by the Associate Committee on Geodesy and Geophysics of the National Research Council of Canada) for a comprehensive review of both fundamental and applied research in geophysics in Canada during 1963.

Gravity

Regional Surveys

Regional gravity coverage in Canada has been extended considerably by the Observatories Branch and several universities. The value of this work in regional geologic interpretation is being given increasing recognition by structural geologists.

Areas in which the Observatories Branch has extended gravity coverage include:

(a) Northern Saskatchewan: Five gravity maps have been compiled and correlation with surface geology is in progress.

(b) Northern Quebec: A compilation for a regional gravity map on a scale of 20 miles = 1 inch has begun.

(c) Hudson and James Bay Lowlands: 5,000 new observations with a spacing of approximately 8 miles have been established north of 48°N. latitude in Ontario.

(d) Ontario-Quebec Mining Belt (Timmins and Rouyn): Additional observations have been made and compilation and interpretation is proceeding. The interpretation devotes particular attention to the intrusive masses and thicknesses of the sedimentary and volcanic rocks.

(e) Southern Prairie Provinces: A compilation of 11,000 observations will result in 9 maps of the Gravity Map Series. These should be available for distribution in 1964.

(f) The Gulf of St. Lawrence: 600 underwater observations in water depth of 100 fathoms or less have been made. These data should provide valuable information regarding the structural relationships between the Appalachian Province and the adjoining Precambrian Shield.

(g) Polar Continental Shelf: This work includes two gravity profiles between Ellesmere Island and Greenland, and 500 observations on Melville, Devon and Ellesmere Islands.

(h) Baffin Island: Substantial progress has been made in assembling the gravity and other available geophysical data in map form, both on a regional basis for the greater part of Baffin Island, and on a detailed basis over the Penny and Barnes Icefields.

The University of Manitoba has completed a regional gravity study of the Kapuskasing gravity high and a manuscript is in preparation. Gravity investigations of the English River gneissic belt have commenced in conjunction with magnetic, seismic and regional geologic studies of this feature.

Dalhousie University and the Nova Scotia Research Foundation have continued systematic measurements of gravity in areas of economic interest within Nova Scotia.

Local Investigations

Fossil crater studies at the Observatories Branch were continued and expanded to include laboratory studies of rocks. These include microscopic and X-ray analyses of crystal deformation and a search for new mineral phases indicative of the high temperature and pressure associated with shock loading. Field investigations included the following circular structures:

Lac Couture, Quebec; a circular structure by the Manicouagan-Mushlagan Lakes in northern Quebec; Brent Crater, Ontario; Holliford Crater, Ontario; Clearwater Lakes, Quebec, the Carswell Lake Ring Structure in northern Saskatchewan.

In addition to the above, the Observatories Branch proceeded with detailed gravity studies of the Muskox basic complex, the Mount Albert ultrabasic intrusion and, in conjunction with McGill University, the Oka alkaline intrusive complex.

The University of Manitoba has completed the gravity studies of the Coronation Mine and is continuing with local gravity investigations in the Kenora area, Ontario.

The Saskatchewan Department of Mineral Resources conducted a short gravity program in the Pasquia Hills area and the Saskatchewan Research Council has been proceeding with gravity work in several localities for the purpose of localizing bedrock channels.

Seismology

Canadian research in seismology during 1963-64 falls into the following categories:

(a) Crustal studies
(b) Local seismic surveys
(c) Fault-plane studies
(d) Station seismology
(e) Local earthquake studies
(f) Seismic regionalization studies
(g) Theoretical and model studies
(h) Instrumental development

Worthy of mention here is the research which falls into categories (a), (b) and (c), for the results of such work are of direct interest to geologists. Research in the other categories is partially reviewed in the survey of current geophysical research and more completely discussed in Vol. 16 of the Canadian Geophysical Bulletin.

Crustal Studies

The most extensive crustal study conducted during the summer of 1963 was the Lake Superior project, in which the Dominion Observatory, the Polar Continental Shelf group, the University of Toronto, the University of Alberta, and the University of Manitoba took part. The project was carried out in cooperation with a large number of United States seismological groups. Shots were fired in Lake Superior along a line from Duluth to Michipicoten Island. The shots were recorded at a number of stations in the United States and Canada along the extension of this line. A combined session for preliminary discussion of results was held at the University of Wisconsin in January 1964. Interpretation has not yet proceeded far enough to offer structural models, but several observations are interesting and well documented by the density of observations. The P-wave velocities in the upper portion of the crust are rather high even for shallow depths of 5-10 km. The apparent velocity for the P-wave in the upper mantle in one direction is 8.2 km/sec. and 9.2 km/sec. in the other. If the M discontinuity is treated as a simple dipping refracting surface the apparent velocities would be in agreement with a dip to the east, and depths on the eastern end would be 15 km. greater than on the western end.

Crustal studies in the Canadian Arctic have proceeded under the direction of the Observatories Branch and the Polar Continental Shelf group of the Department of Mines and Technical Surveys. The Observatories Branch completed seismic profiles in the Cornwallis Island-Grinnell Peninsula-Cape Christian Island-Ellef Ringness Island area, and sedimentary and crustal thickness have been determined. Mean crustal and upper mantle structure in the Arctic Islands have also been determined by analyses of surface waves from nuclear explosions. The Polar Continental Shelf group has completed several short seismic profiles and one continuous traverse across the Sverdrup Basin, giving a composite section of crustal conditions from the Boothia Arch to the continental shelf.

Dalhousie University has continued with crustal refraction studies in the Atlantic provinces area. A refraction profile at the edge of the continental shelf was made in 1963 which indicates a sedimentary sequence under Sable Island 5 kilometers thick with the M discontinuity at a depth of 26 kilometers.

The University of Manitoba began seismic crustal studies in Ontario near the Manitoba border, a project coordinated with regional gravity, magnetic and geologic investigations of the English River gneissic belt. This work will be continued in 1964-65. The University of Saskatchewan and the University of Manitoba used a common shot point during the summer of 1964 to continue crustal investigations west and south of Flin Flon, Manitoba.

Studies of the earth's crust in southern Alberta were continued during the summer of 1963 by the University of Alberta seismic group. At the University of British Columbia, seismic refraction studies of the crust were extended to northern Vancouver Island and the Queen Charlotte Straits.

Local Seismic Surveys

The Geophysics Division of the Geological Survey of Canada has proceeded with seismic surveys of several areas of interest, using both conventional and hammer seismic equipment. Four hammer seismic surveys were completed to study bedrock channels across Chignecto Isthmus, Nova Scotia-New Brunswick; in the Moncton map-area, New Brunswick; in the Kirkland Lake area, Ontario; and near the Beauceville placer gold channels, Quebec. Conventional equipment was used to determine the depth and contour the surface of the basement rocks underlying the Hudson Bay Lowlands of Manitoba and the Athabasca Sandstone area of Saskatchewan.

Dalhousie University and the Nova Scotia Research Foundation have been carrying out seismic reflection and refraction studies in conjunction with gravity and magnetic studies in the sedimentary basins of Nova Scotia. Seismic profiling with an Edgerton Boomer in Hudson Strait, James Sound, Baffin Bay and Davis Strait is also being done.

The Saskatchewan Department of Mineral Resources reports reflection and refraction work in the Pine Channel area of the Lake Athabasca region.

Fault Plane Studies

The Observatories Branch has been continuing the computer program for fault plane solutions. The IBM 1620 has been successfully programmed to produce these solutions and a new program for the faster IBM 7090 is being prepared to put some error limits on the solutions.

Geomagnetism

Current research in this field is so extensive and varied the it is impossible to include, in this brief review, all of the projects under way. Only some of the studies which have geologic application are reviewed.

Aeromagnetic Surveys and Compilation

The second year of operation of the Federal-Provincial Aeromagnetic Program was successfully completed. Map sheets checked and published in 1963 include the following:

Polar Continental Shelf	45
Yukon Territory	56
Northwest Territories	84
Ontario	108
Manitoba	97
Saskatchewan	68
Quebec	15

In addition to these, 67 sheets have been checked and printed and will be published soon.

A total of 183 map sheets were compiled by the Geological Survey of Canada of which 80 were published during the year.

The Geological Survey reports progress in the development of new methods for the quantitative interpretation of aeromagnetic data. The fitting of double Fourier functions to aeromagnetic data has offered a means of calculating first-, second- and higher-order derivatives, components of the total field and down and upward continuations of the field. As well, the Survey continued studies to overcome the problems of aeromagnetic surveys in mountainous terrain.

Anomaly Investigation and Areal Studies

The Observatories Branch has been investigating the anomalies in geomagnetic variations at Alert and at Mould Bay in the Northwest Territories. The Polar Continental Shelf group is conducting geomagnetic investigations in the western Queen Elizabeth Islands where marked crustal thickening is suggested by gravity and preliminary magnetic interpretations.

The University of Manitoba is proceeding with investigations of magnetic anomalies of crustal dimensions in the Canadian Shield and the laws of distribution of magnetization in various regions of the Shield.

The University of Toronto is studying the geological significance of the results of regional magnetic surveys conducted in cooperation with the Great Lakes Institute in the Lake Huron Basin and adjacent areas.

Ship magnetometer surveys off the east coast of Canada were continued by the Geological Survey of Canada in the Ship Harbour-Liscomb area and the Tail of the Banks area of the Grand Banks of Newfoundland. A micromagnetic survey of a Precambrian iron formation near Nakina, Ontario was completed by the Geophysics Division of the Geological Survey in conjunction with the Economic Geology Division. A total of 30,000 ground magnetic readings were taken and 235 oriented specimens were collected for laboratory study.

The Universities of British Columbia and Alberta have made a series of magnetic measurements along a line extending from Vancouver to Lethbridge in an attempt to find major conductivity anomalies in the deep crust or upper mantle comparable to those in North Germany and Japan. Similar studies are being made by the University of Toronto in southwestern Ontario.

Palaeomagnetic Studies

The work of the Geological Survey under this heading includes field collection, laboratory measurements and instrumental development. Of direct interest is the analysis of palaeomagnetic data from the three years' sample collecting in the Maritimes, which has resulted in a more fully confirmed polar wandering curve for the Palaeozoic era in North America. Palaeomagnetic studies of diabase dykes in the Precambrian Shield are also proceeding for the purpose of classification and age determination. As well, preliminary palaeomagnetic work on the Muskox intrusion has begun.

The University of Western Ontario is doing research on the palaeomagnetism of basic rocks from the Superior and Grenville provinces of the Precambrian Shield in conjunction with a program of radiometric dating.

The University of Toronto is concerned with the problem of stress producing systematic errors in palaeomagnetic measurements.

Electrical Methods

The Geological Survey of Canada has been continuing groundwater resistivity investigations in Manitoba near Morris and

Winkler, in conjunction with a drilling program. Attempts have been made to delineate the buried Missouri River Valley east of Steelman, Saskatchewan, and into Manitoba. The Saskatchewan Research Council has conducted resistivity surveys to trace bedrock valleys, particularly in the Last Mountain Lake region.

Field and laboratory low-frequency induced polarization equipment is being designed and tested at the Geological Survey of Canada. The laboratory equipment is to be used for studying membrane polarization in rocks and soils containing clay minerals. With the field equipment it should be possible to determine the depth to horizontal layers and to detect sinks and aquifers. The University of Western Ontario is examining and testing suites of rocks which show normal and anomalous induced polarization behavior. The objective is to obtain some insight into the basic mechanics controlling the induced polarization effect.

The Geological Survey has been conducting experimental airborne electromagnetic work in southern Ontario and southern Manitoba to map near-surface resistivities of Pleistocene deposits.

Some preliminary work has been carried out by Barringer Research Limited on the analysis of sub-audio-frequency electromagnetic fields, and the results are reputed to indicate clearly the potential of the system.

Terrestrial Heat Flow

At the University of Western Ontario attempts are being made to relate geothermal data to regional structural geology. In Western Canada, where good coverage is available, isotherms and geothermal gradients have been contoured, and a good correlation has been obtained between these data and the basement structures interpreted from gravity information.

The McGill University group is continuing its program of heat-flow measurements in the St. Lawrence lowlands of Quebec.

At the Observatories Branch the cooperative program for the measurement of heat-flow in Canada has been set up. Measurements have been made in holes drilled for geological or commercial purposes and in holes drilled by the Observatories in Halifax, Ottawa, London and Penticton. Several additional holes will be drilled by the Observatories during the coming year.

Rock Mechanics

Geological interest in rock mechanics research is steadily increasing. The research has introduced to structural geologists more sophisticated theories of mechanics for rheological analysis of geological materials; as well, it has provided practical tools for the measurement of stresses induced by mining and of elastic strain release in rock. Structural geologists are looking forward to the day when this research will provide means by which absolute crustal stress measurements may be made.

During the past year the Mines Branch of the Department of Mines and Technical Surveys has been engaged in a number of research projects that fall into the realm of rock mechanics. Instrumental development includes work on rigid inclusion stressmeters, bore-hole deformation meters and glass insert biaxial stressmeters. Model experiments are proceeding to examine stress and failure conditions around rooms and pillars. Studies of underground creep consist of measurements of the deformation of salt and potash around mine openings in an attempt to gain fundamental knowledge of material behavior. Both field and laboratory investigations of rock materials from mines experiencing rock-bursts are continuing. A number of projects are being conducted to determine the mechanics of failure in rock slopes. These include laboratory studies of stress distributions occurring in typical slope geometries and field measurements of actual deformation and microseismic activity in deep cut slopes of open pits.

Dalhousie University reports the initiation of a program to measure absolute stress in the crust during 1964. No details of this project are yet available.

Data Collection

The Geophysics Laboratory, University of Toronto, is operating a permanent service for the collection of crustal seismic profiles. Information on crustal layers and velocities is assembled on cards from which print-outs, available for distribution, are made. So far over 1,000 profiles from locations throughout the world have been filed. A similar collection of data on physical age measurements is also being made. This work forms an integral part of the compilation of world-wide crustal geophysical and geologic data under the supervision of Prof. J. Tuzo Wilson.

Heat-flow information from all parts of the world is being collected by the International Heat Flow Committee (Secretary: Lee, The University of California at Los Angeles).

On a more local scale, the Saskatchewan Department of Mineral Resources has been compiling all geophysical data submitted to the department as assessment work in the province, as well as federal and provincial data in the province. Over the years excellent compilation geophysical maps and reports have been prepared utilizing this information.

The University of Alberta reports the trend toward collection of new data on digital computer-compatible formats wherever possible. At the present time output of a mass spectrograph at the University of Alberta is being recorded on punched paper which can be read directly into the computer. A system is under development to collect all data from their observatory (magnetic polarization, telluric current, seismic) via data link directly on digital magnetic tape as well as on the usual visual monitors. For data already recorded in analog form two facilities are in operation to convert to digital form. A manual curve follower is being used for seismic and magnetic variometer data and a high-speed multi-channel system is being used to convert magnetotelluric information.

Computer Applications

The use of computers is increasing in geophysics for data reduction and interpretative procedures. The applications are too numerous to cover here; only a few recent applications reported to the subcommittee are included.

At the University of Alberta a number of research problems are being attempted through the use of computers. These include long-term spectral studies of magnetotelluric information, cross-correlation studies of seismic refraction records and mass spectrometer work.

D.H. Hall, at the University of Manitoba, has been adapting the traditional "model fitting" approach to magnetic interpretation so that numerical curve-fitting by computer can be applied. As well, the computer is being used to filter mathematically and separate regional from local magnetic anomalies. The problem of detecting patterns in magnetic parameters spread over an area, and of specifying the zones in which principal patterns are concentrated, is also being investigated with the aid of the computer.

The use of the computer for the fault-plane studies of the Observatories Branch has been referred to in the section on seismology.

The Geological Survey reports complete automating of the astatic magnetometer and the subsequent development of computer programs to determine pole position.

COMMENTS AND SUGGESTIONS

This section deals with comments, suggestions and research recommendations from subcommittee members and in many cases from their associates. Several general proposals to assist research are treated first, followed by recommendations that refer to specific research topics. Out of necessity many of the proposals appear in a more abbreviated form than that in which they were received.

General Proposals to Assist Research

1. A Directory of Geophysical and Geological Computer Programs
- D.H. Hall and V.A. Saull

It has been suggested that the Geological Survey should establish and maintain a directory of geophysical and geological computer programs.

2. Organized Consideration of Geophysical Prospecting - D.H. Hall

"This branch of geophysics has a scientific role as well as its well-known place in commercial exploration. Observational and interpretational techniques developed in geophysical prospecting can be applied with benefit to a great range of basic scientific studies, as has been done in some branches, notably in seismological studies of the earth's crust. Particularly where underground water and physical parameters of the subsurface are of interest, hydrology and soils mapping are fields in which geophysical exploration techniques can be applied to advantage. The Hydrological Decade is a particular example. Furthermore, it appears that governments rather than private industry will do the bulk of prospecting for groundwater. For these reasons, I believe that it is important to consider the possibility of forming a committee of people from government, universities and industry to continually assess the status, needs and relationships of geophysical prospecting to other branches of science.

"Geophysical prospecting, as presently constituted, has need of closer contact with universities. Geophysical exploration techniques are at a stage where advanced application of modern potential theory, statistics and numerical analysis to interpretation might well produce significant advances. Furthermore, the diverse "methods" as they exist today need to be unified and the range of physical effects that are monitored increased. A committee on geophysical prospecting might contribute materially to such advances by bring geophysical exploration to the attention of various specialists as a field containing scientific problems of the highest order. An important function of such a committee would be to channel funds so as to stimulate work on such problems by electrical engineers, physicists, mathematicians and so on."

3. The Need for an Ad Hoc Subcommittee of the NAC on the Upper Mantle - L.W. Morley

"The subcommittee on the Upper Mantle created by the National Research Council Associate Committee on Geodesy and Geophysics appears to have largely completed its work and its members seem to be falling back to within the confines of their own disciplines. This is to some extent understandable. As far as many geophysicists were concerned, the Upper Mantle Project was no great innovation. It was regarded by many as a legitimate means for getting increased financial support for the kind of work they had been doing and will continue to do.

"For geologists, however, the Upper Mantle Project represents an important opportunity and challenge. They are being asked to translate the physical measurements of the geophysicists which have rather vague geological significance into practical geological terms. Instead of talking in terms of seismic velocities, magnetic susceptibilities and isostatic anomalies, they must translate these into petrographic and structural geologic terms and construct maps and cross-sections of portions of the crust. For the first time in Canada, there are beginning to be enough geophysical data to do this.

"It is submitted that this is the job for geologists - the ball is being thrown to them. The Upper Mantle ball is in very grave danger of being dropped in Canada. This is the committee that should take it up."

Suggested Research Topics

1. Seismological and other Studies of the Earth's Curst - D.H. Hall

"Studies of this nature have already become a part of prospecting in some countries, and undoubtedly will find extensive application everywhere to geological mapping and prospecting in the future. In view of this, it appears to be desirable to initiate in Canada a systematic survey of crustal structure, with the immediate aim of covering selected areas which show promise of yielding data of critical value, and with the ultimate aim of covering the whole country. Close cooperation among the Geological Survey, the Observatories Branch, provincial departments of mines and universities would be required to make the most fruitful selection of areas for initial attention, and to ensure that the best scientific technique available is applied to the problem. A report on the best available technique could be effectively prepared by the Seismology subcommittee of the Associate Committee on Geodesy and Geophysics."

2. Upper Mantle Problems - G.D. Garland

"The explanation of the regional differences in the physical properties (e.g. seismic velocity, electrical conductivity) of the mantle should be sought. Are the regions of anomalous electrical conductivity really hot spots? Are there any large differences in composition of the uppermost mantle from place to place?".

3. Determination of Crustal Movement in the Vicinity of the Peace River Power Project Lake - S.H. de Jong via R.D. Russell

"...The lake that will be formed as a result of this project will be one of the largest loads man has ever placed on the crust of the earth. It would seem desirable to make rather detailed studies of the area before, during, and after the loading takes place. ...the work would involve special levelling, gravity and seismic measurements."

4. Determination of Possible Movement of Vancouver Island with Respect to the Mainland - S.H. de Jong via R.D. Russell

"Prof. de Jong has been considering the desirability of doing some precise surveying and levelling between the coast of British Columbia and the eastern shore of Vancouver Island. This is generally an area in which there is some seismic activity and it is possible that some relative motion has taken place." The study appears to be an interesting one not only because of the possible results but also because of the valuable "experience in this line of work which is apt to take on continually increasing importance due to current interest in crustal motion in general."

5. Remote Airborne Sensing - L.W. Morley

"There is a whole new field of research in exploration geophysics which is receiving little or no attention in Canada. This is the use of radar photography, infrared and ultraviolet scanning and in fact the application of the whole electromagnetic spectrum to the problem of 'terrain sensing' using both active and passive systems. The United States Defence Department has been active in this field for some time and in the past most of this work has been classified - much still is. But it is rapidly being declassified and therefore, bears investigation.

"Since this work in the initial stages will involve instrumentation problems and is still a long way from being useful, perhaps it had best be handled by the Subcommittee on Exploration Geophysics of the Associate Committee on Geodesy and Geophysics. However, I feel this committee should at least be aware of it, and its possible potential for Canada."

6. Rock Magnetism Studies - P.J. Hood via L.W. Morley

"Although magnetic prospecting has a long history, it is well known that there are many examples where interpretations are seriously in error, and the measured anomalies cannot be accounted for. Consideration and measurement of remanent magnetism may help to provide better interpretations in the future.

"Our endeavors at Nakina in 1963 are well summarized in Geological Survey of Canada Paper 64-1, p. 65 (A Micromagnetic Survey near Nakina). To really bring home the point to the mining people it is necessary to carry out the work in a 'local' area by an organization that is well known to them.

"Needless to say the exploration aspect of remanent magnetism has not been stressed in the past."

7. Palaeomagnetic Projects - A. Larochelle via L.W. Morley

"Many of the palaeomagnetic data for North America are based on red beds. Although these rocks are known to bear in general a very stable N.R.M., very little is known about the time elapsed between their original deposition and the acquisition of their present state of magnetization. This question is fundamental if we want to assess the validity of much of the available palaeomagnetic data. Research on the different processes through which red beds may become magnetized and on the formation of red beds in general would thus appear a very useful field of endeavor.

"Among the different applications of rock magnetism to the solution of geological problems, it seems that relatively little thought has been given to the possibilities of directional susceptibilities or saturation magnetizations. Work along this line might open up the possibility of solving certain structure problems which have been only partially solved so far by petrofabric methods."

8. Research in Geophysics Applied to Geology - A.F. Gregory via L.W. Morley

"In the Grenville Project, we plan to apply quantitative analysis to the aeromagnetic observations in an attempt to determine properties and boundaries of magnetic rocks. Extensive field investigations will be carried out at the same time. The overall project is designed to assist regional geological mapping.

"With the development of a portable gamma-ray spectrometer, it is now possible to measure in situ the content of U, Th and K in rocks. Further field studies are warranted to test this instrument as a means of studying the genesis of rocks and ores.

"Relatively simple equations have recently been established for the attenuation in air of gamma rays from mineral sources. In view of the rapid depletion of known uranium reserves that has been forecast for the decade following 1970, further consideration should be given to the development of more refined and exact methods of radiometric prospecting."

9. Electrical Methods in Geologic Mapping - L.S. Collett via L.W. Morley

L.S. Collett advocates extensive research in electrical methods for determining structure at depth. Research is needed not only in field procedure and interpretation techniques but also in the basic principles, the rock properties involved and the natural or artificially induced phenomena employed.

10. Magneto-Telluric and Heat-Flow Measurements - K. Vozoff

A research program "which appears to be yielding a quantity of new and unexpected results is the magneto-telluric program. I would recommend an expanded magneto-telluric mapping program, augmented by a Schmucker-type magnetic variometer program (as now being carried out by the Universities of Toronto, Alberta, and British Columbia).

"Wherever possible, measurements of heat-flow (which has a direct bearing on electrical conduction at depth) and rock-specimen resistivities at high temperature should be made in conjunction with the field programs, to make possible the best geologic interpretation of the results. Probably these measurements should be made initially at locations where gravity, deep seismic and aeromagnetic data exist, for the same reason."

11. Low-Frequency Electromagnetic, Induced-Polarization and Pulse-Electromagnetic Methods - A.R. Barringer

"An area which appears to be of considerable interest is that of the analyses of low-frequency electromagnetic fields, as a means of tracing geologic structure. A fair amount of effort has been concentrated in geomagnetic micro-pulsation studies in the frequency range below one cycle per second and the AFMAG method has been used for prospecting purposes at frequencies above 100 cycles per second. There lies an opportunity for studying the sub-audio-frequency electromagnetic fields, originating from the so-called "slow tails" of lightning flashes. These fields have skin depths of many thousands of feet and their detailed analyses by suitable instrumentation methods could yield a great deal of information on geologic structure.

"An important and very worthwhile additional field of research lies in the exploration for underground water. The possibility of wider application of resistivity and induced polarization techniques to the location of aquifers merits further study in view of the promising results which have been obtained by certain workers in their fields. Induced polarization in particular can give information related to the permeability of aquifers and it would be of very great interest if rapid reconnaissance methods could be developed.

"A final point I would like to make is the application of pulse-electromagnetic methods to a study of geological problems. At the present time, the United States Geological Survey is planning on fitting pulse-electromagnetic equipment manufactured in Canada to its new Convair Geophysical Survey Aircraft. It is hoped that the detailed analyses of the decay curves of the transients which follow pulse excitation will yield detailed information on the resistivity of the upper few hundred feet of underlying terrain, and will indirectly provide additional information on drainage and soil conditions. This represents an experimental new use of airborne electromagnetics and it may yield information of considerable value to both the geologist and hydrogeologist. Research flights to investigate the application in Canada of this type of approach appear to be warranted."

12. Gravity Stripping and the Prairie Evaporites - H.B. Sawatzky

"It is recommended that the available gravity data in the area of Saskatchewan generally underlain by the Middle Devonian Prairie Evaporite be subjected to thorough review employing the gravity-stripping method. The purpose is to determine of what value, if any, the gravity method might be in delineating salt boundaries and estimating thickness. It is realized that the method may have lost its practical value in certain areas where well control and seismic information already provide the answers. However, these are areas where the gravity interpretations might be suitably evaluated so that if results are favorable they could be employed as a cheap exploration tool in relatively unknown areas."

13. Seismic Reflection Profiles in Eastern Saskatchewan
- H.B. Sawatzky

"In addition to the seismic crustal studies that have been carried out along the so called Thompson-Moak Lake gravity trend, it is suggested that a dozen or so continuous seismic reflection profiles (approx. 25 miles in length) be shot at suitably chosen sites along the Saskatchewan portion of the abovementioned trend. The object would be to determine if any abrupt change in basement and/or sedimentary relief is associated with this trend. The potential economic implications are obvious."

14. Statistical Methods in Geology - V. Saull

"Increase the use of statistical methods of correlation, curve fitting, data presentation, time-series analysis and operations-research methods to geological problems. Methods adapted to computers should be particularly stressed. A national symposium or travelling seminar group would be useful, and if so, full use of worked examples should be made."

15. Geophysical Modelling - V. Saull

"In geophysical model work attempts should be made to model a rotating earth in such a way as to permit experiments re continental drift, pole shift, and related interior fracturing or convection. The particular problem is to obtain the effect of radial gravity and magnetic or electrostatic analogues that would be necessary."

16. Boreholes for Geophysical Measurements - V. Saull

"Methods of finishing off boreholes so as to leave them free for geophysical measurement, and yet prevent contamination or destruction of aquifers, should be developed. Quick-setting gels pumped into porous strata might do the job."

REPORT OF THE SUBCOMMITTEE ON PLEISTOCENE GEOLOGY

Presented by W.O. Kupsch

Members of the Subcommittee

W.O. Kupsch (Chairman)	University of Saskatchewan, Saskatoon, Saskatchewan.
L.A. Bayrock (for C.P. Gravenor during his absence)	Research Council of Alberta, Edmonton, Alberta.
I.C. Brown	Geological Survey of Canada, Ottawa, Ontario.
E.A. Christiansen	Saskatchewan Research Council, Saskatoon, Saskatchewan.
Raymond Roy	Department of Natural Resources, Quebec, Quebec.
Aleksis Dreimanis	University of Western Ontario, London, Ontario.
J.A. Elson	McGill University, Montreal, Quebec.
Lockhart Gray	Water Control and Conservation Branch, Winnipeg, Manitoba.
P.F. Karrow	University of Waterloo, Waterloo, Ontario.
R.H. MacNeill	Acadia University, Wolfville, Nova Scotia.
J. Ross Mackay	University of British Columbia, Vancouver, British Columbia.
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

The great diversity of research projects assembled together under the general heading of Pleistocene geology becomes evident if a break-down into several categories is attempted (Table 1). The data presented in Table 1 have to be taken with a grain of salt. Firstly, it is difficult to categorize properly some of the research of wide scope. Secondly, in order to arrive at a numerically conservative estimate, each project has been entered in the table in only one category. Thirdly, studies under way as well as those completed in 1963 have been included, but in the summary of research projects by provinces only those regarded as completed are described in detail. Fourthly, engineering geology is most likely grossly under-represented because only a few of the more comprehensive studies are being reported to the subcommittee. Finally, some projects are much broader in scope than others. For instance in one province a stratigraphic study may be limited to one bore-hole whereas elsewhere it may include tens of wells, but in the table all projects are given equal weight, irrespective of size.

Keeping these shortcomings in mind some useful conclusions can be drawn:

1. The category with the most projects is field mapping, followed by engineering geology and groundwater. This confirms the suspicion of I.C. Brown, Geological Survey of Canada, who writes: "I wonder whether the increasing interest and work done in groundwater and engineering geology has reached the stage where some thought should be given to either renaming this subcommittee or splitting it to cover the fields of groundwater and engineering geology". He goes on to say that personally he feels it unwise to split the subcommittee at this time and that renaming it would be preferable. However, a division may be required in the future when the load of work becomes too great for a single subcommittee.

2. Although many stratigraphic and palaeontologic studies may be a part of field mapping and thus not shown in Table 1, it seems that stratigraphy and palaeontology are low on the totem pole of projects. If this is so it is a serious shortcoming because this kind of information is vital in any serious study of Pleistocene deposits. Moreover, as both J.A. Elson and P.F. Karrow point out, Pleistocene sections are particularly susceptible to destruction and many are only temporarily exposed in excavations. Not only should the stratigraphy be studied but the data and samples obtained should be kept for future reference.

DATA COMPILATION AND PROCESSING

Comments were invited from members of the subcommittee on data compilation and processing in the fields of the subcommittee. In regard to groundwater data I.C. Brown mentions the following:

(a) Most provinces are now collecting groundwater data by requiring reports from drillers, and in this way we have an up-to-date inventory, particularly in those provinces where water problems are most pressing.

(b) Most of these records are collected on manually sorted punch cards, although Saskatchewan is considering using machine-sorted IBM punch cards with microfilm inserts.

(c) This information is required mostly for answering specific requests and these are submitted by reference to political subdivisions. These subdivisions vary so much across Canada that it would be difficult to set up any system to cover the whole country; each province uses the system best adapted to its requirements.

(d) Statistical handling of these data is not yet being done to any very great extent, so that at present we really do not know enough about the requirements to set up our records for machine or computer handling except for specific problems such as evapotranspiration calculations.

(e) Most current groundwater data are collected by the provinces and the repositories in each province would seem to be the most practical data centres. The Geological Survey of Canada compiles groundwater data mainly for its own use. International data centres for groundwater may develop from the Hydrologic Decade program.

A. Dreimanis doubts if world-wide data centres are desirable for most Pleistocene information except for that from studies of international scope such as sea-level changes. In general, data should be compiled by the institutions doing the field work because the best interpretations can be done only by those familiar with field conditions. If any centralization and processing of Pleistocene geological data is desired in Canada the Geological Survey of Canada would be the most appropriate agency. The nation-wide radiocarbon file maintained by the Geological Survey of Canada is an example. For regional centres a uniformity of presentation and filing should be achieved which would facilitate exchange of information and compilation for eventual nationwide centres.

J.A. Elson mentions that, as far as stratigraphic information is concerned, he maintains a personal record of sections seen by him on 3 x 5 inch cards, ordered by latitude and longitude. He adds that a punch-card system could be devised for such data and that a standardized method of recording should be recommended.

Concerning the collecting of samples, A. Dreimanis makes the following comment:

"I have suggested before (1960) that all federal and provincial field parties collect till samples in their areas as a routine procedure, and that these samples be deposited in a

TABLE 1

Projects by Areas

	N.W.T.	Yukon	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	Nfld.	Total
Project categories													
Field mapping	4	-	3	6	4	2	6	4	1	5	4	-	39
Stratigraphy	-	-	1	2	1	1	2	-	-	-	-	-	7
Palaeontology and palynology	-	-	-	1	2	-	2	1	-	1	-	-	7
Geophysics and geochemistry	-	-	-	-	1	1	2	3	1	-	-	-	8
Groundwater	-	-	1	2	6	5	1	-	-	1	1	-	17
Petrography and mineralogy	-	-	2	1	-	-	2	1	1	2	-	-	9
Marine and lacustrine geology	2	-	-	-	-	-	3	-	2	3	-	1	11
Engineering geology	-	1	5	3	1	3	3	6	-	-	-	-	22
Total	6	1	12	15	15	12	21	15	5	12	5	1	120

Till Library to be maintained by the Geological Survey of Canada. Naturally, results of analyses of these samples will also be compiled there. At that time I was mostly concerned with heavy mineral investigations, as they may assist not only in deciphering regional glacial movements, but also in mapping boundaries of bedrock areas with differences in heavy mineral content. Nothing further has been done regarding such a Canadian Till Library, as far as I know. Presently one of the largest of local Canadian "Till Libraries" is at the Geology Department of the University of Western Ontario, consisting of approximately 3,000 (1/2 to 1 pt.) samples of glacial deposits, mostly tills. The majority of them are from Ontario, but several hundred are from the glaciated areas as far west as the Rocky Mountains and as far east as New Brunswick. Various types of partial analyses have been done on more than 1,000 of these samples, and the results are crudely compiled in tables and on cards. I intend to expand this "Library" but I would never be in favor of its expansion to a central library. (Universities are not the right places for central national or world-wide libraries.) In my opinion, we will have to wait for the proposals of the "Committee on the Characterization of Till". After agreement is reached on some standardization of sampling procedures, the desired investigations, and the modes of presentation of results, it will be easier to decide on the compilation and processing of the data."

COMMITTEE ON CHARACTERIZATION OF TILL

With regard to the "Committee on the Characterization of Till"[1] the following information was received from its chairman,

[1] National Advisory Committee on Research in the Geological Sciences, Thirteenth Annual Report, 1963, pp. 57-58.

J.S. Scott, Geological Survey of Canada: "I prepared a first draft of the manual on till characterization and circulated copies to the members of the ad hoc committee last May with a request for their comments on the form and content of the draft. Most of the replies are now in and it is my intent to assimilate these comments into a second draft of the manual which will again be circulated to the committee for comments, after which the first edition will be prepared. Judging from the present rate of progress of the manual it is unlikely that the first edition will be available in the fall of 1964 but there is a good possibility that it will be available in 1965."

REVIEW OF CURRENT RESEARCH

During 1963 various governmental agencies, federal as well as provincial, and several universities carried out research programs in the field and in the laboratory which are summarized below by provinces and territories.

In order to keep this part of the annual report within reasonable bounds it is necessary to present only some highlights of the various regional submissions. Generally only those areal projects which are completed or near completion have been mentioned, leaving others for future reports. Current studies of a more general nature are included even though they may not be too far advanced.

Northwest Territories

B.G. Craig of the Geological Survey of Canada examined the surficial deposits of Northwest Baffin Island where an area of about 55,000 square miles was studied in connection with "Operation Admirality", a reconnaissance geological mapping project. The northern half of the map-area is almost completely devoid of common glacial landforms. In some of the major valleys, however, end and lateral moraines, as well as drumlins indicate glacial flow towards the sea. In the southwest part of the map-area there is widespread evidence of glaciation. In general the elevation of the marine limit varies from about 400 feet in the southwest to about 300 feet in the southeast.

Eastern Bathurst Island was investigated by W. Blake Jr., in a reconnaissance study for the Geological Survey of Canada. The field work included brief visits to Lowther and Helena Islands. Although here, too, common glacial features are absent, the widespread occurrence of erratics, the presence of some till, and an abundance of marginal drainage channels show that Bathurst Island has been glaciated at some time. The limit of postglacial marine submergence varies considerably and it appears to be lower along the east coast of Bathurst Island than on the north coast where it is close to 400 feet above sea level.

Under the auspices of the Polar Continental Shelf Project an investigation of sedimentation in the Prince Gustaf Adolf Sea, commenced previously, was continued during the 1963 field season. The purpose of the investigation is to provide information on the sedimentary environment and late Pleistocene history of the region. Sea-bottom core samples were obtained with a piston-type coring device. Fine- to medium-grained quartzose sand layers in the lower parts of some cores may be related to lower stands of sea-level during late Pleistocene glacial stages. The bottom topography of the western part of the Prince Gustaf Adolf Sea suggests that subaerial erosion may have influenced its present form.

Data on bottom topography, sediments, and fauna were also obtained from the Arctic continental shelf adjacent to the western Queen Elizabeth Islands. Similar studies were undertaken in the eastern Arctic Islands and the collected data from both areas will be interpreted by scientists at the Bedford Institute of Oceanography, Dartmouth, N.S., and at the Geological Survey of Canada, Ottawa. The submarine topographic features as well as the characteristics of the adjacent shores suggest an origin of subaerial erosion by rivers and glaciers (presumably along earlier structural trends), followed by submergence and presently emergence.

J. Ross Mackay and J.K. Stager of the University of British Columbia spent the summer of 1963 working on several of the islands off the Mackenzie River Delta that are composed of Pleistocene sediments. They found glacial ice thrusting much in evidence. Some of the tilted strata have beds of banded ground ice as thick as 25-300 feet in their stratigraphic succession. Preliminary ice-fabric studies show a preferred orientation normal to the banding and the enclosing beds. It appears, therefore, that the ice was originally horizontal and was later deformed along with the rest of the succession. If this is correct, the ground ice would be older than the overriding glacier ice. A comprehensive report on the Mackenzie Delta area was recently published by the Geographical Branch[1], Department of Mines and Technical Surveys.

[1] J.R. Mackay, The Mackenzie Delta Area, N.W.T.: Geogr. Branch, Dept. Mines and Tech. Surveys, Mem. 8, 1963, 202 p.

Still farther north, Victoria Island is the topic of another report[2] of great interest to Pleistocene geologists, especially to those unfamiliar with the fascinating surficial geology of the Arctic. Here, where the geomorphology is not obscured by vegetation or culture, is one of the greatest outdoor laboratories for the study of glacial features.

[2] Fyles, J.G., Surficial geology of Victoria and Stefansson Islands, District of Franklin: Geol. Surv. Canada Bull. 101, 1963, 38 p. map.

Yukon Territory

At the request of the Water Resources Branch of the Department of Northern Affairs and National Resources, E.B. Owen of the Geological Survey of Canada investigated four potential dam sites on the Stewart River, one of the larger tributaries of the Yukon River. One of these sites is presently considered as a source of hydroelectric power by the California Standard Oil Company for its newly discovered iron-ore prospect.

British Columbia

From as far away as New Zealand, where subcommittee member W.H. Mathews is spending his sabbatical leave, a report was received on Pleistocene and Holocene investigations in British Columbia. Dr. Mathews mentions his own studies on ice-dammed lakes and water pressure under a glacier, as well as cooperative research with J.R. Mackay on snow-creep and its effect on soil movement. The results of the latter investigation have been published[1].

[1]Mathew, W.H. and Mackay, J.R., Snow-creep studies, Mount Seymour, B.C. Preliminary field investigations: Geogr. Bull., No. 20, 1963, pp. 58-75.

The sediments of the Fraser River Delta are under continuing investigation. A stratigraphic and aquifer test hole drilled near Aldergrove, B.C., penetrated 785 feet of surficial sediments overlying the bedrock. The total depth of the well is 850 feet. So far no detailed results are available.

Field mapping of the surficial geology of the Vernon west-half map-area was begun in 1963 by R.J. Fulton for the Geological Survey of Canada. The last ice-sheet retreated from the Vernon area by downwasting with the uplands uncovered while inactive ice remained in the valleys. High-level kettled terraces indicate that lakes developed marginally to ice tongues. Lower non-kettled terraces show that the main valleys were occupied at several levels by lakes larger than those of today. Two thin bands of volcanic ash form well-defined marker horizons in postglacial bog and alluvial deposits. The ash falls are tentatively correlated with the Mount Mazama eruption, ±6,700 B.P.

Holocene volcanic ash layers in southern B.C. continue to hold interest for geologists, particularly because of recent work done in adjacent areas of the northwestern United States.

On Vancouver Island, E.C. Halstead, Geological Survey of Canada, commenced field mapping in the Cowichan Lake area of the east coastal plain. Here, till deposited during the last major ice advance fills the valleys and rests upon older unconsolidated materials or bedrock. Deglaciation was accomplished with an advancing sea into which ice contact deltas as well as stony clays were deposited upon the till. Older Pleistocene deposits underlie the till and are exposed in sea cliffs. Sands and gravels of these older deposits provide a source of groundwater. Four observation wells were established to provide data for further hydrological studies of this important aquifer.

Projects of economic interest include, besides groundwater investigations, an examination of sand and gravel deposits in the south-central part of British Columbia, the engineering geology of the Highbury Tunnel, Vancouver, and various dam-site studies.

The applications of Quaternary stratigraphy and geomorphology to various fields such as groundwater geology, engineering geology, geophysical prospecting for petroleum occurrences, and archaeology are fully discussed by W.H. Mathews in his report on the

Fort St. John area[1]. In this publication he mentions that water

[1] Mathews, W.H., Quaternary stratigraphy and geomorphology of the Fort St. John area, northeastern British Columbia: B.C. Dept. Mines and Petroleum Resources, 1963, 22 p.

supplies can be obtained only with difficulty in many parts of the map-area but that the Quaternary succession, being partly or wholly within economic reach of relatively shallow farm wells, offers some possibilities as a practical source of groundwater.

Alberta

In the absence of subcommittee member C.P. Gravenor a report on activities in Pleistocene geology and related research in Alberta was received through the kind offices of L.A. Bayrock, Research Council of Alberta. He mentions the completion of mapping the surficial geology in the Edmonton and Vauxhall areas and the availability of reports[2]. A helicopter reconnaissance of surficial

[2] Bayrock, L.A., and Hughes, G.M., Surficial geology of the Edmonton district, Alberta: Research Council Alta. Prelim. Rept. 62-6, 1962, 40 p.
Bayrock, L.A., and Jones, J.F., Surficial geology of the Vauxhall area, Alberta: Research Council Alta. Prelim. Rept. 63-2, 1963, 4 p.

deposits covering approximately 80,000 square miles was undertaken in northern Alberta in conjunction with a soil survey. For parts of this area preliminary reports are available.

Regional mapping of the Bassano map-area was commenced by A.M. Stalker, Geological Survey of Canada, who reports on his findings as follows:

> "As many as five Laurentide tills are present in the banks of Bow River, and it is expected that these will correlate with those previously found in the stratigraphic section along Oldman River. The various Pleistocene diversions of Bow River were studied. During the last or Classical Wisconsin glaciation major ice advances from the north-northwest and northeast met in the western part of the area. These combined into one massive ice-sheet that retreated northeastward. This ice-sheet blocked normal drainage to form an eastward-descending series of proglacial lakes. As a result, lake silt and sand covers about one-half the area mapped: ground moraine and hummocky moraine are present elsewhere.

"Large quantities of good gravel are present at the base of the drift in the preglacial Bow Valley, though generally too deeply buried for commercial use. Important deltaic gravel deposits were laid down along the northwestern shores of the successive proglacial lakes."

The section along Oldman River to which A.M. Stalker alludes in the above quote is described by him in a recently published paper[1].

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[1] Stalker, A.M., Quaternary stratigraphy in southern Alberta: Geol. Survey of Canada Paper 62-34, 1963, 52p.

In addition to the regional mapping, several more detailed investigations of interest to Pleistocene geologists are currently in progress in Alberta. For instance, the composition of surface tills has been under study for the past few years. It involves a province-wide sampling of tills, and all samples are subjected to a large number of different analyses, whereupon the results are treated statistically. Preliminary data indicate many varieties in composition of tills[2].

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[2] Bayrock, L.A., Heavy minerals in tills of central Alberta: Alta. Soc. Petroleum Geologists Jour., v. 10, 1962, pp. 171-184.

Vertebrate fossils, postglacial delevelling, preglacial buried channels, and the stratigraphic position of the Saskatchewan Gravels are other topics of research. Results to date suggest that the Saskatchewan Gravels, regarded previously by some geologists as late Tertiary, are Pleistocene.

A cooperative mapping project involving various disciplines is being conducted in an area approximately four townships in size. It is one of three such projects in Canada which are being coordinated by J.D. Scott of Waterloo University[3]. In Alberta it is headed by

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[3] National Advisory Committee on Research in the Geological Sciences, Thirteenth Annual Report, 1962-63, pp. 58-59.

S. Pauluk, Department of Agriculture, University of Alberta and the leaders for the various field projects within the framework of the overall study are:

a. Pedology - T.W. Peters, Canada Soil Survey
b. Surface geology - L.A. Bayrock, Research Council of Alberta
c. Bedrock geology - R. Green, Research Council of Alberta
d. Groundwater - D. Lennox, Research Council of Alberta
e. Soil Mechanics - B. Shields, Research Council of Alberta
f. Geophysics - D. Lennox, Research Council of Alberta

The study requires close coordination of, and cooperation between, the various sciences involved and appears to be a worthwhile type of study to acquaint workers in several disciplines with each other's requirements and problems and to promote a better understanding of the merits of such work, particularly among the engineering profession.

Groundwater as well as surface water continues to provide fields of study. Special emphasis was placed on buried channels in the Peace River area where a study of groundwater resources was completed. Engineering investigations are being conducted on scour and bed changes of present rivers in connections with foundation problems of bridges. Recent stream deposits of Alberta have been under study for the past six years, and results indicate that in places local bedrock exerts a strong influence on the composition of river alluvium.

Several papers on groundwater are to be found in a recently published volume[1] comprising the presentations, discussions, and

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[1]Brandon, L.V. (Chairman), Groundwater: Ottawa, National Research Council, Proc. Hydrology Symposium No. 3, 1963, 344 p.

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results of the Hydrology Symposium held at the University of Alberta, Calgary, on 8 and 9 November, 1962.

Saskatchewan

E.A. Christiansen of the Saskatchewan Research Council reports that the systematic reconnaissance mapping of the southern 100,000 square miles of Saskatchewan is now two-thirds complete. Reports on five of the total sixteen areas are available to the public. The latest one to have been published deals with the Wynyard (72-P) area[1].

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[1]Greer, J.E., and Christiansen, E.A., Geology and groundwater resources of the Wynyard area: Sask. Research Council Rept. 3, 1963.

Increasing attention is being paid to stratigraphic information. Test drilling, electric logging, and side-hole coring operations were quadrupled in 1963 through a grant from the Agricultural Rehabilitation and Development Act (ARDA). This grant made it possible to prepare cross-sections of the drift and some bedrock, to draw bedrock-surface topographic maps, and to define permeable zones by means of isopach maps.

Besides field work, laboratory investigations are in progress. At the University of Saskatchewan some of these involve the use of microfossils, mainly ostracods, present in much of the stratified drift. Like pollen and spores, ostracods can be used in palaeoecological studies especially as to water temperature, salinity, and other parameters of the water body in which they lived.

As far as groundwater resources are concerned, the Saskatchewan Research Council prepares hydrogeological maps for all areas under systematic geological investigation. Detailed hydrological studies are in progress in a discharge area southeast of Watrous by a large industrial firm in connection with development of the Devonian potash resources and also in the buried Missouri and Yellowstone Rivers valleys by the Government of Saskatchewan. In both places the actual field and laboratory studies are contracted out to consulting firms.

The Geological Survey of Canada was engaged in several hydrogeological investigations in Saskatchewan during 1963. These were in the Old Wives Lake Drainage Basin (R.A. Freeze), the Assiniboine Basin (P. Meyboom), and the Eaglehill Creek area (A.M. Toth). Freeze's field work included a study of the relationship between water chemistry and groundwater flow systems. Meyboom directed his work toward measuring groundwater discharge from phreatophytic vegetation, and Toth examined the Eaglehill Creek valley as a discharge area. New methods to determine water budgets and of estimating groundwater supplies were initiated.

The Saskatchewan Department of Agriculture in cooperation with the Department of Mineral Resources continues to function as a repository of all groundwater data including samples, logs, and chemical analyses. The availability of the newly established computer centre in Regina will facilitate the classification and accessibility of this information when the time comes to put it on computer cards or tape.

Surface resistivity surveys were undertaken by J.E. Wyder for the Geological Survey of Canada in southern Manitoba and Saskatchewan. In the Oxbow (Saskatchewan) area apparently successful attempts were made to outline the buried Missouri River valley and a major tributary.

Engineering geology and in particular landslides of the rotational slump type were the concern of J.S. Scott of the Geological Survey of Canada who extended his studies over Alberta, Saskatchewan, and Manitoba. The landslides are of common occurrence in Western Canada along river valleys that are carved into clay shales of the Upper Cretaceous Bearpaw Formation and its stratigraphic equivalents, particularly where it contains bentonite layers. The thorough study of terrain by airphotos is to be recommended for all engineering works that could be affected by slope failure because Scott states that "the presence of joints or incipient fractures as evidenced by angular drainage patterns (and which would best be visible on airphotos) indicates the need to consider these planes of weakness in shear-strength determinations and the existence of preferred zones of groundwater flow in the Bearpaw Formation."

Manitoba

At the University of Manitoba a study of the clays of Lake Agassiz is being supported by a grant from the National Research Council. L. Gray, Groundwater Geologist for the Manitoba Department of Agriculture and Conservation, who joined the Pleistocene Subcommittee lately, mentions several economic studies involving groundwater, gravel deposits, and soils. For several towns and villages the Water Control and Conservation Branch undertook the exploration and evaluation of aquifers within the drift and upper bedrock to lead to development of municipal water supplies. The influence of groundwater is of concern in some engineering projects such as the Red River Floodway, the Portage Diversion, and the Oak Lake Dam.

Drilling for stratigraphic information, followed by the installation of piezometers, was undertaken in the Minnedosa drainage basin by A. Lissey for the Geological Survey of Canada; J.E. Charron, also for the Survey, continued the study of the Red River Valley. Because the composition of the groundwater in one part of the area suggested the possibility of a gypsum deposit, a drill-hole was made which intersected a 48-foot section of gypsum, first encountered at a depth of 98 feet below surface. The extent of the deposit is not yet known.

The Manitoba Water Control and Conservation Branch initiated in 1963 a program whereby hydrological and geological data on each water well drilled in the province are collected, compiled, and entered on groundwater data cards.

The Manitoba Department of Public Works initiated a comprehensive program to determine the availability of gravel and other materials for road construction. Airphoto interpretation, geophysical methods, and test drilling will be used in an attempt to take stock of the existing gravel deposits which are becoming rapidly depleted.

In the Morris area J.E. Wyder, Geological Survey of Canada used resistivity methods to delineate five small surficial sand and gravel deposits. A short drilling program revealed that each of the sand and gravel deposits graded into a pebbly till.

Mapping of the surficial deposits of the Manitoba part of the Riding Mountain area (62-K) was completed by R.W. Klassen for the Geological Survey of Canada. The stagnant ice marginal zone of an early ice lobe shrank progressively northwestward up the Assiniboine River valley. A later ice lobe advanced from the northeast to a position just east of the Assiniboine River valley. The Riding Mountain upland was deglaciated while ice lay in adjacent lowlands as indicated by kame moraines and stream trenches across the slopes of the upland. During the initial stages of this deglaciation, meltwater lakes covered stagnant ice as indicated by hummocky lake silts.

Ontario

The Ontario Department of Mines sent two Pleistocene parties to the field in the summer of 1963. One of these, under the direction of P.F. Karrow[1], completed the mapping of the Guelph area

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[1]Karrow, P.F., Pleistocene geology of the Guelph area: Ont. Dept. Mines, Prelim. Map, (p. 189).

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on a scale of 1 inch to 1 mile. A report on the Pleistocene geology of the Hamilton-Galt area is now available[2].

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[2]Karrow, P.F. Pleistocene geology of the Hamilton-Galt area: Ont. Dept. Mines Geol. Rept. 16, 1963, 68 p.

The Woodbridge interstadial site, discovered in 1962, was studied in detail, and two samples have been submitted for radiocarbon dating. The site is within the boundaries of the Cooperative Mapping Project in the Bolton area, which is one of the three small areas being subjected to intensive study by various earth scientists (p. 48). The investigations of the central area, in Ontario, are being coordinated by P.F. Karrow, project leader. Engineering information is being compiled from the several conservation dams, highways, and railways relocation projects in the Bolton area. A hydrologic study of certain aquifers is being carried out and detailed pedologic mapping is anticipated.

A comprehensive summary of sand and gravel deposits of Southern Ontario of considerable economic interest was sponsored and published by the Ontario Department of Mines[1].

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[1]Hewitt, D.F., and Karrow, P.R., Sand and gravel deposits of southern Ontario: Ont. Dept. Mines Industrial Mineral Rept. 11, 1963.

The following information is part of a report received from A. Dreimanis on Pleistocene work carried out at the University of Western Ontario in 1963:

1. A study on the Pleistocene stratigraphy of southern Ontario, which is a continuing project supported by a grant from the Geological Survey of Canada, was restricted in 1963 to the type area of the Post Talbot interstadial. Three test holes, drilled along the north shore of Lake Erie below lake level, penetrated lacustrine deposits as old as the Post Talbot beds and older, and one to two tills below it.

2. A study of the relationship between lithologic composition and grain size of till to bedrock and older Pleistocene deposits is continuing with financial aid from the Ontario Research Foundation. Incorporation of dolomite and limestone in glacial drift and comminution of these rock fragments during glacial transport have been investigated along four traverses parallel to the last glacial movement in Southern Ontario.

3. Field mapping for the Ontario Department of Mines was undertaken in the London-St. Thomas area. Stagnant ice deposits are considerably more extensive than previously suspected. At least four different tills, deposited by the Erie and Huron lobes, were noted. The St. Thomas moraine was found to be contemporaneous with Lower Lake Maumee. Attention was paid to both geological and engineering characteristics of the soils, and more than 800 samples were collected for further studies.

In several departments of institutions of higher learning in Ontario, geological and engineering studies of Recent and Pleistocene sediments are under way. They include the development of ripple marks in the near-shore environment of Lake Huron, equilibrium of slopes in Pleistocene materials, mass properties of dune sands along Lake Huron, mineralogical and chemical composition of glacial clays at various sites, and the Pleistocene stratigraphy of the Bloor-Danforth subway excavations in Toronto.

The Geological Survey of Canada also had several projects under way in Ontario. A refraction seismic program in the Kirkland Lake-Larder Lake area was carried out to measure thickness of overburden, particularly over buried channels as interpreted from airphotos. Results indicate a pronounced bedrock channel with a maximum recorded channel depth of at least 350 feet. Also in the Kirkland Lake area, a geochemical survey of the bedrock is preceding surficial mapping. Because the gold deposits of this area are concentrated in shear zones of physically broken rock, they provided a major selective load to the glaciers. Based on this, a method of gold exploration by detailed quantitative analyses of the overburden has been developed by H.A. Lee[1].

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[1]Lee, H.A., Glacial fans in till from the Kirkland Lake Fault - a method of gold exploration: Geol. Survey of Canada Paper 63-45, 1963.

In the Kingston (Southeast) map-area, where the surficial geology was investigated by E.P. Henderson, Geological Survey of Canada varved silts accumulated in a lake held up by glacial ice in the St. Lawrence valley. Marine clays such as those occurring farther east were not found, and it is concluded that, contrary to some earlier reports, the Champlain Sea did not extend as far west as the Kingston area.

The Sydenham (31C/7) and Bath (31C/2) map-areas are part of an extensive limestone plain, which is divided into blocks by a succession of southwest-trending bedrock valleys that head on the adjoining Shield area. Mapping by E. Mirynech, Geological Survey, has shown that the plain surfaces are covered by a thin discontinuous sheet of stony ground moraine and the bedrock valley floors by stratified silts and clays. It is suggested that the eastern parts of these map-areas experienced substantial glacial erosion during Wisconsin time.

Palynological studies by J. Terasmae, Geological Survey, were done in connection with several stratigraphic projects. The sites for two bore holes through unconsolidated sediments were chosen on the basis of echo sounding and other underwater geological data obtained through the cooperation of the Great Lakes Institute. In the Long Point drilling project, Lake Erie samples were collected in a continuous series from the ground surface of this rapidly growing spit to bedrock, through nearly 400 feet of unconsolidated sediments.

Research allied to palynology and using a similar approach is being carried out by H.C. Duthie, Botany Department, University of Waterloo, who is making a study of fossil diatoms in the Toronto Interglacial Beds that comprise the Don and Scarborough Formations.

The activities of the Ontario Water Resources Commission are reported as follows by A.K. Watt:

> "The Ontario Water Resources Commission issued reports for hydrogeologic surveys carried out for 14 municipalities and was conducting surveys for four other municipalities at the end of 1963. In addition, eight municipal test-drilling and two municipal well-construction projects were being supervised by the Commission. These surveys and projects involved the collection and assembly of detailed data on the local geology and hydrology. The reports were distributed only to those directly involved with the problem. Twenty-eight other investigations of more limited scope dealt with special problems of water supply and waste disposal.
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> "Records for 9,326 water wells were received and filed. Groundwater Bulletin 2 was published by the Commission to provide ready access to data on wells and groundwater levels for the years 1955 and 1956. Reports were published also for regional water-resources surveys dealing mainly with municipal water supply and waste disposal in the counties of Carleton and Peel and the District of Sudbury. A detailed hydrogeologic study of the Big Creek River Basin was initiated toward the end of the year."

Quebec

The following are some quotations from a summary of the groundwater investigations carried out in 1963 by the Hydrology Division, Department of Natural Resources, under the direction of R. Roy:

"The Hydrogeology Division deals with experimental and theoretical groundwater investigations. The technical staff consists of three geological engineers and one geologist who are specialists in groundwater surveying.

"The main purpose is to assist municipalities, public institutions, and aqueduct operators in finding adequate groundwater supplies either for new projects or for old ones which are now out of date owing to an increase in population, a shortage of water, or a lowering of the water table.

"This year the Division began a geochemical groundwater study. Several samples were collected from wells throughout the Sorel area and in the southern part of the Montreal area for a complete analysis by our laboratories. The plotting of these analyses with newly developed methods enables us to determine in previously uninvestigated areas the regional flow of groundwater, the recharge area and, in some places, the structural features.

"Finally, research has been oriented toward determining the relation between grain size in an aquifer and its coefficient of transmissibility, hence its permeability and the specific yield of a well.

"A total of 58 hydrological areal surveys were conducted.

"Pierre Lasalle, part-time geologist, mapped the Pleistocene formations in the Sorel area (31 I/3) during the summer of 1963. This geological study follows work begun in 1961 in the Beloeil area and in 1962 in the Verchères area. A preliminary report (No. 497) on the surficial geology of the Beloeil area (31 H/11) has been published.

"The unconsolidated sediments exposed in the latter area are of glacial, marine, and fluvial origin. The glacial sediments are presumably of Wisconsin age. Other glaciations are also suggested, but their sediments are overlain by recent deposits or have been incorporated into the sediments of subsequent glaciations."

In the Beauceville area, Quebec, an experimental hammer survey was conducted by J. Depatie, Geological Survey of Canada. Its main objective was to find and outline preglacial buried channels in bedrock, which are suspected to contain gold-bearing gravels. A total of 20 bedrock profiles was constructed, half of which indicated the existence of a buried channel. The experiment is considered a success and further similar projects in this area are regarded as worth while.

Some previously unmapped morainic systems in the St. Lawrence Lowlands were studied by N.R. Gadd, Geological Survey of Canada, who contends that ice standing at positions marked by these newly-discovered morainic systems controlled the formation and drainage of many of the glacial lakes along the northern flank of the

Appalachian Highlands and probably the northeastward drainage of the Glacial Great Lakes. They controlled also the occupation of the St. Lawrence valley by marine waters of the Champlain Sea entering along the lower St. Lawrence route.

At the universities many projects are confined mainly to the laboratory and deal with fundamental behavior of soils such as structure and dependence on interparticle forces, frozen soils, swelling of clay, soil suction, the energy status of water in soils, the transmission of water through unsaturated soil, and the geochemistry of marine clays as it affects soil water. Permeameter work is continuing, and the flow of water with various concentrations of sodium chloride through purified attapulgite, in both oriented and unoriented arrangements, is being investigated. Research in these varied fields, briefly summarized in a report by J.A. Elson, appears to be actively pursued in Quebec.

Work on Pleistocene deposits was done not only in the southern part of Quebec but also in the far north of the province. In connection with "Operation Leaf River", E. Mirynech, Geological Survey of Canada, mapped the surficial deposits in a region east of Hudson Bay. Here the continental ice flowed westward from a northwesterly trending ice-flow and meltwater divide belt. As the Wisconsin glacier contracted in Ungava marine waters spread over low-lying areas bordering Hudson and Ungava Bays. The marine beaches then formed were subsequently uplifted due to glacial rebound.

Lastly, it should be mentioned that a very successful field trip was organized by H.A. Lee, Geological Survey of Canada, in the region of Rivière-du-Loup, Quebec for the eastern division of the Friends of the Pleistocene.

New Brunswick

According to subcommittee member R.H. MacNeill, who reported on the Maritime Provinces, two projects on shoreline sedimentology are in progress at the University of New Brunswick. The general mapping of Pleistocene deposits is mentioned as a problem which needs attention. The geology and groundwater occurrences of the Moncton area (21 I/2, W 1/2) were mapped by the Geological Survey of Canada during the summer of 1963. It was concluded from this mapping that no large supplies of groundwater are available for the city of Moncton from either bedrock or Pleistocene aquifers.

A reconnaissance seismic program was carried out in the Chignecto Isthmus, which straddles the provincial boundary between Nova Scotia and New Brunswick, by P. Killeen, Geological Survey of Canada. A bedrock contour map was compiled from 279 seismic shots, numerous outcrops, and 283 bore-holes. No continuous buried preglacial channel extends across the isthmus, although several truncated channels exist.

Nova Scotia

A study of the history of the glaciated land surfaces of Northern Cape Breton Island is under way at St. Francis Xavier University. The laboratory work consists of an analysis of barometric altimeter readings collected for terrace levels, and a profile analysis.

The mapping of Pleistocene deposits, for which the Nova Scotia Research Foundation is responsible, has been completed for Guysborough County, Queens County, and the western part of Lunenburg County. Airphoto studies and till analyses have been started but numerous other problems await future work. Among these are radiocarbon dating to establish the age of certain sediments; till fabric analyses are scheduled to start in 1964. All Pleistocene data are being compiled by the Nova Scotia Research Foundation and preliminary ozalid map sheets are available.

For those sporty types among us who yearn to combine SCUBA-Diving with Pleistocene geology, Nova Scotia appears the place to go in Canada. In St. Margarets and Mahone Bays, south-eastern Nova Scotia, a detailed study of the marine geology by G.A. Bartlett, Geological Survey of Canada, involved the use of SCUBA-Diving equipment which permitted "on-the-spot" planning of under-water traverses. Closely spaced sample stations are variable in both sedimentary facies and faunal content. The bottom sediments change over a short distance from a boulder till, gravel, and sand along the coastal shoreline and the windward side of drumlin islands and isolated ledges to a rich sour-smelling black ooze in the less turbulent areas characterizing back-bays and estuaries.

The study of organic matter in recent sediments off the coast of Halifax is a continuing laboratory and field project in marine geology. Optical, physical, and chemical analyses will be undertaken at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

Groundwater investigations were carried out in Nova Scotia by L.V. Brandon, Geological Survey of Canada, to gather information for the compilation of groundwater probability maps which are to be published on a scale of 1 inch to 4 miles. More than 100 samples of water were obtained from springs and wells for complete chemical analysis.

Lastly, it should be mentioned that a provincial hydro-geologist has been appointed in Nova Scotia and that work in this field is getting under way.

Prince Edward Island

An examination of the surficial deposits in the Charlottetown (West-half) area was carried out by V.K. Prest, Geological Survey of Canada. Glacio-fluvial deposits, ablation till, and ice-sloughed debris are not as common as in areas to the north and east. The basal till was divided into three types (clayey, clay-sand, and sandy). It was found that these diverse though gradational phases have a direct bearing on soil development and land use practice.

For the province as a whole problems relating to a determination of the directions of ice-flow and to source areas for the drift need study.

Newfoundland

According to R.H. MacNeill no systematic work was done in Newfoundland in 1963 and none is planned for 1964. He states: "Any future work will probably be carried out by the Newfoundland Mineral Resources Division, by the Crown Lands Division, or by the Geology Department of the Memorial University under the direction of W.D. Brueckner". A study of the characteristics and distribution of Pleistocene deposits is listed as a problem that needs attention. Some work has been done by the Mineral Resources Division in collecting data on beach deposits of reworked glacial material.

General Research

At the Geological Survey of Canada the Laboratory of Sedimentological Research operated at full capacity during 1963. A Chittick apparatus has been added for carbonate ratio studies. A small engineering laboratory was set up, and a number of two-dimensional groundwater model studies were done on Teledeltos conducting paper models in support of field projects. The Radiocarbon Laboratory at the Geological Survey and the one maintained at the University of Saskatchewan by the National and Saskatchewan Research Councils were both active throughout 1963 and provided many valuable age datings.

RECOMMENDATIONS

The following recommendations for future research are submitted:

1. I.C. Brown, Geological Survey of Canada says it is most desirable to get all provinces to institute a groundwater inventory system such as exists on the Prairies. A second problem is the quantitative study of groundwater use. Several studies of various type drainage basins are under way and we are learning much about recharge flow systems and discharge areas, but we lack quantitative information to complement this.

2. P.F. Karrow, University of Waterloo, calls attention to urban geology, a subject also stressed recently by R.F. Legget, National Research Council of Canada, in several lectures:

> "The growing and already serious problem of urban geology should be thoroughly looked into. In urban areas standard mapping procedures cannot be used, and the only course is to collect, on a long-term basis, information from temporary exposures in excavations. Such information should be supplemented by the examination of test-boring samples and engineering

reports. Where feasible, test-borings can be executed solely for the purpose of geologic mapping.

"It is obvious that a great deal of valuable information of great scientific interest would be thus obtained. Such procedures have already yielded important results on a casual basis during the course of routine geologic mapping. The great practical value of such work in engineering geology should be emphasized.

"The real difficulty in urban geology is in finding a sponsor. Municipal organizations seem entirely removed from the field of geology and, while they are very cooperative in supplying information, they would be hard put to hire one or more geologists. It appears more logical to have an existing geological organization take on the task. This too has proved difficult. No organization seems willing to accept responsibility, on the long-term continuing basis that is essential. A great deal of lobbying, propagandizing and education seems necessary. I would like to see consideration given to ways and means of establishing urban geology projects in the various cities of Canada. Countless exposures are being made every day which are open for only a few days or weeks; they are then covered and another bit of information is lost. While the effects are most notable in the rapidly-expanding large cities, this is not a local problem. Attention was focused on it at the meeting of the Geological Society of America in New York City in 1963 where a symposium on urban geology was held. It is not a new problem: attention was drawn to the value of examining excavations by the Canadian Journal during an earlier period of "Economic expansion" over a hundred years ago. One needs to consider only briefly the changes wrought in our urban areas since the end of World War II, less than 20 years ago, to realize that much ground has already been lost. The prospects are for even greater expansion and construction work in the next few decades. It's later than we think."

3. Ways and means should be explored to strengthen the teaching of Pleistocene geology, geohydrology, engineering geology and related fields that are mainly concerned with surficial materials, on both the technical and scientific level. Some steps in this direction are being taken. For example, at McGill University J.A. Elson has initiated a course in groundwater geology; at Acadia University R.H. MacNeill has started instruction in hydrology; and at the University of Saskatchewan a Division of Hydrology in the College of Engineering has been approved for the 1964-1965 session that will provide a coordinated study in all phases of hydrology. More, however, needs to be done for Canadian students and also for those coming to this country from foreign lands to receive a fundamental geological and engineering training applicable to the problems facing them in their homelands.

APPENDIX

List of publications of Pleistocene geology and related fields provided by members of the subcommittee

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REPORT OF THE SUBCOMMITTEE ON STRATIGRAPHY, PALAEONTOLOGY AND FOSSIL FUELS

Presented by C.R. Stelck

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CURRENT RESEARCH

About 250 research projects open to public scrutiny are under way in Canada that are related to stratigraphy, palaeontology, sedimentation and fossil fuels (Pt. II p. 155). The writer has had an intimate liaison with oil company personnel for many years and would estimate that at least another 500 projects are supported by the petroleum industry, many of immediate practical value and others of more esoteric worth. The stratigraphic thinking and knowledge from such sources filters in slowly but surely, and much of the rapid advance of university and government projects in the last decade may be traced back directly to the sincere efforts of highly trained oil personnel.

As is the case in former years, more projects are listed in the research section (Pt. II p. 155) in stratigraphy and palaeontology than in the other subdivisions, but the inequity towards sedimentation and petroleum would be compensated fully if oil company research endeavors were also listed. Coal is still the poor step-sister in research at present with a scant 5 or 6 projects listed. Very few truly new endeavors are initiated each year in contrast to new titles.

Areas of new interest that are beginning to crystallize into research include the Bedford Institute studies for oceanography and the Polar Continental Shelf projects; T.P. Chamney's (G.S.C.) calibration of the Neocomian micropalaeontology; Saskatchewan's seismic survey of the Athabasca sandstone; the Geological Survey of Canada Operation Porcupine; the studies of the Permian and Pennsylvanian in North Ellesmere Island; the geochemistry of shales by the University of Alberta group; W.R. Danner's study of the carbonates of the western Cordillera; and the palaeotemperature studies by Saull, Clark and Tan.

Age-dating studies have so far made little impact on stratigraphy, as calibration is still in the hands of the palaeontologist, but absolute dates should begin to have an impact on provenance studies in the next decade and assist in developing a true Precambrian stratigraphy discipline.

As in former years, studies in western Canada are dominated by Devonian and Cretaceous concentrations, a direct result of their economic (petroleum) importance.

Projects sponsored by the G.S.C. and (in part) oil companies are often carried out by part-time personnel working towards higher degrees. Consequently much of the research done is, in effect, channelled by the senior survey or by economic considerations.

The Geological Survey of Canada still maintains the dominant position in the number of research projects listed (about 30 per cent), with university personnel cumulatively making up another 30 per cent. The remaining 40 per cent is carried out by students and provincial survey groups. The most outstanding contribution by the petroleum group this coming year is the forthcoming publication of the Atlas of Western Canada Geology by the Alberta Society of Petroleum Geologists and affiliates.

DATA PROCESSING

Data processing has been of questionable use, so far, in stratigraphy, palaeontology, etc. A poll of the members of the sub-committee more often elicited the comments "not used" than any other response. However, indications of the possible use of data processing have been put forward.

W.C. Krumbein's outstanding article on the use of "The computer in geology" (Science, vol. 136, 1962, pp. 1087-92) makes these observations:

> "The data of geology may be classified into three main groups. The first group represents qualitative observations or statements regarding natural objects or events as they are examined in the field or in the geologist's measurement laboratory, and the second represents numerical measurements on these natural objects or events. The third group constitutes quantitative measurement data arising under specified and controlled conditions in an experimental laboratory. The first two groups are called, for convenience, the observational data of geology, in contrast to the third, the experimental data of geology.
>
> "Quantification carries its own problems with it. The development of measurement procedures requires the setting up of operational definitions that express the concept or attribute as a number on the nominal, ordinal, interval, or ratio scale. These numbers lead a life of their own; they are endowed with properties that depend on the measuring process.
>
> "A second problem raised by quantification pervades all of geology. This problem involves making a distinction between

those parts of the science that can best be treated wholly on a quantitative basis and those that may actually be weakened by over-quantification. An example is stratigraphic correlation, where strong qualitative (and subjective) considerations as well as numerical data enter into the problem of subdividing the stratigraphic column into workable units.

"A third problem raised by quantification relates to the selection or design of models appropriate to specific geological problems. Models—in the sense of devices for organizing data—have long been used in geology, and their use is implied in Chamberlin's principle of multiple working hypotheses."

In a more recent article in Oilweek (January 20, 1964, p. 21), R.E. Anderson of Canadian Stratigraphic Service, outlined an industry-wide geological data-processing service scheme and found that:

"Several companies were found to be spending considerable time with experimental projects, especially the companies with research departments. It was also discovered that many problems had been encountered which had kept progress to a minimum.

"The decision which is now facing many of the companies is whether to avail themselves of this (data) service or compile their own geological data for data processing. Companies which have experimented in this field may have an easier time in making their decision as they already know the many problems involved. They also have some estimate of the time required to code geological data as well as its values and uses.

"At present it is estimated that at least 70 per cent of a geologist's time is spent in gathering data before actual interpretation commences. The amount of geological data being added each year is either going to increase the time spent in gathering data, or the geologist is going to use only a limited amount of this information. In addition to the time saved the added information which will readily be available will give the geologist an opportunity to explore various avenues of approach to geologic problems which are not permissible due to the time involved in gathering this data.

"Processing of geological data has actually very little to do with geologic interpretation. The computer is not taking the place of a geologist. Its function is to store large quantities of data which can be retrieved with great speed if required. The individual geologist still must make the interpretation from this data.

"Canadian Stratigraphic Service has over 2 1/2 million feet of stratigraphy ready for coding in British Columbia and the Northwest Territories. In Alberta there is 4 1/2 million feet — ready for coding. Prior to 1957 there is approximately 5 million feet of stratigraphy in Alberta which will require relogging.

"The time involved in coding is great, as the actual coding is very slow due to the criticalness with which it must be recorded. As the work itself is demanding and tedious the time one geologist can continue to code is limited.

"The actual coding of the stratigraphic data must be done in great detail. First to insure that all data which may be required now or later will be stored for retrieval when needed. It also will eliminate ever having to rehandle completed wells. A card is punched for every stratigraphic unit regardless of the thickness, the average being around 20 feet. A new card is punched at every stratigraphic change. An outline is listed below of most of the data recorded.

(1) Environments—at time of deposition
(2) Depth of each stratigraphic unit recorded
(3) Twenty-two Rock Types with percentages
(4) Fourteen grades of grain size
(5) Frame work ratio (percentage of coarse rock)
(6) Thirty-nine various accessories and percentage
(7) Fifteen types of Rock Builders for Carbonates and percentage, example: Amphipora
(8) Sandstone components (four only) and percentage
(9) Degree of rounding and sorting of sandstone
(10) Ten diagenetic factors—cementation, dolomitization, etc.
(11) Colors
(12) Nine grades of porosity
(13) Eight types of porosity
(14) Four grades of oil shows
(15) Fossils
(16) Minerals
(17) Formation names and tops."

In the palaeontological field there is a pressure from the biologists to institute a coding or numerical taxonomy and numerous monographs on the subject, such as Sokal and Smith's "Principles of Numerical Taxonomy" (1963, Freeman & Co.) which contains an appendix on computational methods.

Within the experience of the present subcommittee, the only data-processing methods used were those of the simple punched and slotted cards for the coding of fossil types and specimens in collections (Westermann). Punch- or slotted-card systems are used for compiling subsurface stratigraphic data by the Geological Survey of Canada and by various oil companies and the various conservation boards.

In the oil industry the computers are used mainly for production data, hydrodynamics, formation evaluation, computation of field data, velocity log and theoretical seismograms and in refinery work, of course, the computers have been used for years (Stanton).

T.L. Péwé reports that the Mineral Industry Research Laboratory utilizes physical-chemical and petrographic characteristics of coal to study the effects of blending on Alaskan coals to upgrade the coal.

In palaeontology, Alan McGugan (Calgary) has made an attempt to use a digital computer for biometric analysis of Acrospirifer.

In lithofacies work the Research Council of Alberta has prepared a computer program for lithofacies analysis and has processed the entire Lower Cretaceous sequence in over 650 wells. Computers have also been used for comparative litholog electrolog studies, and the entire file of water analyses in the Oil and Gas Conservation Board has been transferred to tape, and allied model studies have been carried out as well in groundwater.

Khamesra (M.Sc., U. of A.) used a computer for the lithofacies fit for Belly River sand production in the Keystone Field.

The standardization proposed by the Geological Survey of Canada to place all analytical data on IBM cards with a standard proposed code for the analytical file is a necessary start on processing.

Recommendation:

> The subcommittee would recommend that the code adopted by the Geological Survey be accepted by other public and private groups in so far as possible, and that this code be issued as a concise government pamphlet to make the coding process available.

Stanton points out that information retrieval is still the first application of computers.

The future use of computers suggested by the subcommittee is restricted in some measure, but the Research Council of Alberta (Habgood) has suggested statistical processing of coal data to decide continuity of deposits. The Geological Survey of Canada at Calgary hopes to develop automatic processing for formation tops, lithologic content, oil and gas shows and environmental indicators.

J.W. Kerr suggests using data processing for evolutionary sequence studies and F.K. North indicates taping as a possible method of microfaunal processing.

MUSEUMS AND COLLECTIONS

Except for the Royal Ontario Museum (Toronto) and the Federal Government museums at Ottawa, no major display collections of geological material are being assembled. Smaller local display museums and teaching museums in universities are maintained with minimum staff. Extensive reference collections of core and cuttings material are being assembled at Calgary, Regina, Winnipeg, and Fort St. John (Charlie Lake). Reference collections of fossils are maintained at Ottawa, and these collections are increasing at a steady rate from all over Canada. Most universities have a partial catalogue of their specimens, with teaching suites as the primary repository.

Most professors have fairly extensive collections within their own fields of research.

The major oil companies have excellent working suites in Calgary or Edmonton, but these are not readily available to all scholars.

The difficulty new universities experience in obtaining reference collections is best exemplified by T.L. Péwé's report from the University of Alaska that most of the Alaska collections go to the United States Geological Survey and that therefore reference collections are almost non-existent.

Recommendation:

> That the Geological Survey of Canada continue its effort to distribute surplus fossil duplicates and plasto types to improve teaching collections in both younger universities and in local display Museums, whenever possible. The distribution of mineral and rock suites have helped in practical geological and prospecting education across the nation.

RESEARCH PROBLEMS AWAITING SOLUTION

This year subcommittee members were requested to list problems with a personal bias rather than from the standpoint of institutional policy.

Western Canada Stratigraphy

Northeastern British Columbia at the moment has such rapid drilling evaluation that detailed correlations are failing behind in Cretaceous, Permo-Carboniferous, Devonian, and in depositional studies of the petroliferous rock units. This has left the stratigraphic studies of the western Cordilleran sedimentary basins more or less untouched. (S.S. Cosburn.)

The Ordovician of northern British Columbia is almost unknown, and studies here would complement those of Jackson and Lenz in the Yukon and Rocky Mountains. The stratigraphic nomenclature of the western Canadian Ordovician should be re-evaluated when studies of the truncation of the top of the Ordovician in British Columbia are extended. (R. Greggs.)

Type sections need to be established and calibrated for the Nicola, Cache Creek and Nanaimo Groups. The composition and source of the Palaeozoic and Mesozoic rocks of Western British Columbia, especially the greywackes, need to be studied to give discrimination to possible islands or archipelagos. (W.R. Danner.)

In the field of palaeobotany, many projects are awaiting solution—the Huntington group of the Lower Fraser Valley is in need of microfossil examination; the Hat Creek coalfield, Kamloops, has provided cores for palynological research; the Jurassic and Cretaceous of the Queen Charlotte Islands need both macro and micro palaeobotanical studies. To these the Hazelton group might be added as worthy of palynological calibration. (G.E. Rouse.)

A literature study of the Tertiary coal bearing sediments of British Columbia is depressing. More deatiled descriptions and structural mapping of these Tertiary sediments are needed with more detailed petrographic and mineralogic studies of their characteristics for engineering uses in highway and damsite work. (Buckham.)

Detailed studies of Upper Cretaceous sandstone bodies in densely drilled areas (e.g. Pembina, Swan Hills) to outline geometry and probable environments of deposition (such as conducted by Khamesra for the Keystone, Belly River, U. of A. thesis, 1963). Additional detailed studies of carbonates (of the calibre of Ed. Klovan's Ph.D. thesis, Columbia University, on the Redwater D_3). Compaction and draping studies are needed over the Devonian reefs to give details of amount and time. Checking of reef-knoll development along the reef fronts and environmental and origin studies of the Nisku anhydrites are still in abeyance. The work of Williams and of Belz should be followed up to outline the drainage patterns on the old post-Palaeozoic unconformity surfaces. (Helen R. Belyea.)

Age and correlation of the subsurface Saskatchewan Devonian should be extended (following the lead of the work of Kent, etc. of the Saskatchewan Government). Also required is a rework of the Belly River, white speckled shales and other Cretaceous sediments in Saskatchewan for facies time calibration and provenance. (W.G.E. Caldwell.)

In Manitoba, S.J. Nelson's memoir on the Ordovician Palaeontology of the Northern Hudson Bay Lowland[1] Palaeozoics has

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[1]Geol. Soc. America, Memoir 90, 1963.

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filled a bad gap on stratigraphic palaeontology. In 1964 the Geological Survey initiated an investigation of the Devonian classic sections of Lake Winnipegosis. A new evaluation of possible hiati in the Cretaceous section in Manitoba would be invaluable for assessing Cretaceous palaeogeographic outline.

Eastern Canada Stratigraphy

The confusion introduced into the stratigraphy of the St. Lawrence lowland, Ottawa valley and Ontario peninsula by the misuse of biostratigraphic terms needs elucidation. The Ottawa graben system should be dated by stratigraphic evidence. Microfacies of carbonate units of the Palaeozoic should be defined for southern Ontario. The post-Pennsylvanian faunas of the East should be re-examined and further work done. (F.K. North.)

In the Kingston, Ontario, area, a critical appraisal of Middle Ordovician nomenclature is required to facilitate correlation with the Ottawa valley and New York. Some cognizance should be taken of the possible extent of post-Ordovician uplift of the Frontenac axis. (R, Greggs.)

In the Maritimes the various coal basins are in great need of palynological studies tied to local stratigraphy. If tied with sedimentation studies, evaluation of oil or gas potentialities might well be facilitated. The amount of detail required to unscramble the New Brunswick Ordovician-Silurian beds is a prerequisite to the understanding of palaeotectonic movements for historical geology. In the light of the Prince Edward Island discovery of Permian faunas in the red-beds a further effort should be made to recover a vertebrate fauna from the Triassic fresh-water beds of the Maritimes. (H. Greiner.)

The age relationships of the Humber Arm to the Table Head units and the age of the Terranceville conglomerate are needed to analyse the faulting and tectonics of Newfoundland. The Cambrian-Ordovician boundary needs to be resolved on Bell Island. (R.D. Hughes.)

Northern Canada Stratigraphy

The Permo-Pennsylvanian strata of the Yukon and the Arctic Islands need priority for study until a valid calibration can be tied through from Ellesmere Island to northern Yukon and ultimately further south to northern British Columbia. (S.J. Nelson, J.W. Kerr and R. Greggs.)

In Alaska much more reconnaissance work is required to evaluate the distribution of Palaeozoic rocks so that the regional picture of faunas and facies may be given a spatial meaning. This also applies to much of central Yukon, although the two large operations of the Geological Survey of Canada in the Porcupine area and on the south end of the Mackenzie Mountains have given us a good start on the Yukon side. (T.L. Péwé.)

Studies of the Early Cambrian trilobites and enigmata from Ellesmere Island are awaiting intensive study. The new collections of the Arctic Ordovician faunas should be recalibrated against known sections elsewhere. Palynology studies should be extended for the middle and upper Devonian of the Arctic Islands as well as later Palaeozoic. (J.W. Kerr.)

The micro- and macro-palaeobotany of the Tantalus Formation of the Carmacks district, Yukon Territory, needs more study, and a plant-microfossil analysis of the Upper Devonian of the lower Mackenzie Valley is needed. The Tertiary of the Mackenzie Valley, near Fort Norman, should be redated with the use of palynological techniques, and a proper latitude variation for Tertiary floras should be worked out from the international border to the Arctic Islands to assist in the evaluation of the age of isolated Tertiary basins. (G.E. Rouse.)

The Cambrian of the Yukon and Northwest Territories has been neglected because it is usually considered pre-oil. However, with the Crest iron-ore development in Northern Yukon in pre-Ordovician strata some additional stimulus may be provided for stratigraphic and palaeontology studies. (R. Greggs.)

The classic Devonian sections of the Norman Wells-Fort Good Hope area should be restudied in the light of our expanded knowledge of the Givetian generally. A new survey is required between the Shield and the Franklin Mountains. (A.W. Norris.)

Recommendation:

> The Committee suggests a helicopter operation of the Geological Survey of Canada, within the area between the Franklin Mountains and the Shield, since information on basins, facies and floodings in this region is extremely scanty.

General Stratigraphic Problems

A concerted effort should be made to define the Atlantic-Pacific faunal realms of the Cambrian and determine the true presence or time of the so-called New Brunswick geanticline. A complementary philosophic study is required to contrast evolutionary faunal sequences with facies-controlled faunal sequences. (F.K. North.)

Relationships of dolomite and shale facies are in great need of study apart from the reefoid complexes. The question of what constitutes a carbonate front has been too much biased by Devonian (Alberta) and Permian (Texas) studies. (F.K. North.)

The relationships, ecological and stratigraphic, of Permian Tethyan faunas of the western part of North America with those of the Arctic, Cordilleran, and trans-Pacific, need a complete integration before correlations with the American interior can have meaning. (F.K. North.)

A new definition of the Silurian-Devonian boundary for world-wide correlation is possible from the Arctic Islands and northern Yukon, as the sections there seem to be continuous. Drs. Lenz and Boucot are interested in these problems and should have tentative solutions within the next few years. Additional material toward the carbonate-shale facies boundaries will be required from other localities, however. (R. Gregg and A.W. Norris.)

Canada should try to adopt a single set of stage names for the Palaeozoic, as is already being done for the Mesozoic, for calibrating correlation charts, preferably the European names. Our position across the Atlantic and across the Arctic from Europe makes this entirely feasible. (G.E.G. Westermann.)

The problem of the relationship of stratigraphic provinces to structural provinces needs study. The pattern of migration of both types of provinces with time should give a crustal deformation model integrated with the rate of deformation. This of course has an immediate corollary in the influence of basement pattern on sedimentation and later structural analysis. (J.W. Kerr.)

Physical conditions (atmosphere, climate, type and abundance of organic debris, salinity, pH, type and frequence of vulcanism, etc.) must have changed more or less progressively or intermittently with geologic time, and may have resulted in some sort of widespread chemical "fingerprint" preserved in the sedimentary rocks (trace elements, characteristic chemical ratios, isotope variability, etc.) which, if valid, could be used to date strata once reference sections were established. Diagenesis in general, and diagenetic effects on reservoir rocks in particular, need more study. (M.S. Stanton.)

Conclusions

Over fifty per cent of the projects suggested in the 1961-62 report are still on the proposed list and many of the remainder of that year are still unresolved but not considered as pertinent by the present subcommittee. It seems, therefore, that this type of analysis of potential research projects should be done every three years only.

REPORT OF THE SUBCOMMITTEE ON SCHOLARSHIP AND RESEARCH TRAINING

Presented by L.G. Berry

Members of the Subcommittee

L.G. Berry (Chairman)	Queen's University, Kingston, Ontario.
J. Béland	University of Montreal, Montreal, Quebec.
G.M. Brownell	University of Manitoba, Winnipeg, Manitoba.
W.D. Brueckner	Memorial University of Newfoundland, St. John's, Newfoundland.
A.R. Byers	University of Saskatchewan, Saskatoon, Saskatchewan.
R.E. Folinsbee	University of Alberta, Edmonton, Alberta.
C.G.I. Friedlaender	Dalhousie University, Halifax, Nova Scotia.
K.C. McTaggart	The University of British Columbia, Vancouver, British Columbia.
W.W. Moorhouse	University of Toronto, Toronto, Ontario.
F.K. North	Carleton University, Ottawa, Ontario.
G. Perrault	Ecole Polytechnique, Montreal, Quebec.
G.H. Reavely	University of Western Ontario, London, Ontario.
R. Sabourin	Université Laval, Quebec, P.Q.
D.M. Shaw	McMaster University, Hamilton, Ontario.

In January 1964 a circular letter was sent to all university departments in the earth sciences in Canada. Most of the departments replied through one member of staff. The committee listed above is composed of these correspondents. The questions are repeated here with a summary of the replies to each.

SCHOLARSHIPS

(1) Are more scholarships required? Most replies gave an affirmative answer, three replies indicated a greater need for undergraduate scholarships, two emphasized graduate scholarships. Several replies suggested caution because of the uncertainties of job opportunities in the mineral industries in the future.

Two correspondents referred to the difficulty of awarding scholarships which are available from a variety of sources: "Our biggest problem is not being able to make a firm offer of a scholarship to a good student when he applies. Early each spring, we have a number of good students who are making applications for a University Fellowship, N.R.C. Bursary, University Foundation Scholarship or to other scholarship funds across the country. No one knows which one will be granted and the student, as well as the department, is kept in suspense for a long period of time waiting for a reply. This involves a lot of needless work for both applicant and staff. If these scholarships could only be assigned to a department and the department itself be free to make the award, then a great deal of trouble would be avoided. We have one such fellowship in our department, and it is the least trouble to administer. If all the scholarships available by competition were divided equally between the various universities and all this business of applications with the attendant paper work were eliminated, it would be a real blessing" (G.M. Brownell). Many of us have had this difficulty. There is probably no simple solution, but it would simplify the problem if some proportion of the N.R.C. scholarships were assigned to the universities for award, although the present system may result in a fairer distribution to the best candidates.

Three replies gave a negative answer. At Dalhousie University all accepted students can expect to receive a scholarship. One university suggested that more scholarship aid would decrease the number of students available for summer survey employment. At Saskatchewan, it was proposed that all students with a good undergraduate record should be assured of support.

(2) Should there be larger scholarships? Most replies to this question were in the affirmative, although there was considerable divergence of opinion on the desirable size of scholarships. It was pointed out that some scholarships were established a number of years ago and are quite inadequate. This is certainly true of those given at some universities where the amount is governed by the size of some private gift for this purpose. There is little that can be done about this except to supplement the award by payment for laboratory assistance.

The minimum size of scholarship suggested was $1,500 to $2,000. One member suggested that students should receive adequate remuneration on a twelve-month basis—not merely a starvation wage. The amount should increase with experience, especially with senior Ph.D. candidates, who are often expected to accept considerable teaching responsibility. F.K. North comments that, in their particular situation, stipends should be large enough to compare favorably with those available to temporary technical officers at the Federal Agency laboratories. Another suggested that scholarships should be large enough to permit a student to spend full time at studies. At Dalhousie University the stipend is $2,000 to $2,750, including fees and an honorarium for laboratory assisting ($600 - $900). Ecole Polytechnique recommends scholarships of $3,000 and $4,000 per year. Western Ontario recommends: Undergraduate $600 plus fees, M.Sc. $1,200 plus $400 for laboratory assisting, Ph.D. $2,400 plus field expenses.

(3) Should scholarship regulations require or permit some teaching by the holder? Two replies suggested that assisting work should be kept to a minimum to permit maximum concentration on studies or research. In contrast, three replies indicated that assisting work is required to the extent of one or two half-days a week. Two suggested that assisting should be required. The remainder felt that students should be permitted and perhaps encouraged but not required to undertake teaching. One reply suggested that senior graduate students are often expected to accept considerable teaching responsibility at very low remuneration compared with that received by junior staff members. It is hoped that this situation only exists under emergency conditions. Ecole Polytechnique suggests that the following should all be available: Scholarships (no teaching) at least $3,000 per annum; assistantships (minor teaching) at least $3,000 per annum; junior staff appointments, half-time research and studies, half-time teaching, at least $4,000 per annum.

(4) Will more or larger scholarships revive the flow of students into our discipline? Widely divergent opinions were expressed in the replies to this question. Several indicated that the flow of students is now adequate. One expressed the view that the ease with which graduates find suitable jobs is of foremost importance. Jacques Béland states: "As to boosting the recruiting of geologists we feel that as long as the mineral industry and government agencies will not recognize that geologists ought to receive just compensation for the hardships they have to put up with in their trade, the talented students will continue to seek more remunerative, less exacting and more stable fields of activities." It was also suggested that this will encourage foreign students to come to Canada and also slow up the flow of our better students to the United States. W.W. Moorhouse comments: "Scholarships are not enough. Other means must be found for publicizing the earth sciences and keeping high school students and staff informed of the variety of fields available in geology, and of the current employment situation in the mineral sciences. This is a public-relations problem in which all elements of the profession and the mineral industry have a responsibility, not only in their own interests but also in the public and national interest as well." It was

also suggested that better introductory courses in geology and even conferences in high schools would be much more effective. Carleton University suggests that more scholarships would be effective at undergraduate level, especially if tied to honors standing.

(5) Should scholarships combined with remuneration for teaching assistance be large enough to pay the minimum expenses for foreign students under Canadian living standards, since they normally are not eligible for summer field employment? The replies to this question, in general, maintain that scholarships should be adequate for Canadian living standards. It is highly desirable that these people undertake summer field work, for this is one of the advantages of coming to Canada. This is now possible at least in Saskatchewan, Quebec and Nova Scotia. In the latter some discrimination against colored students has been noted. W.W. Moorhouse suggests "Scholarships should be sufficient to support foreign students throughout the year. Another possible way of coping with this would be an industry- and government-supported program of field training and experience, under qualified and experienced instructors, so that foreign students returning to their own countries would have a background of practical experience in field techniques, which in the underdeveloped countries is surely the most important and useful skill they can take home with them." Several years ago two Colombo plan students from Indonesia spent their summer at the joint Massachusetts Institute of Technology-St. Francis Xavier University field school in Nova Scotia; they were supported financially. When field work is impossible some students could be supported as assistants from research grants provided by the National Research Council or Geological Survey of Canada.

(6) Is it desirable to encourage more graduate students to come to Canada from other countries? All agreed that this is desirable, subject to some reservations. Memorial University finds it necessary to accept foreign students to maintain a graduate school. Preference should be given to Canadians if space is restricted. Ratio desirable is one foreign student to three Canadians, although one respondent suggests a limit of one to one. Several point out that our admission standards should be maintained at the usual level. Some emphasize that it is our duty to admit qualified students from the underdeveloped countries, especially Asiatic, African and South American areas; they should return to these countries. It is also desirable to accept students from the United States and United Kingdom.

W.W. Moorhouse proposes: "However, it is most desirable that there should be a central clearing house, where records of such students could be filed, for reference in evaluating new applications. Some schools, in India and Pakistan, for instance, do not provide their students with sufficient background to permit them to cope with graduate programs. Other schools produce excellent students, able to compete with our own graduates on equal terms. This would be a very valuable function which the National Advisory Committee on Research in the Geological Sciences could perform. Most Canadian geology schools have had foreign students from time to time, and our responsibilities in providing graduate facilities for them would be much easier to discharge if experience with students from as many foreign universities as possible could be pooled." This proposal should be considered seriously by the National Advisory Committee. If such data could be collected, kept up-to-date, and made available on request it would greatly help in assessing the record of an applicant from these countries.

RESEARCH TRAINING

(1) Are present facilities—space and research equipment—adequate for research training? Most institutions report that space and equipment for research training are barely adequate, or filled to capacity. In some institutions space and equipment are inadequate but in one they are adequate if only really good students are accepted. Several replies stress the shortage of technicians, and other the shortage of staff to supervise research.

(2) Are the funds currently available for research adequate to support research in which graduate students take part? Most replies indicate that funds are barely adequate to adequate. Presumably the shortage of technicians mentions in (1) is a result of lack of funds. Several replies point out that there is a shortage of funds for field studies outside of the programs carried out by Government surveys. It is noted that "theses based on survey field work, rarely coordinate with existing research programs in university departments, and for this reason tend to accentuate the already rather distressing patchwork pattern which characterizes the research projects of a university geology department. Often the supervising staff member will have only a superficial interest in thesis problems of this type, since they distract him from his own investigations, a situation which is not strictly fair to the student who is doing the work." (W.W. Moorhouse.) One reply mentions the need for funds for post-doctoral fellowships.

It is pointed out that funds are often adequate for equipment and student assistance but the "present system of obtaining and retaining grants makes it difficult to hold on to a good prospective student. At present, applications for grants are submitted in January and the results made known in May or June, often too late to retain an interested student, or the students still available are not interested in the projects for which funds were granted. Advance knowledge of the approval of grants would in part relieve this situation and allow retention of good students interested in a particular research project." (A.R. Byers.)

K.C. McTaggart comments: "It would be desirable to have money available on short notice rather than to have to wait a year or so before getting some relatively small project under way and finished."

For some research facilities such as spectrographic laboratories, assurance of support for two or more years is desirable.

F.K. North comments: "The demands for money and space for research are obviously endless. I would make only two (quite personal) observations on the point. First, whatever may be true of some other countries, Canada is still not at the stage when geological research can be moved bodily out of the field and into the laboratory. Second, we are not at the stage at which we can afford great duplication of research facilities. The growing emphasis on "team" research makes for large individual graduate schools. It is obvious that, unless we can greatly increase the enrolment in undergraduate schools, and also greatly increase the demand for trained geologists, only a handful of our schools can continue to turn out far more M.Sc.'s and Ph.D's than B.Sc.'s. Rather than embark upon open competition for graduate students among the departments in a single province (such as Ontario), might it not be better to let the large schools continue to dominate the graduate scene; or, alternatively, for the departments to agree to stick to certain fields and avoid hiring faculty members whose specialties will drive them into other ones? I am aware of the research men's stock answer to this, but I am not convinced by it, and Canada's research problem is less one of finding a lot more dollars for research (important though that is) than of making the existing research dollars go further."

Recommendations:

(1) There should be a modest increase in the number of scholarships available for undergraduate studies and graduate and post-doctoral studies and research. National Research Council scholarships are about adequate for the students with first-class academic standing. There are, however, many students with high second-class standing who are deserving of scholarship support.

(2) The revised N.R.C. scholarship schedule announced for 1964-65 meets most of the suggestions as to the minimum size of scholarship, but only for students with first-class standing. Even then the value of a twelve-month scholarship falls far short of the winter portion plus the amount which can be earned on field work. Is it not desirable to enable the student to devote twelve months of the year to his chosen research problem rather than breaking off for four to five months to work at something else? Often the summer work is unrelated to his thesis work although providing, in some cases, valuable general experience in his chosen profession. An improved scale of payments from research grants would help in this problem.

(3) The importance of requiring laboratory assistance from scholarship holders depends on the requirements of the university department and the number of graduate students available. Some departments are paying graduate students at a fairly high rate from university or research funds for three to six hours per week to supplement scholarships and attract good students. Again, this requires increased funds from research grants or from university budgets.

(4) An increase in scholarship assistance is desirable for those universities which are staffed and equipped to handle a larger number of students providing the job market does not become flooded.

(5) Foreign students should have sufficient support to meet Canadian living costs. They should be able to take part in field work since this is one of the advantages of coming to Canada.

(6) It is our duty to accept students from underdeveloped countries if they meet our entrance requirements. It is desirable to accept students from Britain and the United States also. It is recommended that some pool of information be collected on our experience with Asiatic students especially. If available to all earth science departments it should help in assessing the background preparation of a student applying from a little-known institution.

Research Training

It is recommended that more technicians should be available especially in those departments where advanced instrumental techniques are employed. This assistance is necessary for staff research as well as for graduate student programs. For the sake of continuity in the work and security for the technician it is preferable that these people be employed by the university unless the research grantors can give some assurance of continuity of support.

It is recommended that funds should be made available to enable students and staff to pursue field investigations in their field of interest rather than being tied to government programs.

Funds should be adequate to enable departments to maintain their equipment and keep it up to date, but it is not recommended that every department attempt to acquire the latest equipment in all fields of earth science research.

REPORT OF THE SUBCOMMITTEE ON MINERALOGY, GEOCHEMISTRY AND PETROLOGY

Presented by D.M. Shaw

Members of Subcommittee

D.M. Shaw (Chairman)	McMaster University, Hamilton, Ontario.
C.M. Allen	Mount Allison University, Sackville, New Brunswick.
R.W. Boyle	Geological Survey of Canada, Ottawa, Ontario.
F.A. Campbell	University of Alberta, Edmonton, Alberta.
R.B. Ferguson	University of Manitoba, Winnipeg, Manitoba.
W.E. Hale	University of New Brunswick, Fredericton, New Brunswick.
J.A. Maxwell	Geological Survey of Canada, Ottawa, Ontario.
V.A. Saull	McGill University, Montreal, Quebec.
F.G. Smith	University of Toronto, Toronto, Ontario.
R.M. Thompson	University of British Columbia, Vancouver, British Columbia.

REVIEW OF CURRENT RESEARCH

Current research projects that have been reported (Pt. II) indicate much work in progress. They fall into the following categories:

Category	Number of Projects
Mineralogy	48, including 3 on meteorites
Geochronology	25
Geochemistry	95
Petrology and Petrography	122

The numbers do not give a true picture of the relative proportions of projects in the different fields because some projects are included under more than one category. Only 17 of the petrology and petrography projects are being carried out at the Geological Survey of Canada. These probably do not include all projects under way there, and a more complete record should be obtained in future years.

A review of the projects indicates:

(1) Many projects are detailed instrumental studies that are based on outgrowths from careful field studies.

(2) The growing use of rapid-analysis methods of various kinds is leading to an ever increasing flood of numerical data.

(3) There is an increasing interest in the application of statistical theory and methods which is an inevitable outcome of the use of rapid-analysis methods.

(4) Geochronological studies are in progress at eight universities (Alberta, British Columbia, Manitoba, McGill, McMaster, Queen's, St. Francis Xavier and Toronto) in addition to the Geological Survey of Canada.

(5) There is a marked contrast between the number of research projects in progress and the number of papers published by Canadian earth scientists. Nobody wants to see all results published regardless of merit and interest, but it seems probable that too many projects are left incomplete, or not written up. What can be done to remedy this situation?

(6) There is a relative lack of projects in the following fields:
  a structural crystallography
  b experimental silicate-phase petrology
  c experimental mineralogical thermo-chemistry
    i.e. determination of thermodynamic parameters of minerals.
  d electron microprobe analysis

No doubt much crystallographic research is going on in physics and metallurgy, but there is a lack of mineralogical crystallographers in Canada. The other fields, considering their importance to geological interpretation, also seem neglected, although they are given attention in several institutions such as the Mines Branch of the Department of Mines and Technical Surveys. The National Advisory Committee might consider ways and means of stimulating further activity in all these fields.

DATA PROCESSING AND STORAGE

There is a growing need to plan ways of handling the flood of data that is accumulating in the earth sciences. Each subcommittee has been asked to examine this problem, but it is most pressing in the fields of this sbucommittee. Included in this problem is the statistical analysis of the data, its publication and storage with means of access by other workers with the attendant problems of verification (proof-reading) and cross-indexing. A related problem is the availability of computer programs.

It is unnecessary to repeat the views reported in last year's report[1]. Most of the subcommittee members have made useful

[1]National Advisory Committee on Research in the Geological Sciences, Thirteenth Annual Report, 1962-63.

suggestions, and three separate areas of interest are becoming apparent. First, there is the general topic of text-retrieval by machine methods which relies on the recording of all published abstracts and/or articles. F.G. Smith, University of Toronto, is currently working on this subject. Second, there is the recording and cross-indexing of numerical data, with attendant questions of standardized format and of a centralized repository. K.R. Dawson, Geological Survey of Canada, has already made much progress in this direction. Thirdly, there is the cataloguing and exchange of computer programs, although this is possibly unnecessary in Canada because (a) computer manufacturers already have extensive library facilities, (b) geology students will need practice in programming for their own needs and (c) an active group in the United States is already working in this area[2].

[2]Garrison, W.L. and Krumbein, W.C.: Computer utilization in the environmental and earth sciences: a reconnaissance of status and needs; Tech. Report No. 3, O.N.R., Task No. 389-135, Northwestern University.

F.G. Smith suggests a liaison service for geologists with data problems. The National Advisory Committee might consider setting up a small committee of geologists conversant with statistical methods and computer systems for particular studies e.g., bibliographic, programs available, general information on computer languages, annual information circular, etc.

ANALYTICAL STANDARDS

There is widespread need for more reference samples and analytical standards so that analytical laboratories may test and compare results. Following last year's report the National Advisory Committee recommended that the Geological Survey sponsor a cooperative plan for the preparation of standards[1]. This recommendation has been accepted,

[1]National Advisory Committee, Thirteenth Annual Report, 1962-63, p. 13.

and J.A. Maxwell, D.M. Shaw and others are implementing the plan. It has been decided that the reference standards will be bottled and made available under Geological Survey labels after homogenization tests have been met.

Owing to shortage of personnel, the Geological Survey has not been able to proceed as quickly as had been hoped. However, J.A. Maxwell reports that the Muskox picrite is well in hand and that "we are making some 450 splits of 100 grams each". J. Gittens, University of Toronto, is preparing a gabbro and considering the preparation of several alkalic rock standards. At McMaster University some progress has been made in the preparation of a calc-silicate rock and a carbonaceous slate. Fifty pounds of the calc-silicate rock have been crushed and screened to minus 100 mesh; it should provide a stringent test of wet chemical procedures because it contains at least six volatile constituents in addition to the usual cations. The carbonaceous shale has proved difficult to crush and screen, and only 15 pounds of minus 100 mesh powder have been prepared. It is hoped that final preparation of these two reference samples will be undertaken by the Geological Survey.

It is recommended that the Geological Survey continue to give every possible assistance to Dr. Maxwell in this worthwhile project. He should also feel free to call on members of this subcommittee for help, if needed, since several again offered their services and facilities.

MISCELLANEOUS TOPICS

Subcommittee members were asked for views on a variety of other topics; some of these are summarized in the following:

Special colloquia on mineralogical, geochemical and mineralogical topics. Several recommended such meetings but mentioned the inherent travel problems. Among the colloquia suggested were ones on analytical methods (J.A. Maxwell), statistical methods on geology (V.A. Saull), and on X-ray diffraction and fluorescence (F.A. Campbell). R.W. Boyle suggests an International Geochemical Year.

Functions of the National Advisory Committee. W.E. Hale suggests the Committee might make its services available to help university geology departments on development and self-appraisal.

Probably most regard the Committee as primarily a granting agency, but it has many other worthwhile functions. The 33-per cent increase in grant funds in 1964-65 is noted with pleasure and it is hoped the upward trend will continue. Perhaps it may eventually be possible to award a few post-doctorate fellowships.

CONCLUSIONS

The principal recommendations of this report may be summarized as follows:

That the National Advisory Committee

(1) consider ways and means of stimulating research in the fields of structural crystallography, experimental petrology (phase studies and thermochemistry), electron microprobe analysis;

(2) set up a liaison committee concerned with data-processing information and studies;

(3) continue and, if possible, accelerate the preparation of analytical reference samples or standards;

(4) again consider the possibility of awarding post-doctorate fellowships;

(5) consider if there is merit in the concept of an International Geochemical Year.

REPORT OF THE SUBCOMMITTEE ON MINERAL DEPOSITS

Presented by A.W. Jolliffe

Members of Subcommittee

A.W. Jolliffe (Chairman)	Queen's University, Kingston, Ontario.
D.R. Derry	Consulting Geologist, Toronto, Ontario.
R.W. Boyle	Geological Survey of Canada, Ottawa, Ontario.
M.H. Frohberg	Consulting Geologist, Toronto, Ontario.
C.P. Jenney	Consulting Geologist, Tucson, Arizona, U.S.A.
A.H. Lang	Geological Survey of Canada, Ottawa, Ontario.

REVIEW OF RESEARCH

The pattern of research in the field of mineral deposits remains relatively unchanged from year to year. Studies that deal primarily with problems of economic geology or that have some economic connotations continue to make up a substantial proportion of those listed (Pt. II, p. 70). In this connection it is suggested that the labors of the secretary and subcommittee chairmen might be eased if each researcher were encouraged to supply some indication of emphasis to clarify and supplement the title of his project.

COMPREHENSIVE RESEARCH STUDIES OF A SELECTED ORE DEPOSIT

The first venture of the National Advisory Committee into this field seems to be drawing to a successful close. The initial suggestion for such an approach stemmed from this subcommittee under the chairmanship of H.C. Gunning in 1957. The Coronation Mine in northern Saskatchewan was selected in 1960, and D.R.E. Whitmore of the Geological Survey of Canada was named to coordinate the project. Although certain research investigations have still to be completed, the scope and progress to date are reflected in the following eight papers presented at the annual meeting of the Canadian Institute of Mining and Metallurgy in Montreal, April, 1964.

Cordierite Anthophyllite Rocks, Coronation Mine Area: E. Froese, Queen's University and D.R.E. Whitmore, Geological Survey of Canada.

Gravity Studies in the Coronation Mine Area: W.C. Brisbin, University of Manitoba.

Some Aspects of the Quantitative Mineralogy of the Coronation Mine, Saskatchewan: J.A. Gilliland, University of Manitoba.

Palaeomagnetism in the Coronation Mine: Z. Hajnal, California Standard Company, Calgary.

Trace Copper and Zinc in the Coronation Mine Overburden: A.R. Byers and B.P. Scott, University of Saskatchewan.

Distribution of Copper, Zinc, and Nickel in Bedrock of the East Amisk Area: J.R. Smith, Saskatchewan Research Council.

Temperatures of Crystallization of Pyrrhotite, Pyrite, Sphalerite, and Quartz from the Coronation Mine, Flin Flon Area, Saskatchewan: R.G. Arnold, Saskatchewan Research Council.

Origin and Development of Pyritic Copper-Zinc Deposits of the Coronation Type: D.R.E. Whitmore, Geological Survey of Canada.

DATA COMPILATION AND PROCESSING

Repeated reference has been made in past subcommittee reports to the problem of coping with the ever-rising flood of geological publications. Advance in all sciences takes place in two quite different ways—by the acquisition of new data, and by the discovery of unifying principles whereby data already known are explained. The former is a more or less continuous process, and an alarmingly accelerating one. The latter is discontinuous and unpredictable but, unquestionably, is responsible for the main milestones in scientific progress. One implication from all this is that the information necessary for the next major "break-through" in the science of economic mineral deposits may well be already available. A further implication is the compelling need for some effective method of working over this glut of information so that any meaningful repetitive patterns or regularities may be revealed.

The problem is particularly acute in the field of mineral deposits where selection, weighting, and recording of data varies so much with the observer. Furthermore, the fact that such a high proportion of geological data cannot be expressed numerically does not render these less valid, but it does make them much less easily handled. The answers yielded by any mechanical data-processing device are obviously no more reliable than the information fed into it. The latter, in the field of mineral deposits, can be incomplete, subjectively biased, and even demonstrably wrong.

Nonetheless, the present ferment regarding data processing serves a most useful purpose in forcing closer scrutiny and reassessment of our basic data. The comments received from subcommittee members reflect to some degree the general lack of agreement within the profession on these matters. Some economic geologists would stress the geological or structural setting, others the mineral paragenesis or enriched element assemblage, and so on. At the same time there seems to be a healthy growth of skepticism towards orthodox genetic classifications which, too often, have colored observations. In any event, one of the prerequisites for progress may be a re-defining of the various sorts of patterns (areal, structural, mineralogical, elemental, etc.) that economic mineral deposits can display, thereby establishing parameters to which all studies of such deposits could be keyed.

A.H. Lang believes that data processing would be important in providing

> "....generalization for such matters as elemental and mineral associations, relationships to geological and structural provinces, etc., etc. This would permit a much more thorough basis for the empirical approach to these matters than ordinary tabulations, simple punch cards, etc. Advanced data processing could probably be done now for local problems, but it does not seem to me to be worth while at present for country-wide compilations because some of the larger companies would probably not supply data, and there would not be much point in going to a lot of trouble to process incomplete data."

C.P. Jenney, after wrestling all winter with problems connected with the evaluation of certain deposits, points out that such a task involves coping not only with all the geological variables, but also with the equally formidable, nebulous, and ever-changing economic factors. He writes:

> "In my opinion, mathematical techniques and computer applications in mining and exploration can be as useful to us in exploration for new mineral deposits as the telephone and telegraph. In development, assessment, exploitation and estimate of future income they can take all the guess-work out of the mine-manager's job and eliminate all the shafts put down in the wrong place and open-pits designed for 10 years' operation which should have been laid out for 40 years' operation ......(However) as far as locating new mines goes, they are, in my opinion, no good at all".

He also points out that not much work along these lines seems to have been done in Canada, whereas two symposia on the computer approach have been held in the United States:

Computer Short Course and Symposium on Mathematical Techniques and Computer Applications in Mining and Exploration; Tucson, Arizona, 1962.

The Applications of Statistics, Operations Research, and Computers in the Mineral Industry; Golden, Colorado, April, 1964.

Canada was represented at the second of these by three speakers. Luciano Martin of Toronto discussed "Study by Computer of the Characteristics of Magnetic Anomalies". "Experimental Approach to Trend Surface Analysis" was reported on by F.P. Agterberg of the Geological Survey of Canada. J.R. Woodward, Eldorado Mining and Refining, outlined "Computer Programs for Solution Balances in a Hydrometallurgical Process". Perhaps the paper of widest interest was that on "Storage and Retrieval of Geological Data" by T.G. Lovering and D.F. Davidson of the United States Geological Survey.

D.R. Derry suggests that the Mineral Occurrence Inventory maintained at the Mineral Resources Division, Department of Mines and Technical Surveys in Ottawa, may prove useful in setting up computer cards or other storage systems appropriate to the field of mineral deposits. At present these files stress economic matters, but Derry sees no reason why "a certain amount of basic information of value in more fundamental research" might not be included. Among the latter he rates age determinations as important. He also pleads for closer studies of country-rocks and points out that a number of important mineral deposits, formerly reported to lie in slate, greywacke, or grit, now prove to be in tuff or in sediments carrying significant amounts of intermixed ash. The same sort of discrepancy has been noted by others in connection with lead, zinc, and gold deposits in Europe and Australia.

R.W. Boyle has just completed a comprehensive review of the geochemistry of deposits of silver, and brings first-hand experience to the problems of data search and compilation. He views the task of attempting this for all metals in all types of deposits as of formidable proportions. However, it might be attempted "if the staff were provided and cooperation obtained from the mining industry." He argues that data on deposits should be "keyed to the geological setting and not to hypothetical temperature zones, magmatic solutions, sedimentary hypothesis, etc., etc.". He also states:

> "I think that the best way to get at this problem of data compilation is to base it on elements rather than on types of deposits. The distribution of each element in all varieties of earth materials should be compiled together with that of the data on the various types of enrichments (deposits) of the element. When this is done one can often see a definite relationship of the element to various rock types, geological environments, and often a specific relationship with other elements, either in the rocks or deposits".

Dr. Boyle's last point strikes a responsive chord in the chairman's bias, and will be elaborated upon: The chemical-element content of an ore deposit seems likely to be more fundamental, more permanent, and more economically important, than is that deposit's mineral assemblage. Furthermore, it constitutes one of those rare features of deposits that can be established readily and objectively (by analysis of a mill-head sample), and that may be treated in a numerical fashion. Accordingly any data-system applied to ore deposits should probably have elemental chemical composition as one of its prime parameters.

Obviously, the mere listing of "associated elements" in an ore deposit is meaningless—presumably one could list some 70-odd elements that are "associated" in a single sample of granite by using sufficiently sensitive analytical techniques now available. Nor is the fashion in which most chemical analyses of geological materials are usually reported particularly helpful. The essential feature of an orebody is that a relatively small number of elements are enriched therein some hundreds or thousands of times above their normal content in rocks. The best available yardstick for measuring such enrichment is the "concentration clarke", by the use of which a long and involved tabulation of an ore analysis becomes strikingly simplified, and attention is immediately directed to those few significant elements that are most strongly enriched.

For example, each of the chief types of uranium deposits shows a rather distinctive enriched-element assemblage, as shown below. The "least enriched" elements have concentration clarkes in excess of 10; the "most enriched" elements have concentration clarkes of about 1,000 or more. In all cases Pb has been omitted, since its degree of enrichment depends upon the age of the deposit.

Type	Most Enriched Least enriched
1. Colorado Plateau	U....V....As...Se...C....S....Mo...Cu
2. Blind River	U........Th........S........Yb.......Y
3. Great Bear Lake	U...Ag...Sb...As..Bi...Mo..Cu..Co..Ni
4. Bancroft	U... Th..B...RE...Zr..La..Y...Ag..Be
5. Oka	Nb....RE.....P......S......Th....... U

These patterns seem reasonably repetitive. Thus, available analyses from a number of Colorado Plateau deposits show much the same enriched-element assemblages as given in (1) above. In some of these the order may show minor shifts; in others certain of the elements listed may fall below the arbitrary cut-off of 10x the normal clarke.

A method of coding analytical data has been proposed in provisional form by K.R. Dawson of the Geological Survey of Canada. This should prove of great use, but such an important step requires the most careful consideration before procedures are finalized. After perusal of Dawson's preliminary submission, at least two points seem worth raising.

(1) Class of Material. An additional category to include ores and orebodies seems most necessary. Such bodies are naturally-occurring mineral assemblages just as much as are "igneous extrusive rocks" or "non-clastic sedimentary rocks". The number and usefulness of analyses of mill-head samples or other ore-mineral aggregates will surely increase. If such a new class

is set up, then a whole series of sub-categories applicable to mineral deposits will have to be formulated—form, structure, mineralogy, texture, enriched element patter, etc.—each with appropriate subdivisions.

(2) Arrangement of Analytical Data. Future advances in analytical techniques are certain, and any element groupings based on present methods or on present frequencies of determinations should be avoided if at all possible. The 73 elements covered in the proposed plan (Cd should probably be included in Card 3 of the Spectrographic File) exclude the inert gases (He, Ne, Ar, Kr, Xe, and Rn); the elements having only transitory natural existence (Ac, At, Fr, Pa, Pm, Po, Ra, Rn, Tc, and the trans-uranium elements); and two of the halogens—Br and I. Some of these may possibly warrant inclusion in the future. In any event, this matter of organization of analytical data is such a key feature in the whole scheme that it should have the closest scrutiny before final decision is made.

In conclusion, at last year's meeting of this committee it was rather rashly suggested that a broad project should be initiated which would culminate eventually in the publication of a volume on the chemistry, mineralogy and petrography of Canadian ore deposits. This would complement the two volumes already published on the structural geology of these deposits. The project envisaged recovery of "unpublished but valuable information lying entombed in countless research theses in university libraries." A preliminary survey (plus some sober second thoughts) indicated the advisability of trying this out on a small scale and within a limited area. A start may be made on this during the 1964 field season.

REPORT OF THE SUBCOMMITTEE ON STRUCTURAL GEOLOGY

Presented by K.C. McTaggart

Members of Subcommittee

K.C. McTaggart (Chairman)	University of British Columbia, Vancouver, 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.
R.J.W. Douglas	Geological Survey of Canada, Ottawa, Ontario.
L.H. Green	Geological Survey of Canada, Whitehorse, Yukon.
V.A. Haw	Mines Branch, Dept. Mines & Technical Surveys, Ottawa, Ontario.
W.H. Poole	Geological Survey of Canada, Ottawa, Ontario.
J.V. Ross	University of British Columbia, Vancouver, British Columbia.
G.A. Russell	University of Manitoba, Winnipeg, Manitoba.
J.O. Wheeler	Geological Survey of Canada, Vancouver, British Columbia.

CURRENT RESEARCH

Topics of current research in structural geology in Canada are listed elsewhere (Pt. II, p.169) and will not be repeated here. It is interesting to find that the number of field projects which, judged by their titles, are concerned largely with structural aspects of geology, is greater by 50 per cent than last year's total. This increase does not necessarily indicate a continuing trend. It may be, however, that with interest increasing in rock mechanics (see below) and with publication of advanced treatises on rock deformation (like Geol. Soc.

America, Memoir 87), research in structural geology will continue to accelerate. One suspects, too, that structural geology gained a little glamor when beta diagrams were produced by a digital computer (Amer. Jour. Science, 1963, p. 913). With the establishment of the Journal of Petrology in 1960, structural geology is the only branch of earth science not having its own publication in English. It seems inevitable that this gap will soon be filled.

One of the most important structural projects under way in Canada is the Tectonic Map of Canada. Dr. C.H. Stockwell has provided the comments that follow:

> "It is now expected that the manuscript will be finished by the end of 1964 and publication scale will be 1:5, 000, 000 (about 80 miles to the inch). The project is a joint effort of the Alberta Society of Petroleum Geologists, Geological Association of Canada and the Geological Survey of Canada. The map will differ from ordinary maps in that the main map units will show the time at which the rocks were involved in orogenies; thus the boundaries between the main units are angular unconformities. Rocks not involved in an orogeny are distinguished from those that are. The legend also indicates the age of deposition or intrusion. This approach makes for a highly complex map, but, it is hoped, a very informative one. In addition, folds, faults, bedding, foliation, diabase dykes, and basement contours are shown.
>
> "Such a compilation and synthesis calls attention to certain weaknesses or deficiencies in the geological maps from which the structural data were drawn. Some maps show few attitudes, especially those of gneissic terranes. In some areas of relatively unmetamorphosed sedimentary rocks which are otherwise well mapped, anticlines and synclines are shown without adequate information on the dips of limbs or axial planes. Some maps do not distinguish between attitudes of beds for which tops are known and those for which tops are unknown."

COMMENTS AND SUGGESTIONS FROM SUBCOMMITTEE MEMBERS

Suggestions by subcommittee members on research and developments in the field of structural geology are condensed below:

J.B. Currie points out that research of various types is carried on now by industry, by government surveys, and by geological departments in universities, and suggests that the universities ought to emphasize "basic research problems rather than problems suggested by structural observation in a particular area. One such basic problem is that of understanding the controls exerted by non-hydrostatic stress on the crystallization of minerals. Such a problem involves a degree of generality that is often missing in many of our short-range programs." J.V. Ross, also interested in laboratory studies on this particular problem, refers to the work of McDonald, Kamb, and Verhoogen. Moreover, he would like to see laboratory research into bending analysis and study of the relation of fold wave lengths to rock type and environment along the lines of work by Biot, Curie, Trump and Ramberg. He believes that in some of such experimental work, ice can be substituted for silicate minerals, with the result that experiments would be relatively simple and equipment inexpensive.

Still in connection with research, R.J. Douglas writes:

> "Notwithstanding the merits of purely structural investigations, the value of structural studies arising out of regional geological investigations should not be down-graded. It is erroneous to presume that the structural aspects of an integrated geological investigation, in stratified rocks at any rate, are of secondary importance—rather the structure and stratigraphy are of equal stature. The greater the stratigraphic refinement, the more precise are the structural observations and conclusions.... Many structural problems arise solely from ignorance of the stratigraphy."

G.A. Russell agrees, and writes:

> "In several instances I have had discussions with Precambrian geologists who seem to be either deficient or uninterested in the applications of basic stratigraphy. By this I mean there appears to be a lack of knowledge of such things as interfingering, not only of sedimentary rock types but also combinations involving sedimentary rocks and contemporaneous volcanic rocks. I think many maps trace different formations as if they had been deposited over thousands of square miles with no variation in lithology or in their stratigraphic relationships with other rocks. For example, one geologist criticized me for my interpretation of a structure as an overthrust simply because there was not a complete repetition of strata on each side of the thrust."

Several subcommittee members argue for better communication between structural specialists. J.V. Ross and W.H. Poole surely speak for most when they favor annual meetings, with symposia on structural geology and publication of the papers presented. A.R. Byers suggests that "some consideration be given to starting an index of publications on structural geology which could be circulated to interested parties on a quarterly basis." He suggests also "annual field conferences of ten days to two weeks to give university teachers of geology a better understanding of geologic structures. Some financial assistance would have to be given to those attending, probably along the lines of the American field conferences conducted under the auspices of the National Science Foundation."

In connection with improvement of training in structural geology, Currie suggests that "it might be discussed among those staff members of Canadian universities who devote a good deal of their teaching time to structural instruction." Such matters as trends in structural research and methods of teaching should be explored.

J.W. Ambrose states that "research in all three fields of structural investigation—geometry, kinematics and dynamics—must be pushed forward. Of these, I think the most exciting, certainly the most fashionable at the moment, is the study of rock mechanics and the relationship of discoveries in this field to structural dynamics."

CANADIAN ADVISORY COMMITTEE ON ROCK MECHANICS

In view of the expanding interest in rock mechanics and its close relation with structural geology, Dr. V.A. Haw, secretary of the Canadian Advisory Committee on Rock Mechanics, was invited to join this subcommittee. He has accepted the invitation and has supplied the following note on the aims of his committee:

"A national advisory committee was organized to stimulate and encourage research in the field of rock mechanics on the initiative of the Mines Branch, Department of Mines and Technical Surveys, in the spring of 1963. It is known as the Canadian Advisory Committee on Rock Mechanics. The committee's main functions are to provide advice to the Director of the Mines Branch on the distribution of federal grants for research, to provide coordination of research activities and to act as a communicating link between all interested parties in Canada working in the field.

"Rock mechanics, insofar as the interests of the committee are concerned, covers rock properties and the behavior of rock in stress environments. Although the scope of the subject will cover basic research in these areas, it is expected that particular emphasis will be given to the application of basic research findings to mining operations and other types of rock excavation. An important role envisaged for the committee will be to link the scientific approach of government and university research laboratories with the background of experience obtained in mining operations. The coupling of the two is considered to be essential in achieving the most effective utilization of effort by all groups.

"Four specific areas of activity have been suggested for the committee's attention: (1) advice on the distribution of government grants to universities; (2) an advisory role on research in government laboratories; (3) an advisory role and assistance to universities in rock-mechanics research; and (4) coordination and liaison amongst groups concerned with research in rock mechanics. For the year 1963, $25,000 was made available for research at universities in rock mechanics. The universities receiving grants, along with the areas in which they are working, are briefly outlined:

1. University of Alberta—permeability of gas to coal in different conditions of stress, and preliminary work related to problems of solution-mining of potash.

2. McGill University—continuing work on the properties of rocks, dynamic testing, loading—time-dependency factors, and failure mechanisms under standard conditions of testing rocks.

3. Queen's University—rheological properties of rocks, and studies of rock fractures—propagation, preferential direction and patterns.

4. University of Toronto—program on model studies.

5. University of Weston Ontario—attenuation coefficients for high-amplitude shock waves in rocks in connection with studies on the control of rock bursts in mines.

"It is recognized that if the committee is to be successful in achieving cooperation amongst all groups interested in rock-mechanics research, it must establish communication with national and regional mining associations, groups working in the related fields of geology and soil mechanics, as well as research organizations active in the general field of materials research.

"The committee consists of eleven members, with Mr. D.F. Coates of the Mines Branch as chairman, and V.A. Haw of the Mines Branch as secretary. The mining industry is represented by five members and the university sector by four members. The members of the committee were chosen, initially, because of their interest and previous activities in support of rock-mechanics research. Present plans call for the holding of two committee meetings a year; one in the spring, primarily to deal with university grants; and the second in the fall at the time of the annual symposium on rock mechanics, held at a Canadian university.

"One of the first projects of the committee as a whole has been the compilation of a bibliography of Canadian contributions in the field of rock mechanics. The bibliography consists of three main sections: (1) published papers by Canadian authors in the field; (2) university thesis abstracts; and (3) Mines Branch reports and publications on rock mechanics and related subjects."

SOUTHERN CORDILLERAN STRUCTURE PROJECT

In its 1963 report the Subcommittee on Structural Geology asked support for a project—study of the structure of a belt across the Cordillera in Southern British Columbia[1]. The project met with

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[1]National Advisory Committee on Research in the Geological Sciences, Thirteenth Annual Report, 1962-63, pp. 17-23.

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approval, and Dr. J.O. Wheeler was named its director. Field-work on the project started in the season of 1964, and Dr. Wheeler reports on it as follows:

"The first report on the southern Cordilleran Structure Project was published in the Thirteenth Annual Report of the National Advisory Committee on Research in the Geological Sciences for 1962-63 (pp. 21-23). It outlined the present state of geological mapping along the strip to be studied, outlined the objectives of the project, and indicated a tentative plan of attack. Since the report was submitted several projects have been initiated. The following report briefly outlines the projects:

1. Cascade Mountains by J. Coates (Ph.D. candidate at University of British Columbia) and one assistant, and supervised by K.C. McTaggart, University of British Columbia. Project included in 1964 field program of Geological Survey of Canada. The project will continue the study of the geology of Cascade Mountains, mainly east of Coquihalla Serpentine Belt (see Hope Sheet, Map 737A), and principally in Manning Park, Coquihalla and adjacent areas, with special emphasis on structure.

   The proposed study is largely an extension of work in the southeastern and central part of the Hope Sheet by K.C. McTaggart and R.M. Thompson. The work completed by them includes sheets 92H-2 (east and west-Skagit) and considerable areas around Hope and north to Alexandra Bridge. Specific problems will be to work out the stratigraphy and structure of the Dewdney Creek, Pasayten, and Jackass Mountain Groups, and to determine their relations to one another; and to study the Hozameen, Gibson, and Chuwanten faults, and to establish the relation of the Cretaceous rocks to the granitic rocks to the east and to the Palaeozoic rocks to the west.

2. Mount Revelstoke Area by J.V. Ross (University of British Columbia) and one assistant. Project is included in 1964 field program of the Geological Survey of Canada. The project involves a study of the structure of the salient of the Shuswap metamorphic complex northeast of Revelstoke. The area lies east of Columbia River and north of the Trans-Canada Highway within map-areas 82M-1 and 82N-4. The proposed study embraces one of the few areas at this latitude where the easternmost or marginal part of the Shuswap metamorphic complex is reasonably well exposed above timberline. Elsewhere this marginal zone lies along the valleys of the Columbia River and Arrow Lakes. Within the salient the dominant structural features are southwest-plunging lineations except near its northeastern margin where lineations plunge gently northwest or southeast. Specific problems will be to determine the change in tectonic style from the main part of the salient to its outer or marginal part and to relate this change to the style of deformation in the structurally higher, less metamorphosed rocks lying to the east. The study will

try to establish the nature of the transition between the Shuswap metamorphic complex and the unmetamorphosed rocks to the east (i.e., is there a dislocation between the two terranes or is there a narrow zone of metamorphic convergence?).

3. Rogers Pass by A.D. Stanley (University of British Columbia). Project supported by the National Research Council and supervised by J.V. Ross. A detailed study of the structures on the western limb of the Illecillewaet syncline. The area adjoins Ross' project (2, above) which lies to the west. It appears to involve structures developed in rocks that are younger and at a structurally higher level than those to the west.

4. Mount Copeland Area by J.T. Fyles (British Columbia Department of Mines and Petroleum Resources). This project is a study in the Shuswap metamorphic complex at the River Jordan Lead-Zinc property 12 miles northwest of Revelstoke, B.C. The mineralization at the property is on a fold which is either conical or is part of an *en echelon* system on the southern flank of the Frenchmen's Cap gneiss dome. The contribution of this study to the structure project will be to determine the nature of the fold and, by means of extending the mapping to include a relatively large area surrounding the property, to establish the relationship of the fold to the structural pattern on the southern flank of the dome.

5. A large helicopter operation in the Rocky Mountain planned by the Geological Survey of Canada has been postponed for 1964. R.A. Price, however, will continue his studies of tectonic fabrics in the southern Rockies.

6. In 1965 Philip Simony, University of Alberta (Calgary) will begin a detailed study of the Northern Dogtooth Mountains, just west of the Rocky Mountain Trench. His work is supported by a grant from the Geological Survey of Canada.

"It is hoped that the project will attract experienced, able, and interested workers in structural geology."

REPORT ON

GEOLOGICAL SURVEY OF CANADA, 1963

Presented by J.M. Harrison

Field work, as usual, took most of the effort of the Geological Survey of Canada in 1963. The Survey had 105 parties in the field which was 11 more than in 1962. The break-down of field parties was as follows:

Thirty-two, systematic bedrock mapping, much of it reconnaissance mapping of remote or little-known areas.

Nineteen surficial deposits or groundwater investigations and engineering geology problems.

Fifteen, stratigraphic and palaeontological problems.

Sixteen, mineral deposits or special studies on granitic, ultrabasic and diabasic rocks, etc.

Twelve, geophysical investigations.

Eleven, geochemical, structural, marine geology and some other specialized studies.

Many thousands of square miles of new territory were mapped in 1963—three major reconnaissance parties completed about 115,000 square miles in the Canadian north. By the end of 1963 the Geological Survey had published geological maps of about 65 per cent of Canada on reconnaissance or more detailed scales; a considerable backlog of material remains unpublished but will appear during the present year. Only in Ontario does the Geological Survey have less than 50 per cent coverage, and some of the remaining 53 per cent is covered by the Ontario Department of Mines maps. In many provinces, of course, in addition to maps published by the Geological Survey, there are those published by provincial governments. During the year some 330,000 line-miles of aeromagnetic surveying was carried out under the joint Federal/Provincial program.

Preparation of the Tectonic Map of Canada which is a joint project in conjunction with the Alberta Society of Petroleum Geologists and the Geological Association of Canada and under the direction of Dr. C.H. Stockwell, continued during the year. A completed manuscript map will be exhibited at the International Geological Congress late in 1964.

The Geological Survey operates four outside offices and has geologists attached to a fifth. These act as sources of geological information for the public as well as providing headquarters for geological research. Some statistics in respect to these regional centres may be of interest. In 1963, the Yellowknife office sold 900 publications and 35 rock and mineral sets, and the resident geologist and his assistant visited 30 mining properties in addition to conducting specific geological studies. The Whitehorse office had 2,035 visitors during the year, sold and distributed 6,500 publications, both topographic and geologic, and during the year the resident geologist visited all operating lode mines and most of the important prospects and placer operations. The Vancouver office had its busiest year with 10,000 visitors registered, 28,000 publications distributed, and 1,000 collections of rocks and minerals sold. The two staff geologists carried out several short field projects during the year, mainly at the request of other government departments. Such requests are becoming more numerous.

During the year the Survey published 10 Memoirs, 15 Bulletins, 1 Economic Geology Series report, 46 Paper Series reports, 22 Multicolored maps, 35 Preliminary Maps, and 577 Aeromagnetic Maps, and there is still a large backlog.

We have recently received official approval to plan for a major western office to be established in Calgary. This will mean a great expansion of the present office which is made up at present entirely of officers from the Fuels and Stratigraphy Division. The new quarters will have representatives from the other divisions as well.

We have continued to have some difficulty because of the austerity program. However, at least partly due to the representations made by the National Advisory Committee at last year's meeting, a considerable easement has been made for Geological Survey recruitment. We are now recruited up to about 95 per cent of our allowable strength, and have received permission to go ahead to recruit up to 100 per cent of strength. We are hoping to gain at least one position in addition.

The build-up of the Marine Geology Unit has been rather slow—it now consists of 5 geologists and 3 technicians—but we hope to gain two more geologists and a technician within the present year. This will at least give us some opportunity to keep up with the ship time available. In addition, we are posting some Regional Geology officers and other specialists to the Bedford Institute in the expectation that it will do both disciplines good to have contact with each other; it may also serve as a recruiting ground for some marine geologists because some of the land-based men may become interested in marine geology.

Because of the general recruitment freeze over the last couple of years, we have made no serious attempt to increase the number of special projects being carried out by the Geological Survey, nor have we been able to expand the number of people engaged on particular projects. With the present easement in recruitment, we may be able to continue our gradual swing to more specialized types of investigations. All of these will not be like that of the Muskox intrusion (Pt. I, p. 10); they will include quadrangle mapping where the quadrangles have been selected mainly for the contained problems. Up to now we have only had about 4 field-party years spent on follow-ups of the reconnaissance work; a great deal needs to be done in this connection.

APPENDIX I

GEOLOGICAL SURVEY OF CANADA RESEARCH

GRANTS TO CANADIAN UNIVERSITIES

1964 - 65

Note - Starred projects have been sponsored by previous grants.

*1. Baadsgaard, Prof. H.,
Department of Geology,
University of Alberta.

Fundamental Research in Geochronology $2,360.00

Laboratory investigations of the relative mobility of various radiogenic daughter elements in minerals and of the relative re-arrangement of uranium, lead, rubidium, strontium, potassium and $argon^{40}$ in rocks during thermal metamorphism.

2. Beales, Prof. F.,
Department of Geological Sciences,
University of Toronto.

Devonian Reef Studies $3,000.00

Field and laboratory studies of Devonian reefs with particular emphasis on the Dawson Bay reefs, Lake Winnipegosis, Manitoba.

*3. Beck, Prof. A.E.,
Department of Geophysics,
University of Western Ontario.

Determination of Underground Water Flows, Coronation Mine $2,000.00

Tritium determinations will be made on samples of water collected in and around the mine, in an attempt to determine the magnitude of underground water flow.

*4. Berry, Prof. L.G.,
Department of Geological Sciences,
Queen's University.

Publication of Canadian Mineralogist $1,500.00

The Mineralogical Association of Canada publishes the Canadian Mineralogist annually. Mineralogical studies are of interest to a relatively small group which necessitates the financial support of this publication.

5. Blais, Prof. R.A.,
Ecole Polytechnique.

Geological Investigations of New Sulphide Occurrences in the Province of Quebec — $2,400.00

Studies of the mineralogy, paragenesis, structure and wall rock alteration of recently discovered sulphide bodies, including use of mineragraphic, petrographic, x-ray diffraction, spectrofluorescence and possibly sulphur isotope and geothermometric methods.

6. Brisbin, Prof. W.C.,
Department of Geology,
University of Manitoba.

Study of Shear Folding in Northwestern Ontario — $1,500.00

The objective of this study is to determine the structural relationship of granitic piercement domes to deformed sedimentary and volcanic series in Fogie-Ewart township in Ontario near the Manitoba border.

7. Brownell, Prof. G.M.,
Department of Geology,
University of Manitoba.

Trace elements in Cretaceous sediments of the Western Plains area and Collapse Breccias and Metal Distribution, Sullivan Mine, B.C. — $1,700.00

The purpose of the first project is to attempt to locate the source of toxic amounts of molybdenum, etc. in the soils of parts of the farm lands of the Swan River Valley, Manitoba. In the second project, mapping and collecting of data at the Sullivan Mine will be followed by laboratory studies to gain more information about the character and origin of the orebody.

8. Brueckner, Prof. W.D.,
Department of Geology,
Memorial University of Newfoundland.

Southern Avalon Geology — $2,800.00

Detailed studies of selected areas to find out the stratigraphic relations of the formations, palaeocurrent patterns, source, and tectonic deformations.

9. Burwash, Prof. R.A.,
Department of Geology,
University of Alberta.

<u>Petrology and Geochronology of Gabbro-Syenite Composite Dyke, Simpson Island, N.W.T.</u> $2,000.00

To determine the time and mode of intrusion of a complex dyke including study of the mineralogy and petrochemistry of the various phases.

10. Caldwell, Prof. W.E.G.,
Department of Geological Science,
University of Saskatchewan.

<u>Stromatoporoidea of Devonian Swan Hills Reef and Devonian Faunas of Mackenzie River Valley</u> $2,500.00

This involves research on the fossil faunas of Devonian rocks with a view to making available descriptions and illustrations of the major groups of invertebrate animals, establishing the age of the rocks in terms of international stages, and zoning the rocks, so that more accurate correlation and palaeographic reconstructions can be made within North America and between North America and Europe.

*11. Clark, Prof. T.H.,
Saull, Prof. V.A.,
Department of Geological Sciences,
McGill University.

<u>Terrestrial Heat Flow in St. Lawrence Lowlands of Quebec</u> $1,200.00

The objectives are to determine depth-temperature curves for boreholes drilled in the vicinity of Montreal; the lithology and thermal properties of the strata penetrated by the holes; and to study the result with particular reference to terrestrial heat flow, artesian water flow, and local and regional rock structure.

12. Clifford, Prof. Paul,
Department of Geology,
McMaster University.

<u>X-ray Petrofabric Analysis and Interpretation</u> $1,360.00

The purpose is to establish the efficacy of x-ray petrofabric analysis in rocks of multimineralic composition and to apply such analysis in structural studies of areas close to the Grenville Front near Sudbury, Ontario.

*13. Cormier, Prof. R.F.,
Departments of Geology and Physics,
St. Francis Xavier University.

Absolute Dating of Rocks and Minerals $2,000.00

The use of the rubidium-strontium method of dating stratigraphically well controlled geological material and the investigation of new methods of dating sediments correctly.

14. Crockett, Prof. J.H.,
Department of Geology,
McMaster University.

Genesis of Strata Bound Ore Deposits $2,500.00

The study of covariance of lead-silver and zinc-cadmium in selected orebodies and wallrocks as evidence for the igneous-hydrothermal replacement or, alternately, the exhalitive sedimentary origin of the deposits.

15. Deane, Prof. R.E.,
Department of Geological Sciences,
University of Toronto.

Geology of Lake Erie Basin $1,700.00

Involves the interpretation of the geological history of the Lake Erie Basin and determination of the sedimentation environment.

*16. Dineley, Prof. D.L.,
Department of Geology,
University of Ottawa.

Conodont Faunas of Ordovician Rocks, Ottawa Valley $ 850.00

The objective is to establish the stratigraphical and palaeoecological value of the conodont faunas and to relate the faunas to the sedimentary environments.

17. Dreimanis, Prof. A.,
Department of Geology,
University of Western Ontario.

Buried Soil in Banff National Park $ 500.00

An investigation of the extensive glacial advance that occurred presumably during the "Little Ice Age", and the climatic conditions that prevailed before this advance.

18. Dreimanis, Prof. A.,
Department of Geology,
University of Western Ontario.

<u>Provenance of Diamonds in Glacial Drift, Great Lakes Region</u> $2,000.00

The objective is to outline possible areas of diamond provenance by study of glacial drift and lithologically probable Precambrian areas along the glacial path.

*19. Dreimanis, Prof. A.,
Department of Geology,
University of Western Ontario.

<u>Stratigraphic Correlations of Glacial Deposits between Lake Huron and the St. Lawrence Lowlands</u> $1,800.00

The research will include lithologic investigation of tills and studies of leeching of soils.

*20. Eakins, Prof. P.R.,
Department of Geological Sciences,
McGill University.

<u>Detailed Structural Studies, Western Appalachian Mountain Belt, Quebec</u> $1,500.00

Studies of deformed rocks in selected areas in an attempt to clarify the fundamental principles of rock folding, cleaving and fracture. Includes field and laboratory examination and collection of data for statistical analysis.

*21. Elson, Prof. John A.,
Department of Geological Sciences,
McGill University.

<u>Glacial Lake Agassiz and Darlingford Moraine</u> $1,500.00

Studies of the shorelines of Lake Agassiz will be of assistance to archaeologists studying sites of early man. The objective of the study of the Darlingford Moraine is to correlate the Pleistocene stratigraphy of Manitoba with that in areas to the east and west.

*22. Fyson, Prof. W.E.,
Department of Geology,
University of Ottawa.

<u>Relation of Minor to Major Structures in the Maritime Provinces</u> $3,000.00

The purpose is to establish the changes in tectonic style of minor structures in Palaeozoic rocks across the Maritime Appalachians and to relate these changes to rock types, position in the geosyncline and time of deformation.

23. Hale, Prof. W.E.,
Department of Geology,
University of New Brunswick.

Triassic Volcanic Rocks as Source of Ore Mineralization, Bay of Fundy Region — $3,000.00

Petrological, mineralogical, chemical and spectrographic studies in an attempt to identify a genetic relationship between post-Carboniferous ore mineralization and the Triassic basalts.

24. Hogarth, Prof. D.D.,
Department of Geology,
University of Ottawa.

Unusual Pyroxenes from Hull and Templeton Townships, P.Q. and the Petrogenic Study of Intrusive Carbonate Rock near Ottawa — $1,000.00

The investigation of the chemical composition and origin of certain pyroxenes with unusual optical properties.

The analysis of coexisting minerals in the carbonate rocks and study of contained pyrrhotite and calcite as geothermometers may help in establishing the origin of these rocks.

25. Jackson, Prof. D.E.,
Department of Geology,
University of Alberta.

Lower Graptolitic Bearing strata in Western Canada — $2,500.00

The purpose is to locate, examine and collect sections of Ordovician and Silurian graptolitic strata in Western Canada that will become standards of reference for intra- and intercontinental correlations.

26. Lajoie, Professeur, J.,
Département de Géologie,
Université de Montréal.

Etude de la "Stratification-Entrecroisée" dans les environnements néritiques — $1,500.00

Le but du projet est de reconstituer aussi fidèlement que possible l'environnement néritique en laboratoire, et de reproduire la formation de ces structures dans un grand nombre de conditions différentes, afin de pouvoir en étudier le produit par statistique.

27. Laming, Professor D.J.C.,
Department of Geology,
University of New Brunswick.

<u>Recent Sedimentation in Northumberland Straits</u> $2,500.00

Study of the bottom sediments, involving sampling, laboratory examination of texture, mineralogy, organic content etc., and statistical analysis.

28. Laming, Prof. D.J.C.,
Department of Geology,
University of New Brunswick.

<u>Recent Continental Slope Deposits Southeast of Nova Scotia</u> $1,500.00

Examination of texture of recent sediments from the continental slope and outer shelf along a number of cross-profiles. This will involve sea bottom grab sampling and laboratory analysis of muds by several physical methods.

29. Lerbekmo, Prof. J.F.,
Department of Geology,
University of Alberta.

<u>Continental Upper Cretaceous and Tertiary Deposits in Alberta</u> $2,360.00

The purpose is to acquire information on the Upper Cretaceous and Tertiary palaeogeography of Western Canada by study of the petrography of the sandstones, radio-active dating and analysis of bentonites, and palaeontology (including palynology).

30. Lenz, Prof. C.A.,
Department of Geology,
University of Western Ontario.

<u>Upper Silurian and Lower Devonian Faunas of Royal Creek Northern Yukon</u> $ 200.00

A study of graptolite, brachiopod, coral and conodont faunas which extend across the Silurian-Devonian boundary in this area.

*31. McAllister, Prof. A.L.,
Department of Geology,
University of New Brunswick.

<u>Carboniferous Volcanic Rocks of Mount Pleasant Region, New Brunswick</u> $1,350.00

This project forms part of a general program of study of the volcanic rocks associated with the tin deposit at Mount Pleasant. It is hoped to substantiate the existing evidence suggesting a caldera origin for the basin as a whole.

32. McTaggart, Prof. K.C.,
Department of Geology,
University of British Columbia.

Structural Studies, Southwestern British Columbia — $3,950.00

Essentially a field and mapping project with supporting laboratory work which forms part of a major structural study along a cross section across the Canadian Cordillera in southern British Columbia.

*33. Middleton, Prof. G.V.,
Department of Geology,
McMaster University.

Quantitative Petrology of Sandstones — $2,500.00

The development of techniques for the quantitative mineralogical, chemical and textural study of sandstones and the study of selected sandstone formations using these techniques.

*34. Moore, Prof. John M.,
Department of Geology,
Carleton University.

Petrology and Structure of Grenville Metasedimentary Rocks, S.E. Ontario — $2,000.00

A study of the structural relations and mineral associations of the pelitic schists and associated rocks of the area.

*35. Moorhouse, Prof. W.W.,
Department of Geological Sciences,
University of Toronto.

Studies of Certain Basic Rocks — $2,000.00

This project is concerned at present with studies of the quartz diorite phase of the Sudbury nickel eruptive along the North Range.

36. Muller, Prof. Fritz,
Department of Geological Sciences,
McGill University.

Closed system Pingos in Mackenzie Delta, Northwest Territories — $1,000.00

An investigation of the crystallographic and structural properties of pingo ice with the specific aim of furthering knowledge of the mechanics of diapirism and differential movement of two geological masses of very different qualities.

37. Nelson, Prof. S.J.,
Department of Geology,
University of Alberta (Calgary).

Palaeozoic Corals $ 800.00

Speciation of coral genera, principally Favosites and Syrngopora with the objective of establishing time ranges of each species.

*38. Peach, Prof. Peter A.,
Department of Geological Sciences,
University of Toronto.

Geological Environment of Molybdenite Mineralization $1,000.00

The objective is to determine the physical and the chemical relations between molybdenite and associated sulphide minerals, gangue minerals, and fluids that occur at the site of deposition when molybdenite is deposited in an acid igneous environment, and to deduce from these relations the possible physical and chemical conditions prevailing at the site at the time of the molybdenite deposition.

*39. Perrault, Prof. Guy,
Ecole Polytechnique.

Mineralogy and Petrology of Oka Alkaline Intrusives $3,000.00

The objectives are to obtain a more thorough understanding of the distribution and composition of the niobium-bearing minerals of the alkaline rocks and of the genesis of the columbium ores.

40. Simony, Prof. P.S.,
Department of Geology,
University of Alberta (Calgary).

Geology of Dogtooth Mountains $1,400.00

To obtain detailed structural information about the Dogtooth Mountains between the Beaver River and the Rocky Mountain trench in order to elucidate the structural geometry and history. It is hoped that the time relations between the tectonic and metamorphic events can be determined.

*41. Shaw, Prof. Denis M.,
Department of Geology,
McMaster University.

Statistical Geochemical Studies $3,785.00

Current work includes study of element abundances in the Canadian Precambrian Shield; geochemistry of the Glamorgan granite, Ontario, and basic rocks of the Matheson area, Ontario; geochemistry of the Blue Mountain nepheline syenite; and several other projects.

*42. Steeves, Dr. M.W.,
Department of Geological Sciences,
University of Saskatchewan.

Palynological Studies in Western Canada $2,500.00

This project involves a study of fossil pollen and spores of non-marine deposits in Saskatchewan to provide more accurate stratal correlation and more complete information concerning the evolution of land floras.

*43. Smith, Prof. F.G.,
Department of Geological Sciences,
University of Toronto.

Study of Equilibrium in Solid State Systems $1,500.00

The development of modals of metamorphic processes using salt systems near their liquidus temperatures.

44. Stelck, Prof. C.R.,
Department of Geology,
University of Alberta.

Palynology of Microvertebrate Beds $2,400.00

The evaluation of ecology of vertebrate occurrences in the Upper Cretaceous and Tertiary by means of spore and pollen analyses from the containing beds.

*45. Tupper, Prof. W.M.,
Department of Geology,
Carleton University.

Paper Chromatographic Analysis for Gold and Tungsten in Rocks and Soils $1,000.00

The separation of elements from complex mixtures using paper chromatography and quantitatively determining the amounts present by emission spectrography are being investigated with particular attention to the development of methods for determining trace amounts of gold and tungsten.

46. Tupper, Prof. W.M.,
Department of Geology,
Carleton University.

<u>Mineralogy and Structural Analysis of Burnt Hill Tungsten Deposit, N.B.</u> $1,500.00

The purpose is to determine the precise variations in mineralogy and chemistry of the ore veins, and their structural control.

47. Wardlaw, Prof. N.C.,
Department of Geological Sciences,
University of Saskatchewan.

<u>Middle Devonian Potash Bearing Deposits of Southern Saskatchewan</u> $1,500.00

Studies of distribution of trace elements in the salt minerals of the Prairie Evaporite formation as an aid in determining their genesis.

*48. Warren Prof. H.V.,
Department of Geology,
University of British Columbia.

<u>Geochemical Pathfinding Anomalies in Rocks, and Plant Accumulators and their Role in Geochemical Prospecting</u> $1,800.00

A study of trace elements in soils, rocks and plants involving development of special chemical techniques. The purpose is to further the application of geochemistry to the art and science of mine finding.

*49. Wilson, Prof. H.D.B.,
Department of Geology,
University of Manitoba.

<u>Modal Composition of Rocks by X-ray Methods</u> $2,000.00

Now that it is possible to make rapid chemical analysis of rocks with a multi-channel x-ray fluorescence unit, a rapid method for making modal analyses, particularly for fine-grained rocks, is needed. The objective is to establish means of obtaining modal mineral compositions using an x-ray spectrometer method.

50. Wilson, Prof. H.D.B.,
Department of Geology,
University of Manitoba.

<u>Sulphide Ores in Peridotites</u> $1,500.00

A study of the relation of nickel sulphide ores to the petrography and composition of associated peridotites.

*51. Wilson, Prof. J.T., Farquhar, R.M., and York, Derek,
Department of Physics,
Toronto University.

Age Determinations and Isotope Studies of Keewatin Greenstone Belts — $3,285.00

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 rocks in selected greenstone belts in the Keewatin Province of the Canadian Shield.

*52. Wynne-Edwards, Prof. H.R.,
Department of Geological Sciences,
Queen's University.

Distribution of Elements in Rocks and Minerals — $2,000.00

Geochemical studies of the partition of elements between coexisting metamorphic minerals. Knowledge of the distribution of elements at different metamorphic grades will enable detailed comparison to be made between the rocks of different areas and ultimately between natural and synthetic systems where the temperatures and pressures are controlled.

SURVEY OF

CURRENT GEOLOGICAL RESEARCH

IN CANADA

1963-64

CURRENT RESEARCH IN THE GEOLOGICAL SCIENCES IN CANADA, JUNE, 1963 - MAY, 1964

Compiled by J.F. Henderson

CONTENTS

INTRODUCTION

The lists of research projects in the bibliography have been obtained from the universities, federal and provincial department of mines, and other non-industrial institutions carrying on research in geological sciences in Canada. With the exception of a few projects, mainly in micropalaeontology, they do not include research by mining and oil company geologists. The survey was made from December 1963 to April 1964 and the bibliography records research in progress for about the period June 1963 to May 1964.

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, of which the results 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. Acknowledgment 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 on 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. Charlesworth, H.A.K., Akehurst, A.J., Bielenstein, H.U., Imrie, A.S., Weiner, J.L., Univ. of Alberta (Edmonton):
   Precambrian geology in the Jasper and Lake Louise areas, Canadian Rocky Mountains, 1960-66; Ph.D. thesis (Weiner), M.Sc. theses (Akehurst, Bielenstein, Imrie).
   See Charlesworth, H.A.K. and Evans, C.R., 1962, Cleavage-boudinage in Precambrian rocks at Jasper, Alberta; Geol. en Mijnb., 41, pp. 356-362.

2. Godfrey, J.D., Research Council of Alberta:
   Studies in the Precambrian Shield of northeastern Alberta, 1957-67.
   Several aspects of this part of the Shield are being considered. Over 600 sq. m. have been mapped. Studies completed to date include a geophysical problem involving measurement of residual magnetism and magnetic susceptibilities; age dating investigations, applying several techniques; mineralogical compositions determined and combined with the appropriate areal extent of each rock type to derive bulk compositions of the study area; petrogenesis of a group of porphyroblastic "granites"; and petrology of a meta-sedimentary volcanic complex. See Limitations of radiometric dating; in Royal Soc. Canada, Special Publication (in press).

3. Hughes, J.E., McGill Univ.:
   The Peace and Pine River foothills (structures and tectonics); Ph.D. thesis.

4. Money, P.L., Univ. of Alberta (Edmonton):
   Geology of Eulas Lake area (West Half), Alberta, 1962-64; Ph.D. thesis.

British Columbia

5. Brown, A.S., British Columbia Dept. of Mines and Petroleum Resources:
   Geological mapping - Queen Charlotte Islands, 1957-64.

Work in 1963 included revision of property mapping, verifying some earlier field observations and logging core from wells drilled on Graham Island by oil companies. See Preliminary geological map published 1962, notes on certain properties, Report of Minister of Mines, B.C., 1962, pp. 10-14.

6. Campbell, R.B., Geol. Surv. Can.:
Canoe River map-area, 1 inch to 4 miles, 1963-65.
See Geol. Surv. Can., Paper 64-1, p. 19.

7. Cosburn, S.S., Callan, D.M., British Columbia Dept. of Mines and Petroleum Resources:
Preliminary geological study of Trimble Lake area, northeastern British Columbia, 1963.

8. Danner, W.R., Univ. of British Columbia:
Geology of Manning Provincial Park, British Columbia 1963-.

9. Eastwood, G.E.P., British Columbia Dept. of Mines and Petroleum Resources:
Geological mapping, mine area, Brynnor Mines Limited, Kennedy Lake, Vancouver Island, 1963-64.

10. Hutchison, W.W., Geol. Surv. Can.:
Port Essington and Prince Rupert map-areas, 1 inch to 4 miles, 1962-.
See Geol. Surv. Can., Paper 63-1 (1963), p. 21.

11. Jeffery, W.G., British Columbia Dept. of Mines and Petroleum Resources:
Buttle Lake area, sequence and structure of pre-Triassic rocks, 1963.

12. Little, H.W., Geol. Surv. Can.:
Greenwood map-area, 1 inch to 1 mile, 1963-64.
See Geol. Surv. Can., Paper 64-1, p. 21.

13. Mountjoy, E.W., McGill Univ. (formerly Geol. Surv. Can.):
Mount Robson southeast map-area, 83E SE, 1959-65.
See Mount Robson (Southeast) map-area, Rocky Mountains of Alberta and British Columbia, Geol. Surv. Can., Paper 61-31.

14. Muller, J.E., Geol. Surv. Can.:
Alberni map-area, 1 inch to 4 miles, 1963-64.
See Geol. Surv. Can., Papet 64-1, p. 22.

15. Pelletier, B.R., Geol. Surv. Can.:
Geology of Tetsa River map-area, British Columbia, 1958-65.
See Geol. Surv. Can., map 29-1959.

16. Souther, J.G., Baer, A.J., Hutchison, W.W., Geol. Surv. Can.:
Reconnaissance mapping of Coast Mountains, British Columbia, 1963-71.
Approximately 4,500 miles of shoreline were mapped using small rubber boats deployed from a large motor vessel. See Geol. Surv. Can., Paper 64-1, p. 24.

17. Taylor, G.C., Geol. Surv. Can.:
Operation Laird, Northeastern British Columbia, 1 inch to 4 miles, 1963-65.
See Geol. Surv. Can., Paper 64-1, p. 25.

18. Tipper, H.W., Geol. Surv. Can.:
Bonaparte River map-area, 1 inch to 4 miles, 1962-63.
See Geol. Surv. Can., Paper 64-1, p. 26.

Manitoba

19. Barry, G.S., Manitoba Mines Branch:
Geology of Pickerel Narrows area, 1963-64.
Study of the relationship between the Sickle series and Kisseynew-type gneisses northeast of Lynn Lake.

20. Bell, C.K., Geol. Surv. Can.:
Upper Nelson River area, Manitoba, 1963-.
See Geol. Surv. Can., Paper 64-1, p. 41.

21. Bristol, C.C., Manitoba Mines Branch:
Geology of Issitt Lake area (West Half), 1963-64.

22. Godard, John D., Manitoba Mines Branch:
Hambone Lake area, Manitoba, 1962-63.
Continuation of studies along the Thompson nickel belt.

23. Pollock, G.D., Manitoba Mines Branch:
Geology of the Russick Lake area, Manitoba, 1963-64.
Petrology and structural geology of the Kisseynew gneisses in the area northwest of Sheridon.

Newfoundland and Labrador

24. Anderson, F.D., Geol. Surv. Can.:
Belleoram map-area, 1 inch to 4 miles, 1963-64.
See Geol. Surv. Can., Paper 64-1, p. 72.

25. Brueckner, Werner D., Memorial Univ. of Newfoundland:
Problems of East Avalon Regional Geology, 1961-.
A detailed analysis of the stratigraphy, petrology historical geology, and structure of the Precambrian rocks within the Torbay map-areas; including questions of correlation with areas farther west. See Note on Precambrian Geology in the area around St. John's, Avalon Peninsula, Newfoundland (abstract), Bull. Can. Mining and Met., vol. 55, No. 599, p. 200, March, 1962.

26. Jackson, G.D., Geol. Surv. Can.:
Opocopa Lake map-area, New Quebec and Labrador, 1 inch to 4 miles, 1963.
See Geol. Surv. Can., Paper 64-1, p. 56.

27. Stevenson, I.M., Bostock, H.H., Skinner, R., and Taylor, F.C., Geol. Surv. Can.:
Operation Leaf River, 1 inch to 8 miles, 1963.
Reconnaissance geological mapping by helicopter of an area of 48,000 square miles west of the Labrador Trough. See Geol. Surv. Can., Paper 64-1, p. 57.

New Brunswick

28. Poole, W.H., Geol. Surv. Can.:
Restigouche map-area, northwestern New Brunswick, 1 inch to 1 mile, 1963-64.
See Geol. Surv. Can., Paper 64-1, p. 61.

29. Potter, R.R., Geol. Surv. Can.:
Upsalquitch Forks map-area, New Brunswick, 1 inch to 1 mile, 1962.
See Geol. Surv. Can., Paper 64-1, p. 64.

30. Williamson, D.H., Mount Allison Univ.:
Geology of the metamorphic basement complex of the northeastern part of the Caledonia Mountains, southern New Brunswick, 1962-65.
A comprehensive geological study to establish the stratigraphic sequence, to investigate the igneous plutons and to determine the role of this massif in the tectonic history of the Canadian Appalachian region.

Northwest Territories

31. Blackadar, R.G., Trettin, H., Davison, W.L., Craig, B.G., Geol. Surv. Can.:
Northwest Baffin Island (Operation Admiralty), 1963.
Reconnaissance geological mapping of northwestern Baffin Island west of longitude 80° and north of Fury and Hecla Strait, an area of about 55,000 square miles. See Geol. Surv. Can., Paper 64-1, p. 2.

32. Gabrielse, H., Roddick, J.A., Geol. Surv. Can.:
Operation Nahanni, 1 inch to 4 miles, 1963.
A geological reconnaissance covering 12,500 square miles in the Logan and Mackenzie Mountains of Yukon Territory and Northwest Territories. See Geol. Surv. Can., Paper 64-1, p. 16.

33. Heywood, W.W., Geol. Surv. Can.:
Benjamin Lake, District of Mackenzie, 1 inch to 1 mile, 1962-63.
See Geol. Surv. Can., Paper 64-1, p. 12.

34. Kerr, J.W., Geol. Surv. Can.:
Stratigraphy and structure of Bathurst Island, 1 inch to 2 miles, 1963-64.
See Geol. Surv. Can., Paper 64-1, p. 4.

35. Marlowe, I., Geol. Surv. Can. and Bedford Institute of Oceanography:
Marine geology of Prince Gustaf Adolf Sea, District of Franklin, 1962-64.
Present project is a sedimentological study with emphasis on the relation of oceanographic conditions to sedimentary processes. See Marine geology of eastern part of Prince Gustaf Adolf Sea; Geol. Surv. Can., Paper 63-22.

36. Pelletier, B.R., Geol. Surv. Can. and Bedford Institute of Oceanography:
Marine geology on Polar Continental Shelf Project, 1960-.
Marine geology of Jones Sound, District of Franklin, Northwest Territories, 1963-.

Nova Scotia

37. Benson, D.G., Geol. Surv. Can.:
Lochaber map-area, Nova Scotia, 1 inch to 1 mile, 1962-63.
See Geol. Surv. Can., Paper 64-1, p. 68.

38. Kelley, D.G., Geol. Surv. Can.:
Cobequid Mountains, 1 mile to 1 inch, 1961-.
See Geol. Surv. Can., Paper 64-1, p. 69.

Ontario

39. Anderson, D.T., Geol. Surv. Can.:
Experimental aeromagnetic-photogeologic survey, Coulonge River basin, southwestern Quebec, 1963.
See Geol. Surv. Can., Paper 64-1, p. 52.

40. Ayres, L.D., Ontario Dept. of Mines:
Muskraldam Lake, District of Kenora, 1 inch to 1 mile, 1963-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 3-4.

41. Card, K.D., Ontario Dept. of Mines:
Denison and Graham townships, District of Sudbury, 1 inch to 1/2 mile, 1962-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 20-22.

42. Card, K.D., Thomson, R., Ontario Dept. of Mines:
Sudbury Cobalt compilation sheet, 1 inch to 4 miles, 1963-66.

43. Clifford, P.M., Ontario Dept. of Mines (part time), McMaster Univ.:
Central Lake, St. Joseph area, District of Thunder Bay and Kenora, 1 inch to 1/2 mile, 1963-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 8-9.

44. Davies, J.C., Ontario Dept. of Mines:
Kenora-Fort Frances compilation sheet, 1 inch to 4 miles, 1963-64.

45. Donovan, J.F., Ontario Dept. of Mines:
Swayze and Dore townships, District of Sudbury, 1 inch to 1/2 mile, 1961-63.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 22-23.

46. Eade, K.E., Geol. Surv. Can.:
Kognack River, District of Keewatin, 1 inch to 4 miles, 1962-63.
See Geol. Surv. Can., Paper 64-1, p. 10.

47. Fenwick, K.G., Ontario Dept. of Mines:
Dayohessarah Lake area, District of Algoma, 1 inch to 1 mile, 1963-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 17-18.

48. Ferguson, S.A., Ontario Dept. of Mines:
Heyson township, Red Lake area, District of Kenora, 1 inch to 1,000 feet, 1963-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 5-6.

49. Giblin, P.E., Ontario Dept. of Mines:
Sault Ste Marie - Elliot Lake compilation sheet, 1 inch to 4 miles, 1963-64.

50. Goodwin, A.M., Ontario Dept. of Mines:
Geochemical studies of volcanic complexes in northwestern Ontario, 1963-.
Detailed stratigraphic studies and chemical samplings were made in the Birch-Uchi Lake area and the north central portion of the Lake of the Woods area. See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 10-12.

51. Hay, R.E., McGill Univ.:
The geology of Sault Ste. Marie area, Ontario; Ph.D. thesis.

52. Hodgkinson, J.M., Ontario Dept. of Mines:
Shebandowan Lake area, District of Thunder Bay, 1 inch to 1/2 mile, 1962-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 12-13.

53. Hewitt, D.F., Ontario Dept. of Mines:
Parry Sound - Bracebridge area, 1 inch to 2 miles, 1962-64.
See Ont. Dept. Mines, Prelim. Rept. 1962-4, p. 34.

54. Leahy, E.J., Ontario Dept. of Mines (part time):
Currie and Bowman townships, District of Cochrane, 1961-64.
See Ont. Dept. of Mines, Prelim. Rept. 1963-2, pp. 23-24.
Townships of Cody, Macklem, Carman, and Thomas, District of Cochrane, 1 inch to 1/2 mile, 1963-65.

55. Lovell, H.L., Ontario Dept. of Mines (part time), Carleton Univ.:
Alma and Baden townships, District of Temiskaming, 1 inch to 1/2 mile, 1963-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 27-28.

56. Lumbers, S.B., Ontario Dept. of Mines:
Cashel township, Hastings county, 1 inch to 1/2 mile, 1962-63.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 30-32.

57. MacKean, B.E., Ontario Dept. of Mines:
Elk Lake area, District of Temiskaming, 1 inch to 1/2 mile, 1963-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 28-30.

58. Milne, V.G., Ontario Dept. of Mines:
Pic River area, District of Thunder Bay, .1 inch to 1/2 mile, 1963-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 14-17.

59. Moore, J.M., Jr., Hounslow, A.W., Carleton Univ.:
Mineral parageneses in pelitic schists, Barrie Clarendon townships, Ontario, 1961-64; M.Sc. thesis (Hounslow).
Detailed (4 inches to 1 mile) structural-stratigraphic mapping and study of metamorphic mineral assemblages and mineral - chemical relations, especially of those bearing staurolite.

60. Pye, E.G. and Davies, J.C., Ontario Dept. of Mines:
Geology and scenery adjacent to highways 11, 71 and 17, Lakehead to Kenora, 1963-64.

61. Pye, E.G., Ontario Dept. of Mines:
Atikokan - Port Arthur compilation sheet, 1 inch to 4 miles, 1962-63. Tashota - Geraldton compilation sheet, 1 inch to 4 miles, 1963-.

62. Robertson, J.A., Ontario Dept. of Mines:
Townships 149, 150, Elliot Lake area, District of Algoma, 1962-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 19-20.

63. Shklanka, R., Ontario Dept. of Mines:
Bee Lake area, District of Kenora, 1 inch to 1/2 mile, 1963-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 6-8.

64. Simony, P.S., Ontario Dept. of Mines (part time), Univ. of Alberta (Calgary):
Geology of Rickard, Knox and Kerrs townships, District of Cochrane, Ontario, 1 inch to 1/2 mile, 1963-64.
The main purpose of this project is to study the structure and stratigraphy of a belt of Archaean volcanic rocks west of Lake Abitibi. The rocks are remarkably fresh and interesting petrographic data may also be obtained. See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 25-27.

65. Wilson, H.D.B., Brisbin, W.C., Univ. of Manitoba:
The geology of the English River gneissic belt, 1962-.
The English River gneissic belt is believed to be a portion of the deeper part of the granitic crust elevated to its present position by faulting. It consists of sedimentary granulites and granite believed to be older than the Keewatin volcanics and to be the source of Kenoran granites. The project has reached the stage where an extensive petrographic and chemical study of the sediments is being started. See Major structural features in the Precambrian Shield, Abstract, Geol. Assoc. Canada, Annual Meeting, June, 1963.

66. Wynne-Edwards, H.R., Geol. Surv. Can. (part time), Queen's Univ.:
Tichborne map-area, 1 inch to 1 mile, 1963.
See Geol. Surv. Can., Paper 64-1, p. 51.

Prince Edward Island

67. Prest, V.K., Geol. Surv. Can.:
Surficial and bedrock geology, Charlottetown (West Half) map-area (P.E.I.), 1 inch to 1 mile, 1962-.
See Geol. Surv. Can., Paper 64-1, 1964, p. 71.

Quebec

68. Anderson, A.T., Quebec Dept. of Natural Resources (part time):
Clarke City area (Duplessis county), 1 inch to 2 miles, 1963-64.

69. Benoit, F.W., Quebec Dept. of Natural Resources:
Chabanel-Roberval area, 1 inch to 1 mile, 1963-64.

70. Berard, J., Quebec Dept. of Natural Resources:
Matonipi Lake area, Chicoutimi county and Upper Outardes River area, Saguenay county, 1 inch to 1 mile, 1963-64.

71. Carlson, H.D., Ontario Dept. of Mines:
Chapleau-Foleyet compilation sheet, 1 inch to 4 miles, 1963-.

72. Chagnon, J.Y., Quebec Dept. of Natural Resources (part time):
Barrière Lake area, Témiscamingue, Rouyn and Noranda counties, 1 inch to 1 mile, 1960-64; Ph.D. thesis, McGill Univ.
See Rémigny-Villars area, Que. Dept. Nat. Res., Prelim. Rept. 478, 1962.

73. Chown, E.H., Quebec Dept. of Natural Resources:
Boivin Lake area, Chicoutimi county, 1 inch to 1 mile, 1963-64.

74. Davies, R., Quebec Dept. of Natural Resources (part time):
St. Augustin area, Duplessis county, 1 inch to 1 mile, 1962-65; Ph.D. thesis, McGill Univ.
See St. Augustin area, Que. Dept. Nat. Res., Prelim. Rept. 506, 1963.

75. Dimroth, E., Quebec Dept. of Natural Resources:
Romanet Lake area, New Quebec, 1 inch to 1 mile, 1963-64.

76. Gilman, W.F., Univ. of Toronto:
Geology of Desmeloizes township, Quebec, with particular reference to the diabase dykes, 1957-64; Ph.D. thesis.
A study of the chemical and petrographic characteristics of a series of large diabase dykes in this area. See Preliminary Report on Desmeloizes township, Quebec Dept. Natural Resources, 1961.

77. Gillis, J.W., Geol. Surv. Can.:
Port aux Basques map-area, 1 inch to 4 miles, 1963-64.
See Geol. Surv. Can., Paper 64-1, p. 72.

78. Gillain, P., Quebec Dept. of Natural Resources:
Jolliett Lakes area, Mistassini Territory, 1 inch to 1 mile, 1963-65.

79. Grove, E.W., McGill Univ.:
Petrochemical and structural study of the Lake Miquelon map-area, Quebec; Ph.D. thesis.

80. Grove, E.W., Quebec Dept. of Natural Resources (part time):
Miquelon Lake area, Saguenay county, 1 inch to 1 mile, 1961-64; Ph.D. thesis, McGill Univ.
See Miquelon Lake area, Que. Dept. Nat. Res., Prelim. Rept. 484, 1962.

81. Hashimoto, T., Quebec Dept. of Natural Resources (part time):
Jogues Lake area, New Quebec, 1 inch to 1 mile, 1962-64.

82. Hubert, C., Quebec Dept. of Natural Resources (part time):
Kamouraska-L'Islet area, Kamouraska and L'Islet counties, 1 inch to 1 mile, 1961-64; Ph.D. thesis, McGill Univ.
See Riviere Ouelle-Ixworth area, Que. Dept. Nat. Res., Prelim. Rept. 494.

83. Katz, M., Quebec Dept. of Natural Resources (part time):
Cousineau area, Montcalm and Terrebonne counties, 1 inch to 1 mile, 1963-65; Ph.D. thesis, McGill Univ.

84. Kelly, R.W., Quebec Dept. of Natural Resources:
Mount St. Cecile and St. Sebastian area, Gayhurst and Whitton townships, Frontenac county, Quebec, 1 inch to 1,000 feet, 1963.

Detailed geological mapping and sampling of an intrusive stock with which is associated molybdenum bearing veins and dykes. The project includes also rock and soil geochemistry.

85. Kish, L., Quebec Dept. of Natural Resources (part time):
Hart-Jaune River area, Saguenay county, 1 inch to 1 mile, 1961-64; Ph.D. thesis, Université Laval.
See Middle Hart-Jaune River area, Que. Dept. Nat. Res., Prelim. Rept. 507, 1963.

86. Lamarche, Robert Y., Université Laval:
Géologie de la region de Sherbrooke, Canton de l'Est, Quebec, 1962-64; D.Sc. thesis.

87. Lamarche, R.Y., Quebec Dept. of Natural Resources (part time):
Sherbrooke area, Eastern Townships, 1 inch to 1,000 feet, 1956-64; Ph.D. thesis, Université Laval.
Study of the lithological and structural relations of the Siluro-Devonian with the Cambrian in the Stoke Mountains, with emphasis on the economic geology of the area. This study follows the detailed mapping of the Cambro-Devonian assemblage at the latitude of the City of Sherbrooke.

88. Laurin, A., Quebec Dept. of Natural Resources:
Gouin Reservoir area, Abitibi East and Laviolette counties, 1 inch to 4 miles, 1962-64.

89. Mahaffy, D.F., McGill Univ.:
Geology of an area in the Wakeham Bay-Capt Smith Nickel Belt, Quebec; M.Sc. thesis.

90. Mathieu, A., Quebec Dept. of Natural Resources:
Northeast quarter of McKenzie township, Abitibi-East county, 1 inch to 1,000 feet, 1963.
Detailed mapping in an area of volcanic and sedimentary rocks with emphasis on stratigraphic aspects within this key section of the Chibougamau greenstone belt.

91. Pyke, D.R., Quebec Dept. of Natural Resources (part time):
Montauban area, Portneuf county, 1 inch to 1 mile, 1963-65; Ph.D. thesis, McGill Univ.

92. Rene, C., Quebec Dept. of Natural Resources (part time):
East half of Carpentier township, Abitibi-East county, 1 inch to 1,000 feet, 1962-64; Ph.D. thesis, Université Laval.
Detailed mapping in an area underlain by volcanic, sedimentary and a large amount of pyroclastic rocks intruded by numerous sills of ultrabasic rocks.

93. Robert, Jean-Louis, Quebec Dept. of Natural Resources:
Mount Hogsback area, Lemieux and Lesseps townships, Gaspé-North county, 1963-66; 1 inch to 1,000 feet.
Detailed mapping to obtain a complete section of the Siluro-Devonian assemblage and possibly part of the Ordovician while making a detailed inventory of the mineral occurrences.

94. Rondot, J., Quebec Dept. of Natural Resources:
Regnault Lake area, Abitibi Territory, 1 inch to 1 mile, 1963-64.

95. Sabourin, R.J.E., Quebec Dept. of Natural Resources (part time), Université Laval:
Bourbonnais-Baskatong area, Pontiac county, 1 inch to 1 mile, 1962-65.
See Bourbonnais-Limousin area, Que. Dept. Nat. Res., Prelim. Rept. 509, 1963.

96. St. Julien, P., Quebec Dept. of Natural Resources:
St. Victor area, Beauce county, 1 inch to 1 mile, 1963-64.

97. Schryver, K., Quebec Dept. of Natural Resources (part time):
Gauthier-Joliette area, Berthier and Joliette counties, 1 inch to 1 mile, 1963-65; Ph.D. thesis, McGill Univ.

98. Sharpe, J.I., Quebec Dept. of Natural Resources (part time):
North part of Isle-Dieu township and the northeast part of Daniel township, Matagami area, Abitibi-East county, 1 inch to 1,000 feet, 1961-63; Ph.D. thesis, McGill Univ.
This completes a three-year mapping project in the Matagami area designed to serve as a basis for a research study of most of the massive sulfide deposits of the region. The newly opened Matagami Lake, Orchan and New Hosco mines are within the limits of the map-area.

See Notes on parts of Daniel, Isle-Dieu and Galinee; R.S-71, 1963 and southeast part of Daniel, southwest part of Isle-Dieu, Que. Dept. Nat. Res., Prelim. Rept. 503, 1964.

99. Skidmore, W.B., Quebec Dept. of Natural Resources:
Perce-Rameau area, Gaspé-South county, 1 inch to 1 mile, 1962-65.

100. Thibault, C., Quebec Dept. of Natural Resources:
West half of Clermont township, Abitibi-East county, Quebec, 1 inch to 1,000 feet, 1963.
Detailed mapping and study of the eastern extension of the ore-bearing formation presently exploited by Normetal Mining Corporation.

101. Valiquette, G., Quebec Dept. of Natural Resources (part time):
Montagnes Lake-Cramoisy Lake area, Mistassini Territory, 1 inch to 1 mile, 1962-65; Ph.D. thesis, Université Laval.
See Montagnes Lake area, Que. Dept. Nat. Res., Prelim. Rept. 500, 1963.

102. Wolhuter, L.E., McGill Univ.:
The geology of a part of Levy township, Quebec, including the Opemiska Mine; Ph.D. thesis.

Saskatchewan

103. Colborne, G.L., Saskatchewan Dept. of Mineral Resources:
Wiley Lake (74-O-8), 1 inch to 1 mile, 1961-62.
Lowe Lake (East Half) 74-O-9-E, 1 inch to 1 mile, 1963-64.
See Summary reports of Geological Survey in the Precambrian area of Saskatchewan 1961, 1962 and 1963, and geology of Wiley Lake (West Half), Sask. Dept. Mineral Resources.

104. Coleman, L.C., Gaskarth, J.W., Smith, J.R., Saskatchewan Research Council:
Geology and bedrock geochemistry of the Hanson Lake area, Saskatchewan, 1962-68.

105. Johnston, F., Saskatchewan Dept. of Mineral Resources:
Geology of the Lytle Lake area, 74-P-6, 1 inch to 1 mile, 1962-64.
See Report and geological map of Lytle Lake area (West Half), Sask. Dept. Mineral Resources, 1963.

106. Kirkham, R.V., British Columbia Dept. of Mines and Petroleum Resources:
Geological study of Hudson Bay Mountain with particular attention to Glacier Gulch, 1963-64; Ph.D. thesis.

107. Koster, F., Saskatchewan Dept. of Mineral Resources:
Harper Lake (North Half) 74-N-12-N, 1 inch to 1 mile 1962-63.
See Geology of the Harper Lake area (North Half), and summary of Geological Surveys conducted in the Precambrian of Saskatchewan, 1961, 1962 and 1963, Sask. Dept. Mineral Resources.
Ena Lake area (East Half) 74-N-16-E, 1 inch to 1 mile, 1963-64.

108. Money, P.L., Saskatchewan Dept. of Mineral Resources:
Eulas Lake (West Half) 73-P-15-W, 1 inch to 1 mile, 1961-63.
Sandfly Lake (East Half) 73-O-9-E, 1 inch to 1 mile, 1962-64; Ph.D. thesis, Univ. of Alberta.
Black Bear Island Lake (West Half) 73-P-12-W, 1 inch to 1 mile, 1963-64.
See Preliminary references in summary reports of Geological Surveys in Precambrian of Saskatchewan, 1961, 1962 and 1963, Sask. Dept. Mineral Resources.

109. Morris, A., Saskatchewan Dept. of Mineral Resources:
Trout Lake (West Half) 73-P-11-W, 1 inch to 1 mile, 1962-63.
Black Bear Island Lake (East Half) 73-P-12-E, 1 inch to 1 mile, 1963-64.
See Geology of the Trout Lake area (West Half), report and geological map and summary report of Geological Surveys conducted in the Precambrian of Saskatchewan, Sask. Dept. Mineral Resources, 1963.

110. Padgham, W.A., Saskatchewan Dept. of Mineral Resources:
Otter Lake and Guncoat Bay (73-P-9, 10), 1 inch to 1 mile, 1959-63; Ph.D. thesis, Univ. of Wisconsin.
See Geology of the Otter Lake (West Half), Sask. Dept. Mineral Resources, 1960; East Half is in press.

Wapawekka Narrows area (73-I-16-N), 1 inch to 1 mile, 1963-64.
See Summary report of Geological Surveys in Precambrian of Saskatchewan, 1963, Sask. Dept. Mineral Resources, 1963.

111. Pyke, M.W., Saskatchewan Dept. of Mineral Resources:
Pelican Narrows area (East Half) 63-M-2-E, 1 inch to 1 mile, 1961-63; Ph.D. thesis, Univ. of Alberta.
Birch Portage area 63-L-15, 1 inch to 1 mile, 1962-64; Ph.D. thesis, Univ. of Alberta.
See Preliminary references in Summary reports of Geological Surveys in Precambrian of Saskatchewan, 1961, 1962 and 1963, Sask. Dept. Mineral Resources.

112. Tremblay, L.P., Geol. Surv. Can.:
Beechey Lake map-area, 1 inch to 4 miles, 1962-.
See Geol. Surv. Can., Paper 64-1, p. 15.

113. Trigg, C.M., McGill Univ.:
The petrology and structure of an area including the Verna Uranium deposit, Beaverlodge, Saskatchewan; Ph.D. thesis.

Yukon Territory

114. Tempelman-Kluit, D., Univ. of British Columbia:
Geology of Haggart Creek Dublin Gulch area, Mayo mining district, Yukon Territory, 1962-64; M.A.Sc. thesis.
The present work is intended to provide a detailed geological framework to aid further exploration.

ENGINEERING GEOLOGY

115. Barron, K., Gyenge, M., Cochrane, T.S., Grant, F., Mines Branch, Dept. of Mines and Technical Surveys:
Development of instrumentation and measurements of stress in situ, 1951-.

Additional field trials have been conducted using the rigid inclusion stressmeter for obtaining measurements of field stresses and mining induced stresses. Some interesting results have been obtained with this instrument. However, further development work is being conducted to permit its use in higher stress fields.

A number of borehole deformation meters, designed by the U.S. Bureau of Mines, have been fabricated and subjected to field trials as an alternate technique for determining stresses in situ. The development of ancilliary equipment for use in hard rocks is proceeding. The instrument is to be used with an overcoring technique to obtain measurements on field stresses and mining induced stresses in pillars.

An improved borehole deformation meter is being developed using differential transformers that will obtain at one position three deformation readings instead of only one that can be obtained with the above deformation meter. Laboratory trials on a prototype have indicated that a practical instrument of this nature can be developed.

At the request of the University of Sheffield, the performance of glass insert biaxial stressmeters, is being assessed. A theoretical appraisal of the instrument has been completed, and laboratory tests have been conducted to assess the performance of two gauges that were supplied. The instrument has many favourable aspects and field trials may be conducted at a later date. See A vibrating wire sensing head for the stressmeter; Mines Branch Rept. IR FMP 63/13-MIN.

116. Barron, K., Mines Branch, Dept. of Mines and Technical Surveys:
Structural modelling, 1961-.

Work has been continuing on the method of applying biaxial stress or deformation conditions to the model constructed to examine the stress and failure conditions around rooms and pillars. The effects of applying a uniform horizontal deformation on the stress distribution in simulated layered formations is being examined.

117. Barron, K., Toews, N., Mines Branch, Dept. of Mines and Technical Surveys:
Study of creep underground, 1962-.

This program consists of measurements of the variation of deformation with time of salt around a shaft and of potash around mine openings in an attempt to gain fundamental knowledge of material behaviour and to correlate this data with theoretical concepts of material properties. Ultimately, the results might assist in appraising the stability of such underground openings. The results that have been obtained to date are in good agreement with general theoretical concepts of co-elastic materials. See Deformation around a mine shaft in salt, Mines Branch, Rept. IR FMP 63/29-MIN.

118. Bozozuk, M., Division of Building Research, National Research Council:
Swelling and shrinkage of Leda Clays, 1954-.
Routine measurements of seasonal vertical ground movements are being maintained and are being correlated with climate observations, water table levels and soil moisture. The effects of a row of elm trees on ground movements are also measured. See Soil shrinkage damages shallow foundations at Ottawa, Canada; Engineering Journal, vol. 45, No. 7, pp. 33-37, July 1962.

119. Brown, R.J.E., Division of Building Research, National Research Council:
Permafrost Distribution in Canada, 1953-.
Observations on the occurrence of permafrost throughout the permafrost region of Canada, with emphasis on the southern fringe area, are being collected continuously by direct field observations, review of the technical literature, reports from other individuals and agencies, and questionnaire; this information is recorded on punch cards and plotted on the 8 mi. : 1 in. maps of Canada. Accompanying this collection of information is the study of the climatic and terrain factors comprising the permafrost environment as a means of improving the understanding of, and ability to predict the distribution and occurrence of permafrost. See The relation between mean annual air and ground temperatures in the Permafrost region of Canada; prepared for presentation to Int. Conf. on Permafrost, Purdue University, November 1963, p. 26.

120. Burn, K.N., Bozozuk, M., Crawford, C.B., Eden, W.J., and Penner, E., Division of Building Research, National Research Council:
Geotechnical properties of Eastern Marine Clay, 1951-.

Studies include the influence of various loading systems, stress paths, rates of strain, temperature and sample disturbance on the stress-deformation properties of marine clays. Of particular interest is the resistance to deformation of the undisturbed soil structure and the influence on this resistance of the applied rate of strain in the laboratory. See The modulus of elasticity of Leda Clay from field measurements; Canadian Geotechnical Journal, vol. 1, No. 1, September, 1963, p. 43, and Cohesion in an undisturbed sensitive clay; Geotechnique, vol. 13, No. 2, June, 1963, pp. 132-146.

121. Coates, D.F., Mines Branch, Dept. of Mines and Technical Surveys and Norris, D.K., Geol. Surv. Can.:
Michel colliery roof support study, 1962-64.
A study in cooperation with Crow's Nest Pass Coal Co. Ltd. on requirements for safe roof bolting. Attempts are being made to correlate measurements of bolt loads, bed separation and timber behaviour with structural details of the roof rock and the coal.

122. Coates, D.F., Cochrane, T., Grant, F., and Barron, K., Mines Branch, Dept. of Mines and Technical Surveys:
Rockburst Research, 1962-.
Studies are being conducted on mining properties that are experiencing rockbursts. These events are seemingly caused in some cases by mining induced stresses but in other cases by inherent residual stresses. Tests are being conducted on the rock substances in the laboratory, on the rock formations for their seismic velocities, on deformations associated with mining operations and on microseismic activities emanating from the surrounding ground. See Studies of ground behaviour in a metal mine in northern Ontario; Mines Branch Rept. IR FMP 63/129-MIN.

123. Coates, D.F., Gyenge, M., Toews, N., and Casey, L., Mines Branch, Dept. of Mines and Technical Surveys:
Rock slope stability, 1960-.
A number of projects are being conducted to determine the mechanics of failure in rock slopes. Basic studies are being pursued into the stress distribution occurring in typical slope geometries. Mathematical and photoelastic techniques are being used for this work. In addition, field measurements are being

conducted on a number of mining properties to determine deformation, groundwater regime and micro-seismic activity associated with deep cut slopes in open pits. Both hard and soft rock formations are being studied. See Analyses of pit slides in some incompetent rocks; Trans. AIEM vol. 226, 1963.

124. Coates, D.F., Larocque, G.E., Mines Branch, Dept. of Mines and Technical Surveys:
Study of engineering rock properties, 1963-.
Tests are being conducted on various core samples to determine if it is possible to classify the rock substances comprising a formation into a few functional categories based on some simple laboratory tests. See Classification of rocks for rock mechanics, a paper for discussion, Mines Branch Rept. IR FMP 63/65-MIN, 1963.

125. Coates, D.F., Larocque, G.E., Sassa, K., Darling, A., Mines Branch, Dept. of Mines and Technical Surveys:
Experimental study of the propagation of shock waves associated with blasting, 1963-.
A laboratory project has been started for the measurement of particle velocity and propagation velocity within the crater zone resulting from a surface explosion. These measurements will be applicable to the ground during the brief time before it is pulverized and extruded. From this work it is expected that information will be obtained on the mechanics of transferring explosive detonation pressures into ground shock pulses. It is anticipated that the impedance ratio between explosive and rock will influence this transfer of energy. The work is to be conducted on various types of rock with various types of explosives. See Rock mechanics applied to the design of underground installations to resist ground shock from nuclear blasts; Proc. Symp. Rock Mechanics, Univ. of Minnesota, Pergamon, 1963.

126. Eden, W.J., Division of Building Research, National Research Council:
Engineering studies of varved clay, 1948-.
Studies of field performance of varved clay have been made at Steep Rock Lake, Beattie Mine and New Liskeard. Case record studies of failures are made to assess the usefulness of current theories on shear

strength of soil when applied to highly stratified clays. See Earthflows at the Beattie Mine; Canadian Geotechnical Journal, vol. 1, No. 2, February, 1964.

127. Hamilton, J.J., Division of Building Research, National Research Council:

Western Canada soils, 1960-.

Ground movements, temperatures and soil moisture contents are being measured and compared with weather records at 4 locations in Manitoba and Saskatchewan in order to study climatic influences on these factors. A number of buildings are under observation to study the influence of ground movements on structures. See Volume changes in undisturbed clay profiles in Western Canada; Canadian Geotechnical Journal, vol. 1, No. 1, pp. 27-42, Sept. 1963.

128. Johnston, G.H., Division of Building Research, National Research Council:

Kelsey Generating Station - Dyke studies, 1958-.

Observations of ground temperature, dyke movements and climate are continuing in the study of the performance of dykes constructed on perennially frozen ground in the southern boundary region of permafrost at the Kelsey Generating Station of the Manitoba Hydro on the Nelson River in Northern Manitoba.

Observations at Inuvik, N.W.T. (new location of townsite of Aklavik), 1954-.

Observations on the performance of various engineering facilities, e.g. building foundations, airstrip, roads, utilidors, erected on permafrost were continued by means of ground temperature and foundation movement measurements. Precise level surveys were run to assess the performance of several special bench marks used to observe foundation movements in the townsite. Topographic surveys were run in disturbed areas where ground slumping was occurring and the depth of thaw was measured at locations having different soil and surface cover conditions.

129. Johnston, G.H., Brown, R.J.E., Division of Building Research, National Research Council:

Investigation of the distribution of Permafrost under bodies of water, 1961-.

Several lakes near Inuvik, Northwest Territories are to be investigated in 1964 to determine the distribution of permafrost under and about them and the thawing effect of the water bodies. This work is essentially a drilling and sampling program combined with studies of the ground thermal regime by means of ground and water temperature measurements.

Permafrost at Thompson, Manitoba, 1961-.

The initial phase of the terrain studies carried out at Thompson with respect to the distribution and occurrence of permafrost has been reported in the reference noted below. These studies are continuing by means of field observations as further development of the townsite is carried out and by ground temperature measurements. Engineering investigations of foundation performance are also continuing by means of level surveys and field observations. See Permafrost investigations at Thompson, Manitoba; Terrain Studies, DBR Tech. Paper No. 158 (NRC 7568), October 1963, p. 94.

130. Larocque, G.E., Mines Branch, Dept. of Mines and Technical Surveys:

Sonic studies of rock competency, 1961-.

A new transistorized portable sonic unit has been completed. The equipment is presently undergoing field tests. The main objective for developing this equipment is to be able to measure the seismic velocity in rock adjacent to underground openings. There is preliminary evidence to show that the competency of the rock is a function of the seismic velocity. Consequently, by being able to measure seismic velocities over a short base line at varying distances from a rock face some measure can be obtained of the stability of the opening and the effects of time and geometry on the stability. See Sonic unit for the determination of dynamic properties of fracture zones, Mines Branch, Report IR 63/121-MRL.

131. Owen, E.B., Geol. Surv. Can.:

Yukon Territory dam sites, 1959-65.

A study of the engineering geology of possible dam sites mainly along the Yukon River. See Geol. Surv. Can., Paper 64-1, p. 18.

132. Paul, Gabrielle, Yong, R., Elson, J.A., McGill Univ.:
The effect of chemical additives on the permeability of soils to water, 1963-; M.Sc. thesis (Miss Paul).

Water containing certain cations in various concentrations is passed through purified clay minerals in a special permeameter that allows a wide range of pressure gradients and control of the spacing of clay particles.

133. Pennér, E., Division of Building Research, National Research Council:
Ground temperatures and frost action, 1948-.

The study of pressure-temperature relations at ice-soil interface in equilibrium systems and measurement of a frost penetration with time at one site and of heave of a number of structures at several sites. See The nature of frost heaving in soils, presented at the International Conference on Permafrost, Purdue Univ., November, 1963.

134. Pullen, M., Univ. of Toronto:
Geology of the Bloor-Danforth Subway - Toronto, Ontario, 1963-65; M.A. thesis.

The drill hole data were used for a Ph.D. thesis for M.E.Z. Lajtai. This project includes examinations of the sections exposed during excavation.

135. Rupp, John H., Univ. of Manitoba:
Stabilization of Lake Agassiž clays, 1963-64; M.Sc. thesis.

The result of various anions and cations in the stabilization of clays, 1963-.

The project is a combination of geology and soil mechanics using differential thermal analysis and X-ray mineralogy to relate compressive strengths to ionic activity.

136. Scott, J.S., Geol. Surv. Can.:
Landslide studies in Manitoba, Saskatchewan, and Alberta, 1963-.

See Geol. Surv. Can., Paper 64-1, p. 83.

GEOCHEMISTRY

137. Arnold, R.G., Saskatchewan Research Council:
Partition of trace metals between pyrite and pyrrhotite, 1962-64.

138. Baadsgaard, H., van Breeman, O., Univ. of Alberta (Edmonton):
Relative effect of thermal metamorphism on various radiometric parent-daughter systems, 1963-65; M.Sc. thesis (van Breeman).
In connection with the work an exhaustive analysis of the distribution of the various parents (U, Rb, K) and daughters (Pb, Sr, Ar) in a granite will be made.

139. Boorman, R.S., Univ. of Toronto:
Sub-solidus equilibria in the system ZnS-FeS, 1961-64.
Data are being obtained on the equilibrium solubility of FeS in cubic ZnS at temperatures below 400°C.

140. Boyle, R.W., Geol. Surv. Can.:
Geochemical studies in New Brunswick, Nova Scotia and Ontario, 1957-.
See Geol. Surv. Can., Paper 64-1, p. 76.

141. Boyle, R.W., and Wanless, R.K., Geol. Surv. Can.:
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.

142. Boyle, R.W., Wanless, R.K., Lowdon, J.A., Stevens, R.D., Geol. Surv. Can.:
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. 55, pp. 1591-1621, 1960.

143. Bristol, C.C., Univ. of Manitoba:
Quantitative modal mineral analysis by the X-ray diffractometer, 1962-65; Ph.D. thesis.

The method may be particularly applicable to fine grained metamorphic rocks where point count methods are impractical. If successful the method is to be applied to Precambrian lavas.

144. Brownell, G.M., Univ. of Manitoba:
Investigation of the molybdenum content of Cretaceous sediments along the Manitoba Escarpment, 1963-64.

145. Bugry, R., Shaw, D.M., McMaster Univ.:
Secular boron variations in shale, 1962-64; M.Sc. thesis (Bugry).

It has been suggested that the boron content of shales (a) increases, (b) decreases with geological age. Spectrographic analyses of Canadian shales from Late Precambrian to Tertiary are being made to investigate this problem.

146. Cabri, L.J.P., McGill Univ.:
Phase relations in the Au-Ag-Te systems; Ph.D. thesis.

147. Cameron, E.M., Geol. Surv. Can.:
Studies in carbonate geochemistry, 1963-.

Geochemistry of reef and off-reef sediments to determine, in particular, trends useful to petroleum industry in exploration for reef structures. See Geol. Surv. Can., Paper 64-1, p. 77.

148. Campbell, F.A., and Lerbekmo, J.F., Univ. of Alberta (Edmonton):
Mineralogy and geochemistry of sedimentary rocks, 1961-.

See Mineralogic and chemical variations between Upper Cretaceous continental Belly River shales and marine Wapiabi shales in western Alberta, Canada; Sedimentology, vol. 2 (1963), pp. 215-226.

149. Carlson, E.H., McGill Univ.:
Experimental work on chemical transport of minerals; Ph.D. thesis.

150. Chamberlain, J.A., and Wanless, R.K., Geol. Surv. Can.:
Absolute Age and Isotope Geology of Uranium Deposits at Port Radium, Northwest Territories, 1960-.

Ages determined on pitchblende and galena from Eldorado Mine may disclose stages of mineralization or remobilization of vein material.

151. Chesworth, W., Shaw, D.M., McMaster Univ.:
Geochemical history of part of the Glamorgan granite complex, Glamorgan township, Ontario, 1961-64; Ph.D. thesis (Chesworth).

Field mapping and collection of grid samples have provided data and material for major and trace element studies. These, together with detailed mineralogy, will provide a basis for interpretation of the history of this complex.

152. Clark, L.A., McGill Univ.:
Geology and geothermometry of the Marbridge nickel deposit, Malartic, Quebec, 1952-64.

Pyrrhotite geothermometry yields a pattern of ore formation temperatures consistent with the sulfide melt hypothesis of ore genesis evolved during field and microscopic studies.

Melting relations in sulfide-silicate-oxide systems, 1963-.

153. Coleman, L.C., Gaskarth, J.W., Univ. of Saskatchewan:
Trace metal distribution, metamorphism and petrogenesis in the Hanson Lake area, Saskatchewan, 1962-67; Ph.D. thesis (Gaskarth).

Geological mapping at 1" = 500' is being conducted in the Hanson Lake area. Bedrock samples collected at approximately 200' intervals are being analyzed by X-ray fluorescence techniques for Cu, Zn, Ni, Pb. The relationship of the distribution of these metals to known sulfide deposits and to the geological structures and rock units in the area is being investigated as is the relationship of Amisk-type and Kisseynew-type rocks.

154. Coleman, L.C., Gaskarth, J.W., Smith, J.R., Saskatchewan Research Council:
Geology and bedrock geochemistry of the Hanson Lake area, Saskatchewan, 1962-68.

155. Crocket, J.H., McMaster Univ.:
Application of neutron activation methods to Rb-Sr geochronology, 1964-.

An investigation of the applicability of neutron activation methods to Rb-Sr technology will be started as soon as possible. The measurement of Rb by activation analysis is routine. As mass spectrometers of the solid source type are subject to fractional isotopic distillation, it seems interesting to attempt to develop a non-spectrometric method for measurement of Sr^{87}/Sr^{86} ratios and total Sr. An attempt to do this by neutron activation and an activation isotope dilution procedure will be attempted.

156. Cumming, G.L., Robertson, D., Univ. of Alberta (Edmonton):
Study of lead isotopes in sulphides of the Yellowknife area, 1963-65; M.Sc. thesis (Robertson).

157. Currie, K.L., Geol. Surv. Can.:
Diffusion studies, 1962-65.
Hydrothermal experimentation aimed at discovering the importance of diffusion in supercritical water under geological conditions.

158. Dave, S.N., McGill Univ.:
Thermo-chemical study of some iron minerals; M.Sc. thesis.

159. Davies, J.L., Carleton Univ.:
Geology and geochemistry of the Austin Brook iron formation, Gloucester county, New Brunswick, 1959-64; Ph.D. thesis.
The project involves a study of the various facies of iron formation in terms of mineralogy and chemistry, including major and minor elements.

160. Dibbs, H.P., Mines Branch, Dept. Mines and Technical Surveys:
Neutron activation analysis of minerals and metals, 1960-65.
Analysis of trace elements and major components in minerals and metals by neutron activation. See Some industrial applications of neutron activation with a neutron generator; Canadian Nuclear Association, Annual Meeting, Montreal, May 27-29, 1963.

161. Doig, R.S., McGill Univ.:
Geologic applications of gamma-ray spectrometry; Ph.D. thesis.

162. Edgar, A.D., Univ. of Western Ontario:
Experimental systems pertaining to undersaturated alkaline rocks and mineral chemistry of nephelines, kalsilites and melilites and other under-saturated minerals, 1959-.

See Studies on cancrinites I - Polymorphism in the sodium carbonate rich cancrinite-natrodavyne; Canadian Mineralogist, vol. 7, pp. 631-642 and Phase equilibrium studies in the system $NaAlSiO_4$ - $NaAlSi_3$ - O_8 - H_2O at 1,000 Kg/cm^2 water vapour pressure; Journal of Geology, vol. 72 (in press).

163. Fahrig, W.F., Eade, K.E., and Maxwell, J.A., Geol. Surv. Can.:
Composition of the Canadian Shield, 1962-65.

The objective is to determine the average composition of the Canadian Shield and the composition of individual cratonic segments, to map aerial chemical variation within cratonic segments and relate chemical abundances to mapped lithology.

164. Farquhar, R.M., Univ. of Toronto:
Lead isotope variation in minerals from the Canadian Precambrian Shield, 1954-.

Large variations in the ratios Pb^{206}/Pb^{204}, Pb^{207}/Pb^{204} and Pb^{208}/Pb^{204} have been observed among lead minerals from the Canadian Shield. Further analyses are being made in an attempt to link the observed variations with specific geological events.

165. Ferguson, R.B., Univ. of Manitoba:
Feldspar phase relationships, 1950-.

With several graduate students two papers are in preparation, one on the variation of K feldspar triclinicities with K-Na-Ca rock contents, and the other on the solubility of Na-Ca in some natural K feldspars. The next project will be the determination of the solubility of K in some natural plagioclases. See A three-dimensional refinement of the structure of low albite; Norsk Geologisk Tidsskrift, 1962, vol. 42, pp. 152-157.

166. Fitzpatrick, M.M., Queen's Univ.:
Isotope analysis, 1963-.

A mass spectrometer was installed in the Department of Geological Sciences in 1963. It has been brought into operation and the first aim will be to set up procedures for obtaining lead and potassium/argon ages. The ultimate goal is to do research on sulphur and oxygen isotopes but this will require considerable modification of the instrument.

167. Fortescue, J.A.C., Geol. Surv. Can.:
Forest biogeochemistry, 1963-.
The initiation of a long term program. In 1963 a peat bog near Ottawa was sampled to provide background information on minor element content of Canadian peat. More than 1,000 samples of soil and plant material were collected also in the vicinity of a drilled but otherwise undisturbed mineral deposit in Eastern Canada and these will form the basis of a systematic study of the occurrence of lead in superficial materials lying over a known lead deposit.

168. Fortesque, J.A., Geol. Surv. Can. and Drinnen, R.E., Fisheries Research Board:
Marine biogeochemical investigation in Eastern Canada, 1963.
An investigation of the effect of zinc pollution in river water on the zinc content in oysters living in the sea into which the rivers flow, and determination of the norms for minor element content of some common species of marine organisms.

169. Frenkel, O.J., McGill Univ.:
The flow of water and ions through clays; M.Sc. thesis.

170. Gaskarth, J.W., McGill Univ.:
Sulphur vapour pressure study of the Cu-S system and effects on solid state transport; M.Sc. thesis.

171. Gill, J.E., Kranck, E.H., Saull, V.A., McGill Univ.:
Silicate and sulphide diabase relationships, 1954-.
See Experimental investigation of solid diffusion and volatilization of certain metallic sulphides, Econ. Geol., vol. 56, pp. 362-391, 1961.

172. Gittins, J., Univ. of Toronto:
Phase equilibrium studies in systems that bear on problems of carbonatite petrogenesis, 1962-.

An investigation of calcium and alkali carbonate systems up to 6 kilobars with and without water. See The system CaF_2 - $CaCO_3$ - $Ca(OH)_2$ at 1,000 bars; American Journal of Science (in press).

173. Goodwin, A.M., Ontario Dept. of Mines:
Geochemical studies of volcanic complexes in northwestern Ontario, 1963-.
Detailed stratigraphic studies and chemical samplings were made in the Birch-Uchi Lake area and the north central part of the Lake of the Woods area. See Ont. Dept. Mines, Prelim. Rept. 1963-2; pp. 10-12.

174. Gross, W.H., Univ. of Toronto:
Quantity and distribution of lead in granite rocks, 1963-64.

175. Gross, W.H., Univ. of Toronto, Thode, H.G., McMaster Univ., 1959-.
Sulphur isotope geochemistry.
The use of sulphur isotope measurements in studies of ore genesis. See Sulphur isotope abundances in basic sills, differentiated granites and meteorites; Journal of Geophysical Research, May 1, 1963.

176. Hayatsu, A., Univ. of Toronto:
Mass spectrometric measurement of strontium and lead isotope ratios, 1959-64; Ph.D. thesis.
Accurate measurement of the isotope ratios, Sr^{87}/Sr^{86}, and Pb^{206}/Pb^{204}, Pb^{207}/Pb^{204} are necessary to make estimates of geological age. Simultaneous collection methods are being applied to improve the accuracies presently obtainable with small samples of strontium and lead.

177. Holman, R.H.C., Geol. Surv. Can.:
Geochemical survey, Kirkland Lake mineralized belt, Ontario, 1962-.
A study initiated to appraise the possibility of applying geochemical techniques to mineral exploration and elucidation of the geology of the district. See Geol. Surv. Can., Paper 64-1, p. 46.

178. Jolliffe, A.W., Queen's Univ.:
Geochemistry of polyvalent elements, 1959-.

Polyvalent elements - such as Fe, Mn, U, V, etc. - are amongst the most sensitive indicators of the environment. Accordingly, study of their valency states in geological materials (weathered products and sedimentary rocks) of various ages, should reveal any secular change.

179. Jongejan, A., Mines Branch, Dept. of Mines and Technical Surveys:
High-temperature phase equilibrium studies in the system $CaO-Nb_2O_5-TiO_2$, 1962-64.
Study of the range of temperature and compositional stability leading to the formation of niobium-bearing perovskites, titanium-bearing pyrochlores, etc.

180. Jongejan, A., and Bright, N.F.H., Mines Branch, Dept. of Mines and Technical Surveys:
Study of the $Cao-Fe_2O_3-Al_2O_3$ ternary system and portions of the $CaO-Fe_2O_3-Al_2O_3-SiO_2$ quaternary system, 1960-64.
An extension of the work on iron-bearing gehlenites, relating to the chemistry of basic refractory clinkers. New compounds in the systems $CaO-Fe_2O_3-Al_2O_3$ and $CaO-Fe_2O_3-Al_2O_3-SiO_2$ have been encountered.
Iron-bearing Gehlenites, 1957-64.
A high-temperature phase equilibrium study undertaken to investigate the constitution of complex basic refractory compositions. See paper presented to American Ceramic Society, Toronto, April, 1961.
Magnesia-ferric-oxide-alumina spinels, 1957-64.
A high-temperature phase equilibrium study of magnesia-rich refractory compositions.

181. Keays, R.R., Crocket, J.H., McMaster Univ.:
Neutron activation technique for determination of Pd, Pt, Ir, Os and Ru and the distribution of these metals in mineral phases of the Sudbury Irruptive, 1963-66; Ph.D. thesis (Keays).
An activation capable of measuring Pt, Pd, Ir, Os and Ru in a single irradiation is at present under development. The basic analytical scheme has been checked by radio-tracer methods and should be in operation by June, 1963. A detailed study of the distribution of these metals in coexisting sulphide minerals and in the silicate minerals of the Sudbury Irruptive will then be started.

182. King, L.H., Geol. Surv. Can., and Bedford Institute of Oceanography:
Organic geochemistry of marine sediments, Scotian Shelf, 1963-.
The structural chemistry of the organic matter will be studied with respect to environment. See A study of sedimented organic matter and its natural derivatives, Mines Branch Research Report R114, Dept. of Mines and Technical Surveys, Ottawa, Canada, June, 1963.

183. Langford, F.F., Smith, J.R., Peet, F., Univ. of Saskatchewan:
Trend surface evaluation of geochemical data, 1963-.

184. McPherson, D., Univ. of Alberta (Edmonton):
Oxygen isotopes in glacial ice, Yukon Territory, 1963-64.

185. Maxwell, J.A., and Courville, S., Geol. Surv. Can.:
An investigation of possible variations in sample composition as a result of sample preparation, 1963.

186. Montgomery, D.S., Goodspeed, F.E., Mines Branch, Dept. of Mines and Technical Surveys:
Infra-red absorption spectra of bituminous substances, 1951-.
The emphasis will be shifted toward a more detailed study of the lower molecular weight components of naturally occurring hydrocarbons. See A study of sedimented organic matter and its natural derivatives; Mines Branch Report R114.

187. Moore, J.C.G., Mount Allison Univ.:
Rock geochemistry as an aid in the search for orebodies, 1962-64.
Includes sampling and analysis of the rocks around the Heath Steele and probably other orebodies to determine if detectible trace elements as well as major elements can be used in the search for additional mineral deposits in the province. The objective is to find halos of dispersed elements or target indicators that will enlarge the target areas for mineral exploration.

188. Nakashiro, M., McGill Univ.:
The variation of crystal cells of quartz according to temperature and localities; M.Sc. thesis.

189. Naldrett, A.J., Queen's Univ.:
The geochemistry of the nickeliferous ultrabasic rocks of the Porcupine district, 1961-64; Ph.D. thesis.

190. Nash, W.A., Univ. of New Brunswick:
Some geochemical aspects of the St. Stephen Gabbro, 1959-64; M.Sc. thesis.

191. Payne, A., Folinsbee, R.E., Univ. of Alberta (Edmonton):
Basic-ultrabasic differentiated sheet, Yellowknife district, Northwest Territories, 1963-64; M.Sc. thesis (Payne).

A petrographic, mineralogic and geochemical study of this mantle derived basic body. Field studies and some drilling suggest it is an ethmolith, not a sheet; radiometric dating suggests it was intruded about 1,900 m.y. ago and much earlier than the somewhat comparable Muskox intrusive.

192. Payne, J., Shaw, D.M., McMaster Univ.:
Statistical geochemical studies of the Blue Mountain nepheline gneisses, Methuen township, Ontario, 1962-65; Ph.D. thesis (Payne).

Field relations and petrology of this complex are being revised. Two-dimensional polynomial regression of various trace element distributions in grid-samples will be used to interpret the significance of country rocks in the history of the nepheline rocks.

193. Pelzer, E., Univ. of Alberta (Edmonton):
Geology and geochemistry of Besa River Formation, 1963-65; Ph.D. thesis.

194. Presant, Edward W., Carleton Univ.:
A trace element study of some selected soil profiles from the Bathurst district of New Brunswick, 1960-63; M.Sc. thesis.

The purpose of the study was to investigate the amount, distribution and nature of iron, manganese, lead, copper, zinc, arsenic, antimony, silver, tin and cadmium in a number of podsol soil profiles from northeastern New Brunswick. Total analyses were done on the soils for these elements, as well as determinations for cation exchange capacity, organic carbon and pH. Statistical correlation studies were carried out to determine the relationships of the different elements with pH and total iron. Soils overlying sulphide deposits were found to be more enriched than "normal" soils in all elements but manganese.

195. Prince, A.T., Rowland, J.F., and Wilkins, A.L., Mines Branch, Dept. of Mines and Technical Surveys:
High-temperature phase equilibrium studies in the system $CaO-Nb_2O_5-SiO_2$.
The quench technique for silicate equilibrium studies has been used to find the fields of primary crystallization in this ternary system. X-ray diffraction studies on natural and synthetic calcium niobates have been conducted. See two papers on the $Nb_2O_5-SiO_2$ and $CaO-Nb_2O_5$ systems published in Journal of the American Ceramic Society, vol. 45, pp. 221-222 and 329-334 (1962).

196. Reilly, G., Shaw, D.M., McMaster Univ.:
Average composition of part of the Precambrian shield in NW Ontario, 1962-64; M.Sc. thesis (Reilly).
Samples made available by the Geological Survey of Canada provide the basis of a statistical-analytical experiment to estimate the abundances of numerous trace elements in a particular region of the crust.

197. Rigg, T., Warchola, S.S., Wagenbauer, H.K., Research Council of Alberta:
Analysis of silicate rocks, 1960-.
See Analysis of silicate rocks. Part I: routine determination of major constituents; Research Council Preliminary Report (in press).

198. Roeder, P.L., Queen's Univ.:
Phase equilibrium studies in silicate systems containing iron oxide, 1957-.
See Effect of oxygen pressure on crystallization in simplified basalt systems, International Geological Congress, XXI Session, Norden, 1960.

199. Rose, E.R., Geol. Surv. Can.:
Preliminary investigations on the geology of vanadium, 1963-.
See Geol. Surv. Can., Paper 64-1, p. 83.

200. Rupp, John, Univ. of Manitoba:
The result of various anions and cations in the stabilization of clays, 1963-.
The project is a combination of geology and soil mechanics using differential thermal analysis and X-ray mineralogy to relate compressive strengths to ionic activity.

201. Russell, R.D., Slawson, W.F., Univ. of British Columbia:
Strontium isotope investigations, 1962-.
Mass spectrometer facilities are being set up to make measurements of the natural strontium isotope ratios.

202. Russell, R.D., Slawson, W.F., Reynolds, P.H., Whittles, A.B.L., Univ. of British Columbia:
Lead isotope investigations, 1958-; M.Sc. and Ph.D. thesis (Reynolds and Whittles).
The project includes the development and improvement of measuring techniques; studies of the characteristics of the Earth's primary lead system; quantitative interpretations of anomalous or multi-stage leads and mantle-crust relationships involving U. Th. Pb. See Age of the North American crust, Nature 200, pp. 413-415 (1963).

203. Saull, V., Clark, T.H., Tan, F., McGill Univ.:
Palaeotemperature determinations on Ordovician rocks of Quebec, 1962-64.
Oxygen 16-oxygen 18 ratios in fossils of certain Ordovician rocks of Quebec are being determined, and the results will be correlated, if possible, with temperature changes in the corresponding Ordovician seas suggested by independent geological evidence.

204. Saull, V.A., McGill Univ.:
Enthalpy changes in metamorphic reactions, 1953-.
See Chemical energy and metamorphism, Geochemica Acta 8, pp. 86-106 (1955).

205. Seguin, M., McGill Univ.:
Phase relations between siderite and the sulphides and oxides of iron; Ph.D. thesis.

206. Shaw, Denis M., McMaster Univ.:
Composition of the Canadian Precambrian Shield, 1962-.
Estimates are being made of elemental abundances in different segments of the shield. Extensive use is being made of rocks collected by the Dominion Observatory and kindly made available. Trace element analyses will be used for testing for regional and secular variations, and some major element data will be also obtained (see Reilly and Shaw).

207. Sheppard, S.M.F., Schwarcz, H.P., McMaster Univ.:
Oxygen and carbon isotope variation in metamorphic calcite-dolomite assemblages, 1963-; Ph.D. thesis (Sheppard).
O^{18}/O^{16} and C^{13}/C^{12} isotopic fractionations between coexisting dolomite and calcite from metamorphic rocks of varying grade are being measured. The fractionation values should indicate the temperature of last recrystallizations. Areas in Ontario, New York and New England have been sampled.
Carbon and oxygen isotope variations during dolomitization, 1962-64; Ph.D. thesis (Sheppard).
Using oxygen and carbon isotopic fractionations between dolomite and calcite in partially dolomitized rocks, it is hoped to shed light on the origin of diagenetic dolomites. Use will be made of the relatively slow rate of carbon isotope exchange and the preservation of primary calcite in coarse fragments of crinoid columnals.

208. Sirois, L.L., Pickett, D.E., Mines Branch, Dept. of Mines and Technical Surveys:
Determination of zero-point-of-charge of silicate minerals, 1963-64.

209. Skippen, G.B., Crocket, J.H., McMaster Univ.:
Geochemical studies on the distribution of palladium in basaltic rocks, 1961-63; Ph.D. thesis (Skippen).
This work is in the final stages. The project consisted of development of a neutron activation analytical method for determination of Pd in basaltic rocks. Results of analysis of 10 oceanic and 13 continental and orogenic basalts in duplicate indicate that the dispersion of Pd values in the oceanic basalts is much less than that in the continental basalts. The average Pd content of oceanic basalts analysed was 1.9 ± 1.2 p.p.b. (parts per billion) with a range of 0.2 to 3.7 p.p.b. The continental basalts however ranged from 0.45 to 29.4

p.p.b. For various continental basalt provinces (Deccan, Karroo, Columbia River, Parana basin) the variance of Pd within any single group is considerably less than that of continental basalts as a whole. This suggests that continental basalts are characterized by Pd provinces.

210. Smith, F.G., Univ. of Toronto:
Processes in multiphase solid systems, 1963-73.
Computer programs for calculating parameters for algebraic description of liquidus surfaces in multicomponent ionic salt systems are being written and tested. Apparatus for observing and measuring precipitation and recrystallization in solid systems is being assembled.

211. Smith, J.R., Saskatchewan Research Council:
Distribution of Cu, Zn and Ni in bedrock of the Coronation-Birch Lake Mines area, Saskatchewan, 1960-64.

212. Speelman, E.L., and Schwarcz, H.P., McMaster Univ.:
Sulfur isotope variations in metamorphic rocks, 1963-65; Ph.D. thesis (Speelman).
S^{32}/S^{34} ratios of coexisting sulfides, sulfates and sulfur-bearing silicates are being investigated to determine if equilibrium is attained during metamorphism between the various chemical species of sulfur. Infrared absorption studies of the silicates are being used to determine the nature of the structural site of sulfur in the silicates.

213. Spence, J.A., McGill Univ.:
Interstitial waters in sediments at depth; M.Sc. thesis.

214. Tan, F.C., McGill Univ.:
Palaeotemperature studies on Ordovician rocks; M.Sc. thesis.

215. Thomas, J.F.J., Mines Branch, Dept. of Mines and Technical Surveys:
Chemical quality of groundwaters in Canada.
Chemical analyses and interpretation of some groundwaters submitted by groundwater geologists each year.
Survey of special waters with reference to metals.

Studies are particularly directed to trace elements and heavy metals to assist geochemists of the Geological Survey of Canada.

Survey of special waters with reference to metals and minor elements.

Studies include analyses of waters to assist geochemists and others of the Geological Survey of Canada, for trace elements and heavy metals. Methods of analysis are also evaluated.

216. Tupper, W.M., Carleton Univ.:

Thermodynamic and physical aspects of isotope fractionation in natural environments, 1958-.

Geology and geochemistry of the Brunswick No. 6, Nigadoo, Orvan Brook, and Captain Deposits, New Brunswick, 1960-64.

217. Tupper, W.M., Mah, S., Carleton Univ.:

Determination of trace amounts of metals in rocks and soils by paper chromatography, 1963-.

Methods have been established for copper, nickel, cobalt, zinc, tin, and silver. Sensitivities of the order of 0.02 have been obtained. Approximately 50 determinations can be made per day.

218. Turnock, A.C., and Bright, N.F.H., Mines Branch, Dept. of Mines and Technical Surveys:

Phase equilibrium studies in the system Fe-Mn-Ta-O, 1962-64.

A study of the range of temperature and compositional stability of minerals of the types tantalite, tapiolite, and wodginite.

219. Van Peteghem, J.K., Thode, H.G., McMaster Univ.:

Sulfur isotope studies of the Walton barite deposit, Nova Scotia, 1963-66; Ph.D. thesis (Van Peteghem).

It is hoped that the genesis of the barite orebody can be elucidated. The barite is associated with massive sulphides that may or may not be contemporaneous with the barite. Sulfur isotope studies may prove or disprove this and also may show the relation of the barite to the surrounding Mississippian evaporites of gypsum and anhydrite.

220. Von Bronsart, G., McMaster Univ.:

The ecological significance of trace elements in recent and fossil oysters, 1963-65; Ph.D. thesis.

221. Wanless, R.K., Leech, G.B., Boyle, R.W., Stevens, R.D., Geol. Surv. Can.:

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; Buddington Volume, Geol. Soc. Amer., 1962, pp. 241-280.

222. Warren, H.V., Delavault, R.E., Univ. of British Columbia:

Biogeochemical anomalies in some British Columbia Mining camps, 1962-65.

As a result of new and systematically made collections of trees and lesser plants, it can be shown that, in some areas, biogeochemistry provides as good, or better, indications of mineralization than does pedogeochemistry.

Pedogeochemical pathfinding elements in British Columbia:

This technique shows great promise, particularly in searching for valuable veins in which the usual metals are not conspicuous, i.e., gold quartz veins. Practical application of some of the more newly acquired knowledge is being started by solving complexities of the analytical problems involved.

223. Washington, R.A., Geol. Surv. Can.:

Study of trace element coprecipitation with hydrous iron oxides, 1961-.

To measure quantitatively the amounts of trace elements coprecipitated with hydrous iron oxides.

Study of trace element adsorption by silicates, 1961-.

To obtain quantitative data on the amounts of trace elements adsorbed by silicate minerals and rocks, in order to develop a reasonable theory of the mechanisms that are operative in the formation, metamorphism, and metasomatism of silicate rocks.

Neutron Activation Analysis, 1962-.

The determination of trace elements in rocks, soils, stream sediments, etc., with greater sensitivity than possible by conventional techniques.

224. Webber, G.R., McGill Univ.:
Application of instrumental methods of analysis to geological materials, 1959-.
See Spectrochemical analysis for some major and minor elements in rocks; Applied Spectroscopy, vol. 16, No. 4, pp. 133-136, 1962.

225. Williams, G.D., Campbell, F.A., Univ. of Alberta (Edmonton):
Chemical variations in shales as an aid to determination of environment of deposition, 1962-64.

226. Winkler, E.W., and Bright, N.F.H., Mines Branch, Dept. of Mines and Technical Surveys:
Phase equilibrium studies in the system gold-bismuth-tellurium, 1963-64.
Although this system is being studied in connection with its potential semiconductor interest, several of the compounds involved also have a mineralogical connotation.

227. Wohlberg, E.G., Univ. of Saskatchewan:
Petrochemistry of metagabbros in the Birch Lake area, 1963-64; M.Sc. thesis.

228. Wynne-Edwards, H.R., Golightly, J.P., Queen's Univ.:
Coexisting plagioclase and hornblendes in regional metamorphism, 1962-64; M.Sc. thesis (Golightly).
Samples of amphibolite from a wide range of metamorphic environments have been collected and their constituent minerals are being analysed to determine the distribution of elements between the phases under different conditions.

229. Wynne-Edwards, H.R., Reinhardt, E.W., Queen's Univ.:
Element distribution in coexisting hypersthene, cordierite, garnet and biotite from metamorphic rocks of the Frontenac Axis, 1960-64; Ph.D. thesis (Reinhardt).
See Coexisting cordierite and garnet in regionally metamorphic rocks from the Westport area, Ontario; Can. Mineralogist, vol. 7, pt. 3, pp. 453-478.

230. Wynne-Edwards, H.R., Smith, M.E., Queen's Univ.:
Element distribution between coexisting feldspars in metamorphic rocks, 1963-65; Ph.D. thesis (Smith).

GEOCHRONOLOGY

231. Baadsgaard, H., Burwash, R.A., Cumming, G.L., Campbell, F.A., and Folinsbee, R.E., Univ. of Alberta (Edmonton):

Diabase dykes of the Yellowknife district, Northwest Territories, 1963-64.

A study of the age relations and trace element content of these rather similar diabase-gabbro diabase dykes of the Yellowknife district has shown the dyke sets to have been intruded at widely separated intervals of late Precambrian time -- about 2,200, 1,900, 1,600 and 1,100 m.y. ago. See Potassium-argon dates of diabase dyke systems, District of Mackenzie, N.W.T. Trans. C.I.M., vol. LXVI, 1963, pp. 303-307.

232. Baadsgaard, H., Cumming, G.L., Folinsbee, R.E., Univ. of Alberta (Edmonton):

Granitic rocks of the Yellowknife geologic province, Northwest Territories, 1963-66.

An isotopic study of the Pb-U, Rb-Sr, and K-Ar content of various minerals and rocks of granitic affinities from the Yellowknife province. Zircons have been separated from the granites (K-Ar radiometric dates 2,400-2,600 m.y.), and from the cobbles in the basal conglomerates and greywackes intruded by the granites in an attempt to establish the time involved in sedimentation and the age of the source material.

233. Baadsgaard, H., Univ. of Alberta (Edmonton) and Godfrey, J., Research Council of Alberta:

Detailed study of the geochronology of a geologically complex area of the Canadian Shield in northeastern Alberta, 1962-.

A field study of the effects of metamorphism of varying grades on radiometric systems (minerals) used in age dating. See Carnegie Institution of Washington, Yearbook, 1962, DTM, age dating report.

234. Baadsgaard, H., van Breeman, O., Univ. of Alberta (Edmonton):

Relative effect of thermal metamorphism on various radiometric parent-daughter systems, 1963-65; M.Sc. thesis (van Breeman).

In connection with the work, an exhaustive analysis of the distribution of the various parents (U, Rb, K) and daughters (Pb, Sr, Ar) in a granite will be made.

235. Cormier, R.F., St. Francis Xavier Univ.:
Absolute Dating, using Rb-Sr analyses, 1959-.

236. Crocket, J.H., McMaster Univ.:
Application of neutron activation methods to Rb-Sr geochronology, 1964-.
An investigation of the applicability of neutron activation methods to Rb-Sr technology will be started as soon as possible. The measurement of Rb by activation analysis is routine. As mass spectrometers of the solid source type are subject to fractional isotopic distillation it seems interesting to attempt to develop a non-spectrometric method of measurement of Sr^{87}/Sr^{86} ratios and total Sr. An attempt to do this by neutron activation and an activation isotope dilution procedure will be attempted.

237. Dyck, W., Geol. Surv. Can.:
Variation of the Natural Radiocarbon concentration in plants with time, 1961-.
The objective is to find out how the C^{14} content in plants has and is varying with time. It includes analyses of samples from an 1,100 year old Douglas Fir to give a measure of the reliability of the C^{14} age determination method, and analyses of annually collected living plants to serve as a monitor on man-made C^{14} and of possible isotope effects in various plants in natural surroundings.

238. Erickson, G.P., White, W.H., Dirom, G., Northcote, K., Univ. of British Columbia:
Age determination by the K-Ar method, 1962-; M.Sc. and Ph.D. theses (Dirom and Northcote).
Laboratory facilities for potassium and argon analyses are being set up for application to problems of geochronology in the Canadian Cordillera, and related studies.

239. Farquhar, R.M., Univ. of Toronto:
Lead isotope variation in minerals from the Canadian Precambrian Shield, 1954-.
Large variations in the ratios Pb^{206}/Pb^{204}, Pb^{207}/Pb^{204} and Pb^{208}/Pb^{204} have been observed among lead minerals from the Canadian Shield. Further analyses are being made in an attempt to link the observed variations with specific geological events.

240. Fitzpatrick, M.M., Queen's Univ.:
Isotope analysis, 1963-.
A mass spectrometer was installed in the Department of Geological Sciences, 1963. It has been brought into operation and the first aim will be to set up procedures for obtaining lead and potassium/argon ages. The ultimate goal is to do research on sulphur and oxygen isotopes but this will require considerable modification of the mass spectrometer.

241. Gambardella, A., Univ. of Manitoba:
The petrology and geochronology of Precambrian inliers in the Lake St. Martin area, Manitoba, 1963-64; M.Sc. thesis.

242. Gertner, H. (Mrs.), Farquhar, R.M., Univ. of Toronto:
Radioactive age data compilation, 1959-.
Data on ages by the Rb-Sr, K-Ar and U-Pb methods are being extracted from the literature and recorded on punched cards. Consideration is being given the possibility of having raw analytical data converted to isotope ratios and ages by means of electronic computer facilities.

243. Hayatsu, A., Univ. of Toronto:
Mass spectrometric measurement of strontium and lead isotope ratios, 1959-64; Ph.D. thesis.
Accurate measurement of the isotope ratios, Sr^{87}/Sr^{86}, and Pb^{206}/Pb^{204}, Pb^{207}/Pb^{204} are necessary to make estimates of geological age. Simultaneous collection methods are being applied to improve the accuracies presently obtainable with small samples of strontium and lead.

244. Lambert, R.St.J., and Dodson, M.H., Univ. of Alberta (Edmonton):
Rb-Sr ages in the Kootenay Bay area, British Columbia, 1963-64.

245. Moorhouse, W.W., Boutcher, S.M.A., Univ. of Toronto:
The Archaean of northeastern Ontario, 1961-.
Separation of minerals from sediments and volcanics in the Kirkland Lake-Lake Timiskaming area, for determining maximum and minimum isotopic ages. A petrographic and sedimentological study of the greywackes and conglomerates on the west shore of Lake Timiskaming is also being carried out.

246. Nascimbene, G., Folinsbee, R.E., Baadsgaard, H., Univ. of Alberta (Edmonton):
Bentonites and geochronology of the Bearpaw Sea, 1962-64; M.Sc. thesis (Nascimbene).
See Radiometric dating of the Bearpaw Sea presented at Inter. A.A.P.G. Res. Symp. Meeting, Toronto, May, 1964.

247. Northcote, K.E., Univ. of British Columbia:
Geology of the Guichon Batholith, Ashcroft, British Columbia, 1963-65; Ph.D. thesis.
Will include K-Ar dating of the "intrusive" phases.

248. Philpotts, A.R., McGill Univ.:
A study of the origin of pseudotachylites and the existence of Precambrian glasses, 1962-64.
The change in chemical composition that occurs during the formation of pseudotachylites by frictional fusion in fault zones has been studied. Potassium-argon dating has been carried out on undevitrified Precambrian glassy pseudotachylites. At the moment the behaviour of the rubidium-strontium system under these conditions of frictional fusion is being studied. See A Precambrian glass from St. Alexis des Monts, Quebec; Geol. Mag. vol. 100, 1963.

249. Russell, R.D., Slawson, W.F., Reynolds, P.H., Whittles, A.B.L., Univ. of British Columbia:
Lead isotope investigations, 1958-; M.Sc. and Ph.D. thesis (Reynolds and Whittles).
The project includes the development and improvement of measuring techniques; studies of the characteristics of the Earth's primary lead system; quantitative interpretations of anomalous or multi-stage leads and mantle-crust relationships involving U.Th.Pb. See Age of the North American crust, Nature 200, pp. 413-415 (1963).

250. Russell, R.D., Slawson, W.F., Univ. of British Columbia:
Strontium isotope investigations, 1962-.
Mass spectrometer facilities are being set up to make measurements of the natural strontium isotope ratios.

251. Shafiqullah, M., Folinsbee, R.E., Baadsgaard, H., Cumming, G.L., Lerbekmo, J.F., Univ. of Alberta (Edmonton):
Geochronology of the Cretaceous-Tertiary Boundary, 1962-64; M.Sc. thesis (Shafiqullah).
A radiometric date for the Cretaceous-Tertiary Boundary in Western North America has been established by K-Ar dating as 63 m.y. + 1 m.y. s.d., in a number of widely separated areas. See Shafiqullah, M. et al., Geochronology of the Cretaceous-Tertiary Boundary; XXII International Geologic Congress, 1964, India: in press.

252. Ulrych, T.J., Univ. of Western Ontario:
Lead isotope studies, 1961-.
See Gas source mass spectrometry of trace leads from Sudbury, Ontario; Geochim et Cosmochim Acta (in press) 1963.

253. Ulrych, T.J., Skibo, D., Univ. of Western Ontario:
Application of the Pb^{210} method to the problem of discordant Pb-U ages, 1963-; M.Sc. thesis (Skibo).
See Discordant Pb-U ages due to the continuous loss of lead; Nature, vol. 200, p.561, 1963.

254. Wanless, R.K., Traill, R.J., Abbey, S., Paris, J.C., Robinson, S.C., and Lowden, J.A., Geol. Surv. Can.:
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. Can., Paper 63-17 (1963).

255. Wilson, H.D.B., Moxam, R.L., Andrews, P.W., and Ramlal, K., Univ. of Manitoba:
Composition and structure of Precambrian lavas, 1961-
The composition of Precambrian lavas is being investigated by X-ray fluorescence analysis using a multi-channel instrument. Analyses are being tied in to the petrography. Regional structure is being investigated by geological and geophysical methods.

GEOMORPHOLOGY

256. Ambrose, J.W., Queen's Univ.:
Exhumed palaeoplains of the Precambrian Shield, 1934-63.

Subaerial erosion surfaces of several ages can be identified within the area of the Canadian Shield. This is an attempt to define their ages, extent, and interrelations. See Am. J. Sci., vol. 262, 1964, pp. 817-857.

257. Andrews, J.T., Geographical Branch, Dept. Mines and Technical Surveys:
Cross-valley moraines of the Remrock and Isortoq River valleys, Baffin Island, Northwest Territories - a descriptive analysis.

See Geog. Bull., Ottawa, vol. 19, 1963, pp. 49-77.

The cross-valley moraines of north-central Baffin Island; a quantitative analysis.

See Geog. Bull., Ottawa, vol. 20, 1963, pp. 82-129.

258. Bird, J.B., McGill Univ.:
The upland surfaces of the Maritime Provinces, 1962-64.

The objective of the research is to re-examine the distribution of surfaces of planation in the Maritime Provinces through map and field analysis and to establish a denudation chronology.

259. Brown, Joyce C., McGill Univ.:
The Post-Champlain evolution of the drainage pattern of the Montreal lowland, 1958-64; Ph.D. thesis.

See The drainage pattern of the lower Ottawa Valley; Canadian Geographer, vol. VI, 1962, pp. 22-31.

260. Compton, P., McGill Univ.:
Shoreline evolution in the Malpeque Bay area, Prince Edward Island, 1963-65; Ph.D. thesis.

261. Cook, Frank A., Geographical Branch, Dept. Mines and Technical Surveys:
Permafrost as a periglacial process.

See Proceedings of First Canadian Permafrost Conference, N.R.C. Tech. Bull., No. 76, Ottawa, 1963, pp. 127-130.

262. Gorman, W.A., Queen's Univ.:
A theoretical approach to the geography of the Champlain Sea, 1963-64.

263. Hill, W.B., Chapman, L.J., Ontario Research Foundation:
Physiography of Northern Ontario, 1961.
See Study of the mineralogical composition of sand in Northern Ontario by Carol I. Dell, Can. J. Soil Sci., vol. 43, pp. 189-200.

264. Ives, J.D., Geographical Branch, Dept. Mines and Technical Surveys:
Determination of marine limit in eastern arctic Canada.
See Geog. Bull., vol. 19, Ottawa, pp. 117-122.

Field problems in determining the maximum extent of Pleistocene glaciation along the eastern Canadian seaboard.
See North Atlantic Biota and their History, Ed. Askel Lowe, Pergamon Press, Oxford, 1963, pp. 337-354.

265. Ives, J.D., Andrews, J.T., Geographical Branch, Dept. Mines and Technical Surveys:
Studies in the physical geography of north central Baffin Island, Northwest Territories.
See Geog. Bull., vol. 19, Ottawa, pp. 5-48.

266. Ives, J.D., Sagar, B.R., Geographical Branch, Dept. Mines and Technical Surveys:
Return to the Ice Age - Geographical Branch research in Baffin Island.
See Can. Geog. J., vol. 67, 1963, pp. 38-47.

267. Mackay, J. Ross, Geographical Branch, Dept. Mines and Technical Surveys (part time), Univ. of British Columbia:
The Mackenzie delta area, Northwest Territories.
See Geog. Br., Ottawa, Mem. 8, 1963.

268. Parry, J.T., Johnson, Miss S.B., McGill Univ.:
Terrain analysis for mobility, 1962-; M.Sc. thesis (Miss Johnson).
An examination of the environmental factors which affect off-road mobility with attempts to establish classes for each factor and estimate their effects. The Laurentian area is being used as a sample and its analogs sought in other parts of the world.

269. Thornes, J.B., McGill Univ.:
The glacial geomorphology of the Coaticook and Moe River valleys, southern Quebec, 1963-64; M.Sc. thesis.

270. Tipper, H.W., Geol. Surv. Can.:
Glacial geomorphology of central British Columbia, 1963-65.
A description of the features, discussion of the origin and interpretation of the glacial history of the region.

GEOPHYSICS

Electrical

271. 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 being used.

Collett, L.S., Ahrens, R.A., Gauvreau, C., Geol. Surv. Can.:
Research for groundwater geophysics - development of low frequency resistivity equipment, 1962-63.
See Geol. Surv. Can., Paper 64-1, p. 78.

272. Collett, L.S., Battacharyya, B.K., and others, Geol. Surv. Can.:
Electromagnetic Radiation Studies, 1961-65.
A study of the effect of earth materials at the surface and in the subsurface on electromagnetic radiation, including model studies.

273. Morley, L.W., Geol. Surv. Can.:
Experimental airborne electromagnetic survey, southern Ontario and southern Manitoba, 1964-65.
The mapping of near surface resistivities of Pleistocene formations using the Barringer Input system to assess its feasibility for surficial geology and groundwater studies.

274. Ulrych, T.J., Denholm, J., Univ. of Western Ontario:
Induced polarization studies, 1963-; M.Sc. thesis (Denholm).

The suites of rocks which show anomalous and normal behaviour in the field are being tested in the laboratory and examined petrographically in an effort to obtain some insight on the basic mechanisms controlling the observed induced polarization effect.

275. Wyder, J.E. Gauvreau, C., Geol. Surv. Can.:
Surface resistivity groundwater surveys in southern Manitoba and Saskatchewan, 1961-.
See Geol. Surv. Can., Paper 64-1, p. 39.

276. Wyder, J.E., Univ. of Saskatchewan:
Geophysical discovery and delineation of a near surface aquifer in south central Manitoba, 1962-64; M.Sc. thesis.

Gravity

277. Brisbin, W.C., Univ. of Manitoba:
Gravity studies at the Coronation Mine, Saskatchewan, 1961-64.

Interpretation of gravity observations made underground and on the surface.

278. Brisbin, W.C., Wilson, H.D.B., Univ. of Manitoba:
Interpretation of the Kapuskasing gravity high, 1960-64.

279. Charette, J.P., Dominion Observatory in collaboration with Gold, D.P., McGill Univ.:
Gravity survey of Oka alkaline complex, Quebec.

An analysis of the data is in progress with a view to obtaining the vertical extent and possible layering of the intrusion.

280. Goodacre, A.K., Nyland, E.D., Dominion Observatory:
Underwater gravity measurements in the Gulf of St. Lawrence.

During the past two years about 600 underwater gravity measurements have been made in areas where water depths are 100 fathoms or less. They should provide valuable information regarding the structural relations of the Appalachian province and adjoining Precambrian Shield.

281. Innes, M.J.S., Tanner, J.G., Dominion Observatory:
The gravity anomaly field in Northern Saskatchewan.
Five gravity maps have been compiled and the correlation of gravity data with surface geology is in progress. Publication in the Gravity Map Series of the Dominion Observatory is anticipated during 1964.

282. Innes, M.J.S., and others, Dominion Observatory:
Gravity measurements, Muskox Intrusion, District of Mackenzie.
No additional measurements were made in 1963 but regional gravity maps on a scale of 1 inch to 1,000 feet are being compiled.
Regional gravimetric study of Baffin Island, 1961-.
Substantial progress has been made in assembling the gravity and other available geophysical data in map form on a regional basis for the greater part of the Island and on a detailed basis on the Penny and Barnes icefields.
Gravity survey of Prairie Provinces.
This project involves the compilation of about 11,000 gravity observations, 6,000 of which have been provided by the oil exploration industry.

283. McConnell, R.K., Weaver, D.W., Dominion Observatory:
Gravity in Hudson Bay and James Bay Lowlands.
Some 5,000 measurements were spaced at 8 mile intervals with higher density in areas with interesting anomalies. The data are adequate for most geodetic and isostatic studies and should provide information about the structure of the Superior geological province and its extension beneath the Lowlands of Hudson and James Bays.

284. Riley, C., Univ. of Manitoba:
Gravity studies in the Kenora area, Ontario, 1961-64; M.Sc. thesis.

285. Sobozak, L.W., Weber, J.R., and others, Dominion Observatory:
Gravity Studies, Polar Continental Shelf Project.
Studies of ice caps on Melville Island, and regional and detailed observations on Devon and Ellesmere Islands were completed. Adverse ice conditions forced cancellation of program of additional measurements over the Shelf and inter-island channel waters and a traverse far out over the Arctic Ocean basin. See (a) Gravity anomalies over the Polar Continental Shelf; Contr. Dom.

Obs., vol. 5, No. 17, (b) Regional gravity survey of Sverdrup Islands, Gravity Map Series, Dom. Obs., No. 11 and (c) Preliminary results of gravity surveys in the Queen Elizabeth Islands, Gravity Map Series, Nos. 12-15.

286. Sobozak, L.W., Weber, J.R., Spector, A., Polar Continental Shelf Project, Dept. of Mines and Technical Surveys:
Gravity observations in the Canadian Arctic Archipelago and over the Polar Continental Shelf, 1959-.
The work in 1964 is part of a continuing survey of the gravity of the Queen Elizabeth Islands, the straits and sounds between the islands, the continental shelf and the upper part of the continental slope. Gravity readings are taken as far as possible on a 12 km. grid over the sea ice and land areas.

287. Tanner, J.G., Dominion Observatory, in collaboration with Smith, C.H., Geol. Surv. Can.:
Gravity study of Mount Albert ultrabasic intrusion, Quebec.

288. Tanner, J.G., McConnell, R.K., Dominion Observatory:
Gravity studies, Northern Quebec.
See Gravity anomaly field in the Ungava Region of Northern Quebec; Gravity Map Series, Dominion Observatory, 1964 and Gravity Anomalies in the Payne Lake-Lake Minto Region, New Quebec; Gravity Map Series, Nos. 7-10.

289. Van Boekel, J., Dominion Observatory:
Gravity studies, Ontario-Quebec Mining Belt.
Considerable gravity data have been collected over the Timmins-Rouyn mining belt for a number of years. An additional 600 observations were made over critical areas in 1963. Interpretation is in progress with particular emphasis on the granitic bodies and the thicknesses of the volcanic and sedimentary rocks.

Heat Flow

290. Beck, A.E., Anglin, F.M., Judge, A.S., Univ. of Western Ontario:
Terrestrial heat flow across Canada, 1957-; Ph.D. and M.Sc. thesis (Anglin and Judge).
The project may be divided in three overlapping sections: collection of thermal data already in existance, making original measurements wherever possible and

instrumental design for improving the laboratory and field work. See Lightweight borehole temperature measuring equipment for resistance thermometers; J. Sci. Inst., vol. 40, p. 452.

291. Jessop, A.M., Blais, R., Dominion Observatory:
Heat Flow, 1962-.
A cooperative programme is being set up for the measurement of heat flow in Canada. Use is being made of holes drilled for commercial or geological purposes and in addition holes have been drilled at Halifax, Ottawa, London, Penticton using Observatory funds. A laboratory for the measurement of thermal conductivity has been set up in Ottawa. The group cooperates closely with professors interested in heat flow at McGill University (Saull and Jacobsen) and University of Western Ontario (Beck).

292. Saull, V.A., Clark, T.H., McGill Univ.:
Terrestrial heat flow in the St. Lawrence Lowland of Quebec, 1958-65.
See Transactions CIMM vol. LXV., pp. 63-66, 1962.

Magnetic

293. Bhattacharyya, B.K., Morley, L.W., McLure, D., Geol. Surv. Can.:
Computer reduction of aeromagnetic data, 1963-.
The study of the possible use of available methods of interpretation of aeromagnetic data by a computer, and research on more precise and suitable methods of data reduction and interpretation by a high speed digital computer.

294. Carmichael, C.M., Slankis, J., Lilley, F.E.M., Univ. of Western Ontario:
Rock magnetism, 1959-; M.Sc. theses (Slankis and Lilley).
Since iron rich olivine in a lava produces some magnetic oxide as it is changed to serpentine and associated minerals, an attempt is being made to alter olivine in fresh basalts to study the change in magnetic properties. A high temperature - high pressure furnace has been obtained for this work. See Magnetisation of an artificial meteorite, Nature, vol. 199, p. 426, 1963.

295. Carmichael, C.M., Palmer, H.C., Univ. of Western Ontario:
Palaeomagnetism of basic intrusive bodies of Northern Ontario, 1962-.

A study of the palaeomagnetism of basic rocks from the Superior and Grenville Provinces of the Canadian Precambrian Shield has been initiated. An integral part of the program is the radiometric dating of the rock units from which reliable pole positions can be determined.

296. Gaucher, E., Fahrig, W.F., Geol. Surv. Can.:
Palaeomagnetic study of diabase dykes, 1962-64.
The objective is a classification and age determination of different swarms of diabase dykes throughout the Canadian Shield.

297. Gross, W.H., Schwarz, E.W., Symons, D.T.N., Univ. of Toronto, 1960-65.
Remanent magnetism studies of the iron ores of the Lake Superior basin and remanent magnetism as applied to studies in ore genesis.
A laboratory outside Toronto is planned where such studies can be made under "magnetically quiet" conditions. See Remanent magnetism and the origin of hard hematites in Precambrian banded iron formation; Econ. Geol., Dec. 1961.

298. Hall, D.H., Univ. of Manitoba:
Rock magnetism and magnetic anomalies, 1962-65.
An investigation of magnetic anomalies of crustal dimensions in the Canadian Shield, and the laws of distribution of magnetization in various regions of the Shield. See The maximization of sensitivity in coil-type magnetometers for rock magnetism, Geophysics, vol. 28, pp. 767-777, 1963.

299. Hood, P.J., Geol. Surv. Can.:
Micromagnetic survey of iron formation near Nakina, Ontario, 1 inch to 10 feet, 1963.
The purpose is to relate magnetic properties of iron-formations to the lithology. See Geol. Surv. Can., Paper 64-1, p. 46.

300. Hood, P.J., Bower, M.E., Owen, K.H., Reveler, D., Geol. Surv. Can.:
Sea magnetometer and continuous subbottom profile reconnaissance of Hudson Bay, 1961-62.
To interpret depth of detrital material over bedrock in Hudson Bay and profile of bedrock surfaces.

301. Law, L.K., DeLaurier, J., Polar Continental Shelf Project, Dept. of Mines and Technical Surveys:
Investigations of geomagnetic variations in the western Queen Elizabeth Islands, Arctic Archipelago, 1963-64.
This is a field experiment to explore the extent of an observed anomalous steepening of the vertical magnetic field power spectrum in the Mould Bay area, which is manifested in a striking absence of variations in the vertical magnetic field. A theoretical interpretation of this anomaly, based on a horizontal layer model of the earth, would require a strong positive temperature anomaly at the top of the mantle. This, to fit the gravity data for the region, apparently would require a marked crustal thinning in the anomalous area. The field work is designed to test this interpretation. If results warrant, it will be followed by heat flow and seismic studies.

302. MacLaren, A.S., Geol. Surv. Can.:
Magnetic susceptibility measurements, 1962-65.
To increase knowledge of magnetic susceptibility of Precambrian rocks.

303. Niblett, E.R., Whitham, K., Darker, W., Plett, F., Dominion Observatory:
Investigation of time-varying gradients in the geomagnetic total intensity, 1956-67.
See The diurnal problem in aeromagnetic surveying in Canada; Geophys. vol. 26, No. 2, pp. 211-228, 1961.

304. Nwachukwu, Silas O., Univ. of Toronto:
The geological significance of geomagnetic measurements over the Lake Huron basin and adjacent areas, 1961-64.
A study of results of regional magnetic surveys conducted in cooperation with the Great Lakes Institute.

305. Robertson, W.A., Geol. Surv. Can. (NRC Post-doctorate Fellow):
Preliminary palaeomagnetic studies of the Muskox intrusion, Northwest Territories, 1963.
The objective is to obtain the relative ages of (1) the Muskox layered intrusion; (2) the serpentinization of certain layers; (3) the intrusion of older and younger sets of diabase dykes and (4) the extrusion of the

overlying lava flows, using the directions of natural remanent magnetism of each group. See Geol. Surv. Can., Paper 64-1, p. 14.

306. Rostoker, G., Farquhar, R.M., Garland, G.D., Univ. of Toronto:
Magneto-telluric measurements of deep crustal and Upper Mantle electrical conductivities, 1962-.
Observations of simultaneous magnetic field disturbances are being made with 4 three-component, recording flux gate magnetometers, in order to delineate zones of anomalous electrical conductivity. An initial survey indicates that no gross conductivity anomalies exist in southwestern Ontario along a line between London and Ottawa. A second series of measurements is now being made along a line from Sherbrooke, Quebec to Ottawa.

307. West, G.F., Hodych, J., Dunlop, D., Univ. of Toronto:
Rock magnetism, 1962-. Ph.D. thesis (Hodych), M.A., thesis (Dunlop).
General aims are to help establish criteria for the stability of the remanent magnetization of rocks. Hodych is studying the effects of uniaxial pressure on rock magnetizations. Dunlop is investigating, theoretically, the mechanism of remanence in small fields.

308. Whitham, K., Law, L.K., Andersen, F., DeLaurier, J., Dominion Observatory:
Investigation of the Alert Anomaly in geomagnetic variations, 1961-67.
See Investigations during 1962 of the Alert Anomaly in geomagnetic variations; Can. J. Phys. vol. 41, pp. 1868-1882, 1963.
Investigations of the anomaly in geomagnetic variations at Mould Bay, Northwest Territories, 1962-68.
See Anomalies in geomagnetic variations in the Arctic Archipelago of Canada; J. Geomag. and Geoelectricity, vol. 15, No. 4, 1963.

Radioactive

309. Doig, R.S., McGill Univ.:
Geologic applications of gamma-ray spectrometry; Ph.D. thesis.

310. Ulrych, T.J., Univ. of Western Ontario:
Lead isotope studies, 1961-.
See Gas source mass spectrometry of trace leads from Sudbury, Ontario; Geochim et Cosmochim Acta (in press) 1963.

311. Ulrych, T.J., Skibo, D., Univ. of Western Ontario:
Application of the Pb^{210} method to the problem of discordant Pb-U ages, 1963-; M.Sc. thesis (Skibo).
See Discordant Pb-U ages due to the continuous loss of lead, Nature, vol. 200, p. 561, 1963.

Seismic

312. Barrett, D.M., McAllister, E., Berger, J., Tsong, C., Ewing, G., Moore, G., Dalhousie Univ.:
Crustal refraction studies in the Atlantic Provinces area, 1962-.
The interpretation of the reversed crustal refraction profile between Cole Harbour, Guysborough county and Port Hebert, Queens county, Nova Scotia was completed. No events which could be interpreted as caused by an intermediate layer have been recognized. Both reflected and refracted shear wave events were noted. The crust is about 34 k.m. thick.
A refraction profile parallel to the edge of the continental shelf using two refraction seismograph systems located on Sable Island was undertaken during the summer of 1963 with depth charges exploded on the bottom from CNAV Sackville as the source of energy. A detailed short range reversed seismic profile was obtained on Sable Island to determine the thicknesses and velocities of the Continental Shelf sediments. A seismic station at Cole Harbour was reoccupied and a number of depth charges fired in an attempt to obtain reflections at angles less than the critical angle.

313. Beck, A.E., Univ. of Western Ontario:
Seismic investigations, 1962-.
This project covers many fields of interest. At the moment a study is being made of the possibility of improving seismic instrumentation for very long period waves by utilizing some of the most recent technological developments in solid state devices. See The use of a coupler in the conversion of impact energy into seismic energy; Geophysics, vol. 28, p. 531, 1963.

314. Beck, A.E., Davenport, A., Uffen, R.J., Milne, W.G., Univ. of Western Ontario:
Seismic regionalization of Canada, 1963-66; Ph.D. thesis (Milne).
Data on earthquake force and magnitudes are being collected and analysed with a view to dividing Canada into a number of areas specifying the probability of earthquake damage occurring in that area.

315. 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.

316. Buchbinder, G.G.R., Dominion Observatory:
Crustal structure in Arctic Islands from surface waves, 1962-63.
The dispersion of surface waves from the nuclear explosions at Novaya Zemlya has been studied from the records at Alert and Resolute. The mean crustal and upper mantle structure has been determined. See Crustal structure in Arctic Canada from Rayleigh Waves; Trans. Royal Society of Canada (in press).

317. Burke, K.B.S., Univ. of Saskatchewan:
Crustal seismic studies, west of Flin Flon, Manitoba, 1963-64.

318. Depatie, J., Houle, R., Geol. Surv. Can.:
Experimental hammer seismic survey, Beauceville area, Quebec, 1963.
To demonstrate the feasibility of locating and outlining buried bedrock channels in the Beauceville area. See Geol. Surv. Can., Paper 64-1, p. 53.

319. Grant, A.C., Brown, I.D., Geol. Surv. Can.:
Refraction seismic survey in Kirkland Lake-Larder Lake area, 1963.
To determine by hammer seismic methods the thickness of overburden at selected locations, to determine suitable sampling sites and to locate buried bedrock channels. See Geol. Surv. Can., Paper 64-1, p. 44.

320. Hobson, G.D., MacAulay, H.A., Hodge, R.A., Geol. Surv. Can.:
Seismic refraction survey, Athabasca Formation, Saskatchewan, 1963.
To determine thickness of Athabasca Formation and to contour the pre-sandstone surface on a regional basis.

321. Hobson, G., McAuley, H.A., Hodge, R., Geol. Surv. Can.:
Seismic reflection and refraction surveys, Kirkland Lake area, Ontario, 1962-63.
To attempt to locate by seismic methods faults and shear zones, and to correlate rock types with seismic velocities. See Geol. Surv. Can., Paper 63-1, p. 45, 1963.

322. Hobson, G.D., MacAulay, H.A., Hodge, R.A., Geol. Surv. Can.:
Seismic refraction and reflection surveys, Hudson Bay, 1963-65.
To determine depth and contour of the surface of the basement rocks underlying the Palaeozoic sediments of the Hudson Bay Lowlands. See Geol. Surv. Can., Paper 64-1, p. 11.

323. Holm, G., Hodge, R., Geol. Surv. Can.:
Seismic velocity and E-logging of Muskox drill holes, Northwest Territories, 1963.

324. Horwood, J.L., Mines Branch, Dept. of Mines and Technical Surveys, Gregory, A.F., Geol. Surv. Can.:
Scattering of gamma-rays in air, 1959-63.
Effect of air scattering on energy spectrum from uranium, thorium and potassium sources with special application to airborne surveying. See Mines Branch Research Report R-110, 1963.

325. Ichikawa, M., Basham, P., Dominion Observatory - Seismological Division Arctic Institute of North America, and ARPA:
Effect of site on seismograph recordings, 1962-64.
Records of the Canadian Seismological Service are being examined in order to find out why some seismograph stations produce better earthquake records than others. Study of three Arctic stations, Alert, Mould Bay and Resolute, is completed and a report is being prepared. Some very unusual effects have been noted,

particularly at Mould Bay. The ARPA contract will close in September 1964 but an extension will be applied for. If granted an attempt will be made to record with magnetic tape to provide more sophisticated analysis of the spectra of earthquakes.

326. Keen, M.J., Manchester, K.S., McGrath, P., Dalhousie Univ.:
Seismic profiling in Hudson Strait, James Sound, Baffin Bay and Davis Strait with an Edgerton Boomer, 1963.

327. Killeen, P.G., and Gale, G.H., Geol. Surv. Can.:
Seismic survey of Chignecto, Isthmus, New Brunswick and Nova Scotia, 1963.
See Geol. Surv. Can., Paper 64-1, p. 67.

328. Larocque, G.E., Mines Branch, Dept. of Mines and Technical Surveys:
Sonic studies of rock competency, 1961-.
A new transistorized portable sonic unit has been completed. The equipment is presently undergoing field tests. The main objective for developing this equipment is to be able to measure the seismic velocity in rock adjacent to underground openings. There is preliminary evidence to show that the competency of the rock is a function of the seismic velocity. Consequently, by being able to measure seismic velocities over a short base line at varying distances from a rock face some measure can be obtained of the stability of the opening and the effects of time and geometry on the stability.
See Sonic unit for the determination of dynamic properties of fracture zones, Mines Branch, Report IR 63/121-MRL.

329. Manchee, E.B., Somers, H., Wickens, A.J., Dominion Observatory:
Yellowknife Array, Northwest Territories.
In cooperation with the British a cross array of seismometers have been installed near Yellowknife. By using a cross correlation technique it is possible to determine the angle and velocity of approach of any seismic wave. The process may be used for many sorts of scientific studies but the primary purpose is to seek a method of distinguishing blasts from earthquakes.
An analysis centre is currently being planned for the Seismological Division in Ottawa that will permit the complete utilization of the array for both nuclear identification and scientific investigations.

330. Mereu, R.F., Cheng, Y.Y., Univ. of Western Ontario:
The generation of seismic energy from impact sources, 1960-65; M.Sc. thesis (Cheng).

The amount of energy that is converted into useful seismic energy during an impact is not very great and depends on a number of factors such as the duration of impact and the elastic and plastic properties of the materials involved near the source. Laboratory and field experiments are being carried out to study this impact phenomena in detail. A practical objective of the research is to improve upon the falling weight method of seismic exploration. The research will also lead to a better understanding of meteorite impact problems. See The use of a coupler in the conversion of impact energy into seismic energy, Geophysics, vol. XXVIII, No. 4, pp. 531-546.

331. Univ. of Toronto, Univ. of Alberta, Univ. of Manitoba, Polar Continental Shelf Group, Dominion Observatory (Chief Coordinator - Dr. G.F. West, Univ. of Toronto):
Lake Superior refraction spread, 1963.

The project was carried out in cooperation with a large number of U.S. geophysicists. Shots were fired in Lake Superior along a line reaching from Duluth to Michipicoten Island. These shots were recorded at a number of stations in United States and Canada along the extension of this line. The results are now being assessed and will probably be published in a single large number of the Journal of Geophysical Research.

332. Sander, G.W., Overton, A., Dominion Observatory:
Crustal studies in Canadian Arctic, 1962-.

Refraction seismic profiles have been run between Cornwallis Island - Grinnell Peninsula - Cape Christian Island and Cape Isachsen on Ellef Ringness Island. During 1964 work will be concentrated in the vicinity of Mould Bay. Sedimentary and crustal thickness have been determined.

333. Sander, G.W., Overton, A., Tyrlik, W., Polar Continental Shelf Project, Dept. of Mines and Technical Surveys:
Seismic investigations of the Sverdrup Basin and of the crust underlying the Queen Elizabeth Islands and the Polar Continental Shelf.

The project is part of an investigation of the structure and nature of the geological formation, the underlying crust and the upper mantle beneath the west-central Queen Elizabeth Islands and the off-lying continental shelf to the edge of the Arctic Ocean basin. Several short seismic profiles and a continuous traverse 450 kilometres long across the Sverdrup basin have given a composite section of crustal conditions from the Boothia Arch to the continental shelf.

334. Savage, J.C., Hasegawa, H.S., Univ. of British Columbia:
Model Seismology, 1959-; Ph.D. thesis (Hasegawa).

The project includes study of attenuation of Rayleigh waves in truncated circular metallic cylinders; radiation from fractures in glass to determine source parameters. See Radiation from a tensile fracture, J. Geophys. Res., vol. 68, p. 6345 (1963).

335. Smith, W.E., Milne, W.G., Dominion Observatory:
Seismology of Canada - a continuing program.

Dr. Milne is studying the rate of energy flux from the seismic zones of Canada and comparing these with the better known seismic areas of California and Alaska. See Earthquakes in Eastern Canada and adjacent areas - 1954-59; Pub. Dom. Obs. and Seismicity of Western Canada; vol. III - Parte Geofisicz, 1960-61, BBGOA.

336. Stevens, A.E., Dominion Observatory:
Earthquake mechanism from shear waves, 1962-.

The general theory for a point source mechanism of earthquakes has been developed which depends on the measurement of angles of polarization of shear waves at a number of stations. A program has been written for the IBM 1620 which permits the selection of mechanism type and the determination of force in the focus. The project will continue as a research contribution of the Seismological Division but the theoretical aspect of the work is now completed. See Earthquake mechanism determination by S-wave data; Bulletin Seismological Society of America (in press).

337. West, G.F., Berry, M.J., Univ. of Toronto:
Studies of the earth's crust by seismic refraction methods, 1962-; Ph.D. thesis (Berry).

Field work in Lake Superior area was completed during 1963. Interpretation will probably be completed before end of 1964. The work will likely continue in other regions.

338. Wickens, A.J., Hodgson, J.H., Dominion Observatory:
Machine computation of fault plane solutions, 1964.

For many years the Observatory has been publishing "fault plane solutions" for major earthquakes. Wickens has now programmed the IBM 1620 to produce these solutions and Hodgson has analysed solutions for about 140 earthquakes for which solutions had already been obtained by geophysical methods. It appears desirable to put some error limits on the solutions and Wickens is now writing a program to do this. This will involve the use of the faster IBM 7090. When this program is available all previously published solutions will be re-done by the computer and in the future solutions will be published for all large earthquakes in a routine way.

General Problems

339. Barron, K., Mines Branch, Dept. of Mines and Technical Surveys:
Structural modelling, 1961-.

Work has been continuing on the method of applying biaxial stress or deformation conditions to the model constructed to examine the stress and failure conditions around rooms and pillars. The effects of applying a uniform horizontal deformation on the stress distribution in simulated layered formations is being examined.

340. Barron, K., Gyenge, M., Cochrane, T.S., Grant, F., Mines Branch, Dept. of Mines and Technical Surveys:
Development of instrumentation and measurements of stress in situ, 1951-.

Additional field trials have been conducted using the rigid inclusion stressmeter for obtaining measurements of field stresses and mining induced stresses. Some interesting results have been obtained with this instrument. However, further development work is being conducted to permit its use in higher stress fields.

A number of borehole deformation meters, designed by the U.S. Bureau of Mines, have been fabricated and subjected to field trials as an alternate technique for determining stresses in situ. The development of ancilliary equipment for use in hard rocks is proceeding. The instrument is to be used with an overcoring technique to obtain measurements on field stresses and mining induced stresses in pillars.

An improved borehole deformation meter is being developed using differential transformers that will obtain at one position three deformation readings instead of only one that can be obtained with the above deformation meter. Laboratory trials on a prototype have indicated that a practical instrument of this nature can be developed.

At the request of the University of Sheffield, the performance of glass insert biaxial stressmeters, is being assessed. A theoretical appraisal of the instrument has been completed, and laboratory tests have been conducted to assess the performance of two gauges that were supplied. The instrument has many favourable aspects and field trials may be conducted at a later date. See A vibrating wire sensing head for the stressmeter; Mines Branch Rept. IR FMP 63/13-MIN.

341. Barron, K., and Toews, N., Mines Branch, Dept. of Mines and Technical Surveys:

Study of creep underground, 1962-.

This program consists of measurements of the variation of deformation of salt with time around a shaft, and of potash around mine openings in an attempt to gain fundamental knowledge of material behaviour and to correlate this data with theoretical concepts of material properties. Ultimately, the results might assist in appraising the stability of such underground openings. The results that have been obtained to date are in good agreement with general theoretical concepts of co-elastic materials. See Deformation around a mine shaft in salt, Mines Branch, Rept. IR FMP 63/29-MIN.

342. Beck, A.E., Univ. of Western Ontario:

Accretion energy and energy available from gravitational reorganization, 1960-.

When the essentially non uniform distribution of energy per gram available from the gravitational reorganization is investigated, it is found that the energy in the mantle greatly exceeds that available in the core, and any thermal history of the earth should be able to account for what has happened to this energy. Using this data and some data given by Carslaw and Jaeger, it appears very unlikely that the whole earth reached a molten stage on completion of the accretion. It also appears quite possible that the earth has always had a solid inner core, that the present inner core contains some compressed primary material, and that the slowness of the melting of the original inner core could result in appreciable quantities of radioactive material being trapped in the inner and outer core. See A note on the thermal history of the earth and the possible origin of a solid inner core, Canadian Journal Physics (in press).

343. Blanchard, J.E., Dalhousie Univ., 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.

344. Burke, K.B.S., Wyder, J.E., Univ. of Saskatchewan:
An investigation of the applicability of certain geophysical methods to the problem of locating and delineating buried river valleys and subsurface aquifers in a Pleistocene environment, 1963-66; Ph.D. thesis (Wyder).
Methods under investigation include seismic gravity, D.C. resistivity, multifrequency, A.C. resistivity and E-logging.

345. Coates, D.F., Cochrane, T., Grant, F., Barron, K., Mines Branch, Dept. of Mines and Technical Surveys:
Rockburst research, 1962-.
Studies are being conducted on mining properties that are experiencing rockbursts. These events are seemingly caused in some cases by mining induced stresses but in other cases by inherent residual stresses. Tests are being conducted on the rock substances in the laboratory, on the rock formations for their seismic velocities, on deformations associated with mining operations and on microseismic activities emanating from the surrounding ground. See studies of ground behaviour in a metal mine in northern Ontario; Mines Branch Rept. IR FMP 63/129-MIN.

346. Coates, D.F., Gyenge, M., Toews, N., Casey, L., Mines Branch, Dept. of Mines and Technical Surveys:
Rock slope stability, 1960-.

A number of projects are being conducted to determine the mechanics of failure in rock slopes. Basic studies are being pursued into the stress distribution occurring in typical slope geometries. Mathematical and photoelastic techniques are being used for this work. In addition, field measurements are being conducted on a number of mining properties to determine deformation, groundwater regime and microseismic activity associated with deep cut slopes in open pits. Both hard and soft rock formations are being studied. See Analyses of pit slides in some incompetent rocks; Trans. AIEM, vol. 226, 1963.

347. Coates, D.F., Larocque, G.E., Mines Branch, Dept. of Mines and Technical Surveys:
Study of engineering rock properties, 1963-.
Tests are being conducted on various core samples to determine if it is possible to classify the rock substances comprising a formation into a few functional categories based on some simple laboratory tests. See Classification of rocks for rock mechanics, a paper for discussion, Mines Branch Rept. IR FMP 63/65-MIN, 1963.

348. Coates, D.F., Larocque, G.E., Sassa, K., Darling, A., Mines Branch, Dept. of Mines and Technical Surveys:
Experimental study of the propagation of shock waves associated with blasting, 1963-.
A laboratory project has been started for the measurement of particle velocity and propagation velocity within the crater zone resulting from a surface explosion. These measurements will be applicable to the ground during the brief time before it is pulverized and extruded. From this work it is expected that information will be obtained on the mechanics of transferring explosive detonation pressures into ground shock pulses. It is anticipated that the impedance ratio between explosive and rock will influence this transfer of energy. The work is to be conducted on various types of rock with various types of explosives. See Rock mechanics applied to the design of underground installations to resist ground shock from nuclear blasts; Proc. Symp. Rock Mechanics, Univ. of Minnesota, Pergamon, 1963.

349. Coates, D.F., Mines Branch, Dept. of Mines and Technical Surveys, Norris, D.K., Geol. Surv. Can.:
Michel colliery roof support study, 1962-64.

A study in cooperation with Crow's Nest Pass Coal Co. Ltd. on requirements for safe roof bolting. Attempts are being made to correlate measurements of bolt loads, bed separation and timber behaviour with structural details of the roof rock and the coal.

350. Hattersley-Smith, G., Defence Research Board:
Geophysical research in the High Arctic, 1962-65.

It is proposed to continue the glaciological, meteorological and other geophysical studies started in the Lake Hazen area in 1957, and to conduct similar studies in the Tanquary Fiord area of northern Ellesmere Island. See Report D Phys R (G) Hazen 21 and Climatic inferences from firn studies in northern Ellesmere Island; Geografiska Annaler (in press).

351. Innes, M.J.S., and others, Dominion Observatory:
Fossil crater studies.

Investigations of fossil craters of possible meteoric origin continued. The program is being expanded to include laboratory study of rocks with particular attention to deformational effects of impact. During 1963 investigations were carried out at Lac Couture in the Ungava region of Northern Quebec, the Manicouagan-Mushlagan Lakes in Northern Quebec, the Brent and Holliford craters in Ontario, the Clearwater Lakes in Northern Quebec and the Carswell Lake ring structure in Northern Saskatchewan. See Evidence in support of a meteorite origin for West Hawk Lake, Manitoba, Canada; J. of Geophysical Research, vol. 68, No. 18, 1963; Study of fossil meteorite craters with the aid of geophysical and diamond drilling techniques; Part C, Crater Symposium, Proceedings of Lawrence Radiation Laboratory, Livermore, California; and Recent advances in meteorite crater research at Dominion Observatory, Ottawa, Canada; Meteoritics (in press).

352. Mereu, R.F., Uffen, R.J., Dubey, A.C., Univ. of Western Ontario:
Dynamic high pressure studies in rocks, 1962-64; M.Sc. thesis (Dubey).

A pin contractor method was developed and used to measure the absorption coefficients for high amplitude waves in cylindrical specimens of rocks. Small charges were used to generate the shock waves with pressures up to 100 kb. All measurements were made within a few cm. of the source. The results showed that the attenuation in the specimens of marble was 3 times that in the granite. At present the effect of geometry on the absorption coefficients is under investigation and an attempt is being made to measure the dynamic yield points of rocks. The results of these experiments will lead to a better understanding of how the energy of explosions can be coupled into seismic energy more efficiently. A study of the effects of shock waves on different types of rock will also be helpful to mining engineers. See The attenuation of high amplitude waves in rocks; Canadian Journal of Physics (in press).

353. Nyland, A., Blanchard, J.E., Dalhousie Univ.:
The measurement of absolute stress in the crust of the Earth, 1963-64.

It is hoped to make measurements of stress in the crust of the earth in 1964.

354. Uffen, R.J., Univ. of Western Ontario:
Palaeoaeronomy and Biogeomagnetism, 1962-.

The study sets forth qualitatively the hypothesis that the thermal history of the earth has determined the origin and development of its core, which has been a major factor in evolution through its control of the main geomagnetic field and consequently of the charged particles which have been able to reach the earth and cause genetic mutations. See The influence of the earth's core on the origin and evolution of life; Nature, vol. 198, p. 143, 1963.

355. Wilson, J.T., Farquhar, R.M., Smirnow, L., Gupta, R., Morrison, R.P., and others, Institute Earth Sciences, Univ. of Toronto:
Studies of the Earth's Crust.

For some kinds of geophysical data world compilations exist; for others (crustal thickness and age determinations) they are being made. For some continents résumés of the geology have been published; for others, including the ocean islands, they are being made. The resulting compilations will be used to attempt to find the mechanism of the earth's behaviour and to synthesize its history. See Hypothesis of the earth's behaviour; Nature, vol. 198, pp. 925-929, 1963.

GLACIOLOGY

356. Black, W.A., Geographical Branch, Dept. Mines and Technical Surveys:
Gulf of St. Lawrence ice survey, winter 1962.
See Geog. Br., Paper 36, 1963.

357. Hattersley-Smith, G., Defence Research Board:
Geophysical research in the High Arctic, 1962-65.
It is proposed to continue the glaciological, meteorological and other geophysical studies started in the Lake Hazen area in 1957, and to conduct similar studies in the Tanquary Fiord area of northern Ellesmere Island. See Report D Phys R (G) Hazen 21 and Climatic inferences from firn studies in northern Ellesmere Island; Geografiska Annaler (in press).

358. Mackay, D.K., Geographical Branch, Dept. of Mines and Technical Surveys:
Trends and factors affecting break-up and freeze-up dates in Nelson River drainage system.
See Geog. Br., Paper 35, 1962.
Ice conditions in Gulf of St. Lawrence and Cabot Strait (with particular reference to Sydney Bight area).
See Cahiers de Geog. de Que., 1963, pp. 211-228.

359. Mackay, J. Ross, Geographical Branch, Dept. of Mines and Technical Surveys (part time), Univ. of British Columbia:
Process of break-up and freeze-up along the Mackenzie River.
See Geog. Bull., vol. 19, 1963, pp. 103-116.

360. Mathews, W.H., Mackay, J. Ross, Geographical Branch, Dept. of Mines and Technical Surveys (part time), Univ. of British Columbia:
Snowcreep studies, Mount Seymour, British Columbia.
See Geog. Bull., vol. 20, 1963, pp. 58-75.

361. Sobczak, L.W., Weber, J.R., and others, Dominion Observatory:
Gravity studies, Polar Continental Shelf Project.
Studies of ice caps on Melville Island, and regional and detailed observations on Devon and Ellesmere Islands were completed. Adverse ice conditions forced cancellation of program of additional measurements over the Shelf and inter-island channel waters and a traverse far out over the Arctic Ocean basin. See (a) Gravity anomalies over the Polar Continental Shelf; Contr. Dom. Obs., vol. 5, No. 17 (b) Regional gravity survey of Sverdrup Islands, Gravity Map Series, Dom. Obs., No. 11 and (c) Preliminary results of gravity surveys in the Queen Elizabeth Islands, Gravity Map Series, Nos. 12-15.

INVENTORIES

362. Beck, L.S., Saskatchewan Dept. of Mineral Resources:
Inventory of Radioactive Mineral Occurrences in northern Saskatchewan, 1960-63.
A compilation of geological data on developed and undeveloped occurrences of radioactive mineral deposits in northern Saskatchewan based on field observations, assessment work reports, and company records.

363. Bolton, T.E., Geol. Surv. Can.:
Maintenance of Geological Survey palaeontological collections.
See Catalogue of type invertebrate fossils of the Geological Survey of Canada, vol. 1, 1960.
Lexicon of stratigraphic names used in Canada, 1958.

364. Buller, John V., Saskatchewan Dept. of Mineral Resources:
The application of an IBM 1410 Computer to the storage and retrieval of geological information, 1962-64.
Mainly concerned with a system for storage of well information in the province.

365. Chamney, T.P., Geol. Surv. Can.:
Micropalaeontological type collection, 1962.
A reference type collection from stratigraphic collections.

366. Dawson, K.R., Geol. Surv. Can.:
Meteorite Collection, 1957-.
The purpose is to catalogue, study, describe, and display the Geological Survey meteorite collection.
See Geol. Surv. Can., Paper 63-37.
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.

367. Gertner, H. (Mrs.), Farquhar, R.M., Univ. of Toronto:
Radioactive age data compilation, 1959-.
Data on ages by the Rb, Sr, K-Ar and U-Pb methods are being extracted from the literature and recorded on punched cards series. Consideration is being given the possibility of having raw analytical data converted to isotope ratios and ages by means of electronic computer facilities.

MINERAL DEPOSITS

Base Metals

368. Allen, R.G.H., Geol. Surv. Can. (part time):
Bird River Sill, Manitoba, 1963; Ph.D. thesis.
A petrological study of the sill and associated chromite deposits. See Geol. Surv. Can., Paper 64-1, p. 41.

369. Blecha, M., McGill Univ.:
A study of the chemical composition of certain dykes at Campbell Chibougamau Mines, Quebec; M.Sc. thesis.

370. Boyle, R.W., Wanless, R.K., Geol. Surv. Can.:
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.

371. Brown, A., Queen's Univ.:
Structural geology of the Opemiska mine, Quebec, 1961-64; Ph.D. thesis.
An intensive study of the structural control of the Opemiska sulphide bodies.

372. Byers, A.R., Goldak, G.R., Univ. of Saskatchewan:
Crystal orientation within natural sulphide bodies, 1963-65; Ph.D. thesis (Goldak).

373. Carr, J.M., British Columbia Dept. of Mines and Petroleum Resources:
Reconnaissance study of porphyries, breccias, and copper mineralization in Copper Mountain area, and in selected localities in southwestern British Columbia including Vancouver Island, 1963-64.

374. Chamberlain, J.A., Geol. Surv. Can.:
Sulphide phase study of Muskox Intrusion, 1962-.
A study of the genesis of the ore mineral phase of the Muskox intrusion relative to the history of the entire igneous body.
Geological studies of nickel deposits in Manitoba and Ontario, 1963-.
See Geol. Surv. Can., Paper 64-1, p. 77.

375. Clark, L.A., McGill Univ.:
Geology and geothermometry of the Marbridge nickel deposit, Malartic, Quebec, 1952-64.
Pyrrhotite geothermometry yields a pattern of ore formation temperatures consistent with the sulphide melt hypothesis of ore genesis evolved during field and microscopic studies.
Melting relations in sulphide-silicate-oxide systems, 1963-.

376. Clark, L.A., Erdosh, G., McGill Univ.:
Geothermometry and geochemistry of the New Calumet zinc-lead deposit, Calumet, Quebec, 1961-65.

377. Coates, Colin, Univ. of Manitoba:
Ultrabasic rocks on the Churchill-Superior boundary, 1962-; Ph.D. thesis.
The chemical composition and petrography of numerous ultrabasic bodies are being investigated. Particular attention is being paid to nickel content and associated nickeliferous or barren sulphides.

378. Coates, J.A., Univ. of British Columbia:
A comparative study of a bedded copper deposit in the Redstone River area, McKenzie District, Northwest Territories, 1963-64; M.Sc. thesis.
A recently discovered copper deposit in this area consists of several types of copper mineralization confined to certain horizons in a red siltstone sequence. The deposit will be described and discussed in relation to bedded copper deposits in other localities.

379. Coleman, L.C., Gaskarth, J.W., Univ. of Saskatchewan:
Trace metal distribution, metamorphism and petrogenesis in the Hanson Lake area, Saskatchewan, 1962-67; Ph.D. thesis (Gaskarth).
Geological mapping at 1" = 500' is being conducted in the Hanson Lake area. Bedrock samples collected at approximately 200' intervals are being analyzed by X-ray fluorescence techniques for Cu, Zn, Ni, Pb. The relationship of the distribution of these metals to known sulfide deposits and to the geological structures and rock units in the area is being investigated, as is the relationship of Amisk-type and Kisseynew-type rocks.

380. Cumming, G.L., Robertson, D., Univ. of Alberta (Edmonton):
Study of lead isotopes in sulphides of the Yellowknife area, 1963-65; M.Sc. thesis (Robertson).

381. Girard, Paul, Blais, R.A., Ecole Polytechnique:
Petrology of the lavas of the Doublet Group, Labrador Trough, 1963-64; M.Sc. thesis (Girard).
Aimed specifically at determining chemical composition, content of trace elements, petrography, degree of metamorphism, structure, and petrogenic associations of these widespread lavas; and to ascertain their economic base-metal possibilities.

382. Juhas, A.P., Univ. of Manitoba:
Copper-nickel deposits of the Bird River area, Manitoba, 1963-64; M.Sc. thesis.
Microscopic and chemical study of the ores and wallrocks.

383. Lickus, R.J., Quebec Dept. of Natural Resources (part time):
Vauze Mine, Dufresnoy township, Rouyn-Noranda county, Quebec, 1963; Ph.D. thesis, McGill Univ.

A case study of a massive sulfide deposit typical of the Rouyn-Noranda area with emphasis on geochemistry, stratigraphy and structure.

384. Mahaffy, D.F., McGill Univ.:
Geology of an area in the Wakeham Bay-Cape Smith Nickel Belt, Quebec; M.Sc. thesis.

385. Meloche, M.J., Queen's Univ.:
Origin of two copper and copper nickel sulphide ores in granite, 1958-64; M.Sc. thesis.

386. Naldrett, A.J., Queen's Univ.:
The geochemistry of the nickeliferous ultrabasic rocks of the Porcupine district, 1961-64; Ph.D. thesis.

387. Norman, John, Gross, W.H., Univ. of Toronto, Taylor, W., Ontario Dept. of Mines:
Sphalerite geothermometry of the Manitouwadge mining camp, 1961-64.
See Direction of flow of mineralizing solutions, Blyklippen mine, Greenland; Ec. Geol. 1956.

388. Roberts, R.G., McGill Univ.:
Mattagami Lake mine; Ph.D. thesis.

389. Sakrison, H.C., McGill Univ.:
Rock composition variation around the Lake Dufault orebody, Noranda, Quebec; Ph.D. thesis.

390. Schiller, E.A., Geol. Surv. Can.:
Determination of minor and trace elements in lead-zinc deposits in vicinity of Great Slave Lake, Northwest Territories, 1963.

391. Sharpe, J.I., Quebec Dept. of Natural Resources (part time):
North part of Isle-Dieu township and the northeast part of Daniel township, Matagami area, Abitibi-East county, 1 inch to 1,000 feet, 1961-63; Ph.D. thesis McGill Univ.
This completes a three-year mapping project in the Matagami area designed to serve as a basis for a research study of most of the massive sulfide deposits of the region. The newly opened Matagami Lake, Orchan and New Hosco mines are within the limits of the map-area. See Notes on parts of Daniel, Isle-Dieu and Galinee; R.S.-71, 1963 and southwest part of Daniel, southwest part of Isle-Dieu, Que. Dept. Nat. Res., Prelim.Rept. 503, 1964.

392. Sherwood, H.G., Univ. of Manitoba:
Gold and silver distribution in base metal ores, 1961-64; M.Sc. thesis.
Statistical analysis to determine the relation between precious metal and base metal content of ores.
Quantitative mineral composition of Canadian base metal ores, 1963-65; Ph.D. thesis.

393. Smith, J.C., Univ. of New Brunswick:
Chlorites and their relation to Bathurst ore deposits, 1962-66; Ph.D. thesis.

394. Smith, J.R., Saskatchewan Research Council:
Distribution of Cu, Zn and Ni in bedrock of the Coronation-Birch Lake mines area, Saskatchewan, 1960-64.

395. Thibault, C., Quebec Dept. of Natural Resources:
West half of Clermont township, Abitibi-East county, Quebec, 1 inch to 1,000 feet, 1963.
Detailed mapping and study of the eastern extension of the ore-bearing formation presently exploited by Normetal Mining Corporation.

396. Tupper, W.M., Carleton Univ.:
Geology and geochemistry of the Brunswick No. 6, Nigadoo, Orvan Brook, and Captain deposits, New Brunswick, 1960-64.

397. Whitmore, D.R.E. (coordinator), Geol. Surv. Can.:
Comprehensive study of the Coronation mine, Manitoba, 1960-.
A study of all geological aspects of the orebody to be coordinated by the Geol. Surv. Can. with cooperation of the Hudson Bay Mining and Smelting Co., universities, provincial governments and others.
Base metal deposits, Saskatchewan and Manitoba, 1962-.
The study of the relation of base metal deposits to one another and to the regional geology, in the light of concepts developed during the Coronation mine study.

398. Wolhuter, L.E., McGill Univ.:
The geology of a part of Levy township, Quebec, including the Opemiska mine; Ph.D. thesis.

Ferrous Metals

399. Benoit, Pierre, Université Laval:
Origine de la formation de fer du Lac Kipawa, Quebec, 1962-64; M.Sc. thesis.

400. Blais, R.A., Ecole Polytechnique:
Origin of the Baffin Island iron deposits, 1963-64.
Includes mineralogy and mineragraphy of these extremely rich hematite-specularite-magnetite ores, study of the major and minor structures in this very little known area, determination of grade of metamorphism of the country rocks, lithological-geophysical correlations, etc.

401. Dave, S.N., McGill Univ.:
Thermo-chemical study of some iron minerals; M.Sc. thesis.

402. Davies, J.L., Carleton Univ.:
Geology and geochemistry of the Austin Brook iron formation, Gloucester county, New Brunswick, 1959-64; Ph.D. thesis.
The project involves a study of the various facies of iron formation in terms of mineralogy and chemistry, including major and minor elements.

403. Gorman, D.H., Boutcher, S.M.A., Moorhouse, W.W., Univ. of Toronto:
Iron silicates in the Animikie Gunflint iron formation, Port Arthur region, 1961-64.
Census of the most important silicates in the Gunflint iron formation; identification by X-ray powder method.

404. Gross, G.A., Geol. Surv. Can.:
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. See Geol. Surv. Can., Map 34-1960, Bull. 82 and Paper 64-1, p. 78.
Iron formations of Canada, 1962-.
The study of sedimentary and stratigraphic features and composition of various types of iron formations and comparison of their respective environments of deposition. See Geol. Surv. Can., Paper 64-1, p. 78.

405. Hashimoto, Tsutomu, Université Laval:
The mode of occurrence of some iron ore minerals in the Labrador Trough, 1961-64; D.Sc. thesis.

406. Hood, P.J., Geol. Surv. Can.:
Micromagnetic survey of iron formation near Nakina, Ontario, 1 inch to 10 feet, 1963.
The purpose is to relate magnetic properties of iron formations to the lithology. See Geol. Surv. Can., Paper 64-1, p. 46.

407. Park, F.B., Queen's Univ.:
Geology of the Marmoraton iron deposit, Ontario, 1963-64; Ph.D. thesis.

408. Sangster, D.F., Univ. of British Columbia, Geol. Surv. Can. (part time):
Contact metasomatic magnetite deposits in southwestern British Columbia, 1961-64; Ph.D. thesis, Univ. of British Columbia.
Spectrographical, mineralogical and geochemical study of eighteen deposits, eleven of which have been mapped on a scale of 1 inch = 50 feet.

409. Seguin, M., McGill Univ.:
Phase relations between siderite and the sulphides and oxides of iron; Ph.D. thesis.

410. Watson, B.F., Univ. of British Columbia:
Experimental work on formation of contact magnetite deposits, 1963-64; M.A.Sc. thesis.

411. Wilton, H.P., Geol. Surv. Can. (part time):
Iron formations in the Lake Temagami area, Ontario, 1963-.
A study of the depositional environment and origin of early Precambrian banded iron formations. See Geol. Surv. Can., Paper 64-1, p. 50.

Radioactive Deposits

412. Beck, L.S., Saskatchewan Dept. of Mineral Resources:
Inventory of radioactive mineral occurrences in northern Saskatchewan, 1960-63.

A compilation of geological data on developed and undeveloped occurrences of radioactive mineral deposits in northern Saskatchewan based on field observations, assessment work reports, and company records.

413. Trigg, C.M., McGill Univ.:
The petrology and structure of an area including the Verna Uranium deposit, Beaverlodge, Saskatchewan, Ph.D. thesis.

Other Metals

414. Alcock, R.A., Univ. of Toronto:
Petrology of the Gowganda diabase sill, 1961-64; Ph.D. thesis.
A petrographic, mineralogic, and chemical investigation of the diabase sill in the vicinity of the Gowganda silver mining camp.

415. Beaton, W.D., McGill Univ.:
A general study of the Malartic North Zone, Quebec, with particular attention to the feldspars; Ph.D. thesis.

416. Boyle, R.W., Geol. Surv. Can.:
Silver in Canada, 1962-64.
A comprehensive study of silver deposits.

417. Brownell, G.M., Univ. of Manitoba:
Investigation of the molybdenum content of Cretaceous sediments along the Manitoba Escarpment, 1963-64.

418. Cabri, L.J.P., McGill Univ.:
Phase relations in the Au-Ag-Te system; Ph.D. thesis.

419. Dastidar, P.G., Univ. of New Brunswick:
A study of manganese minerals in New Brunswick and Nova Scotia, 1963-66; Ph.D. thesis.

420. Fogwill, D., McKillop, J.H., Newfoundland Dept. of Mines, Agriculture and Resources:
Chromite in Newfoundland, 1961-.
Economic reassessment of chromite occurrences including detailed geologic mapping, geophysical surveying, sampling and laboratory investigations as well as diamond drilling where warranted.

421. Gait, R.I., Univ. of Manitoba:
Investigation of the chromite layers in the Bird River sill, 1963-64; M.Sc. thesis.

422. Holland, S.S., British Columbia Dept. of Mines and Petroleum Resources:
Reconnaissance studies of molybdenite occurrences related to Topley intrusives, British Columbia, 1963.
Further studies of jade occurrences in British Columbia, 1961-63.
See Jade in British Columbia, Report of the Minister of Mines 1961, pp. 119-126.

423. Keays, R.R., Crocket, J.H., McMaster Univ.:
Neutron activation technique for determination of Pd, Pt, Ir, Os and Ru and the distribution of these metals in mineral phases of the Sudbury Irruptive, 1963-66; Ph.D. thesis (Keays).
An activation capable of measuring Pt, Pd, Ir, Os and Ru in a single irradiation is at present under development. The basic analytical scheme has been checked by radio-tracer methods and should be in operation by June, 1964. A detailed study of the distribution of these metals in coexisting sulphide minerals and in the silicate minerals of the Sudbury irruptive will then be started.

424. Kelly, R.W., Quebec Dept. of Natural Resources:
Mount St. Cecile and St. Sebastian area, Gayhurst and Whitton townships, Frontenac county, Quebec, 1 inch to 1,000 feet, 1963.
Detailed geological mapping and sampling of an intrusive stock with which is associated molybdenum bearing veins and dykes. The project includes also rock and soil geochemistry.

425. Lee, H.A., Geol. Surv. Can.:
Gold dispersion in the Kirkland Lake till fan, Ontario, 1962-.
See Geol. Surv. Can., Paper 63-45 (1963).

426. Mulligan, R., Geol. Surv. Can.:
Tin and beryllium deposits in Canada, 1961-.
A study and compilation of the geology of tin deposits and occurrences to help mineral exploration. See Geol. Surv. Can., Paper 64-1, p. 81.

427. Nickel, E.H., Charette, D.J., Mark, Miss E., Rowland, J.F., Mines Branch, Dept. of Mines and Technical Surveys:
The mineralogy of beryllium ore from Seal Lake, Labrador, 1960-64.
This complex mineral assemblage, which occurs in an alkaline syenite gneiss, is being studied intensively. A number of rare accessory minerals and some new mineral species have been discovered, and these are being investigated with respect to their optical, physical, chemical and crystallographic properties. See Eudidymite from Seal Lake, Labrador; Can. Mineralogist, vol. 7, pt. 4, 1963, pp. 643-649.

428. Nickel, E.H., Rowland, J.F., McAdam, R.C., Mines Branch, Dept. of Mines and Technical Surveys:
A study of niobium and tantalum minerals, 1957-.
The niobium analogue of astrophyllite has recently been discovered in samples from the alkaline syenite complex at Seal Lake, Labrador. The name "niobophyllite" is being proposed for this mineral. See Niobian perovskite from Oka, Quebec; A new classification for minerals of the Perovskite Group; Can. Mineralogist (in press).

429. Pattison, E.F., McGill Univ.:
Petrography and mineralogy of a manganese horizon in the Ascot Formation near Lennoxville, Quebec; M.Sc. thesis.

430. Petruk, W., Mines Branch, Dept. of Mines and Technical Surveys:
Mineralogy of tin deposit in the Mount Pleasant area, New Brunswick, 1962-64.
This deposit contains a variety of metallic and non-metallic minerals. A detailed study is under way to determine the approximate chemical composition, textural relationships, and trace element contents of each mineral. The results may be useful in suggesting a depositional environment.

431. Radcliffe, D., Univ. of Alberta (Edmonton):
Geology of the Birch Portage beryl pegmatite deposits, northern Saskatchewan, 1963-64; M.Sc. thesis.

432. Renault, Jacques, Univ. of Toronto:
The geological environment of molybdenum mineralization, 1962-64; Ph.D. thesis.

433. Rose, E.R., Geol. Surv. Can.:
Preliminary investigations on the geology of vanadium, 1963-.
See Geol. Surv. Can., Paper 64-1, p. 83.

434. Schiller, E.A., Geol. Surv. Can.:
Petrographic study of the gold bearing amphibolites and related rocks of the Contwoyto Lake area, Northwest Territories, 1963.

435. Soregaroli, Arthur E., Univ. of British Columbia:
The Boss Mountain molybdenite deposit, British Columbia, geology, mineralogy and genesis, 1963-65; Ph.D. thesis.

436. Tait, S.E., McGill Univ.:
Geology of the Mount Pleasant Mine, New Brunswick; M.Sc. thesis.

437. Williams, David, Université Laval:
Chromite deposit of Mountain Lake, Quebec, 1962-64; M.Sc. thesis.

Industrial Minerals

438. Bannatyne, Barry B., Manitoba Mines Branch:
Clays and Shales of Manitoba, 1962-64.
Testing of various clays and shales in Manitoba, primarily for suitability for brick manufacture. Report will include information on composition, properties, firing characteristics of both bedrock shale deposits and surface clay deposits, as well as the geology.

439. Boissonnault, J., Blais, R.A., Ecole Polytechnique:
Pyrophyllite deposit of Carpentier township, Abitibi-East, Quebec, 1963-64; M.Sc. thesis (Boissonnault).
Includes a detailed chemical and mineralogical investigation of the quality of this pyrophyllite, together with an appraisal of its economic potential.

440. Brady, J.G., Dean, R.S., Bell, K.E., Mines Branch, Dept. of Mines and Technical Surveys:
Mineralogical constitution and physical and chemical properties of Canadian clays, 1958-.
See Ceramic clays and shales of British Columbia; J. Canadian Ceramic Society, vol. 32, 1963.

441. Chapman, L. J., Ontario Research Foundation:
Survey of potential foundry sands in southern Ontario, 1963.

442. Clark, A.R., Univ. of Saskatchewan:
Rock fabric of potash ore beds, Saskatchewan, 1962-64; M.Sc. thesis.

Preferred orientation of halite and sylvite grains in potash beds of Middle Devonian Prairie Evaporite Formation are recorded and the results are discussed.

443. Dombrowski, H., Friedlaender, C.G.I., Kühn, R., Loring, H.D., Dalhousie Univ.:
Study of Nova Scotia Halides, 1962-.

Evidence has been found for the presence of living bacteria in rock salt from Pugwash, Nova Scotia. The salt is considered primary, of late Mississippian age, and the bacteria found must be of the same age. A morphological comparison was made between the appearance of the bacteria in thin section and the bacteria after isolation. The bacteria isolated from the rock salt were studied with respect to their physiological reactions.

444. Gillott, J.E., Division of Building Research, National Research Council:
Mechanism and reaction kinetics of alkali-carbonate rock reactivity, 1958-63.

A mechanism has been proposed to account for the expansive reaction which takes place when some argillaceous dolomitic limestones from Kingston, Ontario and certain other localities, are placed in strong alkali. The reaction is of importance to the building industry as the expansion may cause deterioration of concrete in which such rock is used as aggregate. See Petrology of dolomitic limestones, Kingston, Ontario, Canada; Bull. Geol. Soc. Am., June, 1963, vol. 74, No. 6.

445. Gittins, J., Univ. of Toronto:
The metamorphism of nepheline syenites, 1963-.

A study of the mineralogical changes that take place in nepheline syenites under conditions of regional metamorphism. See Igneous nepheline-bearing rocks of the Haliburton-Bancroft province of Ontario; J. Petrology, vol. 2, pp. 38-48, 1961.

446. Guillet, G.R., Ontario Dept. of Mines:
Clay Products Industry of Ontario, 1961-64.
See Ont. Dept. of Mines Prelim. Rept. 1963-2, p. 36.
Talc Deposits of Ontario, 1963.
See Ont. Dept. of Mines Prelim. Rept. 1963-2, p. 37.
Ceramic Industry in Ontario, 1963-64.
See Ont. Dept. of Mines Prelim. Rept. 1962-3, p. 36.
Gypsum in Ontario, 1964.
See Ont. Dept. of Mines Prelim. Rept. 1963-2, p. 36.

447. Hewitt, D.F., Ontario Dept. of Mines:
Silica Deposits in Ontario, 1962-63.
See Ont. Dept. of Mines Prelim. Rept. 1962-4, p. 33.
Building Stone Resources of Ontario, 1962.
See Ont. Dept. of Mines Prelim. Rept. 1963-2, p. 35.
Limestone Industry of Ontario, 1963.
See Ont. Dept. of Mines Prelim. Rept. 1963-2, p. 35.
Graphite in Ontario, 1963-64.
See Ont. Dept. of Mines Prelim. Rept. 1963-2, p. 35.

448. Karrow, P.F., Ontario Dept. of Mines:
Commercial sand and gravel deposits of Ontario, 1961-.
See Ont. Dept. of Mines Prelim. Rept. 1962-4, p. 33.

449. Kwak, T., Univ. of British Columbia:
A syenitic igneous complex near Kamloops, British Columbia, 1963-64; M.Sc. thesis.
The dominant problem is the origin of this undersilicated and in places nepheline bearing rock.

450. Lambo, W.A., Univ. of Manitoba:
The Silver Plains gypsum deposit, Manitoba, 1963-64; M.Sc. thesis.

451. McCammon, J.W., British Columbia Dept. of Mines and Petroleum Resources:
Study of limestone, south of Cowichan Lake and Tulameen River area, 1963.

Detailed examination and mapping of new work, Birch Island fluorite deposit, 1963.
Detailed mapping of magnesite belts, Marysville area and area west of Brisco, 1963.

452. McKillop, J.H., Harris, I., Newfoundland Dept. of Mines, Agriculture and Resources:
Limestones in Newfoundland, 1958-63.
See Geology of the Corner Brook area, Newfoundland, with emphasis on the carbonate deposits; Memorial Univ. of Newfoundland, Geol. Rept. No. 1, 1963.

453. Schwerdtner, W.M., Univ. of Saskatchewan (N.R.C. Post-doctorate Fellow):
Genesis of the potash rocks in the Middle Devonian Prairie Evaporite Formation of Saskatchewan, 1962-63.
The genesis of the potash ore beds is interpreted on the basis of the distribution of the trace element bromine, in combination with various textural observations.

454. Tupper, W.M., Carleton Univ.:
Brucite occurrences in Nova Scotia, 1961-63.
A new occurrence of brucite at the Meat Cove zinc deposit in northern Cape Breton, Nova Scotia, is briefly described. The Meat Cove zinc deposit is a contact metasomatic replacement of marble which has been altered and metasomatized by an intrusion of syenite. The marble occurs as large inclusions in the syenite. Brucite occurs with serpentine as spheroids 1-3 mm in diameter in a coarse mosaic of calcite (marble). Some of the material examined contains up to thirty per cent brucite.

455. Van Peteghem, J.K., Thode, H.G., McMaster Univ.:
Sulfur isotope studies of the Walton barite deposit, Nova Scotia, 1963-66; Ph.D. thesis (Van Peteghem).
It is hoped that the genesis of the barite orebody can be elucidated. The barite is associated with massive sulphides that may or may not be contemporaneous with the barite. Sulfur isotope studies may prove or disprove this and also may show the relation of the barite to the surrounding Mississippian evaporites of gypsum and anhydrite.

456. Wardlaw, N.C., Univ. of Saskatchewan:
Genesis of halite in the Middle Devonian Prairie Evaporite Formation of Saskatchewan.

Alternations of halite and anhydrite in the lower part of the Prairie Evaporite Formation are interpreted in terms of seasonal fluctuations of salinity in the Devonian sea. The work is based on trace element and textural studies. See Geochemistry of bromine in some salt rocks of the Prairie Evaporite Formation of Saskatchewan; Symposium on Salt, 1963, Northern Ohio Geological Society, pp. 240-246.

457. Watson, D., Univ. of Saskatchewan:
Devonian evaporites of the Elk Point basin in Alberta, 1963-66.

Facies analysis of Middle Devonian evaporites in the Elk Point basin in Alberta, with special emphasis on the distribution and genesis of halite rocks.

Petroleum

458. Burk, C.F., Geol. Surv. Can.:
Subsurface Upper Cretaceous stratigraphy of west central Alberta and adjacent British Columbia, 1960-.

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. See Geol. Surv. Can., Paper 62-31.

459. Cameron, E.M., Geol. Surv. Can.:
Studies in carbonate geochemistry, 1963-.

Geochemistry of reef and off-reef sediments. In particular to determine trends useful to petroleum industry in exploration for reef structures. See Geol. Surv. Can., Paper 64-1, p. 77.

460. Carrigy, M.S., Research Council of Alberta:
Athabasca Oil Sands, 1957-.

See Criteria for differentiating the McMurray and Clearwater Formations in the Athabasca Oil Sands; Res. Coun. Alberta, Bull. 14, 1963.

461. Gibson, D.W., Univ. of Toronto:
Triassic stratigraphy between Bow and Peace Rivers, Alberta, 1962-65; Ph.D. thesis.
Important Triassic petroleum reserves in northeast British Columbia make this study of considerable economic interest.

462. MacKenzie, W.S., Univ. of Toronto:
Geology of Southesk Cairn Devonian carbonate complex, Alberta, 1961-64; Ph.D. thesis.
A study with direct bearing on the oil and gas reservoirs of "Leduc type" in the Alberta plains area.

463. Montgomery, D.S., Goodspeed, F.E., Mines Branch, Dept. of Mines and Technical Surveys:
Infra-red absorption spectra of bituminous substances, 1951-.
The emphasis will be shifted toward a more detailed study of the lower molecular weight components of naturally occurring hydrocarbons. See A study of sedimented organic matter and its natural derivatives; Mines Branch Report R114.

Coal and Peat

464. Bannatyne, Barry B., Manitoba Mines Branch:
Peat bogs of southeastern Manitoba, 1962-64.
Sampling and analysis of peat bogs to find deposits of sphagnum moss.

465. Burrough, E.J., Botham, J.C., Mines Branch, Dept. of Mines and Technical Surveys, Hacquebard, P., Geol. Surv. Can.:
Study of coking characteristics on laboratory scale of coal seams and sections in relation to petrographic constituents, 1956-.
A cooperative project with the Coal Research Laboratory of the Geological Survey of Canada. See Evaluation of coking characteristics of samples of the Balmer seam coal from Balmer Mine of Crow's Nest Pass Coal Company; Mines Branch Report FMP 62/125-CG.

466. Cameron, A.R., Hacquebard, P.A., Donaldson, T.R., Birmingham, T.F., Barss, M.S., Geol. Surv. Can.:
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. Can., Paper 62-36.

467. Hill, W.B., Ontario Research Foundation:
Inventory of peat in Humberstone (Ontario) Bog, 1963.

468. Latour, B.A., Geol. Surv. Can.:
Coal reserves of Canada, 1950-.
See Geol. Surv. Can., Paper 64-1, 1964, p. 88.

469. McKillop, J.H., Day, R., Newfoundland Dept. of Mines, Agriculture and Resources:
Peat moss deposits in Newfoundland, 1962-.

General Problems

470. Ambrose, J.W., Carswell, H.C., Queen's Univ.:
Two more solutions of the two drill hole problem, 1962-63.
See Econ. Geol., vol. 58, No. 5, August, 1963.

471. Arnold, R.C., Saskatchewan Research Council:
Partition of trace metals between pyrite and pyrrhotite, 1962-64.

472. Blanchard, J.E., Dalhousie Univ., 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 being used.

473. Boyle, R.W., Wanless, R.K., Lowdon, J.A., Stevens, R.D., Geol. Surv. Can.:
Isotope chemistry of sulphur in rocks and ore deposits, 1955-.

See Sulphur isotope investigation of the gold-quartz deposits of the Yellowknife District; Econ. Geol., vol. 55, pp. 1591-1621, 1960.

474. Cochrane, D.R., Queen's Univ.:
Structure and origin of the Denbigh ore deposit, 1962-64; M.Sc. thesis.

475. Darling, R.G., Queen's Univ.:
Houston ore deposit, 1962-64; M.Sc. thesis.

476. Eastwood, G.E.P., British Columbia Dept. of Mines and Petroleum Resources:
Geological mapping, mine area, Brynnor Mines Limited, Kennedy Lake, Vancouver Island, 1963-64.

477. Fortescue, J.A.C., Geol. Surv. Can.:
Forest biogeochemistry, 1963-.
The initiation of a long term program. In 1963 a peat bog near Ottawa was sampled to provide background information on minor element content of Canadian peat. More than 1,000 samples of soil and plant material were collected also in the vicinity of a drilled but otherwise undisturbed mineral deposit in Eastern Canada and these will form the basis of a systematic study of the occurrence of lead in superficial materials lying over a known lead deposit.

478. Gaskarth, J.W., McGill Univ.:
Sulphur vapor pressure study of the Cu-S system and effects on solid state transport; M.Sc. thesis.

479. Gill, J.E., McGill Univ.:
Origins of ore deposits, 1923-.
See Orogenesis and ore deposits, Can. Mineral, vol. 7, pt. 3, 1963, pp. 378-389.

480. Gill, J.E., Kranck, E.H., Saull, V.A., McGill Univ.:
Silicate and sulphide diabase relationships, 1954-.
See Experimental investigation of solid diffusion and volatilization of certain metallic sulphides, Econ. Geol., vol. 56, 1961, pp. 362-391.

481. Gleeson, C.F., Geol. Surv. Can.:
Heavy mineral studies in the Maritimes and Eastern Townships, 1963-.

To evaluate the usefulness of heavy-mineral surveys as an aid to prospecting and as a means of identifying and outlining metallogenetic provinces in the Appalachian region.

482. Graham, J.D., Univ. of British Columbia:
Mining potential in the Slocan area of British Columbia, 1963-64; M.A.Sc. thesis.
A statistical evaluation of the probability of success and profit from prospecting overburden covered areas in the Slocan camp.

483. Gross, W.H., Univ. of Toronto, Thode, H.G., McMaster Univ., 1959:
Sulphur isotope geochemistry.
The use of sulphur isotope measurements in studies of ore genesis. See Sulphur isotope abundances in basic sills, differentiated granites and meteorites; Journal of Geophysical Research, May 1, 1963.

484. Gross, W.H., Schwarz, E.W., Symons, D.T.N., Univ. of Toronto, 1960-65:
Remanent magnetism studies of the iron ores of the Lake Superior basin and remanent magnetism as applied to studies in ore genesis.
A laboratory outside Toronto is planned where such studies can be made under "magnetically quiet" conditions. See Remanent magnetism and the origin of hard hematites in Precambrian banded iron formation; Econ. Geol., Dec., 1961.

485. Haycock, M.H., Mines Branch, Dept. of Mines and Technical Surveys:
Determination of Spectral reflectivity of ore minerals, 1955-.
The mineralogy of the uranium deposits at the Eldorado Mine, Port Radium, Northwest Territories, 1959-64.
The extensive collections from the underground workings of the Eldorado Mine at Port Radium made during the past decade or more are being studied in detail with the object of providing a complete record of the mineralogy of this famous mine, which is now closed down. See Mineralogy of the ores of Great Bear Lake, Bull. G.S.A., vol. 46, pp. 879-960, 1935.

486. Haycock, M.H., Nickel, E.H., Petruk, W., Mines Branch, Dept. of Mines and Technical Surveys:
Mineralogical investigation of Canadian ores in conjunction with mineral processing research and industrial development.
A wide range of ores is currently studied mineralogically in connection with the development and exploitation of Canadian ore deposits by the mining industry. Much of the data obtained through these studies is useful also in the field of mining and economic geology.

487. Holman, R.H.C., Geol. Surv. Can.:
Geochemical survey, Kirkland Lake mineralized belt, Ontario, 1962-.
A study initiated to appraise the possibility of applying geochemical techniques to mineral exploration and elucidation of geology of the district. See Geol. Surv. Can., Paper 64-1, p. 46.

488. Horwood, J.L., Mines Branch, Dept. of Mines and Technical Surveys, Gregory, A.F., Geol. Surv. Can.:
Scattering of gamma-rays in air, 1959-63.
Effect of air scattering on energy spectrum from uranium, thorium and potassium sources with special application to airborne surveying. See Mines Branch Research Report R110, 1963.

489. Joliffe, A.W., Queen's Univ.:
Element enrichment patterns in ore deposits and their genetic and geochemical significance, 1950-.
The method supplies one of the few objective ways whereby ore deposits can be compared and assessed. Complete chemical analyses of mill-head and other representative samples of ore bodies are required.

490. Kaiman, S., 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 provide mineralogical information in connection with ore treatment investigation.

491. Lamarche, R.Y., Quebec Dept. of Natural Resources (part time):
Sherbrooke area, Eastern Townships, 1 inch to 1,000 feet, 1956-64; Ph.D. thesis, Université Laval.

Study of the lithological and structural relations of the Siluro-Devonian with the Cambrian in the Stoke Mountains, with emphasis on the economic geology of the area. This study follows the detailed mapping of the Cambro-Devonian assemblage at the latitude of the City of Sherbrooke.

492. McCartney, W.D., and others, Geol. Surv. Can.:
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. Can., maps 1045-A, M2, M3, M4 and M5.
Metallogenic studies, Canadian Appalachians, 1962-.
A study of the relation of mineral distribution in the Appalachian geological region to the tectonic evolution (regional) and resultant lithologies, stratigraphy and structures. See Geol. Surv. Can., Paper 64-1, p. 79.

493. McKechnie, N.D., British Columbia Dept. of Mines and Petroleum Resources:
Geological studies at properties being explored for metallic ores, selected areas Vancouver Island and southwestern mainland British Columbia - a continuing project.
See Report of Minister of Mines, B.C., 1962.

494. Moore, J.C.G., Mount Allison Univ.:
Rock geochemistry as an aid in the search for orebodies, 1962-64.
Includes sampling and analysis of the rocks around the Heath Steele and probably other orebodies to determine if detectible trace elements as well as major elements can be used in the search for additional mineral deposits in the province. The objective is to find halos of dispersed elements or target indicators that will enlarge the target areas for mineral exploration.

495. Presant, Edward W., Carleton Univ.:
A trace element study of some selected soil profiles from the Bathurst district of New Brunswick, 1960-63; M.Sc. thesis.
The purpose of the study was to investigate the amount, distribution and nature of iron, manganese, lead, copper, zinc, arsenic, antimony, silver, tin and cadmium in a number of podzol soil profiles from northeastern New Brunswick. Total analyses were done on the soils

for these elements, as well as determinations for cation exchange capacity, organic carbon and pH. Statistical correlation studies were carried out to determine the relationships of the different elements with pH and total iron. Soils overlying sulphide deposits were found to be more enriched than "normal" soils in all elements but manganese.

496. Rene, C., Quebec Dept. of Natural Resources (part time):
East half of Carpentier township, Abitibi-East county, 1 inch to 1,000 feet, 1962-64; Ph.D. thesis, Université Laval.
Detailed mapping in an area underlain by volcanic, sedimentary and a large amount of pyroclastic rocks intruded by numerous sills of ultrabasic rocks.

497. Robert, Jean-Louis, Quebec Dept. of Natural Resources:
Mount Hogsback area, Lemieux and Lesseps townships, Gaspe-North county, 1963-66; 1 inch to 1,000 feet.
Detailed mapping to obtain a complete section of the Siluro-Devonian assemblage and possibly part of the Ordovician while making a detailed inventory of the mineral occurrences.

498. Roscoe, S.M., Geol. Surv. Can.:
Metallogenetic studies between Timmins (Ontario) and Chibougamau (Quebec), 1961-.
See Geol. Surv. Can., Paper 64-1, p. 82.

499. Tempelman-Kluit, D., Univ. of British Columbia:
Geology of Haggart Creek Dublin Gulch area, Mayo mining district, Yukon Territory, 1962-64; M.A.Sc. thesis.
The present work is intended to provide a detailed geological framework to aid further exploration.

500. Tupper, W.M., Mah, S., Carleton Univ.:
Determination of trace amounts of metals in rocks and soils by paper chromatography, 1963-.
Methods have been established for copper, nickel, cobalt, zinc, tin, and silver. Sensitivities of the order of 0.02 PPM have been obtained. Approximately 50 determinations can be made per day.

501. Van Boekel, J., Dominion Observatory:
Gravity studies, Ontario-Quebec Mining Belt.
Considerable gravity data have been collected over the Timmins-Rouyn mining belt for a number of years.

An additional 600 observations were made over critical areas in 1963. Interpretation is in progress with particular emphasis on the granitic bodies and the thicknesses of the volcanic and sedimentary rocks.

502. Warren, H.V., Delavault, R.E., Univ. of British Columbia:
Biogeochemical anomalies in some British Columbia mining camps, 1962-65.
As a result of new and systematically made collections of trees and lesser plants, it can be shown that, in some areas, biogeochemistry provides as good, or better, indications of mineralization than does pedogeochemistry.
Pedogeochemical pathfinding elements in British Columbia.
This technique shows great promise, particularly in searching for valuable veins in which the usual metals are not conspicuous, i.e. gold quartz veins. Practical application of some of the more newly acquired knowledge is being started by solving complexities of the analytical problems involved.

MINERALOGY

Specific Minerals

503. Aumento, F., Friedlaender, C.G.I., Dalhousie Univ.:
X-ray study of Nova Scotia zeolites, 1961-64; Ph.D. thesis (Aumento).
The main species of zeolites occurring at the North Mountain, Nova Scotia, were found to be analcite, apophyllite, chabasite, gmelinite, henlandite, laumontite, mordenite, natrolite, prehnite, stilbite and thomsonite. The X-ray methods used were 1) single crystal precession photography and 2) diffractometry. Approximate cell parameters were obtained with precession photography and subsequently the diffractograms were indexed and the cell parameters were refined. The calculations were carried out with an IBM 1620 computer.

504. Berry, L.G., Queen's Univ.:
X-ray study of epistolite, granomalite, nasonite, 1963-64.

505. Chao, George Y., Carleton University:
Ajoite - its composition and crystallography, 1963-64.
The crystal chemistry of hopeite, parahopeite and graftonite, 1962-.

506. Chao, George Y., Ghose, Subrata, Carleton Univ.:
The crystal structure of garrelsite, 1963-65.

507. Chao, George Y., Hounslow, Arthur W., Carleton Univ.:
Chlorapatite from the Kingston area, Ontario, 1962-64.

508. Chao, George Y., Hounslow, Arthur W., Jambor, John, Carleton Univ.:
The crystal structure of spencerite, 1963-64.

509. Coleman, L.C., Univ. of Saskatchewan:
The unit cell dimensions and optic constants of synthetic monoclinic pyroxenes, 1959-66.
See Effect of ionic substitution on the unit-cell dimensions of synthetic diopside; petrologic studies; Geol. Soc. Amer.; Buddington volume, pp. 429-446, 1962.

510. Ferguson, R.B., Univ. of Manitoba:
Feldspar phase relationships, 1950-.
With several graduate students two papers are in preparation, one on the variation of K feldspar triclinicities with K-Na-Ca rock contents, and the other on the solubility of Na-Ca in some natural K feldspars. The next project will be the determination of the solubility of K in some natural plagioclases. See A three-dimensional refinement of the structure of low albite - Norsk Geologisk Tidsskrift, 1962, vol. 42, pp. 152-157.

511. Frueh, A.J., Jr., McGill Univ.:
Crystal chemistry and crystal structure of minerals, 1961-.
Studies of Leightonite and Dawsonite are well in hand. See Fourier projections of twinned crystals, Nature 193, p. 1172, 1962.

512. Hughson, M.R., Mines Branch, Dept. of Mines and Technical Surveys, Sen Gupta, J.G., Geol. Surv. Can.:
Britholite from Oka, Quebec, 1957-63.
Determination of the chemical composition and some physical properties.

513. Middleton, G.V., McMaster Univ.:
Statistical studies on scapolite, 1962-64.

514. Nakashiro, M., McGill Univ.:
The variation of crystal cells of quartz according to temperature and localities; M.Sc. thesis.

515. Nuffield, E.W., Univ. of Toronto:
Crystal structure of Fülöppite, 1963-64.

516. Nuffield, E.W., Harris, D.C., Univ. of Toronto:
Selenian polybasite - classification of polybasites and pearceites, 1962-64.

Part of a continuing program of research on sulphosalt minerals.

517. Park, W.C., Shaw, D.M., McMaster Univ.:
Further studies on scapolite and related minerals, 1962-65; Ph.D. thesis (Park).

Various aspects of scapolite mineralogy will be examined in more detail. The paragenesis of some scapolitic rocks will be studied from the standpoint of metamorphic history.

518. Perrault, G., Tanguay, M., Ecole Polytechnique:
X-ray diffractometry of clinopyroxenes.

Accurate measurements are being made of 10 clinopyroxenes.

519. Perrault, Guy, Ecole Polytechnique:
X-ray diffractometry of feldspars, 1957-67.

See La structure atomique des feldspaths; L'Ingenieur, Hiver 1957.

Spectrophotometric measurements of reflectivity for opaque minerals with the petrographic microscope, 1964-.

Preliminary results on this new technique which may be used for identifying minerals are encouraging.

520. Petruk, W., Mines Branch, Dept. of Mines and Technical Surveys:
An investigation of the effect of iron content of chlorites on their X-ray diffraction properties and magnetic susceptibilities, 1959-69.

An empirical relationship between the iron content in chlorite and intensities of basal X-ray diffractions has been established. The relationship between the iron content and magnetic susceptibility is being investigated.

See Determination of the heavy atom content in chlorite by means of the X-ray diffractometer, American Mineralogist (in press).

521. Rimsaite, J., Geol. Surv. Can.:
Study of Micas, 1959-63.
A study of the mica family of rock-forming minerals to correlate physical, optical and X-ray properties with chemical composition and crystal structure and to relate these data to the origin, paragenesis, mode of occurrence and history of micas in rocks.

522. Smith, J.C., Univ. of New Brunswick:
Chlorites and their relation to Bathurst ore deposits, 1962-66; Ph.D. thesis.

523. Trembath, L.T., Queen's Univ.:
Structure of olivine, 1962-64; Ph.D. thesis.
Refinement of the atomic positions in fayalite and a high iron olivine.

524. Van Loan, P.R., McGill Univ.:
A crystal structure analysis of aenigmatite; Ph.D. thesis.

General Problems

525. Bartlett, Derek, Univ. of New Brunswick:
Origin and mineralogy of the coloration of some New Brunswick redbeds, 1962-64; M.Sc. thesis.

526. Campbell, F.A., Lerbekmo, J.F., Univ. of Alberta (Edmonton):
Mineralogy and geochemistry of sedimentary rocks, 1961-.
See Mineralogic and chemical variations between Upper Cretaceous continental Belly River shales and marine Wapiabi shales in western Alberta, Canada; Sedimentology, vol. 2 (1963), pp. 215-226.

527. Crawley, W.D., Carleton Univ.:
Petrology and mineralogy of Triassic basalt, Nova Scotia, 1962-64; M.Sc. thesis.
Petrography of basalt; mineralogical study of native copper and zeolites; statistical study of bulk chemistry and joint patterns.

528. Dastidar, P.G., Univ. of New Brunswick:
A study of manganese minerals in New Brunswick and Nova Scotia, 1963-66; Ph.D. thesis.

529. Folinsbee, R.E., Baadsgaard, H., Campbell, F.A., Univ. of Alberta (Edmonton), Bayrock, L., Research Council of Alberta:
Meteorites: study of Bruderheim and Peace River chrondrites, 1960-64.
An intensive study of the mineralogy and chemistry of these two meteorites is underway; this is to be submitted to the Canadian Mineralogist for publication as a memoir (sometime in 1964). See Folinsbee, R.E., and Bayrock, L., The Peace River meteorite; fall and recovery; J. Royal Astronomical Society (in press).

530. Gorman, D.H., Boutcher, S.M.A., Moorhouse, W.W., Univ. of Toronto:
Iron silicates in the Animikie Gunflint iron formation, Port Arthur region, 1961-64.
Census of the most important silicates in the Gunflint iron formation; identification by X-ray powder method.

531. Haycock, M.H., Mines Branch, Dept. of Mines and Technical Surveys:
Determination of spectral reflectivity of ore minerals, 1955-.
The mineralogy of the uranium deposits at the Eldorado Mine, Port Radium, Northwest Territories, 1959-64.
The extensive collections from the underground workings of the Eldorado Mine at Port Radium made during the past decade or more are being studied in detail with the object of providing a complete record of the mineralogy of this famous mine, which is now closed down. See Mineralogy of the ores of Great Bear Lake, Bull. G.S.A., vol. 46, pp. 879-960, 1935.

532. Haycock, M.H., Nickel, E.H., Petruk, W., Mines Branch, Dept. of Mines and Technical Surveys:
Mineralogical investigation of Canadian ores in conjunction with mineral processing research and industrial development.
A wide range of ores is currently studied mineralogically in connection with the development and exploitation of Canadian ore deposits by the mining industry. Much of the data obtained through these studies is useful also in the field of mining and economic geology.

533. Hewitt, D.F., Ontario Dept. of Mines:
Minerals and rocks of Ontario, 1963-64.

534. Kaiman, S., Mines Branch, Dept. of Mines and Technical Surveys:
Uranium in Elliot Lake flotation tailings, 1963-.
A mineralogical study of flotation tailings in connection with an investigation of the floatability of uranium in Elliot Lake ores.

535. Kaiman, S., 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 provide mineralogical information in connection with ore treatment investigation.

536. Nickel, E.H., Rowland, J.F., McAdam, R.C., Mines Branch, Dept. of Mines and Technical Surveys:
A study of niobium and tantalum minerals, 1957-.
The niobium analogue of astrophyllite has recently been discovered in samples from the alkaline syenite complex at Seal Lake, Labrador. The name "niobophyllite" is being proposed for this mineral. See Niobian perovskite from Oka, Quebec; A new classification for minerals of the Perovskite Group; Can. Mineralogist (in press).

537. Nickel, E.H., Charette, D.J., Mark, Miss E., Rowland, J.F., Mines Branch, Dept. Mines and Technical Surveys:
The mineralogy of beryllium ore from Seal Lake, Labrador, 1960-64.
This complex mineral assemblage, which occurs in an alkaline syenite gneiss, is being studied intensively. A number of rare accessory minerals and some new mineral species have been discovered, and these are being investigated with respect to their optical, physical, chemical and crystallographic properties. See Eudidymite from Seal Lake, Labrador; Can. Mineralogist, vol. 7, pt. 4, 1963, pp. 643-649.

538. Peach, Peter A., Gorman, Donald H., Univ. of Toronto:
Studies on the Manitouwabing meteorite, 1963-64.

539. Perrault, Guy, Ecole Polytechnique:
Mineralogy and petrography of the Oka alkaline intrusives, 1957-.
See Determination de la composition chimique due pyrochlore d'Oka par Spectrofluorescence des rayons; L'Ingenieur, Hiver 1960, pp. 1-7.

540. Perrault, G., Boissonnault, J., Ecole Polytechnique:
Mineralogy of the St-Hilaire District, Quebec, 1963-66.

541. Petruk, W., Mines Branch, Dept. of Mines and Technical Surveys:
Mineralogy of Tin Deposit in the Mount Pleasant area, New Brunswick, 1962-64.
This deposit contains a variety of metallic and non-metallic minerals. A detailed study is underway to determine the approximate chemical composition, textural relationships, and trace element contents of each mineral. The results may be useful in suggesting a depositional environment.

542. Rajasekaran, K.C., McGill Univ.:
The mineralogy and petrology of the nepheline syenite rocks of Mount St. Halaire, Quebec; Ph.D. thesis.

543. Roeder, P.L., Queen's Univ.:
Electrophoretic study of silicate minerals, 1962-64.

544. Rowland, J.F., Mines Branch, Dept. of Mines and Technical Surveys:
Crystallographic studies of tantalum-, tin- and niobium-bearing minerals, 1960-64.
Studies related to tantalite, tapiolite, wodginite, ixiolite, columbite-tantalite and similar minerals.

545. Schwarcz, H.P., McMaster Univ.:
Meteorite investigation.
Studies of the mineralogy and texture of chondrites and carbonaceous chondrites and studies on the origin of tektites. See A possible origin of tektites by soil fusion during impact; Nature, vol. 194, No. 3823, pp. 8-10, 1962.

546. Simpson, P.R., Univ. of New Brunswick:
Quantitative measurements on oriented sections of certain opaque minerals, 1963-65; M.Sc. thesis.

547. Stevenson, J.S., McGill Univ.:
Mineralogical studies of ashed lung tissue, 1950-.
Comprehensive petrological and mineralogical study of the Sudbury Basin irruptive, Ontario, 1951-.
See The upper contact phase of the Sudbury micropegmatite; Can. Mineralogist, vol. 7, pt. 3, pp. 413-419, 1963.

548. Stevenson, J.S., Stevenson, Louise S., McGill Univ.:
Mineralogical study of teeth of Carboniferous microsaurs from the Dawson Collection, Joggins, Nova Scotia, 1962-.
Dr. Robert Carroll has recently completed a thorough restudy of the collection and the species identification and age of these animals seems well established. Much research is now being done on the "mineral" components of teeth. As far as known, these are the oldest teeth to be so studied.

549. Traill, R.J., Sabina, A.P., Jambor, J.L., Geol. Surv. Can.:
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. Can., Paper 60-4.

PALAEONTOLOGY

550. Audretsch, A.P., Braun, W., Leskiv, K., Wilkins, L., Shell Canada Ltd.:
Zonation of the microfaunal and floral succession of Western Canada with emphasis on Cretaceous to Recent and Middle to Upper Palaeozoic sediments.

551. Bamber, E.W., Geol. Surv. Can.:
Restudy of Mississippian Coral type specimens in Geological Survey type collections, 1962-63.
Specimens will be thin sectioned, photographed and re-described and thus provide a better basis for the identification of these species, which are common in the Canadian Rocky Mountains.
Mississippian correlation in the Jasper area, Alberta, 1963-64.

A study of the fauna in the Rundle Formation, to aid in detailed correlation of sections.
Palaeontology and stratigraphy of the Carboniferous and Permian of the Northern Yukon, 1963-64.
Information obtained on Operation Porcupine will be assembled to present a general picture of these strata north of the 65th parallel. See Geol. Surv. Can., Paper 64-1, p. 18.

552. Bartlett, G.A., Geol. Surv. Can. (part time), Bedford Institute of Oceanography:
Distribution of benthic foraminifera in the inshore area of the Scotian Shelf, St. Margarets and Mahone Bays.
See A preliminary study of foraminifera distribution on the Atlantic Continental Shelf, southeastern Nova Scotia, Rept. 63-3, Bedford Inst. of Oceanography, Dartmouth, N.S. (unpublished) and Geol. Surv. Can., Paper 64-1, p. 75.

553. Bayrock, L.A., Research Council of Alberta:
Pleistocene vertebrate palaeontology of Alberta, 1959-.
The following species of extinct and living fossil vertebrates are now in the Research Council of Alberta collections: Bison crassicornis, B. occidentalis, B. latifrons? B.b. athabascae, B.b. bison, Mammuthus primigenius, Camelus sp. Bufo cognatus, Scaphiopus hammondi bombifrons, and Cerous sp. Large scale extinction occurred around 8,000 years ago when giant bison, mammoth camel, and horse became extinct. See New data on Bison athabascae; J. Palaeontology (in press).

554. Best, R.V., Univ. of British Columbia:
Canadian olenellid trilobites, 1960-64.
An attempt to incorporate and bring up to date pertinent portions of Ph.D. thesis (Princeton, 1959) on olenellid trilobites of North America. See Two new species of olenellus from British Columbia; Royal Soc. Canada, Trans., vol. 46, ser. 3, sec. 4, pp. 13-22, 1952.

555. Bolton, Thomas E., Geol. Surv Can.:
Late Silurian trilobites from Arctic Canada, 1962-63.
Examination and description of trilobita collected from Late Silurian strata exposed on Ellesmere and surrounding islands.
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.

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.

Maintenance of Geological Survey palaeontological collections.

See Catalogue of type invertebrate fossils of the Geological Survey of Canada, vol. I, 1960.

556. Brindle, J.E., Saskatchewan Dept. Mineral Resources:

Brachiopoda of the Upper Devonian Big Valley Formation of southwestern Saskatchewan, 1963-64.

The work may be extended to cover other macrofossils collected from the formation. Correlations will be made with other areas in western North America.

557. Caldwell, W.G.E., Hogg, A.W., Univ. of Saskatchewan:

Devonian faunas of the Mackenzie River Valley, 1959-; M.Sc. thesis (Hogg).

The study is concerned mainly with the systematic description of the brachiopods and corals of the late Middle and early Upper Devonian rocks of the Mackenzie River-Great Slave Lake region.

558. Caldwell, W.G.E., North, B.R., Park, J.M., Univ. of Saskatchewan:

Stratigraphic studies in Cretaceous rocks, 1959-; M.Sc. thesis (Park).

At present, the foraminiferal assemblages of the Lea Park Formation of the Montana Group and of the formations of the Colorado Group in south-central Saskatchewan are being described. Information on the Lea Park faunas will be available as a Report of the Saskatchewan Research Council. See A Cretaceous rudist from Canada, and a redescription of the holotype of Ichthyosarcolites coraldoides; J. Palaeontology, vol. 37, No. 3, pp. 615-620.

559. Chamney, T.P., Geol. Surv. Can.:

Micropalaeontological type collection, 1962.

A reference type collection from stratigraphic collections.

Neocomian Micropalaeontology, 1962-63.

Illustrations and taxonomic descriptions of significant species of Foraminifera to demonstrate the biostratigraphic control provided by this class of animals.

560. Churcher, C S., Royal Ontario Museum:
A faunal investigation of the mammalia from the Talara Tar Seeps, Peru - present genus under investigation - Smilodon, 1959-.
The investigation of Smilodon involves a comparative study of all skeletal elements from Talara, other South American localities and North America, especially Rancho la Brea. This is leading towards a revision of the genus and a consideration of Smilodontopsis and Dinobastis. Material in North American and European museums has been examined and that in South American museums will be examined in the summer of 1964, funds permitting. See Odocoileus and Mazama sp. from the tar seeps of Talara, Peru, Roy. Ont. Mus., Life Sciences Division, Contrib., No. 57, 1962.

561. Copeland, M., Geol. Surv. Can.:
Jurassic microfauna of the Prairies and Foothills, 1957-.
A study with special emphasis on Jurassic ostracod occurrences.
Ordovician Ostracoda, Lake Temiskaming, Ontario, 1959-62.
A description of new ostracods from the above area, and of the strata with which they are associated.
Canadian Fossil Ostracoda, Conchostraca, 1962-64.
Includes examination of 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.
Middle Devonian Ostracoda from drill cores, southwestern Ontario, 1962-.

562. Cumming, L.M., Geol. Surv. Can.:
Graptolite faunas, Gaspé Peninsula, Quebec, 1961.
To describe and figure graptolite faunas from Silurian and Ordovician rocks of Gaspé Peninsula and report on their stratigraphic significance.

563. Delorme, D.L., Univ. of Saskatchewan:
Pleistocene and post-glacial ostracodes of Saskatchewan, 1962-65; Ph.D. thesis.

564. Edmund, A.G., Royal Ontario Museum:
Osteology and systematics of the neotropical megatheres, and the subfamily scelidotheriinae, 1961-65.

Material collected by the writer in Peru in 1958, and in Ecuador in 1961 will permit a detailed description of all parts of the Skeletons of the megathere Eremotherium and the scelidothere, Scelidodon. Problems arising from the incomplete knowledge of geological and geographic distribution are being investigated by examination of all available specimens in museums in North and South America. It is expected that this work will result in two revisionary monographs.

A study of the giant fossil armadillo, chlamytherium, 1961-65.

The giant armadillos evolved in South America, where they were widely distributed. In Pleistocene time they reached North America where they extended to the range of the present nine-banded armadillo. Excellent specimens collected in Ecuador in 1961 will permit a complete description of Chlamythetrium Occidentale, previously known only from scraps. This will be compared with all available material in order to clarify its systematic position.

565. Ferguson, Laing, Mount Allison Univ.:

Compaction-distortion of fossil brachiopods and its bearing on taxonomy, 1959-64.

The study is at present concentrated on the distortion of productids. See Distortion of Crurithyris Urei (Fleming) from the Visean rocks of Fife, Scotland, by Compaction of the Containing Sediments; J. of Palaeontology, vol. 36, No. 1, pp. 115-119, January, 1962.

566. Frebold, H., Geol. Surv. Can.:

Jurassic Faunas of the Canadian Arctic, 1963.

567. Fritz, Madeleine A., Univ. of Toronto:

A new trilobite genus of the family Scutelluidae from Lower Silurian, Hudson Bay Lowland, 1963-64.

This new genus to be known as Grandiscutellum and the genotype: G. regale Fritz is being described and figured and will appear in the Proceedings of the Geological Association of Canada early in 1964.

Middle Ordovician Bryozoa from Mendoza province, Argentina, 1963-64.

The collection belongs to Professor Carlos Ruscani of the Meseo de Historia Natural de Mendoza.

568. Germundson, R.K., Research Council of Alberta:
Microfaunal study of the Willow Creek Formation of southern Alberta, 1961-64; Ph.D. thesis, Univ. of Missouri.
Charophytes, ostracodes and clay minerals are being used in an effort to determine the time and environmental relationships of the members within the Willow Creek and contiguous formations.

569. Globensky, Y.R., Univ. of New Brunswick:
Non-carbonate microfauna and palaeoecology of the Windsor Formation of the Atlantic Provinces, 1963-65; Ph.D. thesis.

570. Green, Robert, Research Council of Alberta:
Mississippian ostracodes of northern Alberta, 1963-66.

571. Greggs, R.G., Queen's Univ.:
Upper Cambrian faunas of Rocky Mountains, 1958-.
See Upper Cambrian-Lower Ordovician rock nomenclature in the southern Rocky Mountains; Edmonton Geol. Society Guide Book, 5th Annual Field trip, August, 1963.

572. Guliov, P., Univ. of Saskatchewan:
Palaeoecology of post-glacial invertebrates, 1961-63; M.Sc. thesis.

573. Harper, J.D., Univ. of Toronto:
The sedimentary ecology of the Middle Ordovician strata exposed at Kirkfield Quarry, Ontario, 1962-64; M.A. thesis.
An attempt to develop various quantitative methods of presenting complex skeletal limestone data.

574. Hills, L.V., Univ. of Alberta (Edmonton):
Tertiary Palynology of British Columbia, 1961-65; Ph.D. thesis.
Microflora of Princeton Formation and correlative beds.

575. Hooper, K., Bedford Institute of Oceanography (part time), Carleton Univ.:
Foraminifera and sediments of the Gulf of St. Lawrence and the eastern Canadian Continental Shelf, 1960-.

Post-Wisconsin microfaunas and sediments of Eastern Canada, 1963-.
Elemental composition and distribution in tests of foraminifera, 1961-.
See Nature, vol. 200, 23 Nov. 1963.

576. Hopkins, S., Univ. of British Columbia:
Early Tertiary palynology in the Fraser Lowlands, British Columbia and Washington, 1963-65; Ph.D. thesis.

577. Hueber, F.M., Geol. Surv. Can.:
Morphologic and taxonomic study of the Devonian megafossil floras of Eastern Canada, 1962-65.

578. Jansonius, Jan, Imperial Oil Co. Ltd.:
Chitinozoa and other fossil groups.

579. Jeletzky, J.A., Geol. Surv. Can.:
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-.
Late Upper Jurassic and Early Lower Cretaceous Buchia (= Aucella) zones of the Canadian Western Cordillera, British Columbia, 1962.
Cretaceous index fossils of sedimentary basins of western and Arctic Canada, 1961-63.
Upper Volgian (Uppermost Jurassic) faunas of Arctic Canada, 1963.

580. Jeletzky, J.A., Geol. Surv. Can., in cooperation with Gordon, M., United States Geological Survey:
Dibranchiate volume, treatise on invertebrate palaeontology, 1960-64.
A summary of the present state of knowledge of this subclass of mollusks.

581. Leith, E., Univ. of Manitoba, Sutton, R., Manitoba Museum Association:
Extinct bison in Manitoba, 1962-64.

582. Lemon, R.R.H., Royal Ontario Museum:
Pleistocene geology and palaeontology of southeast Ecuador and coastal regions of Peru, 1958-.
Study of ecologic variation in Scleractinian corals based on material from Pleistocene and Recent reefs in the Florida Keys, 1960-.

583. Loranger, D.M., Imperial Oil Co. Ltd.:
Devonian palaeoecology of northeastern Alberta.
Includes study of the transitional boundary between the Givetian and Frasmian stages.

584. McGill, Peter, Imperial Oil Co. Ltd.:
Ostracods of the uppermost Givetian.

585. McGregor, D.C., Geol. Surv. Can.:
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.
Botanic (Morphologic and Taxonomic) study of Early Devonian floras of Eastern Canada, 1960-65.
A revision of the Gaspe and related floras which will be related to the stratigraphy of the areas. See Geol. Surv. Can., Bull. 76, 1961.

586. McGugan, A., Univ. of Alberta (Calgary):
Upper Cretaceous agglutinated foraminifera, Vancouver Island, British Columbia, 1964-65.
See Upper Cretaceous Foram. Zones, Vancouver Island, B.C., J. A.S.P.G., vol. 10, No. 11, 1962.

587. Norford, B.S., Geol. Surv. Can.:
Late Ordovician and Silurian fauna of southern British Columbia, 1960-65.
See Geol. Surv. Can., Paper 64-1, p. 81.

588. Petryk, A.A., McGill Univ.:
The stromporoidas of the Arctic Ordovician, northwestern Baffin Island; M.Sc. thesis.

589. Pocock, S.A.J., Imperial Oil Co. Ltd.:

Palynology of the Jurassic sediments of Western Canada; Ph.D. thesis, Univ. of Western Ontario.

Pollen and spores of the Chlamydospermidae and Schizaeceae from Upper Mannville strata of the Saskatoon area, Saskatchewan. See Grana Palynologica, vol. 5 (in press).

590. Radforth, N.W., McMaster Univ.:

Palaeozoic and Mesozoic micropalaeontology.

Includes ecological comparisons, as revealed by microfossils in Gaspe Devonian strata; micropalaeontology of the Archaeopteris beds at Goose Fjord, Ellesmere Island; micropalaeontology of Ellesmere Island coal as compared with Cretaceous (?) beds at Lake Hazen; petrified wood assemblage from Ellesmere Island; and palaeobotanical analysis as applied to the Minto flora.

591. Russell, L.S., Royal Ontario Museum:

Tertiary mammals of Saskatchewan, 1957-.

A detailed revision and description of the fossil mammals from the Swift Current Creek beds (Upper Eocene), the Cypress Hills Formation (Lower Oligocene), and the Wood Mountain gravels (Middle or Upper Miocene). Specimens in the National Museum of Canada and the Royal Ontario Museum. See Titanotheres from the Lower Oligocene Cypress Hills Formation of Saskatchewan, Trans. Roy. Soc. Canada, ser. 3, vol. 34, sec. 4, pp. 89-100.

Fossil non-marine mollusca of Western Canada, 1958-.

Molluscan faunas in the non-marine Cretaceous and Tertiary of Saskatchewan, Alberta and British Columbia are being described, while a general systematic monograph on the combined faunas is being compiled. See Mollusca from the Tertiary of Princeton, British Columbia, National Museum of Canada, Bull. 147, pp. 84-95, pls. 1, 2, 1958.

592. Scott, Gertrude M., Univ. of Toronto:

A study of certain fossil assemblages found in Upper Ordovician rocks on the Credit River near Streetsville, Ontario, 1962-64; M.A. thesis.

The fossil accumulations are in the form of biostromes and bioherms. These are being studied to determine the fossil organisms represented which include in abundance stromatoporoids, corals, bryozoas, and algae; correlation of exposed outcrops; relationship of the organisms to the sediments in which they are entombed.

593. Singh, C., and Vagvolgyi, A., Univ. of Alberta (Edmonton):
Palynology of Lower Cretaceous, Alberta, 1959-70;
Ph.D. thesis (Singh) and M.Sc. thesis (Vagvolgyi).
Microflora of Mannville of central Alberta illustrated; type section McMurray microflora.

594. Staplin, F.L., Jansonius, Jan, Imperial Oil Co. Ltd.:
Elucidation of some Palaeozoic densospores.
See Palaeonlographica, Abt. B (in press).

595. Staplin, F.L., Jansonius, Jan, Pocock, S.A.J., Imperial Oil Co. Ltd.:
Revision of certain "acritarchus" hystrichospheres.

596. Stearn, C.W., McGill Univ.:
Upper and Middle Devonian stromatoporoids of Western Canada, 1957-.
See Some stromatoporoids from the Beaverhill Lake Formation (Devonian) of the Swan Hills area, Alberta, J. Palaeontology, vol. 37, pp. 651-668, 1963.
Revision of the Stromatoporoidea, 1964-65.
Stromatoporoid collections in the United States, England, Belgium and Germany will be visited in the spring of 1964 to obtain an overall view of the whole order as a background for its complete revision.

597. Steeves, Margaret W., Univ. of Saskatchewan:
Palynological studies in Western Canada, 1960-.
Areas in Saskatchewan under study include post-glacial deposits at Earl Grey and La Ronge; Lower Cretaceous Blairmore Formation, Saskatoon; and Upper Cretaceous Ravenscrag Formation.

598. Stevenson, J.S., Stevenson, L.S., McGill Univ.:
Mineralogical study of teeth of Carboniferous microsaurs from the Dawson Collection, Joggins, Nova Scotia, 1962-.
Dr. Robert Carroll has recently completed a thorough restudy of the collection and the species identification and age of these animals seems well established. Much research is now being done on the "mineral" components of teeth. As far as known, these are the oldest teeth to be so studied.

599. Terasmae, J., Geol. Surv. Can.:
Survey of airborne pollen, 1963.
To obtain record of airborne pollen at present time in various areas, for comparison with fossil record.
Pleistocene palynological studies, 1961-.
See Geol. Surv. Can., Paper 64-1, p. 85.

600. Usher, J.L., Queen's Univ.:
Atrypella species from the Canadian Arctic, 1963-64.
Statistical examination and comparison of the several species of Atrypella from Silurian rocks in the Canadian Arctic with a view to investigating their stratigraphic range and comparative value as stratigraphic markers.

601. Vilks, G., Geol. Surv. Can., Bedford Institute of Oceanography:
Bottom sediment and foraminifera studies in marine channels of the Arctic Archipelago, 1962-.
The studies primarily involve the correlation of foraminiferal distribution to bathymetry, type of sediment and other oceanographic data, such as temperature salinity, etc. See Marine geology, eastern part of Prince Gustaf Adolf Sea, District of Franklin, Geol. Surv. Can., Paper 63-22.
Bottom sediment and foraminifera studies on East Bay, Mackenzie King Island, 1963-.
See Geol. Surv. Can., Paper 64-1, p. 8.

602. Von Bronsart, G., McMaster Univ.:
The ecological significance of trace elements in recent and fossil oysters, 1963-65; Ph.D. thesis.

603. Wagner, F.J.E., Geol. Surv. Can.:
Micropalaeontology of recent Arctic marine sediments, 1960-.
See Faunal report - submarine geology program - Polar Continental Shelf Project, Isachsen, District of Franklin, Geol. Surv. Can., Paper 61-27.

604. Wall, J.H., Research Council of Alberta:
Microfaunal study of the Cretaceous marine sequence in the Foothills of Alberta, 1959-64.
A paper discussing the stratigraphic and ecologic significance of ten microfaunal assemblages in the Alberta Group is now in press (Bull. of Can. Petrol. Geol.). Work is proceeding on the taxonomic aspects

of the study and a paper dealing with the systematics of the microfaunas will be submitted for publication in 1964. See Evaluation of foraminifera and scaphitoid ammonites as correlation criteria in Upper Cretaceous sediments of the Foothills of the Canadian Rockies; Geol. Soc. Amer., Program Ann. Meeting, Nov. 1963 (Abstract).

605. Westermann, G.E.G., McMaster Univ.:

Jurassic, in particular Aalenian and Bajocian, ammonite faunas of the Chile-Argentina Andes and their significance to North American bio-stratigraphy, 1964-66.

See The ammonoid fauna of the Kialagvik Formation at Wide Bay, Alaska Peninsula; Bull. Am. Palaeont. March/April, 1964.

The ammonoid fauna of the Kialagvik Formation at Wide Bay, Alaska Peninsula. II. Middle Bajocian Sowerbyi Zone, 1963-65.

Part 1. "Lower Bajocian (Aalenian)" of above monograph is in press (to be published March-April 1964), Bull. Am. Palaeont.

606. Winder, C.G., Univ. of Western Ontario:

Conodont fauna of the Kettle Point shale, 1957-.

Examination of chip samples for conodonts from a well in Sombra township through an almost complete section of the Kettle Point has been finished but study of the individuals has not been completed. See Upper Devonian age of the Kettle Point shale; Trans. Roy. Soc. Can., vol. 54, ser. III, 1962, pp. 85-95.

PETROLOGY AND PETROGRAPHY

Alberta

607. Carrigy, M.A., Research Council of Alberta:

Lithology of Alberta Sandstones, 1960-.

This project consists of field measurement of cross-stratification to determine palaeoslope directions as well as the petrographic study of samples in the laboratory. See Authigenic clay mineral cements in Cretaceous and Tertiary sandstones of Alberta; J. Sed. Pet. (in press).

608 Gibson, D.W., Geol. Surv. Can.:
Triassic Rocks near northern boundary of Jasper National Park, 1962-63; Ph.D. thesis, Univ. of Toronto.

Study of the stratigraphy and petrology to establish stratigraphic relationships and correlation, their sedimentary features, conditions of deposition, and their potentialities as possible reservoirs for oil and gas. See Geol. Surv. Can., Paper 64-1, p. 33.

609 MacQueen, R.W., Geol. Surv. Can. (part time):
Mississippian stratigraphy and petrology, Bow and Highwood Rivers area, Alberta, 1963-64; Ph.D. thesis.

See Geol. Surv. Can., Paper 64-1, p. 34.

610. Pearce, T.H., Queen's Univ.:
A petrographic and chemical study of the Crowsnest Volcanics, Alberta, 1963-65; Ph.D. thesis.

The Crowsnest Formation near Crowsnest Pass, Alberta, consists of breccia, agglomerate, volcanic sandstones and ash beds. It is the earliest Mesozoic volcanic formation in that part of the Canadian Cordillera, and is unusually high in K_2O, Na_2O, and BaO. Because of its distinctive lithology, it has been used extensively as a marker horizon. The investigation will include studies of the lateral and vertical variations of the mineralogy and chemistry of the formation, and the origin and nature of deposition of the different units in it.

611. Rapson, June E., Univ. of Alberta (Calgary):
Petrography and depositional environment of the Permian sediments (clastics, carbonates, phosphates, etc.) of Alberta and eastern British Columbia, 1964-68.

See Permo-Carboniferous stratigraphy between Banff and Jasper, Alberta (including petrography). Bull. Can. Petrol. Geol., vol. 11, No. 2, pp. 150-160.

Petrography and depositional environment of the transitional Jurassic/Cretaceous clastics, southern Alberta, 1962-64.

See Diagenesis in Jurassic-Cretaceous clastic rocks in southwestern Alberta and the interpretation of sedimentary environments (outcrop and subsurface material), Paper presented S.E.P.M. Meeting, Toronto, 1964.

British Columbia

612. Carr, J.M., British Columbia Dept. of Mines and Petroleum Resources:
Reconnaissance study of porphyries, breccias, and copper mineralization in Copper Mountain area, and in selected localities in southwestern British Columbia including Vancouver Island, 1963-64.

613. Church, N.B., Univ. of British Columbia:
Petrology of the Tertiary Rocks of the White Lake Basin, British Columbia, 1963-65; Ph.D. thesis.
The study is focused on a group of Tertiary lavas, lake sediments, and breccias centred about a diatreme-like structure in the south Okanagan Valley near Penticton.

614. Dodds, C.H., Univ. of Alberta (Edmonton):
Composition of garnet in relation to metamorphic grade in the Kootenay Bay area, British Columbia, 1963-64; M.Sc. thesis.

615. Fox, P.E., Carleton Univ.:
Petrology of the Adamant Range pluton, Selkirk Mountains, British Columbia, 1961-64; Ph.D. thesis.
Petrology and mineral chemistry of a zoned pyroxene monzonite-granodiorite intrusion.

616. Kwak, T., Univ. of British Columbia:
A syenitic igneous complex near Kamloops, British Columbia, 1963-64; M.Sc. thesis.
The dominant problem is the origin of this undersilicated and in places nepheline bearing rock.

617. Mason, I.M., Clifford, P.M., McMaster Univ.:
Contact metamorphism at Salmo, British Columbia, 1964-66; M.Sc. thesis (Mason).
Monzonite stocks have metamorphosed a series of sedimentary rocks at Salmo, B.C. Mineralogical and chemical variations in a "marker" horizon are to be related to fabric of the bed, distance from stock, etc.

618. Montgomery, J.H., Univ. of British Columbia:
Petrology of the Copper Mountain stock near Princeton, British Columbia, 1959-64; Ph.D. thesis.

The project is concerned with the petrology, mineralogy, and structure of the stock which ranges from gabbro to perthosite, with emphasis on the chemistry of differentiation and study of feldspars in relation to this process.

619. Northcote, K.E., Univ. of British Columbia:
Geology of the Guichon Batholith, Ashcroft, British Columbia, 1963-65; Ph.D. thesis.
Will include K-Ar dating of the "intrusive" phases.

620. Peach, Peter A., Univ. of Toronto:
Petrology of the Takomkane volcano, British Columbia, 1962-64.

621. Read, P.B., Geol. Surv. Can.:
A study of the environs of the east contact of the Kuskanax batholith, British Columbia.
See Geol. Surv. Can., Paper 64-1, 1964, p. 23.

622. Reesor, J.E., Geol. Surv. Can.:
Granitic rocks, Thor-Oden area, British Columbia, 1957-.
Part of a continuing program of detailed mapping of representative granitic bodies with special attention to providing comprehensive geological information concerning their scientific and economic aspects. See Geol. Surv. Can., Paper 64-1, p. 23.

Manitoba

623. Allen, R.G.H., Geol. Surv. Can. (part time):
Bird River Sill, Manitoba, 1963; Ph.D. thesis.
A petrological study of the sill and associated chromite deposits. See Geol. Surv. Can., Paper 64-1, p. 41.

624. Coates, Colin, Univ. of Manitoba:
Ultrabasic rocks on the Churchill-Superior boundary, 1962-; Ph.D. thesis.
The chemical composition and petrography of numerous ultrabasic bodies are being investigated. Particular attention is being paid to nickel content and associated nickeliferous or barren sulphides

625. Gait, R.I., Univ. of Manitoba:
Investigation of the chromite layers in the Bird River sill, 1963-64; M.Sc. thesis.

626. Gambardella, A., Univ. of Manitoba:
The petrology and geochronology of Precambrian inliers in the Lake St. Martin area, Manitoba, 1963-64; M.Sc. thesis.

New Brunswick

627. Bennett, Gerald, Univ. of New Brunswick:
Petrology of the Stewarton gabbroic mass, 1961-64; M.Sc. thesis.

628. Cooper, G.E., Univ. of New Brunswick:
Geology of the Benton granitic stock, 1961-64; M.Sc. thesis.

629. Harris, F., New Brunswick Mines Branch:
A study of the volcanic rocks of the Sunday Lake area, New Brunswick, 1962-64; M.Sc. thesis, Univ. of New Brunswick.
Continuation of a study of volcanic rocks associated with the Mt. Pleasant tin prospect.

Newfoundland and Labrador

630. Clifford, P.M., McMaster Univ.:
Rate of cooling and igneous fabric, with particular reference to diabases and basalt flows in north Newfoundland, 1962-64.

631. Girard, Paul, Blais, R.A., Ecole Polytechnique:
Petrology of the lavas of the Doublet Group, Labrador Trough, 1963-64; M.Sc. thesis (Girard).
Aimed specifically at determining chemical composition, content of trace elements, petrography, degree of metamorphism, structure, and petrogenic associations of these widespread lavas; and to ascertain their economic base-metal possibilities.

632. Papezik, V.S., Memorial Univ. of Newfoundland:
Petrology of the area between Springdale and Little Bay, Newfoundland, 1963-65.

Petrological investigation of metamorphosed volcanics and sediments deposited in a eugeosynclinal environment. Several copper deposits lie in this belt.

633. Papezik, V.S., Barning, K., Memorial Univ. of Newfoundland:
Mineralogy and petrology of the Holyrood granite and the intruded rocks, 1963-; M.Sc. thesis (Barning).
Detailed investigation of the contact features of a granitic batholith intruding andesitic and rhyolitic volcanics.

Northwest Territories and Yukon

634. Baadsgaard, H., Cumming, G.L., Folinsbee, R.E., Univ. of Alberta (Edmonton):
Granitic rocks of the Yellowknife Geologic Province, Northwest Territories, 1963-66.
An isotopic study of the Pb-U, Rb-Sr, and K-Ar content of various minerals and rocks of granitic affinities from the Yellowknife Province. Zircons have been separated from the granites (K-Ar radiometric dates 2,400-2,600 m.y.), and from the cobbles in the basal conglomerates and greywackes intruded by the granites, in an effort to establish the time involved in sedimentation, and the age of the source material.

635. Baadsgaard, H., Burwash, R.A., Cumming, G.L., Campbell, F.A., Folinsbee, R.E., Univ. of Alberta (Edmonton):
Diabase dykes of the Yellowknife District, Northwest Territories, 1963-64.
A study of the age relations and trace element content of these rather similar diabase-gabbro diabase dykes of the Yellowknife District has shown the dyke sets to have been intruded at widely separated intervals of late Precambrian time - about 2,200, 1,900, 1,600 and 1,100 m.y. ago. See Potassium-argon dates of diabase dyke systems, District of Mackenzie, N.W.T. Trans. C.I.M., vol. LXVI, 1963, pp. 303-307.

636. Findlay, D.C., Geol. Surv. Can.:
Diamond drilling activities, Muskox Intrusion, Northwest Territories, 1962-63.
See Geol. Surv. Can., Paper 64-1, p. 12.

637. Gabisi, Abdul H., Carleton Univ.:
Metamorphism in the Muskox Intrusion aureole, Northwest Territories, 1961-64; M.Sc. thesis.

638. Jamieson, E.R., Geol. Surv. Can. (part time):
Stratigraphy and petrology of Upper Devonian Rocks, Hay River area, Northwest Territories, 1962; Ph.D. thesis.

The study of Upper Devonian rocks in vicinity of Hay River to obtain appropriate suites of samples for petrographic examination to determine their potentialities as sources and reservoirs for oil and gas. See Geol. Surv. Can., Paper 64-1, p. 13.

639. Kranck, Kate M., Geol. Surv. Can. (part time) and Bedford Institute of Oceanography.
Recent marine sediments of Exeter Bay, Northwest Territories, 1962-63; M.Sc. thesis.

Purpose is to present a petrographic analysis of bottom sediments of Exeter Bay, Baffin Island and to relate the petrographic observations to known depths of water, submarine topography, oceanic currents, and drifts of the floes.

640. Payne, A., Folinsbee, R.E., Univ. of Alberta (Edmonton):
Basic-ultrabasic differentiated sheet, Yellowknife District, Northwest Territories, 1963-64; M.Sc. thesis (Payne).

A petrographic mineralogic and geochemical study of this mantle derived basic body. Field studies and some drilling suggest it is an ethmolith, not a sheet; radiometric dating suggests it was intruded about 1,900 m.y. ago and much earlier than the somewhat comparable Muskox intrusive.

641. Robertson, W.A., Geol. Surv. Can. (NRC Post-doctorate Fellow):
Preliminary palaeomagnetic studies of the Muskox Intrusion, Northwest Territories, 1963.

The objective is to obtain the relative ages of (1) the Muskox layered intrusion (2) the serpentinization of certain layers (3) the intrusion of older and younger sets of diabase dykes and (4) the extrusion of the overlying lava flows, using the directions of natural remanent magnetism of each group. See Geol. Surv. Can., Paper 64-1, p. 14.

642. Schiller, E.A., Geol. Surv. Can.:
Petrographic study of the gold-bearing amphibolites and related rocks of the Contwoyto Lake area, Northwest Territories, 1963.

Nova Scotia

643. Crawley, W.D., Carleton Univ.:
Petrology and mineralogy of Triassic basalt, Nova Scotia, 1962-64; M.Sc. thesis.
Petrography of basalt; mineralogical study of native copper and zeolites; statistical study of bulk chemistry and joint patterns.

644. Dawson, J.B., Dalhousie Univ. (N.R.C. Post-doctorate Fellow):
Petrology and geochemistry of the George River Series, Cape Breton Island, 1962-64.

645. Mackasey, W.O., Carleton Univ.:
Petrography and stratigraphy of a Lower Mississippian, pre-Horton volcanic succession in northwestern Cape Breton Island, Nova Scotia, 1961-63; M.Sc. thesis.

646. Taylor, F.C., Geol. Surv. Can.:
Regionally developed cordierite, andalusite, and staurolite in the Shelburne map-area, Nova Scotia, 1963-64.

Ontario

647. Alcock, R.A., Univ. of Toronto:
Petrology of the Gowganda diabase sill, 1961-64; Ph.D. thesis.
A petrographic, mineralogic, and chemical investigation of the diabase sill in the vicinity of the Gowganda silver mining camp.

648. Beales, Frank W., Univ. of Toronto:
Petrography and sedimentary ecology of ancient and modern limestones including Precambrian limestones of the Lakehead area, Swan Hills Devonian reef and Black River/Lower Trenton limestones of southern Ontario.

649. Chesworth, W., Shaw, D.M., McMaster Univ.:
Geochemical history of part of the Glamorgan granite complex, Glamorgan township, Ontario, 1961-64; Ph.D. thesis (Chesworth).
Field mapping and collection of grid samples have provided data and material for major and trace element studies. These, together with detailed mineralogy, will provide a basis for interpretation of the history of this complex.

650. Cook, D.G., Queen's Univ.:
Structure and petrology of the Buck Lake syncline, Ontario, 1963-64; M.Sc. thesis.
This is one of a number of similar projects either done or contemplated in the Westport and Gananoque areas under the direction of J.W. Ambrose and H.R. Wynne-Edwards.

651. Cook, D.L., Univ. of Toronto:
The Temiskaming volcanics and associated sediments of the Kirkland Lake area, Ontario, 1962-65; Ph.D. thesis.
A field, petrographic, and chemical investigation of the trachyte volcanics and their contributions to the associated sediments.

652. Dence, M.R., Carleton Univ.:
Study of some Precambrian conglomerates, 1960-64.
Petrographic study and regional geological compilation of data relating to some fragmental rocks of the Superior and Grenville tectonic provinces.

653. Forsythe, L.H., Univ. of Saskatchewan:
Petrology of the feldspar of the Dome stock, Red Lake, Ontario, 1963-64; M.Sc. thesis.

654. Gittins, J., Univ. of Toronto:
The metamorphism of nepheline syenites, 1963-.
A study of the mineralogical changes that take place in nepheline syenites under conditions of regional metamorphism. See Igneous nepheline-bearing rocks of the Haliburton-Bancroft province of Ontario; J. Petrology, vol. 2, pp. 38-48, 1961.

655. Henderson, J.R., Clifford, P.M., McMaster Univ.:
Structural studies along the Grenville front, between Sudbury and Killarney, 1964-; Ph.D. thesis (Henderson).

This project to determine the nature of the Grenville front in the Killarney area, involves structural field studies and comprehensive petrofabric analysis by optical and X-ray methods.

656. Hewitt, D.F., Ontario Dept. of Mines:
Mineral and Rocks of Ontario, 1963-64.

657. Hodgson, C.J., Univ. of Toronto:
The petrology of the Weslemkoon batholith, south-eastern Ontario, 1963-64.
A statistical, petrographic investigation of a part of the batholith.

658. Knight, C.J., Univ. of Toronto:
A petrographic study of the Sudbury Series, 1963-64.
A petrographic comparison of metamorphosed rocks south of the Murray Fault, Blind River area with typical Sudbury Series rocks in the Sudbury area.

659. Lal, R.K., Univ. of Toronto:
The petrology of the cordierite-anthophyllite rocks and associated gneisses on Fishtail Lake, Harcourt township, Ontario, 1963-65.
A petrographic and chemical study of the very striking cordierite-anthophyllite rocks and associated gneisses in this area.

660. MacRae, N., Shaw, D.M., McMaster Univ., Irvine, T.N., Geol. Surv. Can.:
Ultrabasic rocks of Munro township, 1961-65; Ph.D. thesis (MacRae).
Petrographic and trace-element studies of differentiation and serpentinization of a series of olivine-pyroxene-hornblende rocks.

661. Martini, I.P., McMaster Univ.:
Petrology and fabric of Medina Sandstones, Ontario and New York State, 1962-65; Ph.D. thesis.

662. Moore, J.M. Jr., Hounslow, A.W., Carleton Univ.:
Mineral parageneses in pelitic schists, Barrie Clarendon townships, Ontario, 1961-64; M.Sc. thesis (Hounslow).
Detailed (4" to 1 mile) structural-stratigraphic mapping and study of metamorphic mineral assemblages and mineral - chemical relations, especially of those bearing staurolite.

663. Moorhouse, W.W., Univ. of Toronto:
Studies of Precambrian Sediments, 1950-.
The petrography, chemistry, mineralogy, and sedimentation features of the Animikie Iron Formation. See Concretions from the Animikie of the Port Arthur Region, Geol. Assoc. Can., Proceedings, 1963.

664. Moorhouse, W.W., Boutcher, S.M.A., Univ. of Toronto:
The Archaean of northeastern Ontario, 1961-.
Separation of minerals from sediments and volcanics in the Kirkland Lake-Lake Timiskaming area, for determining maximum and minimum isotopic ages. A petrographic and sedimentological study of the greywackes and conglomerates on the west shore of Lake Timiskaming is also being carried out.

665. Naldrett, A.J., Queen's Univ.:
The geochemistry of the nickeliferous ultrabasic rocks of the Porcupine district, 1961-64; Ph.D. thesis.

666. Payne, J., Shaw, D.M., McMaster Univ.:
Statistical geochemical studies of the Blue Mountain nepheline gneisses, Methuen township, Ontario, 1962-65; Ph.D. thesis (Payne).
Field relations and petrography of this complex are being revised. Two-dimensional polynomial regression of various trace element distributions in grid-samples will be used to interpret the significance of country rocks in the history of the nepheline rocks.

667. Scoates, R.F.J., Univ. of Manitoba:
Composition and petrography of the peridotites along the Gordon Lake - Werner Lake fault, northwestern Ontario, 1963-65; Ph.D. thesis.

668. Shaw, D.M., McMaster Univ.:
Composition of the Apsley Paragneiss, Chandos township, Ontario.
The Apsley paragneiss has chemical features resembling both greywackes and intermediate volcanic rocks. The research begun by P.S. Simony (M.Sc. thesis, McMaster Univ., 1962) to evaluate the most likely origin is being continued; and the chemical changes of the formation in the aureole of the Loon Lake pluton are being studied. See Chandos township; Ont. Dept. Mines Geol. Rept. No. 11, 1962.

669. Stevenson, J.S., McGill Univ.:
Comprehensive petrological and mineralogical study of the Sudbury Basin irruptive, Ontario, 1951-.
See The upper contact phase of the Sudbury micropegmatite; Can. Mineralogist, vol. 7, pt. 3, pp. 413-419, 1963.

670. Vox, M.A., Univ. of Toronto:
The geology of some quartz diorites of the Sudbury Basin, 1961-64; Ph.D. thesis.
A study of the petrology and chemistry of quartz diorites at the north contact of the norite, North Range, Sudbury.

671. Wilson, H.D.B., Brisbin, W.C., Univ. of Manitoba:
The geology of the English River gneissic belt, 1962-.
The English River gneissic belt is believed to be a portion of the deeper part of the granitic crust elevated to its present position by faulting. It consists of sedimentary granulites and granite believed to be older than the Keewatin volcanics and to be the source of Kenoran granites. The project has reached the stage where an extensive petrographic and chemical study of the sediments is being started. See Major structural features in the Precambrian Shield, Abstract, Geol. Assoc. Can., Annual Meeting, June, 1963.

672. Winder, C.G., Univ. of Western Ontario:
Carbonate clasticity, dolomitization and insoluble residues, Middle Ordovician limestones, 1962-.
The sedimentary petrology of the Cobourg Limestone in the St. Lawrence Cement Quarry, Colborne, is being investigated in detail. The stratigraphic distribution of the -40 +140 mesh insolubles, conodonts, other microscopic invertebrates such as gastropods, brachiopods, chitinozoa, etc., allogenic and authigenic mineral, faecal pellets, Ca/Mg ratio and other entities have been determined. Peel sections of the limestone reveal a myriad of sedimentary structures. It is planned to collect large oriented blocks for trend analysis both parallel and perpendicular to bedding. The distribution of insolubles in the different lithologies of limestone will also be investigated.

673. Wynne-Edwards, H.R., Cook, B., Queen's Univ.:
Diabases of the Frontenac Axis, 1962-64; M.Sc. thesis (Cook).

See Gananoque map-area, Ontario; Geol. Surv. Can., Map 27-1962.

674. Wynne-Edwards, H.R., Reinhardt, E.W., Queen's Univ.:
Element distribution in coexisting hypersthene, cordierite, garnet and biotite from metamorphic rocks of the Frontenac Axis, 1960-64; Ph.D. thesis (Reinhardt).

See Coexisting cordierite and garnet in regionally metamorphic rocks from the Westport area, Ontario; Can. Mineralogist, vol. 7, pt. 3, pp. 453-478.

675. Wynne-Edwards, H.R., Sauerbrei, J.A., Queen's Univ.:
Granitic rocks of the Frontenac Axis. 1962-64; M.Sc. thesis (Sauerbrei).

A coarse grained hypersolvus syenite - monzonite (Frontenac-type) and a medium grained 2-feldspar alaskite (Rockport-type) are in contact for a distance of 30 miles near the St. Lawrence River. Each of these rock-types forms dykes cutting the other, and each contains inclusions of the other, so that they both appear to have been mobile at the same time at different places. A detailed petrographic study of the two types, supported by some chemical work, is underway. See Brockville - Mallorytown map-area, Ontario, Geol. Surv. Can., Map 7-1963.

676. Wynne-Edwards, H.R., Shaw, C.M. Elizabeth, Queen's Univ.
Structure and petrology of a gabbro body at Leo Lake, Ontario, 1963-; M.Sc. thesis (Mrs. Shaw).

See Gananoque map-area, Ontario; Geol. Surv. Can., Map 27-1962.

Quebec

677. Blecha, M., McGill Univ.:
A study of the chemical composition of certain dykes at Campbell Chibougamau Mines, Quebec; M.Sc. thesis.

678. Charette, J.P., Dominion Observatory, in collaboration with Gold, D.P., McGill Univ.:
Gravity survey of Oka alkaline complex, Quebec.

An analysis of the data is in progress with a view to obtaining the vertical extent and possible layering of the intrusion.

679. Currie, K.L., Geol. Surv. Can.:
Geology of Manicouagan-Mushalagan Lakes, Quebec, 1963-.
An investigation of the core of Manicouagan-Mushalagan Lake structure and its relationship to surrounding lava plateau. See Geol. Surv. Can., Paper 64-1, p. 52.

680. Depatie, Jean, Université Laval:
Roches tuffacées de la région de Beauceville, Quebec, 1963-64; M.Sc. thesis.

681. Emslie, R.F., Geol. Surv. Can.:
Compositions of olivine and plagioclase in the Michikamau anorthosite, 1962-63.
A study of the range and manner of variation of these minerals through a stratigraphic thickness of some 25,000 feet in the anorthosite. See Geol. Surv. Can., Paper 64-1, p. 56.

682. Gandhi, S.K., McGill Univ.:
The petrology of Mount Yamaska, Quebec; Ph.D. thesis.

683. Gilman, W.F., Univ. of Toronto:
Geology of Desmeloizes township, Quebec, with particular reference to the diabase dikes, 1957-64; Ph.D. thesis.
A study of the chemical and petrographic characteristics of a series of large diabase dikes in this area. See Preliminary Report on Desmeloizes township, Quebec Dept. Natural Resources, 1961.

684. Middleton, G.V., McMaster Univ.:
Petrology of Charny Sandstones, Quebec, 1962-64.

685. Pattison, E.F., McGill Univ.:
Petrography and mineralogy of a manganese horizon in the Ascot Formation near Lennoxville, Quebec; M.Sc. thesis.

686. Perrault, Guy, Ecole Polytechnique:
Mineralogy and petrography of the Oka alkaline intrusives, 1957-.
See Détermination de la composition chimique du pyrochlore d'Oka par spectrofluorescence des rayons-X; L'Ingénieur, Hiver 1960, pp. 1-7.

687. Peredery, W.V., McGill Univ.:
A study of cordierte and crynthophyllite-bearing rocks, northwest of Lake Mistassini, Quebec; M.Sc. thesis.

688. Rajasekaran, K.C., McGill Univ.:
The mineralogy and petrology of the nepheline syenite rocks of Mount St. Hilaire, Quebec; Ph.D. thesis.

689. Rene, Claude, Université Laval:
Etude pétrologique des syénites ellipsoidales de la région de Poupore, Quebec, 1962-64; M.Sc. thesis.

690. Sakrison, H.C., McGill Univ.:
Rock composition variation around the Lake Dufault ore-body, Noranda, Quebec; Ph.D. thesis.

691. Tanner, J.G., Dominion Observatory, in collaboration with Smith, C.H., Geol. Surv. Can.:
Gravity study of Mount Albert ultrabasic intrusion, Quebec.

692. Van Ingen, Robert, McGill Univ.:
A study of the granite masses in Weldon and Megantic districts, Quebec; Ph.D. thesis.

693. Warren, Bertrand, Université Laval:
Etude d'une intrusion de syénite de l'ile Paul Nadeau, Quebec; M.Sc. thesis, 1962-64.

694. Young, F.G., McGill Univ.:
Petrography of Deschambault limestone northwest of Montreal; M.Sc. thesis.

Saskatchewan

695. Brandt, J.A., Univ. of Saskatchewan:
Petrological study of the Cretaceous Colorado Group in Saskatchewan, 1963-65; M.Sc. thesis.

696. Clark, A.R., Univ. of Saskatchewan:
Rock fabric of potash ore beds, Saskatchewan, 1962-64; M.Sc. thesis.

Preferred orientation of halite and sylvite grains in potash beds of Middle Devonian Prairie Evaporite Formation are recorded and the results are discussed.

697. Coleman, L.C., Gaskarth, J.W., Univ. of Saskatchewan:
Trace metal distribution, metamorphism and petrogenesis in the Hanson Lake area, Saskatchewan, 1962-67; Ph.D. thesis (Gaskarth).

Geological mapping at 1" = 500' is being conducted in the Hanson Lake area. Bedrock samples collected at approximately 200' intervals are being analyzed by X-ray fluorescence techniques for Cu, Zn, Ni, Pb. The relation of the distribution of these metals to known sulfide deposits and to the geological structures and rock units in the area is being investigated, as is the relationship of Amisk-type and Kisseynew-type rocks.

698. Wohlberg, E.G., Univ. of Saskatchewan:
Petrochemistry of metagabbros in the Birch Lake area, 1963-64; M.Sc. thesis.

General Problems

699. Allen, C.M., Mount Allison Univ.:
Triassic vulcanicity in the Maritime Provinces of Canada, 1963-66.

A detailed petrologic, geochemical and structural study of selected areas of Triassic basalts in the Maritime Provinces with a view to assessing the mechanisms of eruption of tholeiitic basalts and the relationships of these volcanic rocks to Appalachian tectonics.

700. Baadsgaard, H., van Breeman, O., Univ. of Alberta (Edmonton):
Relative effect of thermal metamorphism on various radiometric parent-daughter systems, 1963-65; M.Sc. thesis (van Breeman).

In connection with the work, an exhaustive analysis of the distribution of the various parents (U, Rb, K) and daughters (Pb, Sr, Ar) in a granite will be made.

701. Baragar, W.R.A., Geol. Surv. Can.:
Volcanic rocks of Canada, 1963-64.

702. Bristol, C.C., Univ. of Manitoba:
Quantitative modal mineral analysis by the X-ray diffractometer, 1962-65; Ph.D. thesis.

The method may be particularly applicable to fine grained metamorphic rocks where point count methods are impractical. If successful the method is to be applied to Precambrian lavas.

703. Church, W.R., Univ. of Western Ontario:
Revision of the Lacroix's work on the ariegites of the French Pyrenees, 1962-.
The ariegite facies: relevance to 'nodule-like inclusions' in alkali basalts; composition of the mantle; and the origin of magmas.
Metamorphic eclogites from County Donegal, Eire, 1957-.

704. Clifford, P.M., McMaster Univ.:
Rock fabric and failure, 1963-64.
Cleavage refraction through thin, well-graded epiclastic rocks suggest that there is a definite correlation between strength of a rock and its mechanical behaviour, on the one hand, and mean grain size, degree of sorting and amount and nature of cement, on the other.

705. Davies, R., McGill Univ.:
The structure and petrology of the Mutton Bay, Sylvite and adjacent formations; Ph.D. thesis.

706. Edgar, A.D., Univ. of Western Ontario:
Experimental systems pertaining to undersaturated alkaline rocks and mineral chemistry of nephelines, kalsilites, melilites and other undersaturated minerals, 1959-.
See studies on cancrinites I - Polymorphism in the sodium carbonate rich cancrinite-natrodavyne; Canadian Mineralogist, vol. 7, pp. 631-642 and Phase equilibrium studies in the system NaAlSiO -$NaAlSi_3$ -O_8-H_2O at 1,000 Kg/cm^2 water vapour pressure; J. of Geology, vol. 72 (in press).

707. Fahrig, W.F., Geol. Surv. Can.:
Diabase dykes of Canadian Shield, 1961-.
The 1963 phase of this study comprised work on bodies of diabase in shield areas in the southern part of the Northwest Territories, Northern Saskatchewan, Manitoba, and in northeastern Ontario.

708. Folinsbee, R.E., Baadsgaard, H., Campbell, F.A., Univ. of Alberta (Edmonton) and Bayrock, L., Research Council of Alberta:

Meteorites: study of Bruderheim and Peace River chrondrites, 1960-64.

An intensive study of the mineralogy and chemistry of these two meteorites is underway; this is to be submitted to the Canadian Mineralogist for publication as a memoir (sometime in 1964). See Folinsbee, R.E. and Bayrock, L., The Peace River meteorite; fall and recovery: J. Royal Astronomical Society (in press).

709. Gaucher, E., Fahrig, W.F., Geol. Surv. Can.:

Palaeomagnetic study of diabase dykes, 1962-64.

The objective is a classification and age determination of different swarms of diabase dykes throughout the Canadian Shield.

710. Gittins, J., Univ. of Toronto:

Phase equilibrium studies in systems that bear on problems of carbonatite petrogenesis, 1962-.

An investigation of calcium and alkali carbonate systems up to 6 kilobars with and without water. See The system CaF_2 - $CaCO_3$ - Ca(OH) at 1,000 bars; American J. of Science (in press).

711. Gleeson, C.F., Geol. Surv. Can.:

Heavy mineral studies in the Maritimes and Eastern townships, 1963-.

To evaluate the usefulness of heavy-mineral surveys as an aid to prospecting and as a means of identifying and outlining Metallogenetic Provinces in the Appalachian region.

712. Golightly, J.P., McGill Univ.:

An investigation into the cause of pleochroism in certain silicates; Ph.D. thesis.

713. Gross, W.H., Univ. of Toronto:

Quantity and distribution of lead in granite rocks, 1963-64.

714. Gwinn, V.E., McMaster Univ.; Klein, G., Univ. of Pennsylvania:

Mineralogical differentiation in Tuscarora and Pocono sandstones, Central Appalachians, 1963-66.

715. Kranck, E.H., McGill Univ.:
Continuation of work on granitization and gneiss tectonics and anorthosites.
Petrography of certain types of Monteregian rocks.

716. Moorhouse, W.W., Univ. of Toronto:
Origin of Lamprophyres, 1962-64.
A consideration on the origin of lamprophyres, in the light of evidence from "conglomerate" dikes, and their relationship with diabases and batholithic rocks.

717. Onions, Diane, McMaster Univ.:
Petrology and fabric of Normanskill sandstones, 1963-64; M.Sc. thesis.

718. Park, W.C., Shaw, D.M., McMaster Univ.:
Further studies on scapolite and related minerals, 1962-65; Ph.D. thesis (Park).
Various aspects of scapolite mineralogy will be examined in more detail. The paragenesis of some scapolitic rocks will be studied from the standpoint of metamorphic history.

719. Philpotts, A.R., McGill Univ.:
Origin of anorthosites and associated rocks, 1960-.
Work to date has shown that the anorthosite-mangerite suite of rocks is of comagmatic origin, having been derived from a parental calc-alkali magma by strong fractional crystallization. At present, special emphasis is being placed on the study of the intermediate members of this series which show very strong iron and titanium enrichment. The possibility of liquid immiscibility in these rocks is being investigated in the hope that some light can be shed on the origin of the massive ilmenite-magnetite deposits associated with anorthosite.
A study of the origin of pseudotachylites and the existence of Precambrian glasses, 1962-64.
The change in chemical composition that occurs during the formation of pseudotachylites by frictional fusion in fault zones has been studied. Potassium argon dating has been carried out on undevitrified Precambrian glassy pseudotachylites. At the moment the behaviour of the rubidium-strontium system under these conditions of frictional fusion is being studied. See A Precambrian glass from St. Alexis des Monts, Quebec; Geol. Mag., vol. 100, 1963.

720. Schwarcz, H.P., McMaster Univ.:
Meteorite investigations.

Studies of the mineralogy and texture of chondrites and carbonaceous chondrites and studies on the origin of tektites. See A possible origin of tektites by soil fusion during impact; Nature, vol. 194, No. 3823, pp. 8-10, 1962.

721. Sheppard, S.M.F., Schwarcz, H.P., McMaster Univ.:
Oxygen and carbon isotope variation in metamorphic calcite-dolomite assemblages, 1963-; Ph.D. thesis (Sheppard).

O^{18}/O^{16} and C^{13}/C^{12} isotopic fractionations between coexisting dolomite and calcite from metamorphic rocks of varying grade are being measured. The fractionation values should indicate the temperature of last recrystallizations. Areas in Ontario, New York and New England have been sampled.

Carbon and oxygen isotope variations during dolomitization, 1962-65; Ph.D. thesis (Sheppard).

Using oxygen and carbon isotopic fractionations between dolomite and calcite in partially dolomitized rocks, it is hoped to shed light on the origin of diagenetic dolomites. Use will be made of the relatively slow rate of carbon isotope exchange and the preservation of primary calcite in coarse fragments of crinoid columnals.

722. Skippen, G.B., Crocket, J.H., McMaster Univ.:
Geochemical studies on the distribution of palladium in basaltic rocks, 1961-63; Ph.D. thesis (Skippen).

This work is in the final stages. The project consisted of development of a neutron activation analytical method for determination of Pd in basaltic rocks. Results of analysis of 10 oceanic and 13 continental and orogenic basalts in duplicate indicate that the dispersion of Pd values in the oceanic basalts is much less than that in the continental basalts. The average Pd content of oceanic basalts analysed was 1.9 ± 1.2 p.p.b. (parts per billion) with a range of 0.2 to 3.7 p.p.b. The continental basalts however ranged from 0.45 to 29.4 p.p.b. For various continental basalt provinces (Deccan, Karroo, Columbia River, Parana basin) the variance of Pd within any single group is considerably less than that of continental basalts as a whole. This suggests that continental basalts are characterized by Pd provinces.

723. Smith, C.H., Irvine, T.N., Findlay, D.C., Scoates, R.F.J., Geol. Surv. Can.:
Ultrabasic intrusions of Canada, 1957-.
The detailed mapping of representative ultrabasic intrusions with special emphasis on their scientific and economic features, including Mount Albert Ultrabasic Pluton, Gaspe, Quebec; Muskox Complex, Coppermine River, Northwest Territories; Tulameen, British Columbia; Gordon Lake, Ontario.

724. Speelman, E.L., Schwarcz, H.P., McMaster Univ.:
Sulfur isotope variations in metamorphic rocks, 1963-65; Ph.D. thesis (Speelman).
S^{32}/S^{34} ratios of coexisting sulfides, sulfates and sulfur-bearing silicates are being investigated to determine if equilibrium is attained during metamorphism between the various chemical species of sulfur. Infrared absorption studies of the silicates are being used to determine the nature of the structural site of sulfur in the silicates.

725. van de Kamp, P.C., Shaw, D.M., McMaster Univ.:
The para-amphibolite problem, 1963-65; M.Sc. thesis (van de Kamp).
The recent trace element studies by A.M. Kudo on amphibolites (unpublished M.Sc. thesis), suggested a method of discrimination between ortho- and para-amphibolites. This work is being extended to para-amphibolites of diverse localities and ages.

726. Wilson, H.D.B., Moxam, R.L., Andrews, P.W., Ramlal, K., Univ. of Manitoba:
Composition and structure of Precambrian lavas, 1961-.
The composition of Precambrian lavas is being investigated by X-ray fluorescence analysis using a multi-channel instrument. Analyses are being tied into the petrography. Regional structure is being investigated by geological and geophysical methods.

727. Wynne-Edwards, H.R., Golightly, J.P., Queen's Univ.:
Coexisting plagioclase and hornblends in regional metamorphism, 1962-64; M.Sc. thesis (Golightly).
Samples of amphibolite from a wide range of metamorphic environments have been collected and their constituent minerals are being analysed to determine the distribution of elements between the phases under different conditions.

728. Wynne-Edwards, H.R., Smith, M.E., Queen's Univ.:
Element distribution between coexisting feldspars in metamorphic rocks, 1963-65; Ph.D. thesis (Smith).

PLEISTOCENE AND GROUNDWATER

Alberta

729. Bayrock, L.A., Research Council of Alberta:
Exploratory survey of surficial deposits of Northern Alberta (north of 57° latitude), 1958-63.

The mapping project was carried out in conjunction with helicopter soil survey of northern Alberta. See Appendices to Research Council, Alberta, Prelim. Soil Repts. 59-1, 60-1, 61-1, 62-1, 63-1.

Pleistocene vertebrate palaeontology of Alberta, 1959-.

The following species of extinct and living fossil vertebrates are now in the Research Council of Alberta collection: Bison crassicornis, B. occidentalis, B. latifrons? B.b. athabascae, B.b. bison, Mammuthus primigenius, Camelus sp. Bufo cognatus, Scaphiopus hammondi bombifrons, and Cerous sp. Large scale extinction occurred around 8,000 years ago when giant bison, mammoth, camel, and horse became extinct. See New data on Bison athabascae; J. Palaeontology (in press).

Post-glacial delevelling of Alberta, 1962-66.

The tilt is of the order of 8.3 feet per mile in central Alberta — the mountains to the west having been uplifted relative to the plains in the east. The divide of the Rocky Mountains has been uplifted a minimum of 1,700 feet relative to the Edmonton area. See Recent orogenic uplift in Western Canada indicated by tilted glacial Lake Edmonton, Alberta; submitted to the XXII International Geol. Congress, New Delhi, India.

Stratigraphy and sedimentation of Saskatchewan gravels and sands, 1962-65.

The Saskatchewan gravels and sands are comprised of lithologically similar deposits which range from late Tertiary to Pleistocene in age. See Periglacial structures in Saskatchewan gravels and sands; J. Geol. (in press).

730. Bayrock, L.A., Gravenor, C.P., Research Council of Alberta:
Surficial deposits of National Topographic Series Sheet 73D, 1954-63.

See Research Council of Alberta, Prelim. Repts. 55-1, 56-2, 57-1, 57-2, 57-3.

731. Bayrock, L.A., Hughes, G.M., Research Council of Alberta:
Surficial deposits of the Edmonton district, Alberta, 1958-63.

See Surficial geology of the Edmonton district, Alberta; Res. Coun. Alta., Prelim. Rept. 62-6.

732. Domenico, P.A., Research Council of Alberta:
Groundwater resources of the Edmonton Formation in the Edmonton area, 1960-63; M.Sc. thesis, Syracuse Univ.

733. Gabert, G.M., Research Council of Alberta:
Analysis of pump test results, 1962-63.
Groundwater hydrology of the Edmonton area, 1963-66.

734. Geiger, K.W., Research Council of Alberta:
Groundwater geology of southwestern Alberta (includes drainage basins of the Oldman, Belly and St. Mary Rivers), 1961-65.

In the study of such a large area it is expected that several more restricted reports will be published before a comprehensive treatment can be completed. These earlier reports will include results of studies of smaller areas and of special aspects of the overall research program. Some of these studies which are in an advanced stage are a contour map of the bedrock topography for the entire research area (drainage basins of Oldman, Belly and St. Mary Rivers) and a preliminary report on the groundwater geology of the Lethbridge area, both of which are to be submitted for publication in 1964.

735. Halferdahl, L.B., Research Council of Alberta:
Stream deposits in Alberta, 1957-65.

This project has involved the study of samples collected systematically from the beds of some of the major rivers in Alberta. The bed material is recognized as having come from three sources: the Cordillera to the west, the Cretaceous and Tertiary strata in the plains and foothills, and glacially transported rock from and adjacent to the Canadian Shield to the north and northeast. The influence of each of these sources as well as some hydraulic factors on the size distributions and the heavy mineral concentrations is being determined.

736. Jones, J.F., Research Council of Alberta:
Geology and groundwater resources, Peace River District, 1961-64.
Field work has been completed and the first draft of a bulletin prepared.
Aquifer-testing and well-completion methods for Alberta, 1961-63.
See Aquifer-testing procedures and other information used in evaluating groundwater supplies in Alberta; Research Council of Alberta Prelim. Rept. 63-1.

737. Le Breton, E.G., Research Council of Alberta:
Groundwater geology and hydrology of the Wainwright area, 1961-65.
Groundwater geology and hydrology of east-central Alberta, 1957-63.
Groundwater geology and hydrology of the Lamont-Chipman area, 1963-65.

738. Lennox, D.H., Carlson, V., Research Council of Alberta:
Geophysics in groundwater exploration, 1957-.
See Early contributions to the groundwater hydrology of Alberta; Research Council of Alberta, Bull. 12, pp. 38-56.

739. Nielsen, G.L., Research Council of Alberta:
Groundwater resources of the Blindman River basin, 1962-63; M.Sc. thesis, University of Alberta.

740. Pawluk, S., University of Alberta, Bayrock, L.A., Research Council of Alberta:
Composition of Alberta Tills, 1958-67.
This is a long term project of study of variations in composition of surface tills of the Province of Alberta. Initial results show a strong influence of local bedrock on the overall composition of till. See Heavy minerals in till of central Alberta; J. Alta. Soc. Petrol. Geol., vol. 10, pp. 171-184.

741. Roed, A., Research Council of Alberta:
Surficial geology SW of 82 O, 1964-67.

742. Rutter, N.W., University of Alberta (Edmonton):
Glacial geology, Bow River, Alberta, 1963-65; Ph.D. thesis.

743. Stalker, A.M., Geol. Surv. Can.:
Surficial geology, Bassano map-area, 1 inch to 4 miles, 1963-.
See Geol. Surv. Can., Paper 64-1, p. 36.

744. Toth, J., Research Council of Alberta:
Groundwater resources of the Red Deer-Calgary area, 1962-65.
Development and investigation of methods to determine the groundwater regime in uninstrumented drainage basins, 1963-64.

745. Vanden Berg, A., Research Council of Alberta:
Groundwater movement and groundwater chemistry in the Hand Hills-Bullpound Creek area, 1963-65.
A complete picture of the movement and chemistry of groundwater in a small area has been obtained by fieldwork in 1963. Another field season will be spent enlarging the area of investigation before a complete report is published.
Groundwater resources of the Stettler area, 1962-64.

746. Westgate, J., Research Council of Alberta:
Surficial deposits of the Cypress Hills area (72E), 1960-64; Ph.D. thesis, University of Alberta.
The Cypress Hills in southeastern Alberta formed a nunatak some 300 feet high during Wisconsin maximum. During the recession there occurred three readvances of the continental ice sheet. The area was free of ice about 11,000 years ago.

British Columbia

747. Fulton, R.J., Geol. Surv. Can.:
Surficial geology, Vernon (West Half) map-area, 1963-.
See Geol. Surv. Can., Paper 64-1, p. 19.

748. Halstead, E.C., Treichel, A., Geol. Surv. Can.:
Surficial geology and groundwater survey of Nanaimo-Duncan-Gulf Islands map-areas, British Columbia, 1961-.
See Geol. Surv. Can., Paper 64-1, p. 20.

749. Leaming, S.F., Geol. Surv. Can.:
Sand gravel deposits in southcentral British Columbia, 1963-.
See Geol. Surv. Can., Paper 64-1, p. 21.

750. Tipper, H.W., Geol. Surv. Can.:
Glacial geomorphology of central British Columbia, 1963-65.
A description of the features, discussion of their origin and interpretation of the glacial history of the region.

Manitoba

751. Charron, J., Geol. Surv. Can.:
Hydrogeological study of Red River valley - Winnipeg area, Manitoba, 1959-64.
See Geol. Surv. Can., Paper 63-1 (1963), p. 42.

752. Klassen, R.W., Geol. Surv. Can. (part time):
Surficial geology of Riding Mountain area, 1962-64; Ph.D. thesis, University of Saskatchewan.
See Surficial geology Riding Mountain Manitoba (62K); Geol. Surv. Can., Map 11-1962 and Paper 64-1, p. 42.

753. Morley, L.W., Geol. Surv. Can.:
Experimental airborne electromagnetic survey, southern Ontario and southern Manitoba, 1964-65.
The mapping of near surface resistivities of Pleistocene formations using the Barringer Input system to assess its feasibility for surficial geology and groundwater studies.

754. Rupp, John H., University of Manitoba:
Stabilization of Lake Agassiz clays, 1963-64; M.Sc. thesis.

755. Scott, J.S., Geol. Surv. Can.:
Landslide studies in Manitoba, Saskatchewan and Alberta, 1963-.
See Geol. Surv. Can., Paper 64-1, p. 83.

756. Wyder, J.E., University of Saskatchewan:
Geophysical discovery and delineation of a near surface aquifer in southcentral Manitoba, 1962-64; M.Sc. thesis.

757. Wyder, J.E., Gauvreau, C., Geol. Surv. Can.:
Surface resistivity groundwater surveys in southern Manitoba and Saskatchewan, 1961-.
See Geol. Surv. Can., Paper 64-1, p. 39.

New Brunswick, Nova Scotia and Prince Edward Island

758. Brandon, L.V., Geol. Surv. Can.:
Groundwater studies, Nova Scotia and Prince Edward Island, 1962-63.
See Geol. Surv. Can., Paper 64-1, p. 76.

759. Carr, P.A., Geol. Surv. Can.:
Geology and groundwater studies in the Moncton area, 1960-64; Ph.D. thesis, University of Illinois.
See Geol. Surv. Can., Paper 64-1, p. 62.

760. Prest, V.K., Geol. Surv. Can.:
Surficial and bedrock geology, Charlottetown (West Half) map-area, P.E.I., 1 inch to 1 mile, 1962-.
See Geol. Surv. Can., Paper 64-1, 1964, p. 71.

Northwest Territories and Yukon

761. Blake, W., Jr., Geol. Surv. Can.:
Surficial geology, eastern Bathurst Island, 1963.
See Geol. Surv. Can., Paper 64-1, p. 5.

762. Craig, B.G., Geol. Surv. Can.:
Surficial geology, Northwest Baffin Island (Operation Admiralty), 1963.
See Geol. Surv. Can., Paper 64-1, p. 3.

763. Hanson, L.W., Univ. of Alberta (Edmonton):
Size distribution within the Recent White River Ash Fall, Yukon Territory, 1963-64; M.Sc. thesis.

764. Johnston, G.H., Brown, R.J.E., Division of Building Research, National Research Council:
Investigation of the distribution of Permafrost under bodies of water, 1961-.

Several lakes near Inuvik, Northwest Territories are to be investigated in 1964 to determine the distribution of permafrost under and about them and the thawing effect of the water bodies. This work is essentially a drilling and sampling program combined with studies of the ground thermal regime by means of ground and water temperature measurements.

Permafrost at Thompson, Manitoba, 1961-.

The initial phase of the terrain studies carried out at Thompson with respect to the distribution and occurrence of permafrost has been reported in the reference noted below. These studies are continuing by means of field observations as further development of the townsite is carried out and by ground temperature measurements. Engineering investigations of foundation performance are also continuing by means of level surveys and field observations. See Permafrost investigations at Thompson, Manitoba; Terrain Studies, DBR Tech. Paper No. 158 (NRC 7568), October 1963, p. 94.

Ontario

765. Dreimanis, A., Ontario Dept. of Mines (part time), University of Western Ontario:
Pleistocene geology of the London-St. Thomas and Port Stanley areas, 1 inch to 1 mile, 1963-64.
See Ont. Dept. Mines, Prelim. Rept. 1963-2, pp. 33-34.

766. Dreimanis, A., McKenzie, G.D., University of Western Ontario:
Stratigraphic correlations of glacial deposits between Lake Huron and St. Lawrence Lowland, 1958-65; M.Sc. thesis (McKenzie).
Further test drilling below lake level in the Port Talbot-Plum Point area along the north shore of Lake Erie and preliminary investigations of the samples obtained by drilling have shown that a) the Port Talbot interstadial beds are considerably thicker than previously known from the exposures above lake level, b) the interstadial beds are underlain by at least one till layer. See Lake Warren and the Two Creeks Interval, J. of Geology, March, 1964.

767. Dreimanis, A., Vagners, U.J., University of Western Ontario:
Relationship of lithologic and granulometric composition of till to bedrock and older Pleistocene sediments, 1962-65; M.Sc. thesis (Vagners).
Incorporation of dolomite and limestone in glacial drift and comminution of these rock fragments during glacial transport have been investigated along four lines parallel to the last glacial movement in southern Ontario.

768. Eden, W.J., Division of Building Research, National Research Council:
Engineering studies of varved clay, 1948-.
Studies of field performance of varved clay have been made at Steep Rock Lake, Beattie Mine and New Liskeard. Case record studies of failures are made to assess the usefulness of current theories on shear strength of soil when applied to highly stratified clays. See Earthflows at the Beattie Mine; Canadian Geotechnical Journal, vol. 1, No. 2, February 1964.

769. Grant, A.C., Brown, I.D., Geol. Surv. Can.:
Refraction seismic survey in Kirkland Lake-Larder Lake area, 1963.
To determine by hammer seismic methods the thickness of overburden at selected locations, to determine suitable sampling sites and to locate buried bedrock channels. See. Geol. Surv. Can., Paper 64-1, p. 44.

770. Hill, W.B., Ontario Research Foundation:
Inventory of peat in Humberstone (Ontario) Bog, 1963.

771. Hill, W.B., Chapman, L.J., Ontario Research Foundation:
Physiography of Northern Ontario, 1961.
See Study of the mineralogical composition of sand in Northern Ontario by Carol I. Dell, Can. J. Soil. Sci., vol. 43, pp. 189-200.

772. Karrow, P.F., Ontario Dept. of Mines:
Pleistocene Geology of the Guelph and Bolton areas, 1962-64.
See Ont. Dept. Mines Prelim. Rept. 1963-2, pp. 32-33.
Commercial Sand and Gravel Deposits of Ontario, 1961-63.
See Ont. Dept. of Mines, Prelim. Rept. 1962-4, p. 33.

773. Lee, H.A., Geol. Surv. Can.:
Surficial geology of Kirkland Lake district, Ontario, 1962-.
Mapping of the surficial geology with special emphasis on criteria that will assist mineral exploration and development in the region. See Geol. Surv. Can., Paper 63-45.

774. Lewis, C.F.M., University of Toronto:
Geology of the Lake Erie Basin, 1962-64; Ph.D. thesis.
Includes development and use of various types of equipment for investigating bottom and subbottom material (sparker, echo sounder, hydrostatic corer, gravity corer, bottom grab). A survey of the lake basin involves closely spaced traverses across the lake totalling several thousand miles and collection of core and bottom samples.

775. Mirynech, E., Henderson, E.P., Geol. Surv. Can.:
Surficial geology of Kingston area, 1963.
See Geol. Surv. Can., Rept. 64-1, p. 48.

776. Pullen, M., University of Toronto:
Geology of the Bloor-Danforth Subway - Toronto, Ontario, 1963-65; M.A. thesis.
The drill hole data was used for a Ph.D. thesis for M.E.Z. Lajtai. This project includes examinations of the sections exposed during excavation.

Quebec

777. Bird, J.B., Adams, P., Subarctic Research Station staff, McGill Univ.:
Permafrost and periglacial studies in the Knob Lake area, Quebec, 1960-.
Summaries of progress are contained in the annual reports of the McGill University subarctic laboratory.

778. Brown, Joyce C., McGill Univ.:
The post-Champlain evolution of the drainage pattern of the Montreal lowland, 1958-64; Ph.D. thesis.
See The drainage pattern of the lower Ottawa Valley; Canadian Geographer, vol. 6, 1962, pp. 22-31.

779. Chagnon, J.Y., McGill Univ.:
Surficial geology of the Des Quinze Lake area, Temiscamingue county; Ph.D. thesis.

780. Depatie, J., Houle, R., Geol. Surv. Can.:
Experimental hammer seismic survey, Beauceville area, Quebec, 1963.
To demonstrate the feasibility of locating and outlining buried bedrock channels in the Beauceville area. See Geol. Surv. Can., Paper 64-1, p. 53.

781. Elson, J.A., McGill Univ.:
Fluctuations in level of glacial Lake Agassiz, 1964.
Several field areas will be re-examined in some detail to determine the sequence of water levels in this glacial lake. The geological situation of an archaeological site in relation to the shores of the lake will be studied.

782. Elson, J.A., McGill Univ. and others:
Surficial deposits exposed in Montreal subway excavations, 1963-.

783. Gadd, N.R., Geol. Surv. Can.:
Surficial geology of part of the Quebec - Thetford - Beauceville areas, Quebec, 1 inch to 2 miles, 1962-.
See Geol. Surv. Can., Paper 64-1, p. 54.

784. Gorman, W.A., Queen's Univ.:
A theoretical approach to the geography of the Champlain Sea, 1963-64.

785. Lasalle, P., Quebec Dept. of Natural Resources (part time):
Beloeil-Verchères area, Iberville and Verchères counties, 1 inch to 1 mile, 1961-64; Ph.D. thesis, McGill University.
Pleistocene and Recent geological studies with particular reference to water supply and engineering problems. See Surficial geology of the Beloeil area, Que. Dept. Nat. Res., Prelim. Rept. 497, 1962.

786. Mirynech, E., Geol. Surv. Can.:
Pleistocene geology, operation Leaf River, Quebec, 1963.
The region lies between the east coast of Hudson Bay and the 75th meridian, between latitudes 56 and 61 degrees. See Geol. Surv. Can., Paper 64-1, p. 59.

787. Thornes, J.B., McGill Univ.:
The glacial geomorphology of the Coaticook and Moe River valleys, southern Quebec, 1963-64; M.Sc. thesis.

Saskatchewan

788. Christiansen, E.A., Meneley, W.A., Greer, J.E., David, P.P., Whitaker, S.H., Cherry, J.A., Saskatchewan Research Council:

Geology and groundwater resources of southern Saskatchewan, 1959-.

See Geology and groundwater resources of the Wynyard area (72P), Saskatchewan; Sask. Res. Counc., Geology Div. Rept. No. 3.

789. David, P.P., McGill Univ.:

Geology of the Great Sand Hills area, Saskatchewan; Ph.D. thesis.

790. Delorme, D.L., Univ. of Saskatchewan:

Pleistocene and post-glacial ostracodes of Saskatchewan, 1962-65; Ph.D. thesis.

791. Eweida, E.A., Research Council of Alberta:

Hydrogeological studies in Ponoka area, 1960-; M.Sc. thesis, Univ. of Saskatchewan.

792. Freeze, R.A., Geol. Surv. Can.:

Groundwater study of Old Wives Lake drainage basin, Saskatchewan, 1962-66.

The hydrogeological study of an internal drainage basin. See Geol. Surv. Can., Paper 64-1, p. 37.

793. Meneley, W.A., Saskatchewan Research Council:

Groundwater inventory studies in southern Saskatchewan, 1964-.

The overall objectives are to accumulate and interpret information leading to the quantitative assessment of the groundwater resources of the province, and to study methods of optimum exploitation of these resources.

794. Meyboom, P., Geol. Surv. Can.:

Assiniboine River drainage basin, Saskatchewan, 1962-.

Hydrogeological study of large drainage basin to develop methods of study. See Geol. Surv. Can., Paper 64-1, p. 35.

795. Toth, A.M., Geol. Surv. Can.:

Eaglehill Creek drainage basin, Saskatchewan, 1962-63.

A hydrogeological study of part of basin with emphasis on transmissibility data on various materials. See Geol. Surv. Can., Paper 64-1, p. 38.

Groundwater flow in the Saskatoon area, Saskatchewan, 1962-63; M.Sc. thesis, Univ. of Saskatchewan.

A hydrogeological study of the glacial and late Cretaceous sediments. The influence of the geology on the groundwater flow will be considered. See Groundwater resources of the rural municipality of Cory, Geol. Surv. Can., Paper 60-25, 1960.

796. Toth, A.M., Lissey, A., Parsons, M.L., Univ. of Saskatchewan:
Pleistocene stratigraphy and the occurrence and distribution of aquifers in the glacial drift: detailed studies of bedrock aquifers in specific localities, 1962-; M.Sc. thesis.
Currently, three particular investigations include study of glacial drift aquifers of the Regina area with special regard to safe yield estimates; variation in chemical composition of Cretaceous and Jurassic aquifers in the Shaunavon area, Saskatchewan; and hydrologic profile in the Saskatoon area.

General Problems

797. Armstrong, J.M., Geol. Surv. Can.:
Pleistocene stratigraphy of the Pacific Northwest, 1963.
A cooperative project with D.R. Crandell, J. Noble, D.J. Easterbrook and other workers to attempt to correlate the stratigraphy in Washington State and British Columbia.

798. Bozozuk, M., Division of Building Research, National Research Council:
Swelling and shrinkage of Leda clays, 1954-.
Routine measurements of seasonal vertical ground movements are being maintained and are being correlated with climate observations, water table levels and soil moisture. The effects of a row of elm trees on ground movements are also measured. See Soil shrinkage damages shallow foundations at Ottawa, Canada; Engineering J., vol. 45, No. 7, pp. 33-37, July 1962.

799. Brown, I.C., Geol. Surv. Can.:
Groundwater of Canada, 1963-66.
A comprehensive report on groundwater in Canada covering; hydrological cycle and water balance, relation of movement and chemistry of groundwater to geologic materials, groundwater provinces as defined by climate and geology, methods of exploration and development, use, model studies, relation to engineering problems, sources of information.

800. Brown, R.J.E., Division of Building Research, National Research Council:
Permafrost Distribution in Canada, 1953-.
Observations on the occurrence of permafrost throughout the permafrost region of Canada, with emphasis on the southern fringe area, are being collected continuously by direct field observations, review of the technical literature, reports from other individuals and agencies, and questionnaire. This information is recorded on punch cards and plotted on the 8 mile to 1 inch maps of Canada. Accompanying this collection of information is the study of the climatic and terrain factors comprising the permafrost environment as a means of improving the understanding of and ability to predict the distribution and occurrence of permafrost. See The relation between mean annual air and ground temperatures in the Permafrost region of Canada; prepared for presentation to Int. Conf. on Permafrost, Purdue University, November 1963.

801. Burke, K.B.S., Wyder, J.E., Univ. of Saskatchewan:
An investigation of the applicability of certain geophysical methods to the problem of locating and delineating buried river valleys and subsurface aquifers in a Pleistocene environment, 1963-66; Ph.D. thesis (Wyder).
Methods under investigation include seismic, gravity, D.C. resistivity, multifrequency, A.C. resistivity and E-logging.

802. Burn, K.N., Bozozuk, M., Crawford, C.B., Eden, W.J., Penner, E., Division of Building Research, National Research Council:
Geotechnical properties of Eastern Marine Clay, 1951-.
Studies include the influence of various loading systems, stress paths, rates of strain, temperature and sample disturbance on the stress-deformation properties of marine clays. Of particular interest is the resistance to deformation of the undisturbed soil structure and the influence on this resistance of the applied rate of strain in the laboratory. See The modulus of elasticity of Leda clay from field measurements; Canadian Geotechnical J., vol. 1, No. 1, September, 1963, p. 43, and Cohesion in an undisturbed sensitive clay; Geotechnique, vol. 13, No. 2, June, 1963, pp. 132-146.

803. Collett, L.S., Ahrens, R.A., Gauvreau, C., Geol. Surv. Can.:
Research for groundwater geophysics - development of low frequency resistivity equipment, 1962-63. See Geol. Surv. Can., Paper 64-1, p. 78.

804. Deane, R.E., Univ. of Toronto:
Geology of South Bay, Manitoulin Island, Ontario, 1963-64.
Includes echo sounding survey of South Bay, together with bottom sampling and coring.

805. Dyck, W., Geol. Surv. Can.:
Variation of the natural radiocarbon concentration in plants with time, 1961-.
The objective is to find out how the C^{14} content in plants has and is varying with time. It includes analyses of samples from an 1,100 years old Douglas fir to give a measure of the reliability of the C^{14} age determination method, and analyses of annually collected living plants to serve as a monitor on man-made C^{14} and of possible isotope effects in various plants in natural surroundings.

806. Frenkel, O.J., McGill Univ.:
The flow of water and ions through clays; M.Sc. thesis.

807. Guliov, P., Univ. of Saskatchewan:
Palaeoecology of post-glacial invertebrates, 1961-63; M.Sc. thesis.

808. Hamilton, J.J., Division of Building Research, National Research Council:
Western Canada soils, 1960-.
Ground movements, temperatures and soil moisture contents are being measured and compared with weather records at 4 locations in Manitoba and Saskatchewan in order to study climatic influences on these factors. A number of buildings are under observation to study the influence of ground movements on structures. See volume changes in undisturbed clay profiles in Western Canada; Canadian Geotechnical J., vol. 1, No. 1, pp. 27-42, Sept. 1963.

809. Keeler, C.M., McGill Univ.:
A study of the relationships between climatic factors-ablation - and runoff in the ablation zone of an Arctic glacier; M.Sc. thesis.

810. Lemon, R.R.H., Royal Ontario Museum:
Pleistocene geology and palaeontology of Southeast Ecuador and coastal regions of Peru, 1958-.

Study of ecologic variation in Scleractinian corals based on material from Pleistocene and Recent reefs on the Florida Keys, 1960-.

811. Lissey, A., Nind, T.E.W., Univ. of Saskatchewan:
Effects of consolidation on groundwater movement, 1962-65.

The effect of consolidation of clays and shales on aquifer recharge.

812. Nind, T.E.W., Univ. of Saskatchewan:
Theory of aquifer tests, 1962-.

A critical review of the literature of aquifer tests indicates areas in which further study is desirable; for example, the application of the method of images may be limited under transient flow by the non-applicability of the necessary conditions permitting conformal mapping; the "two-part" recovery curve following a pump test may result from water movement into the well bore; prolonged pump tests may lead to a semi-steady state, amenable to analytic treatment; the interpretation of piezometer reading in relation to water movement in unsaturated media.

813. Paul, Gabrielle, Yong, R., Elson, J.A., McGill Univ.:
The effect of chemical additives on the permeability of soils to water, 1963-; M.Sc. thesis (Miss Paul).

Water containing certain cations in various concentrations is passed through purified clay minerals in a special permeameter that allows a wide range of pressure gradients and control of the spacing of clay particles.

814. Penner, E., Division of Building Research, National Research Council:
Ground temperatures and frost action, 1948-.

The studying of pressure-temperature relations at ice-soil interface in equilibrium systems and measurement of a frost penetration with time at one site and of heave of a number of structures at several sites. See The nature of frost heaving in soils, presented at the International Conference on Permafrost, Purdue University, November, 1963.

815. Terasmae, J., Mott, R., Geol. Surv. Can.:
Palynological and related studies of Pleistocene and Recent deposits, 1962-.
Stratigraphic Pleistocene Palynology of Canada, 1961-.
The purpose is to establish throughout Canada a basis for correlating Pleistocene formations by study of pollen. See Geol. Surv. Can., Paper 63-1 (1963), p. 66.

816. Thomas, J.F.J., Mines Branch, Dept. of Mines and Technical Surveys:
Chemical quality of groundwaters in Canada.
Chemical analyses and interpretation of some of groundwaters submitted by groundwater geologists each year.

817. van Everdingen, R.O., Geol. Surv. Can.:
Groundwater in bedrock aquifers of the Prairie Provinces, 1962-.
See Geol. Surv. Can., Paper 64-1, p. 39.

SEDIMENTATION

818. Ali, S.I., Univ. of New Brunswick:
Recent beach sedimentation at the mouth of the Alma River, Bay of Fundy, 1962-64; M.Sc. thesis.

819. Bartlett, Derek, Univ. of New Brunswick:
Origin and mineralogy of the coloration of some New Brunswick redbeds, 1962-64; M.Sc. thesis.

820. Bartlett, G.A., Geol. Surv. Can. (part time) and Bedford Institute of Oceanography:
Distribution of Benthic Foraminifera in the inshore area of the Scotian Shelf, St. Margarets and Mahone Bays.
See A preliminary study of Foraminifera distribution on the Atlantic Continental Shelf, southeastern Nova Scotia, Report 63-3, Bedford Inst. of Oceanography, Dartmouth, N.S. (unpublished), and Geol. Surv. Can., Paper 64-1, p. 75.

821. Bayrock, L.A., Research Council of Alberta:
Stratigraphy and sedimentation of Saskatchewan gravels and sands, 1962-65.

The Saskatchewan gravels and sands are comprised of lithologically similar deposits which range from late Tertiary to Pleistocene in age. See Periglacial structures in Saskatchewan gravels and sands; J. Geol. (in press).

822. Beales, Frank W., Univ. of Toronto:
Petrography and sedimentary ecology of ancient and modern limestones including Precambrian limestones of the Lakehead area, Swan Hills Devonian reef and Black River/Lower Trenton limestones of southern Ontario.

823. Bonham-Carter, G.F., Univ. of Toronto:
Geology of the Pennsylvanian reefs of the Blue Mountains, North Ellesmere Islands, 1963-65; Ph.D. thesis.
These are the most northerly reefs yet reported and in consequence have considerable palaeoclimatic interest.

824. Buckley, D.E., Bedford Institute of Oceanography:
Mechanical analyses of macroscopic dispersal systems by means of a settling tube, 1961-64.
Plans are presently under way for the construction of a settling tube which will duplicate an existing model now at the University of Western Ontario. This apparatus will have the capability of analysing all sediments from silt size to coarse sand size on the basis of the settling velocities of the particles. The tube is also designed to facilitate separation of the individual settling fractions.
Recent sedimentation rates in an oyster farming area, Ellerslie, Prince Edward Island, 1963-64.
An investigation of the present and past sedimentation rates in a bay environment, and the effect on oyster production. Involved in this study are physical and chemical analyses of 70 core samples and 50 interface samples.

825. Campbell, F.A., Lerbekmo, J.F., Univ. of Alberta (Edmonton):
Mineralogy and geochemistry of sedimentary rocks, 1961-.
See Mineralogic and chemical variations between Upper Cretaceous continental Belly River shales and marine Wapiabi shales in western Alberta, Canada; Sedimentology, vol. 2 (1963), pp. 215-226.

826. Carrigy, M.A., Research Council of Alberta:
Lithology of Alberta Sandstones, 1960-.
This project consists of field measurement of cross-stratification to determine palaeoslope directions as well as the petrographic study of samples in the laboratory. See Authigenic clay mineral cements in Cretaceous and Tertiary sandstones of Alberta; J. Sed. Pet. (in press).

827. Danner, W.R., Univ. of British Columbia:
Stratigraphy, sedimentation, and palaeontology of the Triassic and Jurassic sediments of the Nicola Group, British Columbia, 1960-.
Geology of Chilliwack Group, Cache Creek Group and related rocks, British Columbia and Washington 1959-.
Stratigraphy and palaeontology of Devonian, Pennsylvanian and Permian rocks comprising the Chilliwack Group and of the Pennsylvanian and Permian of the Cache Creek Group.
Carbonate facies of the western Cordillera of British Columbia, Washington, and Oregon, 1958-.
Petrographic and palaeontologic studies of Palaeozoic, Mesozoic, and Cenozoic limestones of the eugeosyncline of the west coast of North America. See Limestones of western Washington, Wash. State Division of Mines and Geology (in press).

828. Deane, R.E., Univ. of Toronto:
Geology of South Bay, Manitoulin Island, Ontario, 1963-64.
Includes echo sounding survey of South Bay, together with bottom sampling and coring.

829. Gwinn, V.E., McMaster Univ.:
Stratigraphic, sedimentologic, and petrologic analyses of Cretaceous rocks in the vicinity of the Boulder batholith, western Montana, 1958-64.
See Geology of the Drummond area, central-western Montana; Spec. Pub. 21, Montana Bureau of Mines and Geology, Butte, Montana.

830. Gwinn, V.E., Bain, D.M., McMaster Univ.:
Variation and interrelationship of composition, internal structures and texture in Upper Silurian carbonate rocks, central Pennsylvania and S.W. Ontario, 1963-66; Ph.D. thesis (Bain).

See Penecontemporaneous dolomite in Upper Silurian strata, south-central Pennsylvania; Meetings of AAPG-SEPM-G.A.C., Toronto, 1964 (Abstract).

831. Gwinn, V.E., McMaster Univ.; Klein, G., Univ. of Pennsylvania:
Mineralogical differentiation in Tuscarora and Pocono sandstones, Central Appalachians, 1963-66.

832. Halferdahal, L.B., Research Council of Alberta:
Stream deposits in Alberta, 1957-65.
This project has involved the study of samples collected systematically from the beds of some of the major rivers in Alberta. The bed material is recognized as having come from three sources; the Cordillera to the west, the Cretaceous and Tertiary strata in the plains and foothills, and glacially transported rock from and adjacent to the Canadian Shield to the north and northeast. The influence of each of these sources as well as some hydraulic factors on the size distributions and the heavy mineral concentrations is being determined.

833. Hooper, Kenneth, Carleton Univ.:
Foraminifera and sediments of the Gulf of St. Lawrence and the eastern Canadian Continental Shelf, 1960-.
Post-Wisconsin microfaunas and sediments of Eastern Canada, 1963-.

834. Johnston, R.H., Univ. of Saskatchewan:
Jurassic sediments of southeastern Alberta, 1963-65; M.Sc. thesis.
Facies study of Jurassic sediments in the region of the Sweetgrass Arch, Alberta.

835. King, L.H., Geol. Surv. Can. and Bedford Institute of Oceanography:
Organic geochemistry of marine sediments, Scotian Shelf, 1963-.
The structural chemistry of the organic matter will be studied with respect to environment. See A study of sedimented organic matter and its natural derivatives, Mines Branch Research Rept. R114, Dept. of Mines and Technical Surveys, Ottawa, Canada, June 1963.

836. Kranck, Kate M., Geol. Surv. Can. and Bedford Institute of Oceanography (part time):
Recent marine sediments of Exeter Bay, Northwest Territories, 1962-63; M.Sc. thesis.
Purpose is to present a petrographic analysis of bottom sediments of Exeter Bay, Baffin Island and to relate the petrographic observations to known depths of water, submarine topography, oceanic currents, and drifts of the floes.

837. Lakey, B., Univ. of Saskatchewan:
Middle Devonian sediments of the Swift Current Platform, Saskatchewan, 1961-64; M.Sc. thesis.
Special emphasis on genesis of salt-free areas as the result of non-deposition and also, locally, as the result of deposition and subsequent removal in solution of soluble salts.

838. Leslie, R.J., Geol. Surv. Can. and Bedford Institute of Oceanography (part time):
Marine geology of Hudson Bay, 1961-65; Ph.D. thesis Univ. of Southern California.
See Foraminiferal study of a cross-section of Hudson Bay, Canada, Geol. Surv. Can., Paper 63-16.
Marine geology of the Churchill estuary and adjacent area of Hudson Bay, 1962-63.
See Geol. Surv. Can., Paper 63-1 (1963), p. 41.

839. Lewis, C.F.M., Univ. of Toronto:
Geology of the Lake Erie Basin, 1962-64; Ph.D. thesis.
Includes development and use of various types of equipment for investigating bottom and subbottom material (sparker, echo sounder, hydrostatic corer, gravity corer, bottom grab). A survey of the lake basin involves closely spaced traverses across the lake totalling several 1,000 miles, and collection of core and bottom samples.

840. McIlwaine, W.H., Univ. of New Brunswick:
Origin and age of the Perry Formation, Charlotte county, New Brunswick, 1962-64; M.Sc. thesis.

841. Marlowe, I., Geol. Surv. Can. and Bedford Institute of Oceanography:
Marine geology of Prince Gustaf Adolf Sea, District of Franklin, 1962-64.

Present project is a sedimentological study with emphasis on the relation of oceanographic conditions to sedimentary processes. See Marine Geology of eastern part of Prince Gustaf Adolf Sea; Geol. Surv. Can., Paper 63-22.

842. Marlowe, J.I., Vilks, G., Geol. Surv. Can.:
Marine Geology program, Polar Continental Shelf Project, 1962-63.
An investigation of sedimentation in Prince Gustaf Adolf Sea and McLean Strait in the Western Queen Elizabeth Islands. See Geol. Surv. Can., Paper 64-1, p. 8.

843. Maycock, I.D., Saskatchewan Dept. of Mineral Resources:
The Lower Cretaceous of west-central Saskatchewan, 1963-64.
Sedimentological stratigraphic study of the Blairmore Formation.

844. Middleton, G.V., McMaster Univ.:
Mathematical models for the generation of size frequency distributions in geology, 1963-64.
The results will be prepared as a report to the S.E.P.M. Committee on size distribution of sediments. See On sorting, sorting coefficients, and the lognormality of the grain-size distribution of sandstones; a discussion; J. Geol., vol. 70, pp. 754-756.

845. Moorhouse, W.W., Univ. of Toronto:
Studies of Precambrian sediments, 1950-.
The petrography, chemistry, mineralogy, and sedimentation features of the Animikie iron formation. See concretions from the Animikie of the Port Arthur Region, Geol. Assoc. Can., Proceedings, 1963.

846. Nwachukwu, Silas O., Univ. of Toronto:
The geological significance of geomagnetic measurements over the Lake Huron basin and adjacent areas, 1961-64.
A study of results of regional magnetic surveys conducted in cooperation with the Great Lakes Institute.

847. Oliver, T.A., Univ. of Alberta (Calgary):
Depositional slopes in ancient and modern environments, 1962.

Recent work on Devonian rocks by the writer has indicated the significance of primary slopes in sedimentary processes and environments. The problem is being handled by further subsurface work and proposed work on slopes of deltas in modern lakes. See Depositional environments of the Ireton Formation, central Alberta; Bull. of Canadian Petroleum Geology, June, 1963, pp. 183-202.

848. Pelletier, B.R., Geol. Surv. Can., Bedford Institute of Oceanography:
Submarine geology; Arctic Ocean adjacent to Queen Elizabeth Islands, 1960-.
Distribution, origin, lithologic, and biologic character of sediments on continental shelf areas and physiographic interpretation of sea floor. See Geol. Surv. Can., Paper 64-1, p. 6.
Marine geology on Polar Continental Shelf Project, 1960-.
Marine geology of Jones Sound, District of Franklin, Northwest Territories, 1963-.
Palaeocurrents in the Triassic of northeastern British Columbia, 1963-64.

849. Peterson, N.N., Queen's Univ.:
Limestone environments in Ordovician rocks of the Kingston area, 1963-64; M.Sc. thesis.
A study of the Ordovician limestones of the Kingston area with a view toward determining environments of deposition.

850. Pugh, D.C., Geol. Surv. Can.:
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.

851. Rapson, June E., Univ. of Alberta (Calgary):
Petrography and depositional environment of the Permian sediments (clastics, carbonates, phosphates, etc.) of Alberta and eastern British Columbia, 1964-68.
See Permo-Carboniferous stratigraphy between Banff and Jasper, Alberta (including petrography). Bull. Can. Petrol. Geol., vol. 11, No. 2, pp. 150-160.

Petrography and depositional environment of the transitional Jurassic - Cretaceous clastics, southern Alberta, 1962-64.

See Diagenesis in Jurassic - Cretaceous clastic rocks in southwestern Alberta and the interpretation of sedimentary environments (outcrop and subsurface material). Paper presented S.E.P.M. Meeting, Toronto, 1964.

852. Rowling, J.W., Univ. of New Brunswick:
Recent sedimentation at the Mouth of Rustico Harbour, Prince Edward Island, 1962-64; M.Sc. thesis.

853. Saull, V., Clark, T.H., Tan, F., McGill Univ.:
Palaeotemperature determinations on Ordovician rocks of Quebec, 1962-64.

Oxygen 16-oxygen 18 ratios in fossils of certain Ordovician rocks of Quebec are being determined, and the results will be correlated, if possible, with temperature changes in the corresponding Ordovician seas suggested by independent geological evidence.

854. Schwerdtner, W.M., Univ. of Saskatchewan (N.R.C. Post-doctorate Fellow):
Genesis of the potash rocks in the Middle Devonian Prairie Evaporite Formation of Saskatchewan, 1962-63.

The genesis of the potash ore beds is interpreted on the basis of the distribution of the trace element bromine, in combination with various textural observations.

855. Scott, Gertrude M. (Mrs.), Univ. of Toronto:
A study of certain fossil assemblages found in Upper Ordovician rocks on the Credit River near Streetsville, Ontario, 1962-64; M.A. thesis.

The fossil accumulations are in the form of biostromes and bioherms. These are being studied to determine the fossil organisms represented which include in abundance stromatoporoids, corals, bryozoas, and algae; correlation of exposed outcrops; relationship of the organisms to the sediments in which they are entombed.

856. Spence, J.A., McGill Univ.:
Interstitial waters in sediments at depth; M.Sc. thesis.

857. Tan, F.C., McGill Univ.:
Palaeo-temperature studies on Ordovician rocks; M.Sc. thesis.

858. Vilks, G., Geol. Surv. Can., Bedford Institute of Oceanography:
Bottom sediment and foraminifera studies on East Bay, Mackenzie King Island, Northwest Territories, 1963-.
See Geol. Surv. Can., Paper 64-1, p. 8.
Bottom sediment and foraminifera studies in marine channels of the Arctic Archipelago, 1962-.
The studies primarily involve the correlation of foraminiferal distribution to bathymetry, type of sediment and other oceanographic data, such as, temperature salinity, etc. See Marine geology, eastern part of Prince Gustaf Adolf Sea, District of Franklin, Geol. Surv. Can., Paper 63-22.

859. Vonhof, J.A., Univ. of Saskatchewan:
Tertiary stream deposits of Western Canada, 1963-65; M.Sc. thesis.

860. Wardlaw, N.C., Univ. of Saskatchewan:
Genesis of halite in the Middle Devonian Prairie Evaporite Formation of Saskatchewan.
Alternations of halite and anhydrite in the lower part of the Prairie Evaporite Formation are interpreted in terms of seasonal fluctuations of salinity in the Devonian sea. The work is based on trace element and textural studies. See Geochemistry of bromine in some salt rocks of the Prairie Evaporite Formation of Saskatchewan; Symposium on Salt, 1963, Northern Ohio Geological Society, pp. 240-246.

861. Williams, G.D., Univ. of Alberta (Edmonton):
Fluviatile sedimentation in Western Canada, 1962-64.
Sedimentation studies along the North and South Saskatchewan Rivers in Alberta and Saskatchewan.

862. Williams, G.D., Campbell, F.A., Univ. of Alberta (Edmonton):
Chemical variations in shale as an aid to determination of environment of deposition, 1962-64.

863 Winder, C.G., Univ. of Western Ontario:
Carbonate clasticity, dolomitization and insoluble residues, Middle Ordovician limestones, 1962-.

The sedimentary petrology of the Cobourg Limestone in the St. Lawrence Cement Quarry, Colborne, is being investigated in detail. The stratigraphic distribution of the -40 +140 mesh insolubles, conodonts, other microscopic invertebrates such as gastropods, brachiopods, chitinozoa, etc., allogenic and authigenic mineral, faecal pellets, Ca/Mg ratio and other entities have been determined. Peel sections of the limestone reveal a myriad of sedimentary structures. It is planned to collect large oriented blocks for trend analysis both parallel and perpendicular to bedding. The distribution of insolubles in the different lithologies of limestone will also be investigated.

STRATIGRAPHY AND PALAEONTOLOGY

Precambrian

864. Cooke, D.L., Univ. of Toronto:
The Temiskaming volcanics and associated sediments of the Kirkland Lake area, Ontario, 1962-65; Ph.D. thesis.
A field, petrographic, and chemical investigation of the trachyte volcanics and their contributions to the associated sediments.

865. Dawson, J.B., Dalhousie Univ. (N.R.C. Post-doctorate Fellow):
Petrology and geochemistry of the George River Series, Cape Breton Island, 1962-64.

866. Dence, M.R., Carleton Univ.:
Study of some Precambrian conglomerates, 1960-64.
Petrographic study and regional geological compilation of data relating to some fragmental rocks of the Superior and Grenville tectonic provinces.

867. Donaldson, J.A., Geol. Surv. Can.:
Geological investigations of the Dubawnt Group, Northwest Territories.
See Geol. Surv. Can., Paper 64-1, p. 10.

868. Hobson, G.D., MacAulay, H.A., Hodge, R.A., Geol. Surv. Can.:
Seismic refraction survey, Athabasca Formation, Saskatchewan, 1963.

To determine thickness of Athabasca Formation and to contour the pre-sandstone surface on a regional basis.

869. Hubert, C.M., McGill Univ.:
The stratigraphy of the Quebec Group in Kamouraska district, Quebec; Ph.D. thesis.

870. Keating, B.J., St. Francis Xavier Univ.:
Geological and petrofabric study of the George River Group of North Mountain, Cape Breton, Nova Scotia, 1961-64.

871. Knight, C.J., Univ. of Toronto:
A petrographic study of the Sudbury Series, 1963-64.
A petrographic comparison of metamorphosed rocks south of the Murray Fault, Blind River area with typical Sudbury Series rocks in the Sudbury area.

872. Moorhouse, W.W., Boutcher, S.M.A., Univ. of Toronto:
The Archaean of northeastern Ontario, 1961-.
Separation of minerals from sediments and volcanics in the Kirkland Lake-Lake Timiskaming area, for determining maximum and minimum isotopic ages. A petrographic and sedimentological study of the greywackes and conglomerates on the west shore of Lake Timiskaming is also being carried out.

873. Ross, J.V., Univ. of British Columbia:
Snare-Yellowknife relations in Northwest Territories, 1957-64.
See Concentric folding of basement and cover at Basler Lake, Northwest Territories, Canada; J. Geol., vol. 71, No. 5, 1963.

Cambrian to Silurian

874. Greene, B.A., Geol. Surv. Can. (part time):
Cambrian stratigraphy of St. John area, New Brunswick, 1963-64; Ph.D. thesis.
See Geol. Surv. Can., Paper 64-1, p. 63.

875. Gwinn, V.E., Bain, D.M., McMaster Univ.:
Variation and interrelationship of composition, internal structures and texture in Upper Silurian carbonate rocks, central Pennsylvania and S.W. Ontario,

1963-66; Ph.D. thesis (Bain).

See Penecontemporaneous dolomite in Upper Silurian strata, south-central Pennsylvania; meetings of AAPG-SEPM-GAC, Toronto, 1964 (Abstract).

876. Jackson, D.E., Larson, M., Davies, E., Univ. of Alberta (Edmonton):

Stratigraphy and palaeontology of graptolitic strata of Ordovician and Silurian age in Western Canada, 1963-; Ph.D. and M.Sc. theses (Larson and Davies).

See Age of Whittaker Formation, Northwest Territories; Bull. Can. Petrol. Geol., vol. 11, No. 1, 1963.

877. King, K., Univ. of Manitoba:

The stratigraphy of the Interlake Group of Manitoba, 1963-64; M.Sc. thesis.

878. Lewis, D.W., McGill Univ.:

The Potsdam sandstone, southern Quebec; Ph.D. thesis.

879. Lilly, H.D., Stevens, R.K., Memorial Univ. of Newfoundland:

A study of the structure and stratigraphy of the Cambro-Ordovician of central-west Newfoundland, 1958-65; M.Sc. thesis (Stevens).

This work is a continuation of investigations started in 1958 - chiefly on the carbonate rocks of the St. George Group - which in turn has led to further investigations of both the carbonate and clastic associations of the St. George and Humber Arm Groups. See Geology of Hughes Brook - Goose Arm area, west Newfoundland; Memorial Univ. Geology Report No. 2, 1963.

880. Martini, I.P., McMaster Univ.:

Petrology and fabric of Medina sandstones, Ontario and New York State, 1962-65; Ph.D. thesis.

881. Middleton, G.V., McMaster Univ.:

Petrology of Charny Sandstones, Quebec, 1962-64.

882. Mountjoy, E.W., McGill Univ. (formerly Geol. Surv. Can.):

Cambrian stratigraphy and petrology of northern Jasper Park, Alberta, 1964-66.

Regional study of Cambrian stratigraphy to determine distribution, thickness and petrography of various units. A study of Ordovician strata and the pre-Devonian unconformity is also included. A brief summary of work up to 1961 published in Geol. Surv. Can., Paper 61-31 (1962).

883. Norford, B.S., Geol. Surv. Can.:
Ordovician and Silurian biostratigraphy of British Columbia and Alberta, 1961-.
See Geol. Surv. Can., Paper 64-1, 1964, p. 81.
Middle Ordovician stratigraphic and faunal study, southern Alberta and southeast British Columbia, 1962-64.

884. Onions, Diane, McMaster Univ.:
Petrology and fabric of Normanskill sandstones, 1963-64; M.Sc. thesis.

885. Sanford, B.V., Geol. Surv. Can.:
Subsurface studies of the Palaeozoic systems of southwestern Ontario (Cambrian, Ordovician, Silurian and Devonian), 1958-.
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. Can., Paper 63-1, p. 66.

Devonian to Permian

886. Aitken, J.D., Geol. Surv. Can.:
Pre-Devonian stratigraphy, southern Rocky Mountains, 1961-64.
A study of pre-Devonian stratigraphy in such detail as to permit precise correlations and to delineate depositional trends and to develop criteria by which subsurface pre-Devonian strata of the foothills and plains may be correlated with the exposed sections. See Geol. Surv. Can., Paper 64-1, p. 29.

887. Bamber, E.W., Geol. Surv. Can.:
Mississippian correlations in the Jasper area, Alberta, 1963-64.
A study of the fauna in the Rundle Formation, to aid in detailed correlation of sections.

Palaeontology and stratigraphy of the Carboniferous and Permian of the northern Yukon, 1963-64.

Information obtained on Operation Porcupine will be assembled to present a general picture of these strata north of the 65th parallel.

888. Belyea, Helen R., Geol. Surv. Can.:

Devonian of Alberta, British Columbia and District of Mackenzie.

A continuing project involving the compilation of cross-sections and isopach and lithofacies maps of all Upper Devonian formations.

889. Bonham-Carter, G.F., Univ. of Toronto:

Geology of the Pennsylvanian reefs of the Blue Mountains, North Ellesmere Islands, 1963-65; Ph.D. thesis.

These are the most northerly reefs yet reported and in consequence have considerable palaeo-climatic interest.

890. Christie, R.L., Geol. Surv. Can.:

Stratigraphic studies on permo-Carboniferous to Cretaceous beds near Tanquary Fiord, Ellesmere Island, 1963-64.

See Geol. Surv. Can., Paper 64-1, p. 3.

891. Ferguson, Laing, Mount Allison Univ.:

A stratigraphic and faunal study of the Permian of north-central Ellesmere Island, Northwest Territories, 1961-67.

Studies of a lower Carboniferous marine transgression, 1957-64.

See The palaeoecology of Lingula squamiformis Phillips during a Scottish Mississippian marine transgression; J. of Palaeontology, vol. 37, May 1963, pp. 669-681.

A stratigraphic and palaeoecologic study of the Permo-Pennsylvanian productid genus Waagenoconcha Chao from the Yukon and Northwest Territories, 1960-65.

The study involves the correlation of shell size, stage at which geniculation occurs and coarseness of ornament with stratigraphic position and sediment types.

892. Jamieson, Esther R., Geol. Surv. Can. (part time):

Stratigraphy and petrology of Upper Devonian rocks, Hay River area, Northwest Territories, 1963; Ph.D. thesis.

The study of upper Devonian rocks in vicinity of Hay River to obtain appropriate suites of samples for petrographic examination to determine their potentialities as sources and reservoirs for oil and gas. See Geol. Surv. Can., Paper 64-1, p. 13.

893. Jones, H.L., Saskatchewan Dept. of Mineral Resources:
The Middle Devonian Winnipegosis Formation of Saskatchewan, 1961-64.

894. Kent, D.M., Saskatchewan Dept. of Mineral Resources:
Some aspects of the geology of the Upper Devonian Saskatchewan Group in western Saskatchewan, and equivalent rocks in eastern Alberta and north-central Montana, 1962-64; Ph.D. thesis, Univ. of Alberta.

See Stratigraphy of the Upper Devonian Saskatchewan Group of southwestern Saskatchewan - Saskatchewan Dept. of Mineral Resources, Rept. No. 73.

895. Mackasey, W.O., Carleton Univ.:
Petrography and stratigraphy of a Lower Mississippian, pre-Horton volcanic succession in northwestern Cape Breton Island, Nova Scotia, 1961-63; M.Sc. thesis.

896. Mackenzie, W.S., Geol. Surv. Can. (part time):
Devonian stratigraphy, northwest margin of the Southesk-Cairn carbonate complex, Alberta, 1961-64; Ph.D. thesis, Univ. of Toronto.
See Geol. Surv. Can., Paper 64-1, p. 34.

897. MacQueen, R.W., Geol. Surv. Can. (part time):
Mississippian stratigraphy and petrology, Bow and Highwood Rivers area, Alberta, 1963-64; Ph.D. thesis.
See Geol. Surv. Can., Paper 64-1, p. 34.

898. Martin, H.L., Geol. Surv. Can.:
Subsurface study of Mississippian on Sylvan Lake-Gilby area, north-central Alberta, 1963-64.

A detailed stratigraphic analysis of the Elkton, Shunda, Pekisko, Banff and Exshaw Formations.

899. McGugan, A., Rapson, June E., Univ. of Alberta (Calgary):
Permo-Carboniferous stratigraphy, northeastern British Columbia, 1963-65.
See Permian stratigraphy and nomenclature, western Alberta and adjacent regions; Edmonton Geol. Soc. Guidebook, 5th Annual Field Conference, 1963.

900. McIlwaine, W.H., Univ. of New Brunswick:
Origin and age of the Perry Formation, Charlotte county, New Brunswick, 1962-64; M.Sc. thesis.

901. McLaren, D.J., Geol. Surv. Can.:
Devonian biostratigraphy, Halfway River and Fernie map-areas, British Columbia, 1963.
See Geol. Surv. Can., Paper 64-1, p. 30.
The stratigraphy of Mackenzie River Devonian Corals, 1962-63.

902. Monger, James, W.H., Univ. of British Columbia:
Stratigraphy of the Chilliwack Group in southwestern British Columbia, 1962-65; Ph.D. thesis.

903. Mountjoy, E.W., McGill Univ. (formerly Geol. Surv. Can.):
Carboniferous stratigraphy and petrology of northern Jasper Park, Alberta, 1959-.
A regional study of Carboniferous stratigraphy to determine extent, thickness and petrography of various units.
Upper Devonian ancient wall reef complex, Alta, 1960-.
A study of the gross stratigraphic relations and petrology and detailed examination of the reef margins to determine depositional history and environments. See Geol. Surv. Can., Paper 63-31 (1962).

904. Oliver, T.A., Univ. of Alberta (Calgary):
Depositional slopes in ancient and modern environments, 1962-.
Recent work on Devonian rocks has indicated the significance of primary slopes in sedimentary processes and environments. The problem is being handled by further subsurface work and proposed work on slopes of deltas in modern lakes. See Depositional environments of the Ireton Formation, central Alberta; Bull. of Canadian Petroleum Geology, June, 1963, pp. 183-202.

905. Pelzer, E., Univ. of Alberta (Edmonton):
Geology and geochemistry of Besa River Formation, 1963-65; Ph.D. thesis.

906. Tassonyi, E.J., Geol. Surv. Can.:
Subsurface geology, lower Mackenzie River and Anderson River areas, District of Mackenzie, Northwest Territories, 1962-63.
The study of facies changes, structural relations and correlation of stratigraphic units, with special emphasis on Middle Devonian.

907. Tozer, E.T., Geol. Surv. Can.:
Triassic biostratigraphy, Halfway River and Taseko Lakes map-area, British Columbia, 1963.
See Geol. Surv. Can., Paper 64-1, p. 27.

908. Watson, D., Univ. of Saskatchewan:
Devonian evaporites of the Elk Point basin in Alberta, 1963-66.
Facies analysis of Middle Devonian evaporites in the Elk Point basin in Alberta, with special emphasis on the distribution and genesis of halite rocks.

Mesozoic

909. Berven, R.J., Univ. of Saskatchewan:
Stratigraphy of Lower Cardium sand, Alberta, 1963-65; M.Sc. thesis.
Mineralogy and structure of sandstone bodies.

910. Brandt, J.A., Univ. of Saskatchewan:
Petrological study of the Cretaceous Colorado Group in Saskatchewan, 1963-65; M.Sc. thesis.

911. Burk, C.F., Geol. Surv. Can.:
Subsurface upper Cretaceous stratigraphy of west-central Alberta and adjacent British Columbia, 1960-.
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. See Geol. Surv. Can., Paper 62-3.

912. Caldwell, W.G.E., North, B.R., Park, J.M., Univ. of Saskatchewan:
Stratigraphic studies in Cretaceous rocks, 1959-; M.Sc. thesis (Park).

At present, the foraminiferal assemblages of the Lea Park Formation of the Montana Group and of the formations of the Colorado Group in south-central Saskatchewan are being described. Information on the Lea Park faunas will be available as a report of the Saskatchewan Research Council. See A Cretaceous rudist from Canada, and a redescription of the holotype of Ichthyosarcolites coraloides; J. Palaeontology, vol. 37, No. 3, pp. 615-620.

913. Carrigy, M.A., Research Council of Alberta:
Athabasca Oil Sands, 1957-.
See Criteria for differentiating the McMurray and Clearwater Formations in the Athabasca oil sands; Res. Coun. Alberta, Bull. 14 (1963).

914. Christopher, James E., Saskatchewan Dept. of Mineral Resources:
Shaunavon (middle Jurassic) Formation of southwestern Saskatchewan, 1961-63.

915. Cox, R.L., Geol. Surv. Can.:
Study of the Paddy Member, Peace River Formation (Lower Cretaceous), 1962-63.
The determination of the limits of the Paddy Member by examination of the type section and correlation with the subsurface by examination of well samples and mechanical logs.

916. Danner, W.R., Univ. of British Columbia:
Stratigraphy, sedimentation, and palaeontology of the Triassic and Jurassic sediments of the Nicola Group, British Columbia, 1960-.
Geology of Chilliwack Group, Cache Creek Group and related rocks, British Columbia and Washington, 1959-.
Stratigraphy and palaeontology of Devonian, Pennsylvanian and Permian rocks comprising the Chilliwack Group and of the Pennsylvanian and Permian of the Cache Creek Group.
Carbonate facies of the western Cordillera of British Columbia, Washington, and Oregon, 1958-.
Petrographic and palaeontologic studies of Palaeozoic, Mesozoic, and Cenozoic limestones of the eugeosyncline of the western Washington, Wash. State Division of Mines and Geology (in press).

917. Edmunds, F.H., University of Saskatchewan:
Stratigraphy of the Cretaceous Colorado Group in Saskatchewan, 1959-65.
Coordination of work done and being done by graduate students on various phases of Colorado stratigraphy including micropalaeontology, petrology and subsurface distribution.

918. Gibson, D.W., Geol. Surv. Can. (part time):
Triassic rocks near northern boundary of Jasper National Park, 1962-63; Ph.D. thesis, Univ. of Toronto.
Study of the stratigraphy and petrology to establish their stratigraphic relationships and correlation, their sedimentary features, conditions of deposition, and their potentialities as possible reservoirs for oil and gas. See. Geol. Surv. Can., Paper 64-1, p. 33.

919. Green, R., Mellon, G.B., Research Council of Alberta:
Cretaceous stratigraphy of northwestern Alberta, 1962-65.
A study of Cretaceous stratigraphy of northwestern Alberta, based on a helicopter mapping-survey, and subsurface data.

920. Gwinn, V.E., McMaster Univ.:
Stratigraphic, sedimentologic, and petrologic analyses of Cretaceous rocks in the vicinity of the Boulder batholith, western Montana, 1958-64.
See Geology of the Drummond area, central-western Montana; Spec. Pub. 21, Montana Bureau of Mines and Geology, Butte, Montana.

921. Johnson, R.H., Univ. of Saskatchewan:
Jurassic sediments of southeastern Alberta, 1963-65; M.Sc. thesis.
Facies study of Jurassic sediments in the region of the Sweetgrass Arch, Alberta.

922. Lerbekmo, J.F., Univ. of Alberta (Edmonton):
Correlation of Upper Cretaceous and Palaeocene continental formations in the foothills and planes of Alberta, 1958-.
See Petrology of the Belly River Formation, southern foothills of Alberta; sedimentology, vol. 2, pp. 54-86, 1963.

923. Maycock, I.D., Saskatchewan Dept. of Mineral Resources:
The Lower Cretaceous of west-central Saskatchewan, 1963-64.
Sedimentological stratigraphic study of the Blairmore Formation.

924. Mellon, G.B., Research Council of Alberta:
Lower Cretaceous stratigraphy and associated projects, 1956-64.
Final report on lower Cretaceous (Blairmore) stratigraphy of the Alberta foothills and planes to be published in 1964. See Discriminatory analysis of calcite – and silicate – cemented phases of the Mountain Park Sandstone; J. Geology (in press).

925. Mountjoy, E.W., McGill Univ. (formerly Geol. Surv. Can.):
Mesozoic stratigraphy of northern Yukon, 1961-.
A regional study of the Mesozoic stratigraphy of northern Yukon. Includes determination of gross stratigraphic relationships, stratigraphic relationships, petrography and depositoral history of these rocks.

926. Nascimbene, G., Folinsbee, R.E., Baadsgaard, H., Univ. of Alberta (Edmonton):
Bentonites and geochronology of the Bearpaw Sea, 1962-64; M.Sc. thesis (Nascimbene).
See Radiometric dating of the Bearpaw Sea (in preparation for Inter. A.A.P.G. Res. Symp. Meeting, Toronto, May 1964).

927. Pelletier, B.R., Geol. Surv. Can.:
Triassic stratigraphy of the foothills, northeastern British Columbia, 1959-65.
See Triassic stratigraphy of the Rocky Mountain foothills between Peace and Mushwa Rivers, northeastern British Columbia, Geol. Surv. Can., Paper 62-53.

928. Price, L.L., Geol. Surv. Can.:
Contour map on base of 'Fish Scale' zone of Cretaceous, British Columbia and adjoining parts of Alberta and Northwest Territories, 1959-63.
Preparation of structure contour map on base of Cretaceous 'Fish Scale' zone from wells drilled for oil and gas.
Contour map on base of the Favel Formation (Cretaceous), southwestern Manitoba.

Preparation of a structure contour map on the base of the Favel Formation directly from subsurface data obtained from wells drilled for oil and gas.

929. Procter, R.M., Geol. Surv. Can.:
Subsurface study of the Mississippian, Pennsylvanian and Permian systems of Northeastern British Columbia, 1960-.
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.

930. Procter, R.M., Geol. Surv. Can. and Officers of National Energy Board:
Subsurface study of Triassic of northeastern British Columbia, 1963-.

931. Scott, D.A., Geol. Surv. Can. (part time):
Mississippian and Permo-Pennsylvanian stratigraphy, southern Rocky Mountains, British Columbia and Alberta, 1961-62; Ph.D. thesis, Univ. of British Columbia.
Detailed study of stratigraphy, subdivisions, facies, correlations, and petrographic character of late Palaeozoic succession. See Geol. Surv. Can., Paper 64-1, p. 31.

932. Shafiqullah, M., Folinsbee, R.E., Baadsgaard, H., Cumming, G.L., Lerbekmo, J.F., Univ. of Alberta (Edmonton):
Geochronology of the Cretaceous-Tertiary Boundary, 1962-64; M.Sc. thesis (Shafiqullah).
A radiometric date for the Cretaceous-Tertiary Boundary in western North America has been established by K-Ar dating as 63 m.y. + 1 m.y. s.d., in a number of widely separated areas. See Shafiqullah, M., et al., Geochronology of the Cretaceous-Tertiary Boundary, XXII International Geologic Congress, 1964, India; in press.

933. Stelck, C.R., Mellon, G.B., Wall, J.H., Univ. of Alberta (Edmonton):
Lower Cretaceous stratigraphy of Western Canada, 1947-.
See Lower Cretaceous section, Belcourt Ridge, northeastern British Columbia: Bull. Can. Petrol. Geol., vol. 11, No. 1, 1963, pp. 64-72.

934. Stott, D.F., Geol. Surv. Can.:
Subsurface studies of Cretaceous in Northeastern British Columbia, 1962-65.
Cretaceous stratigraphy of Northeast British Columbia Foothills, 1961-62.
Detailed stratigraphy, facies study, and correlation of Fort St. John and equivalent strata - Peace River to 60th parallel. See Geol. Surv. Can., Paper 63-1 (1963), p. 26.

935. Tater, J.M., Univ. of Alberta (Edmonton):
Petrology of Upper Cretaceous Dunvegan sandstones, 1962-64; M.Sc. thesis.

Cenozoic

936. Church, N.B., Univ. of British Columbia:
Petrology of the Tertiary Rocks of the White Lake Basin, British Columbia, 1963-65; Ph.D. thesis.
The study is focused on a group of Tertiary lavas, lake sediments, and breccias centred about a diatreme-like structure in the south Okanagan Valley near Penticton.

937. Cox, Raymond L., Geol. Surv. Can.:
Biostratigraphy of the Sooke and Carmanah Formations, Vancouver Island, 1963-65.
To review critically the geology, palaeontology and palaeobotany of these middle Tertiary units.

938. Vonhof, J.A., Univ. of Saskatchewan:
Tertiary stream deposits of Western Canada, 1963-65; M.Sc. thesis.

General Problems

939. Bartlett, Derek, Univ. of New Brunswick:
Origin and mineralogy of the coloration of some New Brunswick redbeds, 1962-64; M.Sc. thesis.

940. Beales, Frank W., Univ. of Toronto:
Petrography and sedimentary ecology of ancient and modern limestones including Precambrian limestones of the Lakehead area, Swan Hills Devonian reef and Black River/Lower Trenton limestones of southern Ontario.

941. Blusson, S.L., Geol. Surv. Can. (part time):
Stratigraphic and structural studies near Canada Tungsten property, District of Mackenzie and Yukon Territory, 1962-63; Ph.D. thesis.
See Geol. Surv. Can., Paper 64-1, p. 16.

942. Bolton, T.E., Geol. Surv. Can.:
Lexicon of stratigraphic names used in Canada, 1958-.

943. Cameron, E.M., Geol. Surv. Can.:
Studies in carbonate geochemistry, 1963-.
Geochemistry of reef and off-reef sediments. In particular to determine trends useful to petroleum industry in exploration for reef structures. See Geol. Surv. Can., Paper 64-1, p. 77.

944. Herr, R.L., Geol. Surv. Can.:
Subsurface geology of the foothills of Alberta, 1959-.
Involves study of samples and cores from wells drilled mainly in the foothills of Alberta.

945. Irish, E.J.W., Geol. Surv. Can.:
Stratigraphy of near-surface rocks in the plains of Alberta and Saskatchewan, 1963.

946. Kerr, J.W., Geol. Surv. Can.:
Stratigraphy and structure of Bathurst Island, Northwest Territories, 1 inch to 2 miles, 1963-64.
See Geol. Surv. Can., Paper 64-1, p. 4.

947. Liberty, B.A., Geol. Surv. Can.:
Palaeozoic outliers of the Canadian Shield, 1957-.
A study of the distribution and geology of these outliers to evaluate their palaeogeographical and other geological significance.
Palaeozoic rocks of southeastern Ontario, 1 inch to 4 miles, 1959-61.
Includes the area of Palaeozoic rocks in Ontario eastward to the Frontenac axis. See Geol. Surv. Can., Paper 60-14, 60-31.

948. Preto, V.A., Univ. of British Columbia:
Structural relations between "Cache Creek Group" and Shuswap type rocks in southern British Columbia, 1963-64; M.A.Sc. thesis.
The study is mainly concerned with the possible existence of an unconformity between them.

949. Swerdtner, W.M., Geol. Surv. Can. (part time), Univ. of Saskatchewan:
Studies of gypsum dome emplacement, Axel Heiberg and Ellesmere Islands, 1963.
See Geol. Surv. Can., Paper 64-1, p. 8.

STRUCTURAL GEOLOGY

British Columbia, Alberta, Saskatchewan and Manitoba

950. Brisbin, W.C., Hall, D.H., Wilson, H.D.B., Univ. of Manitoba:
The Superior-Churchill boundary in Manitoba and Saskatchewan, 1959-.
The nature of the Churchill-Superior boundary is being studied using geological, gravity, seismic and magnetic data. See Tectonics of the Canadian Shield in northern Manitoba, Royal Soc. of Canada Special Publication No. 4, 1962.

951. Byers, A.R., Univ. of Saskatchewan:
Structural geology of Saskatchewan, 1960-.

952. Coates, D.F., Mines Branch, Dept. of Mines and Technical Surveys and Norris, D.K., Geol. Surv. Can.:
Michel colliery roof support study, 1962-64.
A study in cooperation with Crow's Nest Pass Coal Co. Ltd., on requirements for safe roof bolting. Attempts are being made to correlate measurements of bolt loads, bed separation and timber behaviour with structural details of the roof rock and the coal.

953. Fyles, J.T., British Columbia Dept. of Mines and Petroleum Resources:
Detailed structural studies of the northern Kootenay Lake area, 1960-64.
See Two phases of deformation in the Kootenay area; Western Miner and Oil Review, July 1962, vol. 35, No. 7, pp. 20-26.

954. Innes, M.J.S. and others, Dominion Observatory:
Gravity survey of Prairie Provinces.
This involves the compilation of about 11,000 gravity observations, 6,000 of which have been provided by the oil exploration industry.

955. Innes, M.J.S., Tanner, J.G., Dominion Observatory:
The gravity anomaly field in northern Saskatchewan.
Five gravity maps have been compiled and the correlation of gravity data with surface geology is in progress. Publication in the gravity map series of the Dominion Observatory is anticipated during 1964.

956. Kornick, L.J., Univ. of Manitoba:
Structural studies of the Russick Lake area, Manitoba, 1963-64; M.Sc. thesis.

957. McTaggart, K.C., Univ. of British Columbia:
Structural studies and geological mapping in south-western British Columbia, 1957-.

958. Mountjoy, E.W., McGill Univ. (formerly Geol. Surv. Can.):
Structure of front and main ranges, northern Jasper Park, Alberta, 1957-.
Extent, geometry and development of fold and thrust structures, relationships of folds with abrupt termination of thrusts, interrelations of hanging-wall and foot-wall structures. See Geol. Surv. Can., Map 40-1959, Paper 61-31.

959. Preto, V.A., Univ. of British Columbia:
Structural relations between "Cache Greek Group" and Shuswap type rocks in southern British Columbia, 1963-64; M.A.Sc. thesis.
The study is mainly concerned with the possible existence of an unconformity between them.

960. Price, R.A., Geol. Surv. Can.:
Fabrics of folded rocks, Fernie map-area, Alberta and British Columbia, 1961-63.
See Geol. Surv. Can., Paper 64-1, p. 31.

961. Rance, H., Univ. of Western Ontario:
Structural relationships in the boundary region between the Churchill and Superior provinces, Wabowden township, Manitoba, 1962-66; Ph.D. thesis.

962. Rector, R.J., Univ. of Manitoba:
Structural study of the San Antonio Formation, Manitoba, 1963-64; M.Sc. thesis.

963. Ross, J.V., Stanley, A.D., University of British Columbia:
Ice fabrics and glacier flow, 1960-64.

964. Stanley, A.D., Univ. of British Columbia:
Mechanics of deformation and recrystallization of ice under stress, 1961-64; Ph.D. thesis.
Ice fabrics and secondary structures on the Athabasca glacier, Jasper National Park, have been examined and attempts are being made to reproduce in the laboratory the fabrics observed in the glacier.

965. von Rosen, G.E.A., Univ. of British Columbia:
Breccia body at Horseshoe Bay, British Columbia, 1963-64; M.Sc. thesis.

New Brunswick, Newfoundland and Nova Scotia

966. Allen, C.M., Mount Allison Univ.:
Triassic vulcanicity in the Maritime Provinces of Canada, 1963-66.
A detailed petrologic geochemical and structural study of selected areas of Triassic basalts in the Maritime Provinces with a view to assessing the mechanism of eruption of tholeiitic basalts and the relationships of these volcanic rocks to Appalachian tectonics.

967. Blackburn, C., Univ. of Western Ontario:
Structural analysis of Mic-Mic Lake area, White Bay South, Newfoundland, 1963-66; Ph.D. thesis.

968. 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.
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.

969. Keating, B.J., St. Francis Xavier Univ.:
Geological and petrofabric study of the George River Group of North Mountain, Cape Breton, Nova Scotia, 1961-64.

970. Lilly, H.D., Stevens, R.K., Memorial Univ. of Newfoundland:
A study of the structure and stratigraphy of the Cambro-Ordovician of central west Newfoundland, 1958-65; M.Sc. thesis (Stevens).

This work is a continuation of investigations started in 1958 - chiefly on the carbonate rocks of the St. George Group - which in turn has led to further investigation of both the carbonate and clastic associations of the St. George and Humber Arm Groups. See Geology of Hughes Brook-Goose Arm area, west Newfoundland; Memorial University, Geology Rept. No. 2, 1963.

Northwest Territories and Yukon

971. Blusson, S.L. (part time), Geol. Surv. Can.:
Stratigraphic and structural studies near Canada Tungsten property, District of Mackenzie and Yukon Territory, 1962-63; Ph.D. thesis. See Geol. Surv. Can., Paper 64-1, p. 16.

972. Innes, M.J.S. and others, Dominion Observatory:
Gravity measurements, Muskox Intrusion, District of Mackenzie.

No additional measurements were made in 1963 but regional gravity maps on a scale of 1 inch to 1,000 feet are being compiled.

Regional gravimetric study of Baffin Island, 1961-.

Substantial progress has been made in assembling the gravity and other available geophysical data in map form on a regional basis for the greater part of the island and on a detailed basis on the Penny and Barnes icefields.

973. Ross, J.V., Univ. of British Columbia:
Snare-Yellowknife relations in Northwest Territories, 1957-64.

See Concentric folding of basement and cover at Basler Lake, Northwest Territories, Canada; J. Geol., vol. 71, No. 5, 1963.

974. Sander, G.W., Overton, A., Tyrlik, W., Polar Continental Shelf Project, Dept. of Mines and Technical Surveys:
Seismic investigations of the Sverdrup basin and of the crust underlying the Queen Elizabeth Islands and the Polar Continental Shelf.

The project is part of an investigation of the structure and nature of the geological formation, the underlying crust and the upper mantle beneath the west-central Queen Elizabeth Islands and the off-lying continental shelf to the edge of the Arctic Ocean basin. Several short seismic profiles and a continuous traverse 450 kilometres long across the Sverdrup basin have given a composite section of crustal conditions from the Boothia Arch to the Continental Shelf.

975. Sobczak, L.W., Weber, J.R., and others, Dominion Observatory:
Gravity studies, Polar Continental Shelf Project.
Studies of ice caps on Melville Island, and regional and detailed observations on Devon and Ellesmere Islands were completed. Adverse ice conditions forced cancellation of program of additional measurements over the shelf and inter-island channel waters and a traverse far out over the Arctic Ocean basin. See (a) Gravity anomalies over the Polar Continental Shelf, Contr. Dom. Obs., vol. 5, No. 17. (b) Regional gravity survey of Sverdrup Islands, Gravity Map Series, Dom. Obs., No. 11 and (c) Preliminary results of gravity surveys in the Queen Elizabeth Islands, Gravity Map Series, Nos. 12-15.

976. Swerdtner, W.M., Geol. Surv. Can. (part time), Univ. of Saskatchewan:
Studies of gypsum dome emplacement, Axel Heiberg and Ellesmere Islands, 1963.
See Geol. Surv. Can., Paper 64-1, p. 8.

Ontario

977. Brisbin, W.C., Univ. of Manitoba:
Studies of shear folding in Forgie and Ewart townships, Ontario, 1963-65.
Recent geologic mapping by the Ontario Dept. of Mines in Forgie and Ewart townships near the Manitoba border has indicated a complex structural history the last event of which appears to have been shear folding. Megascopic and microscopic structural analyses in critical subareas are proposed to investigate the mechanics of this type of folding. Oriented specimens from one locality have already been studied and the orientation of slip surfaces and the direction of transport have been determined. Field observations at several

exposures of agglomerate and conglomerate have revealed differing degrees of shear elongation of large particles and suggest that detailed studies of this effect will be useful to the interpretation.

978. Church, W.R., Univ. of Western Ontario:
Structural analysis of the Whitefish Falls region, south of Espanola, Ontario, 1963-.
Comparative analysis of the structures in the Fleur de Lys, Baie Verte, Cape St. John's and the Snooks Arm Groups in the White Baie South and Greey Bay districts of Newfoundland, 1963-.

979. Cook, D.G., Queen's Univ.:
Structure and petrology of the Buck Lake syncline, Ontario, 1963-64; M.Sc. thesis.

This is one of a number of similar projects either done or contemplated in the Westport and Gananoque areas under the direction of J.W. Ambrose and H.R. Wynne-Edwards.

980. Henderson, J.R., Clifford, P.M., McMaster Univ.:
Structural studies along the Grenville Front, between Sudbury and Killarney, 1964-; Ph.D. thesis (Henderson).

This project to determine the nature of the Grenville Front in the Killarney area, involves structural field studies and comprehensive petrofabric analysis by optical and X-ray methods.

981. West, G.F., Berry, M.J., Univ. of Toronto:
Studies of the earth's crust by seismic refraction methods, 1962-; Ph.D. thesis (Berry).

Field work in Lake Superior area was completed during 1963. Interpretation will probably be completed before end of 1964. The work will likely continue in other regions.

982. Wynne-Edwards, H.R., Shaw, C.M. Elizabeth, Queen's Univ.:
Structure and petrology of a gabbro body at Leo Lake, Ontario, 1963-; M.Sc. thesis (Mrs. Shaw).

See Gananoque map-area, Ontario; Geol. Surv. Can., Map 27-1962.

Quebec

983. Brown, A., Queen's Univ.:
Structural geology of the Opemiska mine, Quebec, 1961-64; Ph.D. thesis.
An intensive study of the structural control of the Opemiska sulphide bodies.

984. Charette, J.P., Dominion Observatory in collaboration with Gold, D.P., McGill Univ.:
Gravity survey of Oka alkaline complex, Quebec.
An analysis of the data is in progress with a view to obtaining the vertical extent and possible layering of the intrusion.

985. Clark, T.H., McGill Univ.:
Structure and stratigraphy of the St. Lawrence Lowlands of Quebec, 1938-64.
See Two Ordovician palaeoclimatological indicators in Quebec; Trans. Roy. Soc. Can., 3rd Ser., vol. LVI, Sec. III, 1962.

986. Currie, K.L., Geol. Surv. Can.:
Geology of Manicouagan-Mushalagan Lakes, Quebec, 1963-.
An investigation of the core of Manicouagan-Mushalagan Lake structure and its relationship to surrounding lava plateau. See Geol. Surv. Can., Paper 64-1, p. 52.

987. Eakins, P.R., McGill Univ.:
Structural studies in the southern Appalachians of Quebec, 1963-65.

988. Goodacre, A.K., Nyland, E.D., Dominion Observatory:
Underwater gravity measurements in the Gulf of St. Lawrence.
During the past two years about 600 underwater gravity measurements have been made in areas where water depths are 100 fathoms or less. They should provide valuable information regarding the structural relations of the Appalachian province and adjoining Precambrian Shield.

989. Roth, H., McGill Univ.:
Structural analysis of the rocks across the Sutton Mountains, Quebec; Ph.D. thesis.

990. Tanner, J.G., McConnell, R.K., Dominion Observatory:
Gravity Studies, Northern Quebec.
See gravity anomaly field in the Ungava region of northern Quebec; Gravity Map Series, Dominion Observatory, 1964 and Gravity anomalies in the Payne Lake-Lake Minto region, New Quebec; Gravity Map Series Nos. 7-10.

991. Williams, F.M.G., McGill Univ.:
Tectonics of the Rioux Quarry, Cowansville, Quebec; M.Sc. thesis.

General Problems

992. Ambrose, J.W., Queen's Univ.:
Exhumed palaeoplains of the Precambrian Shield, 1934-63.
Subaerial erosion surfaces of several ages can be identified within the area of the Canadian Shield. A paper attempting to define their ages, extent, and interrelations has been accepted for publication by the Amer. J. of Sci.

993. Ambrose, J.W., Carswell, H.C., Queen's Univ.:
Two more solutions of the two drill hole problem, 1962-63.
See Econ. Geol., vol. 58, No. 5, August, 1963.

994. Barron, K., Mines Branch, Dept. of Mines and Technical Surveys:
Structural modelling, 1961-.
Work has been continuing on the method of applying biaxial stress or deformation conditions to the model constructed to examine the stress and failure conditions around rooms and pillars. The effects of applying a uniform horizontal deformation on the stress distribution in simulated layered formations is being examined.

995. Barron, K., Gyenge, M., Cochrane, T.S., Grant, F., Mines Branch, Dept. of Mines and Technical Surveys:
Development of instrumentation and measurements of stress in situ, 1951-.
Additional field trials have been conducted using the rigid inclusion stressmeter for obtaining measurements of field stresses and mining induced stresses. Some interesting results have been obtained with this instrument. However, further development work is

being conducted to permit its use in higher stress fields.

A number of borehole deformation meters, designed by the U.S. Bureau of Mines, have been fabricated and subjected to field trials as an alternate technique for determining stresses in situ. The development of ancilliary equipment for use in hard rocks is proceeding. The instrument is to be used with an overcoring technique to obtain measurements on field stresses and mining induced stresses in pillars.

An improved borehole deformation meter is being developed using differential transformers that will obtain at one position three deformation readings instead of only one that can be obtained with the above deformation meter. Laboratory trials on a prototype have indicated that a practical instrument of this nature can be developed.

At the request of the University of Sheffield, the performance of glass insert biaxial stressmeters, is being assessed. A theoretical appraisal of the instrument has been completed, and laboratory tests have been conducted to assess the performance of two gauges that were supplied. The instrument has many favourable aspects and field trials may be conducted at a later date. See A vibrating wire sensing head for the stressmeter; Mines Branch Rept. IR FMP 63/13-MIN.

996. Barron, K., Toews, N., Mines Branch, Dept. of Mines and Technical Surveys:
Study of creep underground, 1962-.

This program consists of measurements of the variation of deformation with time of salt around a shaft and of potash around mine openings in an attempt to gain fundamental knowledge of material behaviour and to correlate this data with theoretical concepts of material properties. Ultimately, the results might assist in appraising the stability of such underground openings. The results that have been obtained to date are in good agreement with general theoretical concepts of co-elastic materials. See Deformation around a mine shaft in salt, Mines Branch, Rept. IR FMP 63/29-MIN.

997. Charlesworth, H.A.K., Muecke, G.K., Univ. of Alberta (Edmonton):
Fracture-analysis in the Canadian Rocky Mountains, 1963-64; M.Sc. thesis (Muecke).

998. Coates, D.F., Cochrane, T., Grant, F., Barron, K., Mines Branch, Dept. of Mines and Technical Surveys:
Rockburst research, 1962-.
Studies are being conducted on mining properties that are experiencing rockbursts. These events are seemingly caused in some cases by mining induced stresses but in other cases by inherent residual stresses. Tests are being conducted on the rock substances in the laboratory, on the rock formations for their seismic velocities, on deformations associated with mining operations and on micro-seismic activities emanating from the surrounding ground. See Studies of ground behaviour in a metal mine in northern Ontario; Mines Branch Rept. IR FMP 63/129-MIN.

999. Coates, D.F., Gyenge, M., Toews, N., Casey, L., Mines Branch, Dept. of Mines and Technical Surveys:
Rock slope stability, 1960-.
A number of projects are being conducted to determine the mechanics of failure in rock slopes. Basic studies are being pursued into the stress distribution occurring in typical slope geometries. Mathematical and photoelastic techniques are being used for this work. In addition, field measurements are being conducted on a number of mining properties to determine deformation, groundwater regime and microseismic activity associated with deep cut slopes in open pits. Both hard and soft rock formations are being studied. See Analyses of pit slides in some incompetent rocks; Trans. AIME vol. 226, 1963.

1000. Coates, D.F., Larocque, G.E., Mines Branch, Dept. of Mines and Technical Surveys:
Study of engineering rock properties, 1963-.
Tests are being conducted on various core samples to determine if it is possible to classify the rock substances comprising a formation into a few functional categories based on some simple laboratory tests. See Classification of rocks for rock mechanics, a paper for discussion, Mines Branch Rept. IR FMP 63/65-MIN, 1963.

1001. Coates, D.F., Larocque, G.E., Sassa, K., Darling, A., Mines Branch, Dept. of Mines and Technical Surveys:
Experimental study of the propagation of shock waves associated with blasting, 1963-.

A laboratory project has been started for the measurement of particle velocity and propagation velocity within the crater zone resulting from a surface explosion. These measurements will be applicable to the ground during the brief time before it is pulverized and extruded. From this work it is expected that information will be obtained on the mechanics of transferring explosive detonation pressures into ground shock pulses. It is anticipated that the impedance ratio between explosive and rock will influence this transfer of energy. The work is to be conducted on various types of rock with various types of explosives. See Rock mechanics applied to the design of underground installations to resist ground shock from nuclear blasts; Proc. Symp. Rock Mechanics, Univ. of Minnesota, Pergamon, 1963.

1002. Clifford, P.M., McMaster Univ.:
Rock fabric and failure, 1963-64.
Cleavage refraction through thin, well-graded epiclastic rocks suggest that there is a definite correlation between strength of a rock and its mechanical behaviour, on the one hand, and mean grain size, degree of sorting and amount and nature of cement, on the other.

1003. Cochrane, D.R., Queen's Univ.:
Structure and origin of the Denbigh ore deposit, 1962-64; M.Sc. thesis.

1004. Davies, R., McGill Univ.:
The structure and petrology of the Muttom Bay, Sylvite and adjacent formations; Ph.D. thesis.

1005. Edmond, K.L. (Mrs.), Univ. of Toronto:
Analysis of methods used in structural cross-sections, 1961-64; M.A. thesis.

1006. Gwinn, V.E., McMaster Univ.:
Thin-skinned deformation in the central Appalachians, 1960-64.
See Thin-skinned deformation in the central Appalachians; Geol. Soc. Amer., Annual Meeting, 1963 (Abstract).

1007. Larocque, G.E., Mines Branch, Dept. of Mines and Technical Surveys:
Sonic studies of rock competency, 1961-.

A new transistorized portable sonic unit has been completed. The equipment is presently undergoing field tests. The main objective for developing this equipment is to be able to measure the seismic velocity in rock adjacent to underground openings. There is preliminary evidence to show that the competency of the rock is a function of the seismic velocity. Consequently, by being able to measure seismic velocities over a short base line at varying distances from a rock face some measure can be obtained of the stability of the opening and the effects of time and geometry on the stability. See Sonic unit for the determination of dynamic properties of fracture zones, Mines Branch Rept. IR 63/121-MRL.

1008. McConnell, R.K., Weaver, D.W., Dominion Observatory:
Gravity in Hudson Bay and James Bay lowlands.

Some 5,000 measurements were spaced at 8 mile intervals with higher density in areas with interesting anomalies. The data are adequate for most geodetic and isostatic studies and should provide information about the structure of the Superior geological province and its extension beneath the lowlands of Hudson and James Bays.

1009. Mereu, R.F., Uffen, R.J., Dubey, A.C., Univ. of Western Ontario:
Dynamic high pressure studies in rocks, 1962-64; M.Sc. thesis (Dubey).

A pin contactor method was developed and used to measure the absorption coefficients for high amplitude waves in cylindrical specimens of rocks. Small charges were used to generate the shock waves with pressures up to 100 kb. All measurements were made within a few cm. of the source. The results showed that the attenuation in the specimens of marble was 3 times that in the granite. At present the effect of geometry on the absorption coefficients is under investigation and an attempt is being made to measure the dynamic yield points of rocks. The results of these experiments will lead to a better understanding of how the energy of explosions can be coupled into seismic energy more efficiently. A study of the effects of shock waves on different types of rock will also be helpful to mining engineers. See The attenuation of high amplitude waves in rocks; Canadian J. of Physics (in press).

1010. Norris, D.K., Geol. Surv. Can.:
Stress analysis of small scale geological structures, 1961-.

To model and attempt to evaluate the local stress and strain patterns in scale geological structures in the laboratory.

1011. Nyland, A., Blanchard, J.E., Dalhousie Univ.:
The measurement of absolute stress in the crust of the earth, 1963-64.

It is hoped to make measurements of stress in the crust of the earth in 1964.

1012. Stockwell, C.H., Chairman of Tectonic map committee, Geol. Surv. Can.:
Tectonic map of Canada, 1958-64.

This map will form part of the World Tectonic Map to be published by the International Geological Congress. See Geol. Surv. Can., Paper 62-17 (1962).

1013. Van Boekel, J., Dominion Observatory:
Gravity studies, Ontario-Quebec mining belt.

Considerable gravity data have been collected over the Timmins-Rouyn mining belt for a number of years. An additional 600 observations were made over critical areas in 1963. Interpretation is in progress with particular emphasis in the granitic bodies and the thicknesses of the volcanic and sedimentary rocks.

1014. Wickens, A.J., Hodgson, J.H., Dominion Observatory:
Machine computation of fault plane solutions, 1964.

For many years the Observatory has been publishing "fault plane solutions" for major earthquakes. Wickens has now programmed the IBM 1620 to produce these solutions and Hodgson has analysed solutions for about 140 earthquakes for which solutions had already been obtained by geophysical methods. It appears desirable to put some error limits on the solutions and Wickens is now writing a program to do this. This will involve the use of the faster IBM 7090. When this program is available all previously published solutions will be re-done by the computer and in the future solutions will be published for all large earthquakes in a routine way.

1015. Wilson, H.D.B., Moxam, R.L., Andrews, P.Q., Ramlal, K., Univ. of Manitoba:
Composition and structure of Precambrian lavas, 1961-.
The composition of Precambrian lavas is being investigated by X-ray fluorescence analysis using a multi-channel instrument. Analyses are being tied in to the petrography. Regional structure is being investigated by geological and geophysical methods.

1016. Wilson, J.T., Farquhar, R.M., Smirnow, L., Gupta, R., Morrison, R.P., and others, Institute of Earth Sciences, Univ. of Toronto:
Studies of the Earth's crust.
For some kinds of geophysical data world compilations exist; for others (crustal thickness and age determinations) they are being made. For some continents résumés of the geology have been published; for others, including the ocean islands, they are being made. The resulting compilations will be used to attempt to find the mechanism of the Earth's behaviour and to synthesize its history. See Hypothesis of the Earth's behaviour; Nature, vol. 198, pp. 925-929, 1963.

1017. Wynne-Edwards, H.R., Queen's Univ.:
Flow folding, 1958-.
A continuing investigation of the structures found in high grade metamorphic rocks. See Flow folding, Am. J. Sci., vol. 261, pp. 793-814, 1963.

AUTHOR INDEX