CANADA

NATIONAL ADVISORY COMMITTEE ON RESEARCH IN THE GEOLOGICAL SCIENCES

SEVENTH ANNUAL REPORT 1956-57

(Including Survey of Current Research in the Geological Sciences in Canada, 1956-57)

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Victoria Memorial Museum,
Ottawa, October 31, 1957.

The Honourable Paul Comtois,
Minister of Mines and Technical Surveys,
Ottawa, Ontario.

Sir:

I have the honour to submit to you the Seventh Annual Report of the National Advisory Committee on Research in the Geological Sciences covering the period September 1st, 1956 to August 31st, 1957.

Respectfully submitted,

J. M. Harrison,
Chairman.

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Meetings:

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Dr. J.E. Gill .... McGill University, Montreal, Quebec

Dr. J.E. Hawley .... Queen's University Kingston, Ontario.

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

Meetings:

December 27, 1956, Victoria Memorial Museum, Ottawa, Ont.

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Dr. H.J. Fraser .... Falconbridge Nickel Mines Ltd., Toronto, Ontario.

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

Dr. B.T. Denis .... Dept. of Mines, Quebec, P.Q.

Dr. G.S. MacKenzie.................. University of New Brunswick, Fredericton, N.B.

Meetings:

June 12, 1957, Victoria Memorial Museum, Ottawa, Ont.

THE YEAR IN REVIEW

INTRODUCTION

The National Advisory Committee on Research in the Geological Sciences has a threefold purpose: to stimulate and co-ordinate geological research carried on in Canada; to suggest research projects that should receive attention; and to aid in having these projects undertaken. The Committee does not carry on research. Its function is to stimulate research by the universities, the federal and provincial departments of mines, and by other organizations equipped for the work.

The first part of this report gives a summary of the work of the Committee in the period September 1, 1956, to August 31, 1957. The second part contains the reports of the subcommittees covering the different fields of the geological sciences. These record developments in 1956-57 and suggest some further problems for study.

The report includes the annual survey of current geological research in Canada. This records information on research by the universities, federal and provincial departments of mines, research councils and foundations. The annual survey of Canadian geological students attending Canadian universities is included.

COMPREHENSIVE STUDY OF A CANADIAN ORE DEPOSIT

As emphasized in the report of the subcommittee on Mineral Deposits (p. 11), geological studies of mining districts and of orebodies in these districts have provided much basic information, but the results in the main have been far below expectations largely because such studies have been much too narrow in scope; each deals with but one or two of the many facets that make up the overall problem. What is needed are investigations having a much wider range, concentrated on certain ore deposits, and carried on by groups of scientists with diverse training and experience. We need new knowledge in geology, and in geophysics and geochemistry, which are now essential parts of geology, but equally, or more important, we need the integration and synthesis of our knowledge into a connected whole. Such comprehensive investigations of ore deposits should result in much more rapid advance in our knowledge of fundamental geological processes, of the source of the metals, and of how the orebodies attained their present position and form. This in turn should lead to increased efficiency in mineral exploration.

So that such a project or projects might be started the subcommittee recommended that the National Advisory Committee assume responsibility for the initiation and long term execution of a complete study of one or more Canadian ore deposits. The National Advisory Committee at its annual meeting (April, 1957) endorsed this recommendation and Dean Gunning, Chairman of the subcommittee on Mineral Deposits, and his subcommittee, plus additional members of his own choosing, were asked to investigate ways and means of carrying it out. Specifically this subcommittee was asked to formulate a plan for the thorough study of a particular deposit or deposits, including consideration of the fields of investigation and the organization and personnel that should carry it out.

This subcommittee met in Ottawa on June 11th, 1957 to formulate a plan. The following were present:

R.W. Boyle, Geological Survey of Canada, Cttawa, Cnt.
D.R. Derry, Rio Canadian Exploration Ltd., Toronto, Ont.
H.J. Fraser, Falconbridge Nickel Mines Ltd., Toronto, Cnt.
J.E. Gill, McGill University, Montreal, Que.
H.C. Gunning, University of British Columbia, Vancouver, B.C.
J.E. Hawley, Queen's University, Kingston, Cntario.
J.M. Harrison, Geological Survey of Canada, Ottawa, Cnt.
J.F. Henderson, Geological Survey of Canada, Ottawa, Cnt.
W.F. James, Toronto, Cntario.
A.H. Lang, Geological Survey of Canada, Cttawa, Cnt.
J.T. Wilson, University of Toronto, Toronto, Cnt.

The conclusions reached at this meeting are summarized in the following paragraphs:

Selection of Cre Deposit or Deposits

It was agreed that, ideally, (1) the orebody or orebodies selected for study should be isolated, so that the aureole about it should not be complicated by overlap of aureoles of nearby deposits (2) the geological environment should be simple rather than complex although over-simplicity should be avoided (3) preferably the upper limit of the orebody should be below the present erosion surface (4) the orebody should not be too large and (5) most or all of the mine workings should be accessible. Several specific deposits were discussed and tentative agreement was reached on one that appeared to meet most of the above qualifications.

Sponsorship

I was agreed, that, although a number of organizations would participate in the project, one, preferably a national organization with overall responsibility, must sponsor it and ensure it was brought to a successful conclusion. The National Advisory Committee was not considered to be a suitable organization for this task. It is advisory only; it initiates but does not carry out projects. It was agreed that the Geological Survey of Canada was the logical choice; also that the Survey publications would be particularly desirable media for publication of the results of the investigation. However, it was emphasized that this must be a co-operative project and although the Geological Survey should be entrusted with overall responsibility for its promotion and co-ordination, it must not be regarded as primarily a Geological Survey project.

Crganization and Personnel

It was agreed that since the Geological Survey was to have overall responsibility for the project, the Director of the Survey should act as Chairman of a small technical or working committee made up of representatives of the mines, provincial departments of mines, and universities that were participating. A larger committee, including specialists in the different fields of the geological and related sciences (geophysicists, geochemists, mineralogists, etc.), also chaired by the Director, might be set up to advise on what investigations should be undertaken, or the National Advisory Committee might act in this capacity.

It was further agreed that there must be a technical director or co- ordinator of the different phases of the investigation. He might come from the staffs of one of the participating organizations. His job would involve providing liaison between all workers, co-ordination of their work, and preferably he should undertake one or more phases of the investigation himself. His would be the essential task of providing leadership and stimulation to the group as a whole. It was agreed he should be a relatively young man, preferably between 35 and 40 years of age, of demonstrated ability in leader ship in research, and in getting along well with his colleagues and fellow workers.

In discussion of other technical personnel, it was agreed that the mine geologist would be a key man. Many of the special studies would be based on his geological mapping. He should be keenly interested in the whole project, and like the co-ordinator, supply leadership in ideas as well as full co-operation.

Others that might work in various special studies might include provincial geologists, National Research Council post-doctorate fellows from both the universities and the Geological Survey, and Ph.D. students from the universities. Specialists in geophysics, geochemistry, etc., would be called on in either a consultative or working capacity. Some of the Geological Survey funds available for the support of geological research in the universities might be funnelled toward support of laboratory research in the universities that was related to the major investigation.

Implementation of the Project

It was agreed that the next step would be the appointment of a small working technical committee by the Director of the Geological Survey of Canada, of which he would be chairman. This committee would see that the project got underway. In due time, it would report to the National Advisory Committee on Research in the Geological Sciences or to the Executive of that Committee. Dr. Harrison, Director of the Geological Survey, agreed to accept the responsibility of setting up the working technical committee and see that steps were taken to get the project underway.

GLACIAL MAP OF CANADA

The compilation and publication of a Glacial (Pleistocene) map of Canada was recommended in the first report of the subcommittee on Pleistocene geology and the need for such a map has been stressed in subsequent reports of this subcommittee. The project was discussed at the April 1956 annual meeting of the National Advisory Committee[1] and a subcommittee was appointed composed of C.S. Lord, J.T. Wilson, and H.C. Gunning (Chairman) to investigate means of carrying it out. This subcommittee met with the executive of the Association who agreed to sponsor the publication of the map and appointed a committee composed of G. Falconer, W.H. Mathews, V. Prest and J.T. Wilson (Chairman) to undertake the task.

This committee reports that all the material to be included in the map has been assembled and compiled and that the final drafting of the map is nearing completion. Arrangements have been made for printing the map which, it is hoped, will be published by the end of 1957. The map will be a single sheet, measuring 51 x 63 inches, on the scale of 1 inch to 60 miles, with an inset of the Canadian Shield showing the proportions of rock outcrop and drift covered areas. The map will be published by the Geological Association of Canada with the support of the Geological Survey of Canada, the Defence Research Board and the National Research Council.

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(1) National Advisory Committee on Research in the Geological Sciences, Sixth Annual Report, 1955-56, p. 3.

"THE CANADIAN MINERALOGIST"

As outlined in the last annual report [(1)] the newly formed

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(1) National Advisory Committee on Research in the Geological Sciences, Sixth Annual Report, 1955-56, p. 2-3.

Mineralogical Association of Canada in 1955 sought the support of the National Advisory Committee in finding means of publishing the journal of the Association. The National Advisory Committee recognizing that publication of results is one of the best ways of stimulating research, advised the Association to make application to the Geological Survey of Canada for a grant-in-aid for publication of the first number. On the recommendation of the National Advisory Committee a grant of $2,478 was made in 1956 for the publication of the journal.

The first number of "The Canadian Mineralogist" appeared in September, 1957. It is a well printed volume of 159 pages containing 13 papers on mineralogical and related subjects with much data of fundamental interest. If the standard of papers is maintained or improved in subsequent numbers there is little doubt that the journal's circle of readers will enlarge rapidly, particularly outside Canada, and that decreasing amounts of financial assistance will be needed.

RESEARCH GRANTS TO UNIVERSITIES

The purpose of the grants which were initiated in 1951, is to stimulate and support geological research in Canadian universities. Applications for grants are received from members of university staffs. These applications which are submitted to the Director, Geological Survey of Canada, are reviewed by the Projects Committee of the National Advisory Committee and the grants are awarded by the Geological Survey on the basis of the resulting recommendations.

In the year under review grants totalling $40,000 were awarded to 9 universities in support of 16 research projects. Amounts of the grants and descriptions of the projects being supported are given in Appendix II (p. 82).

Thirty-one projects in 11 universities are now (Sept. 1957) being supported; 27 other projects have been completed. Since 1951, when the grants were initiated, 53 papers have been published in scientific periodicals recording the results of projects supported by the grants. In addition, the results of a number of others are embodied in 12 M.Sc. and 7 Ph.D. theses.

Summaries on projects completed in the year under review, and on some others that are obtaining results of interest are given in Appendix I (p. 77).

CHANGES IN PERSONNEL OF COMMITTEE

Dr. George Hanson, Director of the Geological Survey of Canada and Chairman of the National Advisory Committee since 1954, retired in 1956. Dr. J.M. Harrison succeeds him as Director of the Survey and Chairman of the Committee.

The terms of office of J.E. Thomson, P.S. Warren and J.T. Wilson expired in 1956. They have been succeeded by Drs. J. Satterly, R.E. Folinsbee and G.B. Langford.

All members join in expressing appreciation of the good work of the retiring members during their terms of office.

RE-ORGANIZATION OF SUB-COMMITTEES

The sub-committee on "Non-Metallic Mineral Deposits, Industrial Minerals, Coal and Oil" has been discontinued and the fields allotted to other subcommittees. Non-Metallic mineral deposits and industrial minerals will be covered by the subcommittee on Metallic Mineral Deposits, which will be known as the subcommittee on Mineral Deposits. Oil, gas and coal will be included with the fields covered by the subcommittee on Stratigraphy and Palaeontology which will henceforth be called the subcommittee on Stratigraphy, Palaeontology, and Fossil Fuels.

The subcommittee on Pleistocene Geology has covered the fields of Pleistocene Geology, glacial, water supply, engineering geology and geomorphology. Henceforth the fields of geomorphology and glaciology will be dropped or covered by the Pleistocene subcommittee only to the extent that they are of direct concern to Pleistocene geology. In future geomorphology will be covered by the subcommittee on Structural Geology.

SUBCOMMITTEE REPORTS

(Summary Statement)

Seven subcommittees cover the different fields on the geological sciences and maintain a continuous survey of developments in these fields and of the problems most urgently in need of investigation. The reports of these subcommittees, which were presented at the annual meeting of the National Advisory Committee (April, 1957), are given in full in a later (p. 11) section of this report. Summaries of the reports and of the discussions that followed their presentation are given below.

The Subcommittee on Mineral Deposits briefly reviews current research in this field. The importance of knowledge of the genesis of mineral deposits in exploration is discussed by several members of the subcommittee. It is suggested that slow progress toward an understanding of ore-forming processes is in part due to failure to test and apply ideas and methods developed by geochemists, geophysicists, and mineralogists in a truly systematic way. More support for basic research and more co-operative effort is needed.

The part played by geophysics in recent discoveries of base metal deposits in Manitoba is reviewed.

It is suggested that lead-zinc deposits may occur in the Palaeozoic sediments bordering the Precambrian shield on the strike of prominant lineaments such as those that apparently controlled the development of the Pine Point deposits.

A review of the present state of knowledge of ore genesis leads to the conclusion that geologists' studies of ore deposits could be strengthened by better knowledge of the work of, and closer co-operation with the bacteriologist and metallurgist.

The need for more fundamental research is stressed. It is felt that the results from geological studies of mining districts have been disappointing because such studies have been too narrow in scope. The need is for comprehensive and better co-ordinated investigations carried on by groups of scientists with diverse training and experience. So that such comprehensive investigations may be undertaken the subcommittee recommends that the National Advisory Committee assume long term responsibility for assuring that complete geological (scientific) information be obtained on at least one Canadian metallic mineral deposit.

An appendix to the report by A. H. Lang reviews the research projects that have been suggested to the subcommittee from its inception in 1950, to the end of 1956.

Following a lengthy discussion of the report in which general agreement was reached on the need for one or more long term comprehensive investigations of metallic mineral deposits, a committee was appointed to investigate ways and means of carrying it out (see also p. 1).

<u>The Subcommittee on Pysical Methods Applied to Geological Problems</u> notes the continuing shortage of trained personnel for teaching, research, and industry in this field and the need for greater support by industry of existing geophysics departments in our universities. Each of the fields of geophysical research are discussed under the headings of Gravity, Seismology, Geomagnetism, Heat Flow and Thermal History of the Earth, Radioactivity, Glaciology, Earth Structure, and Mining Geophysics, including mention under each heading, of current research of particular interest to geologists. The section on Mining Geophysics describes the successes and failures of different geophysical methods in finding orebodies in Manitoba and Saskatchewan, including those in the Mystery-Moak Lakes area and Flin Flon and Herb Lake-Snow Lake areas. Experience in these areas indicates that, although electromagnetic surveys may find mines and were 80 per cent effective in detecting 10 mines found in one district, negative results do not always denote absence of mineral deposits. Also since a particular orebody surveyed with a magnetometer did not show a magnetic anomaly it is apparent that ground cannot be eliminated by magnetic methods when searching for copper-zinc orebodies. Current research in mining geophysics is reviewed briefly and several research projects are suggested. The report concludes with a section on geophysical work by the Geological Survey of Canada and how it might be expanded, and brief notes on the International Geophysical Year and the Eleventh General Assembly of the International Union of Geodesy and Geophysics that was held in Toronto in 1957.

The Subcommittee on Scholarship and Research Training deals with the need for rapid expansion in space, facilities, and staff of geology departments in Canadian universities in the next 10 years. The report is based largely on replies to a questionnaire sent to departments of geology of Canadian universities in March, 1957. It concludes that in the next 10 years the increase in undergraduate enrolment in geology will be about 80 per cent; that an increase in teaching staff of between 25 and 50 per cent will be necessary for the increased enrolment; that an increase in space of between 100 to 200 per cent will be required; and that the aggregate cost of extra equipment needed by 1965 will be $500,000 for geology departments in Canada. To finance the increased number of graduate students, an estimated 75 new graduate scholarships and 63 part-time demonstratorships will be needed. Undergraduate scholarships for students in geology are few; it is suggested that about 100 new ones should be available for the estimated 1,000 undergraduate specialists in 1965.

Discussion of the report centred around the need to attract more students to geology as a profession and the need for greater financial support for the universities (and geology departments in particular) by industry and government. Some members expressed disagreement with the implication in the report that the sizes of geology departments will increase at the same rate as the increase in sizes of universities as a whole. The view was expressed that, with increasing urbanization in Canada, fewer students will specialize in geology. The peak demand for geologists in Canada may have been reached as it already has been in the United States. Many companies have now recruited full staffs of relatively young geologists, and demand may decline.

Plans for the stimulation of greater participation in financial support of the universities by industry and the public were discussed. These included that of the British Columbia Government to match capital gifts for building expansion by industry and the public to the University of British Columbia dollar for dollar, up to a maximum of 5 million dollars; the offer of a large industrial company to match gifts of its employees to universities dollar for dollar; and the action of another large company in giving gifts to universities equivalent to the cost of training each graduate it employs. Such schemes to stimulate support by both industry and the public were working well and should be more widely adopted.

The Subcommittee on Mineralogy, Geochemistry and Petrology emphasizes that, if advances are to be made on application of geology to further discovery and development of mineral resources, much more intensive research is essential in the basic fields of this subcommittee. Distinct progress is noted in four projects initiated by the subcommittee dealing with the need for a summary of modern physical and chemical analytical methods; assembling data on the geochemistry of Canadian rocks and minerals; the nomenclature of metamorphic rocks, facies and phenomena; and the correlation of age determinations with mineralogical and petrological data. Support is recommended for the establishment in Canada of a translation and distribution centre for foreign (especially Russian) literature on geochemistry.

The report also recommends that the Department of Mines and Technical Surveys facilitate the preparation and distribution of non-metallic spectrographic standards.

The recommendation for support of the establishment in Canada of a translation and distribution centre for foreign literature aroused much discussion in which it was brought out that a considerable amount of translation work is already being done in the United States, Canada, and Great Britain. In Canada some staff is available at the University of British Columbia and probably in several other universities for making translations of foreign literature, if it could be financed. However, the first step must be to find out what is being done already by all the different organizations, both national and international, that are preparing translations and what attempt is being made to co-ordinate their efforts and make the material available to all interested. It was suggested that the Geological Survey of Canada might make these enquiries.

With reference to the second recommendation dealing with the preparation and distribution of non-metallic spectrographic standards, the Chairman stated that an officer of the Geological Survey is a member of the committee of the Canadian Association of Applied Spectroscopy that was sponsoring the project. He was confident it would receive full co-operation from the Department of Mines and Technical Surveys.

The Subcommittee on Stratigraphy, Palaeontology and Fossil Fuels points out the increasing role of industry in encouraging research and disseminating knowledge of fundamental importance in these fields. The Western Canada sedimentary basin underlies an area of 700,000 square miles in Manitoba, Saskatchewan, Alberta, northern British Columbia and the Northwest Territories, all of which is potentially productive territory for petroleum and natural gas. About 30 reservoirs contained in 7 geological systems at depths ranging from 1,000 to 10,000 feet have been found. Nevertheless it is essential that the search for oil and gas in Canada continue. Geological research, by adding to our knowledge of the origin, constitution, age, correlation and structure of the strata containing the oil will help in the search for additional reserves. The report concludes with discussion of a number of research projects that merit attention.

In discussion of the report it was suggested there was need for better liaison between provincial and federal geological surveys in naming new geological formations. Dr. Caley said the Geological Survey of Canada had appointed a committee in December 1956 to advise field officers of the Survey on problems of stratigraphic nomenclature. This committee is responsible for ascertaining that the new names for rock units are not pre-occupied, and that they conform to the rules of the American Commission of Stratigraphic Nomenclature or to the procedure adopted by the Geological Survey. The Alberta Association of Petroleum Geologists had set up a committee with a similar purpose, of which an officer of the Geological Survey is a member. There is thus liaison between the two organizations. The Chairman pointed out that the Committee was just starting to function; eventually it might act as a clearing house for Canadian stratigraphic names although its main function at present is within the Geological Survey.

Dr. Baird said the Newfoundland Geological Survey would be most pleased to co-operate with the G.S.C. committee by exchange of new names as they were proposed.

The Subcommittee on Pleistocene Geology reviews the major recommendations in the first report of the subcommittee made seven years ago, [1] and the progress made in their implementation. Considerable headway can

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(1) National Advisory Committee on Research in the Geological Sciences, 1st Annual Report, 1950-51, p. 71-87.

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be reported in some. A Pleistocene map of Canada, on the scale of 1 inch to 60 miles, is currently being prepared by the Geological Association of Canada with the aid of a grant from the Defence Research Board and supported by geological information from the Geological Survey of Canada, provincial organizations, and individuals. The compilation of an annotated bibliography and index of the Pleistocene Geology of Canada is also underway at the University of Toronto. The Pleistocene staff of the Geological Survey of Canada has been expanded and by attaching Pleistocene geologists to each of its 5 large helicopter operations the Survey has greatly broadened mapping and study of surficial materials over large areas of Canada in the past 5 years. The provincial governments are also giving increased attention to Pleistocene and groundwater studies. The Alberta Research Council and the recently formed Ontario Water Resources Commission are particularly active in this field, and British Columbia, Saskatchewan, Nova Scotia and Quebec also carry out mapping programs or specific studies. Several glaciological studies suggested in the first report have received attention, study of ground frost phenomena has increased, and liaison between the many governmental and other agencies is now established through the Associate Committee on Soil and Snow Mechanics of the National Research Council. The report concludes with a regional survey of recent and current research in Pleistocene geology in Canada and lists several projects that merit early attention.

In discussion of the report Dr. Prest pointed out that the original title of the subcommittee had been "Pleistocene, Glacial, Water Supply, Engineering Geology, and Geomorphology" and although the name had been shortened to "Pleistocene Geology" the fields covered were the same. He suggested that the coverage was far too broad; the fields of geomorphology and glaciology should be dropped or covered only to the extent that they were of direct interest to Pleistocene geology. It was agreed that in future the Pleistocene subcommittee should attempt to cover only the fields of Pleistocene geology, engineering geology, and water supply; the field of geomorphology can be covered, if necessary, by the subcommittee on "Structural Geology".

The Subcommittee on Structural Geology points out that most of the research in this field deals with practical problems. However, a number of studies of a more academic and fundamental nature are underway and these are discussed briefly. The report concludes with the observation that only three of the 95 geological research projects that have received grants on the recommendation of the National Advisory Committee since 1950, deal with structural geology. This is perhaps because most structural projects are field studies and the money for them is obtained from other sources.

In discussion of a suggestion in the report that formal courses in vulcanology should be given in Canadian universities it was agreed generally that this subject had been neglected in the past but that as a result of Thomson's and Howell's work in the Sudbury Basin it will be given more attention as part of other courses in the future. Most members thought that, if a formal course were devoted to this subject, it should be for graduate students. The undergraduate curriculum is already overcrowded and in any case undergraduates do not have the necessary experience and knowledge to appreciate such a coarse.

THE REPORT OF THE SUBCOMMITTEE

ON MINERAL DEPOSITS

Presented by H.C. Gunning

Members of Subcommittee

H.C. Gunning(Chairman)	-	University of British Columbia, Vancouver, British Columbia.
D.R. Derry	-	Rio Canadian Exploration Ltd. Toronto, Ontario.
A.H. Lang	-	Geological Survey of Canada, Ottawa, Ontario.
G.B. Langford	-	University of Toronto, Toronto, Ontario
C.E. Michener	-	International Nickel Co. of Canada Limited, Copper Cliff, Ontario.

CURRENT RESEARCH

The list of current research projects (p. 117) can be subdivided as follows by general headings: base metals - 26; ferrous metals - 12; radioactive deposits - 13; other metals - 7; general problems - 15. In addition, a great many of the research projects in mineralogy, geochemistry and petrology have a direct or indirect relation to research on metallic mineral deposits.

Six of the base metal projects deal with New Brunswick deposits and two with copper deposits of the Highland Valley, B.C. Four of the ferrous metal projects deal with the Labrador trough. Four of the radioactive projects include studies of the Blind River region, and two centre on the Beaverlodge area.

During the year, the Ontario Department of Mines has distributed, in preliminary form, two accounts of important research work on the Sudbury area [1]. The original presentation was made

[1] "Sudbury Vulcanology", Can. Inst.Min. and Metallurgy, Annual Meeting, Quebec, 1956. J.E. Thomson & Howell Williams. "The Myth of the Sudbury Lopolith", XXth International Geological Congress, Mexico City, Sept. 1956.

by J.E. Thomson at the Quebec meeting of the Canadian Institute of Mining and Metallurgy, April 1956. The interpretation of the Sudbury basin as a volcano-tectonic sink, with subsequent intrusions of norite and micropegmatite along bordering fractures after the basin structure had been established, and the correlation, as approximately coeval, of the Onaping and Stobie volcanic rocks, supports previous conclusions of Phemister and Yates and seems greatly to clarify the geologic history of the basin. The implications in regard to the emplacement and genesis of the copper-nickel ores are self-evident and all mining geologists will await with impatience the final reports [2]. It is worth noting that the work is the result of the co-

[2] Annual report, Ont. Dept. Mines, Vol. LXV, Pt. III, 1956.

operative effort of an experienced Precambrian geologist and an authority on vulcanology.

D.R. Derry reports that it has not been possible to carry to conclusion the geochemical study of the glacial material overlying sulphide mineralization in the Noranda area mentioned in last year's report [1] because the

[1] National Advisory Committee on Research in the Geological Sciences, Sixth Annual Report, 1955-56, p. 19

mineralization beneath the till was found to be too low-grade to justify further development at this time. The limited investigation of the possibility of picking up faint traces of metals in the till was not encouraging.

Section 6 of the XXth International Geological Congress at Mexico City, September, 1956, dealt with the origin of mineral deposits. Sixty papers were obtained, of which the resumes are available. As is to be expected, a wide range of philosophy on genesis was exhibited. L.C. Graton recorded "the conviction, held by many, that Lindgren's philosophy, progressively improved, remains a sound approach to understanding ore genesis". An Australian-Canadian, C.J. Sullivan, believes that ore "deposits may be truly syngenetic (Rand, Blind River, White Pine, etc.); reconcentrated by circulating waters (Colorado Plateau); or concentrated thermally during metamorphism and granitization (most uranium and some lead-zinc provinces and some copper and gold provinces)...... granite is not a source of ore, but a sign of heat". Over one-half the papers are by European geologists.

Projects by the Geological Survey of Canada

Dr. Lang has contributed the following notes on projects underway and planned by the Geological Survey of Canada:

"Nickel. We hoped to begin a study leading to publication of an economic geology series report on nickel deposits of Canada but no geologist was available for this project.

"Lithium. One small party is continuing the study of lithium deposits in Canada. This should be finished in 1957 so that a report on lithium deposits of Canada can be issued. In the meantime a preliminary report on last year's work is in preparation.

"Rare Earths. We hope to have one small party studying pegmatitic and contact metasomatic rare earth deposits in the Grenville region, paying particular attention to the heavier rare earths such as gadolinium.

"Beryllium. We hoped to have one small party studying the possibility of finding helvite in some of the known occurrences of skarns in various parts of Canada. However, no geologist was available for this work.

"Heavy Minerals in Placers, Beach Sands, etc. We hope to begin a project working out methods of prospecting and evaluating deposits of these kinds and of recognizing places where private prospecting might be done to best advantage. We shall probably begin with the Atlantic Coast region. This will not be essentially a prospecting program, but rather an attempt to develop information of use to prospectors and companies on how to recognize places worth investigating and how to go about such investigations. It will also provide some resources data on heavy minerals in accessible and readily mineable deposits.

"Iron. A geologist familiar with iron deposits will begin a long term study of Canadian deposits with field work in 1957 mainly in Labrador and Newfoundland. We expect to issue preliminary reports and eventually a comprehensive report in the Economic Geology series.

"Uranium. We hope to finish field work on our Blind River project next summer. One party will continue the study of factors effecting the origin and distribution of the deposits. We also expect to assign one thesis project here on a special phase of this problem, which would be under the direction of the permanent officer who has been in charge of the project.

"There may be an opportunity for another thesis problem at Blind River, which might be done better under direct sponsorship of a university than as a Survey thesis. This would be largely a chemical investigation of the possibility that the pyrite in the Blind River ores was formed by conversion of magnetite to pyrite. These ores are deficient in magnetite, although it would be expected in sediments of the kind present, regardless of whether the ores are of placer or replacement origin. I believe that various geologists have looked into this question in Canada and in South Africa, but that a comprehensive study might be worth while.

"One small party will continue studies of uranium deposits in various parts of Canada to round out the field work necessary for the second edition of "Canadian Deposits of Uranium and Thorium."

"Columbium. The manuscript for "Columbium Deposits of Canada" was completed in the spring of 1956."

Dr. Lang has also undertaken a continuing comprehensive compilation of research that has been suggested in the field of mineral deposits and a periodical review of the progress that has been made. The first recapitulation is included as an appendix to this report (p.20).

GENESIS OF MINERAL DEPOSITS AND EXPLORATION

The last two reports of this subcommittee included sections on the genesis of mineral deposits and suggested some avenues of attack that were thought to merit special attention. This year, Dr. C.E. Michener contributed the following comments on this subject:

"For lack of greater knowledge regarding the nature of ore-forming processes the geologist today is using the empirical methods which have been in use since the profession became a useful part of the mining industry, some fifty odd years ago. In most mine work structural geology becomes structural geometry.

In the same period the mineralogists, through the use of x-ray, electron microscope and mass spectrograph, have greatly advanced their science. In the past ten years, the whole aspect of base metal exploration has been changed as a result of the advance in geophysical techniques.

"The economic geologist is faced with the dilemma of being outstripped by his confederates in allied fields. In order to keep control of his profession he is faced with two choices; either he must develop new methods in his own particular field, which will place him in a paramount position in the profession of mineral exploration, or he must become sufficiently well acquainted in the fields of mineralogy and geophysics, so that he can use these techniques to advance the general status of his profession.

"The first alternative is a difficult one as it revolves around the basic problem of the nature of the ore-forming process. I do not believe that this is capable of a single solution. My own experience in the field of nickel geology leads to the conclusion that there are at least four processes at work; (1) lateritization which includes atomic substitution of nickel for magnesium (2) magmatic segregation (3) hydrothermal and (4) sulphur leaching, a process whereby original olivine-bearing peridotites which contain nickel in the silicate form are subject to regional and thermal metamorphism, including sulphur in gaseous or liquid form, resulting in the removal of silicate nickel and its combination with sulphur to produce sulphide deposits associated with, and disseminated in, peridotite masses. This type of deposit contains practically no copper.

"The second alternative is a more realistic approach, for the simple reason that it can be attained. At INCO an attempt has been made, in building our exploration staff, to produce a completely integrated group, but the starting point should be at the universities. Let us consider then that one important field of research is an enquiry into what is required of the men who enter the geological profession.

"This discussion does not mean that basic research in geology has no future. We have recently had some very interesting results from a study of the ratios of sulphur isotopes in various deposits in the Sudbury district. Studies of the correlation of nickel ore types with rock types have led to interesting conclusions of a general nature, but not sufficiently diagnostic to be a practical tool in exploration. Geochemical studies have led to the conclusion that these methods must be used with caution, particularly in areas of deep overburden.

"It is hoped that the new building to house the Geological Survey in Ottawa will contain a completely equipped laboratory devoted to geological research".

Dr. G.H. Charlewood, in correspondence with the Chairman, indicates a similar concern for increased fundamental research in geology, lest the geophysicist replace the geologist in ore search. Franc Joubin emphasized this possibility at a C.I.M. address in Vancouver late in 1956, and many others have expressed similar views. It seems to the writer that sentiments of this kind can be misleading. The world will have need for all the tools it can produce, if it is to maintain its mineral reserves. Geophysicists and geochemists are an essential part of the geological profession. Their findings add greatly to the store of basic geologic information that is essential to progress in geology. The proper application of geochemistry and geophysics to mineral exploration calls for more work in, and a better understanding of, pure geology, whether it be areal geology, the factual details of occurrence of mineral deposits, or better fundamental knowledge of the physical and chemical properties of minerals and rocks. It also calls for geologic interpretation of the physical or chemical data and for geologic guidance of subsequent explorations, developments or extractions. Seismic exploration has played a notable part in developing the petroleum resources of Western Canada in the past ten years; as a result, over a thousand geologists are working in an area in which, twenty years ago, only a few were employed, and they have contributed, and are contributing, greatly to geologic research. Mr. Joubin is given credit for the development of the Blind River uranium ores. Geiger counters played an important part in the developments. But the original discovery of ore and all the subsequent developments that have led to production contracts or letters of intent totalling over one billion dollars worth of uranium concentrates [1], were

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[1] R.A. Simpson - Can. Min. Journ. Vol. 78, No. 2, p. 129, Feb. 1957

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guided chiefly by geology and were ultimately based on the recognition by Joubin and others of the basic geologic fact that uranium compounds may be soluble in the acid solutions that are yielded by oxidation of pyrite[2]. Surely Dr. Michener's alternative

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[2] F.R. Joubin - Trans. C.I.M. Vol. LVII. pp. 431-437. 1954

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of a completely integrated exploration staff, with no let-up on basic geologic research, is the only correct approach.

D.R. Derry supplied the Chairman with the following statement on Blind River ores:

"New data apropos the origin of the Blind River uranium deposits are being accummulated gradually both from underground development and from the compilation and study of diamond drilling data. My personal impression of the direction in which this accumulating evidence is directing us is:

(1) It seems more and more clear that there has been hydrothermal transportation and deposition of uranium and thorium, although this would not necessarily mean that these metals had a magmatic origin.

(2) On the other hand, the evidence is also pointing to the paramount importance of old drainage patterns within the Mississagi sediments as indicated by the thickening and thinning of certain beds or series of beds near the base of the formation.

In other words, the radioactive metals may have been brought in in a hydrothermal medium but the course it followed seems to be controlled by the sedimentary history in Mississagi times."

A recent paper on the origin of uranium deposits[1]

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[1] McKelvey, V.E., Everhart, D.L., and Garrels, R.N. "Crigin of Uranium Deposits" Economic Geology, 50th Ann. Vol. pp. 464-533. 1955.

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lends support to Derry's statement. According to these authors, isotopic studies indicate that the Colorado Plateau uranium deposits are epigenetic and suggest, but do not prove, that the uranium came from a deep-seated source. It may have been derived from sedimentary layers and have been transported to its present place by groundwater or petroleum with reduction, in large part related to decaying organic matter, playing an important part in fixation of uranium and associated metals. The authors conclude, while recognizing that other authorities may disagree:

"The sum total of the facts of the occurrence of the deposits in the Colorado P'ateau and Witwatersrand suggests to us that they were formed by deep-seated solutions, probably originating from igneous rocks that for the most part did not reach the surface. These solutions arose along fractures to permeable beds, which they then followed. Somc minerals notably copper, were deposited rather quickly after tne solutions reached these beds, perhaps as a result of decrease in pressure, but others were carried in solution to areas where the transmissibility of the channel decreased and where chemical factors caused their precipitation. We believe that this interpretation fits the facts of the occurrence of similar deposits in other important areas, such as the Black Hills area of South Dakota and Wyoming, and the newly discovered deposits in the Blind River area of southwestern Cntario."

Dr. Charlewood has contributed the following interesting comments on recent mineral developments in Manitoba that have been of great national significance:

"In the past year (1956-57) some interesting changes in the base metal picture of Manitoba have taken place, with notable additions to the reserves of nickel, copper, and zinc.

"It might be interesting to speculate on how this new ore was found and whether geological research, direct or indirect, contributed. In the direct sense, the new copper and zinc deposits were found by the application of "saturation geophysics" to areas chosen by examination of geological maps. Research in geophysics, of course, led to the development of the electro-magnetic equipment by means of which the anomalies, completely hidden by lake and swamp, were located. In the case of the zinc deposit the anomaly was so weak that it would have been ignored but for the company policy of drilling every anomaly. Cbviously this thorough approach is possible to relatively few organizations. Though there is no obvious clue to the presence of the ore in the outcrops of gneiss nearby, is it not possible that research may reveal something in the line of trace elements or type of alteration?

This is not an original thought, of course, but it seems worthwhile to reiterate when one considers the potentialities of such "needles in the haystack." represented by hidden orebodies in geologically favourable areas. It will recur each time a hidden deposit is discovered and the need for research will arise in each district.

"In the case of the Mystery-Moak Lakes nickel deposits, here again we see the reward of years of effort directed to an area considered to be structurally and petrologically favourable, but in which outcrop is rare. The area was petrologically favourable in that it was known to contain nickeliferous rock, though not of a grade or quantity to make ore at the time. Here we have elongated masses of basic igneous rock, some at least detectable by magnetic methods, in a belt of major faulting. Here is a situation similar to that at Lynn Lake where research on the ore-bearing intrusions and genesis of the ore itself may aid in prospecting other basic intrusions in the area.

"Trace element and alteration product investigation could be carried to the rocks bordering the Precambrian. The Pine Point lead-zinc deposits occur in Palaeozoic limestone on strike of the Great Slave fault lineament. Research on the environment of these deposits would help in the search for the same sort of thing under similar structural circumstances, for example, in the Palaeozoic rocks on the strike of the Burntwood River fault lineament in Manitoba which is a major structural feature, the effect of which is evident well out into the Plains."

The present state of knowledge regarding ore genesis has been reviewed during 1956 by A.B. Edwards[1]. He points to the relatively

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[1]Proceedings Australasian Inst. Mining and Met. No. 177, pp. 69-116. March 1956.

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satisfactory condition of our knowledge of genesis of such types of deposits as supergene enrichments and residual ores of iron, aluminium, etc., and to the slightly less acceptable theories on sedimentary iron formations or deposits of chromite and ilmenite in basic igneous rocks. For many other ores there are, he says, no generally acceptable theories of genesis. He considers that Schneiderhohn's recent[2]

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[2]Neujahrbuch fur Mineralogie 1952 pp. 48-49 1953.

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fourfold subdivision of these is useful for discussions of genesis. Schneiderhohn recognizes only those deposits formed during great orogenies as being of primary magmatic (hydrothermal) origin. In post-Cambrian time in Europe, these were formed chiefly during the Variscan revolution. The ores of Mesozoic and Tertiary rocks of Europe and Africa which are in strata effected only by epeirogenic warping and fracturing, are considered secondary hydrothermal deposits formed, possibly, by transport in chlorine-bearing volcanic waters from metals derived from older and deeper ores. Most of L.C. Graton's telethermal deposits belong in this group. Schneiderhohn recognizes another group of young ore deposits that are found in alpine-type mountain chains. These he considers "regenerated" and considers them either the result of dissolution and transportation to higher horizons of older Variscan ores or a mingling of this with some juvenile materials, including metals, from the younger orogeny. Possibly such puzzling

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"In the case of the Mystery [illegible]
again we see the reward of [illegible]
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Lake where research on the ore [illegible]
the ore itself may aid in prospecting other basic intrusions in the [illegible]

Trace element and alteration product investigation [illegible]
carried to the rocks bordering the [illegible]
zinc deposits occur in [illegible]
Slave fault lineament. Research on the [illegible]
would help in the search for the [illegible]
structural circumstances, for example [illegible]
the strike of the [illegible]
is a major structural feature, the [illegible]
into the Plains.

The present state of knowledge regarding ore genesis [illegible]
reviewed during [illegible]

(1)Proceedings Australasian [illegible]
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satisfactory conditions [illegible]
deposits as [illegible]
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For many other [illegible]
theories of genesis [illegible]

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Sulphide [illegible]
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deposits as the complex silver-tin ores of Bolivia belong in this category. Schneiderhohn suggests that only the first class, his primary deposits, create metallogenetic provinces, and that no uncontiminated, really primary magmas could develop in later superimposed orogenies. The Precambrian ores are considered to be "polymetamorphic" -- of very complex and obscure origin.

Edwards disagrees with some of these conceptions, particularly for some Precambrian ores in Australia, and presents a lengthy and helpful discussion of current hypotheses of ore transport and deposition. He devotes special attention to the volatility of metal compounds, including sulphides, and discusses the contributions of J.S. Brown, Hsiao and Schlechten (Journal of Metals 4 (1), 1950), J.E. Hawley, and others. In this connection, he gives an interesting example of the deposition of galena and chalcocite on a brick wall in a stope during a fire in a Broken Hill mine. The brick was partly replaced by the sulphides. He concedes some merit to J.S. Brown's metallurgical hypothesis ("Ore Genesis," 1950), but is skeptical of his anhydrous ore magma--"Brown's ore Magma won't hold water".

Edwards points to the necessity for a fifth group in Schneiderhohn's list--the stratigraphically controlled sulphide ores, such as the Kupferschiefer, the Rhodesian copper deposits, Mount Isa, Cloncurry, Nairne pyrite, etc. His final plea is for a concerted attack by geo-biology on the mechanism of sedimentary deposition of sulphides. St. Paul's first epistle to the Corinthians, Chapter 8, verse 2 is a fitting conclusion.

The present writer concludes, after reading Edwards' article, that the geologists' studies of ore genesis would be strengthened by a better knowledge of, or closer cooperation with, the work of bacteriologists and metallurgists. Dr. Michener's well-integrated exploration group may have to be enlarged to include these and other scientists.

FUNDAMENTAL RESEARCH

During 1956 the report of the Advisory Committee on Minerals Research was presented to the National Science Foundation, Washington 25, D.C., and is available on request from that Foundation. It contains the recommendations of subcommittees on (1) Fundamental Geochemical Research, (2) Fundamental Geological Research and (3) Fundamental Geophysical Research. The little volume, containing 76 pages, is worthy of attention by all Canadians interested in mineral exploration. The subcommittees recommended the establishment of a Foundation for Research in Mineral Deposits under the incentive of the National Science Foundation. The U.S. Advisory Committee on Minerals Research supported this recommendation and sought authorization to explore the matter with representatives of the mining industry. It was suggested that the Foundation "be staffed and administered as an entity independent of any existing organization, and that it be initially financed by grants from the National Science Foundation. It is hoped that the mining companies will contribute to the support of the proposed Foundation and that eventually it will be sustained entirely by the metal mining industry."

The subcommittee on Fundamental Geological Research in stressing the steadily decreasing ratio between mineral demand and mineral reserves says "unless we develop new principles by careful research in both field and laboratory, we cannot properly exploit the ore potential of even our known districts - much less can we discover ore that we believe may be mined in the future from districts now unproductive or from areas yet to be discovered."

Forty-one specific research topics are listed on pages 31 to 36 of their report; a large percentage (not all) of them are suitable for the Canadian scene and are commended as suitable topics for research in Canada. However, the basic philosophy of the recommendations seems to be expressed by the following quotation (page 29) -

"Studies of mining districts by individuals and small groups have provided a great deal of basic information, but results have fallen below expectations, largely because of the inherent limitations of such projects. Investigations having a wider range and carried on by a group of scientists with diverse training and experience should result in a more rapid advance in our knowledge of fundamental processes. We believe that the most fruitful approach is to begin with the tangible facts of ore deposits and to endeavour by using all promising means of investigation to find out the source of the metals and how the orebodies attained their present position and form."

This conclusion, reached by a United States Committee, is true also for Canada. Here too geological studies of mining districts and of orebodies in these districts have provided much basic information, but the results, on the whole, have been disappointing largely because such studies have been narrow in scope and deal with but one or two of the many facets that make up the overall problem. What is needed is investigations having a much wider range, concentrated on certain ore deposits and carried on by a group of scientists with diverse training and experience. Such comprehensive investigations would result in more rapid advance in our knowledge of fundamental geological processes; of the source of the metals; and of how the orebodies attained their present position and form. This in turn should lead to increased efficiency in mineral exploration.

Therefore this subcommittee recommends that the National Advisory Committee on Research in the Geological Sciences assume long term responsibility for assuring that complete geological (scientific) information be obtained on at least one Canadian metallic mineral deposit.

Providing the National Advisory Committee approves the above recommendation it is suggested that a special subcommittee be appointed to explore ways and means of having it carried out. A prime rider to such a project would be the eventual publication of the pertinent results.

APPENDIX

SUMMARY OF PROJECTS SUGGESTED TO SUB-COMMITTEE ON MINERAL DEPOSITS, 1950-56

by A. H. Lang

About sixty projects were suggested to the sub-committee on metallic mineral deposits from its inception in 1950 to the end of 1956. Some of these proposals were accompanied by requests for grants through the National Advisory Committee, but most were simply suggestions for projects that the sub-committee might endorese and try to have undertaken by some organization or individual. The annual reports of the sub-committee summarize progress on certain projects, mainly those for which grants were obtained, but it was impossible for them to cover the whole subject. Early in 1957 the writer suggested that some important suggestions may be overlooked and that it might be useful to review all the past proposals and the work done on them, if any. In this way attention could be directed to worthwhile projects, and less important ones; and those outside our sphere could be written off our lists. In other words, it seemed time to take stock of the situation.

A preliminary summary was made by reviewing the annual reports and the records of the secretary of the National Advisory Committee, and by making additional inquiries when this seemed desirable. The summary was sent to the members of the sub-committee for comments, and the replies are incorporated in the following general analysis of the general situation which is followed by notes on individual projects.

GENERAL ANALYSIS

The earliest suggestions were obtained from an appeal made by a committee of the C.I.M., headed by Dr. Hawley, which resulted in the formation of the National Advisory Committee and its sub-committees. The first action of our sub-committee was to prepare a circular letter explaining its aims and asking for suggestions. This was sent to more than 1,000 Canadian geologists and other persons, but relatively few replies were received. Additional suggestions have been received from time to time, or made by members of the sub-committee.

Fifty-six projects have been suggested. Of these, 14 are judged to be outside the field of this sub-committee because they deal entirely with metallurgy, geophysics, or ordinary geological mapping; these are not discussed further. The remaining 42 may be divided as follows: completed, 4; undertaken to some extent, 25; apparently not undertaken, 13.

Projects Completed.

Four undertakings were carried to satisfactory conclusions and the results were published or incorporated in unpublished theses.

Projects Undertaken to Some Extent.

The 25 suggestions judged to be in this category compris[e] 19 broad long-term projects and 6 smaller projects. The broad projects deal with basic research on various aspects of the origin of mineral deposits and clues for detecting the deposits by geological and geochemical means, the delimiting of metallogenetic provinces, and the compilation of resources data. Most of these proposals are interrelated and point to the need for much work in these fields. Study of the various suggestions and comments would aid in formulating a comprehensive plan for attacking these problems.

Projects Not Undertaken.

The 13 projects in this class comprise 9 broad long-term projects, mainly related to genesis of deposits and clues for prospecting, and 4 small projects.

Grants.

The four completed projects were done under grants to Canadian universities arranged through the National Advisory Committee and obtained from G.S.C. funds. Grants were also provided for two uncompleted projects on geochemical and biogeochemical techniques for prospecting. Substantial progress has been made on one of these and work on the other was retarded by lack of suitable personnel. The six grants total $24,221. This is almost exactly one-sixth of the total of $145,000 granted through the National Advisory Committee, indicating that research on metallic deposits has been receiving its share, particularly since several other assisted projects on geophysics, mineralogy, structure, etc. are related to work on metallic deposits. However these figures are fairly modest, and a strong case may be presented for supporting additional outstanding projects.

NOTES ON INDIVIDUAL PROJECTS

A. PROJECTS COMPLETED

Continuation of geothermal research.

There were several recommendations for more work on temperature of formation of mineral deposits. An independent check was advocated, and was undertaken by R.W. Boyle of Geological Survey of Canada in a study of Yellowknife ores. He concluded that neither the pyrite nor the quartz decrepitation methods gave satisfactory results. This conclusion has since been corroborated by several published and unpublished statements. As a side-issue of this project F.G. Smith was granted $256 for construction of a heating stage which was reported to be reasonably satisfactory.

Study of Relation of pyrrhotite 'dykes' to ore deposits.

A grant of $450 was made to H.D.B. Wilson and associates to pursue this subject. The results suggest that banded pyrrhotite-magnetite iron formation is produced from normal cherty iron formation by reaction with H_2S.

A thesis project at University of Manitoba suggests that major pyrrhotite deposits may form from action of sulphurous vapours on common rock minerals.

C.E. Michener comments that observations and laboratory experiments indicate a strong possibility that iron sulphides and some nickel sulphides result from a process whereby sulphur, either as liquid or gas, takes up metals from silicate minerals and forms sulphide minerals. Cccurrences of this kind are much more common in Archaean rocks, probably because deeply buried rocks would have more opportunity to come in contact with sulphur.

Construction of high-temperature pressure phase relations of sulphides and silicates re genegis of ores.

$10,500 granted to J.E. Gill and associates. Satisfactory results incorporated in three theses.

Testing leaching of copper and zinc ores with various proportions of ferric sulphate.

$960 granted to H.C. Gunning and associates. Results incorporated in thesis showed that presence of pyrite is important, that rate of leaching of copper increases up to a concentration of 0.001 N, and that there is an optimum concentration of ferric sulphate around 0.01.

B. PROJECTS UNDERTAKEN, AT LEAST TO SOME EXTENT

1. Broad Projects

Basic research on the genesis of ore deposits.

Several geologists suggested this independently, and several other proposals listed on these pages are simply parts of this general subject. A little has been done on it, here and there, but far more remains to be done. When summarizing these proposals A.H. Lang suggested that the sub-committee or a speial committee should review the entire subject, summarize what is being done in Canada and in other countries, and prepare a comprehensive outline of topics that could be undertaken by various organizations and individuals as parts of an entegrated research program. D.R. Derry agreed that such a review would be of value and suggested that it should be arranged under two main headings 'synthetic' laboratory research and deductions from field and laboratory observations. G.B. Langford commented that a long-term program should work toward solving the problem of transfer from source material to ore deposits.

Spectrographic studies to correlate ore and gangue minerals and minerals in associated intrusives and wall-rocks.

Work of this kind has been done as follows:

(1) Study of Ca, Na, K, Fe, and Mg about sulphide mineralization, at McGill University.

(2) Trace element behaviour during metamorphism of argillaceous rocks, at McMaster University.

(3) Geochemistry of platinum metals, and spectrographic research on granites and gneisses at Queen's University.

(4) The Consolidated Mining and Smelting Company is sponsoring the study of trace elements in the carbonate rocks associated with the Pine Point lead-zinc deposits, N. W. T. at Queen's University.

(5) The Geological Survey of Canada has been carrying on detailed geochemical studies of the Yellowknife gold deposits N. W. T. and the Mayo silver-lead-zinc deposits, Yukon Territory.

Detailed studies of orebodies to determine variations with depth.

A study has been made of variations in content of minor elements in pyrite.

D.R. Derry commented that a statistical summary of knowledge to date on this subject would be valuable and should be related to age determinations and geothermometry.

Determination of the direction of flow of mineralizing solutions.

A study of this kind was recently made on a deposit in Greenland by W.H. Gross of University of Toronto.

D.R. Derry commented that he would strongly support further studies of this kind.

A statistical study of past and present producing mines to evaluate favourable geological conditions and the manner of discovery of deposits.

D.R. Derry and G.B. Langford commented that this is too vague a project. Lang agrees that the summarized statement is vague, because of the difficulty of condensing a fairly long statement submitted when the proposal was originally suggested. He believes, however, that it would be useful to undertake detailed statistical studies of such factors as manner of discovery (to aid in evaluating roles of ordinary prospecting, general geology, structure, mineralogy, alteration, and various geophysical and geochemical methods), mineral associations, kinds and ages of host rocks, structural control, wall-rock alteration, ratios of length of deposit to depth of deposit, variations with depth, etc. The G.S.C. has done some work along these lines, particularly in connection with uranium, and hopes eventually to do more comprehensive work on all types of deposits, with the aid of data-processing equipment.

Geochemical and isotopic studies to determine the source of gold and other elements in veins, because of doubt that all metalliferous deposits are derived from magmas.

Work along these lines has been done in connection with deposits at Pine Point, Yellowknife, and Mayo.

Study of replacement ores, particularly lead-zinc ores in limestone.

Some work of this kind has been done in connection with lead-zinc deposits in British Columbia.

C.E. Michener commented that this subject is right at the heart of mining geology problems, and is of vital importance.

Study of Pine Point deposits and of areas containing more or less similar rocks where additional deposits might be found.

The Consolidated Mining and Smelting Company has made considerable investigations at Pine Point.

G.B. Langford commented that further work should not be attempted by others until the obovementioned studies have been published. D.R. Derry commented that work of this kind should be undertaken by companies, not by government-supported projects.

Delineation of Metallogenetic Provinces in Canada.

Several geologists suggested a large-scale, long-term project, possibly as a cooperative effort. Some progress has been made, but much remains to be done. This is related to the statistical study mentioned above.

C.E. Michener commented in 1950 that such a project should include recording of data, including assays and minerals; frequency studies, plotting of density maps showing ore types, rock types, and structures; and data re granitic rocks that may be related to deposits.

D.R. Derry commented that this kind of work is properly within the scope of the G.S.C. G.B. Langford commented that the Bird River area of Manitoba might be a good region for which to begin such a study, and that the G.S.C. may be the best agency to undertake it.

Compilation and maintenance of a mineral inventory for Canada.

Considerable progress is being made by G.S.C., Dept. of Mines and Technical Surveys, and certain provincial mining departments, but much more could be done if personnel were available.

G.B. Langford commented that this is a project for the G.S.C. or the Mines Branch. (The former division of the Mines Branch that deals with reserves and mineral economics is now attached to head office of the Dept. of Mines and Technical Surveys.)

Studies and compilations re low-grade deposits that may eventually be developed as ores.

Work is being done by G.S.C., at present mainly in connection with uranium, thorium, and heavy minerals in sands and gravels. G.B. Langford commented that this is not a problem for this sub-committee. D.R. Derry commented that it is part of the mineral inventory discussed above.

Further research on biogeochemical prospecting.

H.V. Warren and associates were granted a total of $10, 025 from 1951 to 1955 to continue this work. Several progress reports and publications were presented. These dealt mainly with sampling techniques and research on tests for copper, zinc, molybdenum, nickel, and cobalt. Tests for the first three metals were said to be satisfactory, and for nickel and copper, moderately so.

Evaluation of techniques for geochemical prospecting.

The amount of work being done by various persons and agencies in Canada and the number of requests for advice on what techniques to use suggests that a comprehensive evaluation of techniques should be made and kept up. This is being done to some extent by G.S.C.

G.B. Langford agreed that such an appraisal should be undertaken.

Correlation of geophysical surveys of various kinds with geological conditions to which deposits are related, so that misconceptions may be corrected.

The G.S.C. has been doing work of this kind intermittently since 1928. At present it has a Geological Interpretation Section in its Geophysics Division.

Investigation of glacial drift, particularly in the barrens, by geochemical methods to aid in outlining areas of outstanding interest for prospecting or in actually discovering deposits.

The use of geochemical methods in areas of permafrost has been studied by University of B.C. and G.S.C.

G.B. Langford commented that the entire field of boulder trains and their economic significance deserves much more study. D.R. Derry commented that work by his company was discouraging except when done in quite thin drift, but that he thought the subject worthy of more attention.

Research on iron deposits and allied deposits such as manganese.

The lists of current research since 1950 show about 60 projects on iron deposits. The G.S.C. has recently assigned a geologist to make a comprehensive study of iron deposits, including field work and summarizing of the literature and company data. G.B. Langford commented that the latter should be the responsibility of the G.S.C.

Research on origin of Blind River uranium ores.

Work has been done by companies, by thesis projects, and by a four-year G.S.C. project involving a considerable number of geologists, mineralogists, physicists, chemists, and laboratory technicians. However, this is a very large and complex matter and the work done and in hand is not exhaustive.

D.R. Derry suggested a symposium a year or so from now to correlate results and indicate further lines of attack.

Mathematical studies of frequency curves of assay values of gold and other deposits.

D.R. Derry commented that companies at Blind River with which he is connected have made such studies in a fairly broad way, and that he thinks further work is desirable.

Further studies of the economic geology of the Artic regions of Canada.

The G.S.C. is doing as much of this work as personnel permits. Messrs. Langford and Derry commented that this is work for the G.S.C.

2. Smaller Projects

That the G.S.C. undertake special studies to try to develop new or improved techniques for prospecting for chromite and asbestos.

The G.S.C. is completing in 1957 field work on a comprehensive study of chromite deposits of Canada which, it is hoped, will throw some light on prospecting for chromite.

Study of known placer occurrences of uranium and thorium in B.C.

Work on this has been done by Quebec Metallurgical Industries and G.S.C.

A complete study of the pegmatite maps at Quadville, Ontario with respect to rare-element minerals.

Some work has been done on this by Ontario Dept. of Mines, G.S.C. and as a thesis project.

Further study of copper deposits in sandstone in New Brunswick, and of veins along the Bay of Fundy.

Some of these deposits were studied thoroughly by Kennco Explorations. Some were studied by G.S.C. in connection with uranium which accompanies copper in certain deposits.

Structure of iron-bearing rocks at Conception Bay, Newfoundland

This has been partly undertaken by G.S.C.

Study of sulphide mineral belt of Notre Dame Bay, Newfoundland.

G.S.C. has done much geological mapping here but has not undertaken a specific study of deposits.

G.B. Langford commented that this is not a matter that need be considered by the sub-committee.

C. PROJECTS APPARENTLY NOT UNDERTAKEN

1. Broad Projects

A critical analysis of the whole problem of geological research and the furtherance of geological knowledge.

In proposing this M.S. Hedley wrote:

"You ask for suggestions: I would like to see, before priority lists of specific problems are set up, an attempt to make a critical analysis of the whole subject of geological research and the furtherance of geological knowledge. Field geology is a young man's game and too many of us attain wisdom too slowly to make the most of our mental and physical capacity. A good, critical paper by a master mind who has served his time in the field should be of great benefit to all of us and should be of particular value at the training level. In looking into the possible reasons for the dearth of positive knowledge of replacement deposits and the very slow growth of ideas concerning them, I found imperfections in observation, technique, and attitude on the part of workers that have hindered rather than aided progress. The same can be said of other fields in geology, and it is my belief that the situation could be bettered if the average geologist could be made to see some of the weak points in his work and writing. Such a paper would be of little benefit unless it were written by one of the top senior brains in the profession."

G.B. Langford commented: "Hear! Hear!"

Studies of the chemical and physical character of ore bearing solutions.

Some related work has been done on certain minerals but it is hard to say whether this constitutes work on this problem as outlined above.

A country-wide effort to solve the problems relating to the replacement process.

This is a branch of the broader project suggested re genesis of ore deposits.

Study of the mechanics of the formation of veins.

This is a branch of the broader project suggested re genesis of ore deposits.

Establishment of field stations for continued detailed study by geologists, mineralogists, geochemists, and geophysicists.

G.B. Langford, who proposed this, commented later that it is related to his current proposal re establishment of a Precambrian Research Institute.

A.H. Lang commented that it is so difficult to obtain staffs for central laboratories that it would be impracticable at present to organize completely-equipped stations; also that it is no great problem for field men to return to headquarters for their office and laboratory work and to send samples to headquarters for other laboratory services.

Major research on the distribution of metals in sedimentary strata and their migration under mild metamorphic environment.

G.B. Langford commented that this deserves attention.

A comprehensive study of wallrock alteration related to Canadian deposits, to correlate and augment individual studies already done.

A.H. Lang suggested that this would be a useful project for the Mineral Deposits Division of G.S.C.; D.R. Derry and G.B. Langford agreed.

Preparation of comprehensive reports on Copper Deposits of Canada and Nickel Deposits of Canada, by Geological Survey of Canada.

A geologist was assigned in 1956 to study nickel deposits of Canada, but circumstances made it necessary to transfer him to the study of iron deposits before he could do more than assemble a bibliography on nickel.

2. Smaller Projects

Development of a device for rapid mechanical construction of isometric drawings of mine workings.

A request for $500 to continue research on geochemical prospecting in association with the Ontario Department of Mines.

No grant was made because the man concerned became unavailable.

Studies of small scattered sulphide occurrences in Newfoundland, in the hope that some might lead to orebodies.

Geochemical studies of basic intrusives in Lynn Lake area.

THE REPORT OF THE SUBCOMMITTEE

ON PHYSICAL METHODS APPLIED TO GEOLOGICAL PROBLEMS

Presented by H.D.B. Wilson

Members of Subcommittee

H.D.B. Wilson (Chairman)	University of Manitoba, Winnipeg, Man.
H. Carmichael	Atomic Energy of Canada, Ltd., Chalk River, Ontario.
G.D. Garland	University of Alberta, Edmonton, Alta.
J.H. Hodgson	Dominion Observatory, Ottawa, Ont.
M.J.S. Innes	Dominion Observatory, Ottawa, Ont.
A.A. Koffman	Hudson Bay Mining and Smelting Co., Ltd. Flin Flon, Manitoba.
A.D. Misener	University of Western Ontario, London, Ontario.
G.P. Mitchell	Falconbridge Nickel Mines Ltd., Toronto, Ontario.
L.W. Morley	Geological Survey of Canada, Ottawa, Ontario.
R.J. Uffen	University of Western Ontario, London, Ontario.
J.T. Wilson	University of Toronto, Toronto, Ont.

INTRODUCTION

The members of the subcommittee wish to acknowledge the fine service rendered by Dr. J.T. Wilson, who was chairman of the subcommittee from the time the National Advisory Committee was organized until the end of 1956. He continues as a member of the subcommittee to offer guidance and advice.

Five new members have been added to the subcommittee, A.A. Koffman of Hudson Bay Mining and Smelting Co., Ltd., G.P. Mitchell of Falconbridge Nickel Mines Ltd., L.W. Morley of the Geological Survey of Canada, R.J. Uffen of the University of Western Ontario and H.D.B. Wilson of the University of Manitoba.

Most subcommittee members believe that many research projects are obvious, but two main difficulties prevent their being carried out, the first, the lack of trained geophysicists and the small number of universities training geophysicists, and second, many of the projects are on such a large scale that they require several men or large sums of money. This committee can aid these projects in only a limited way. Various federal and provincial government departments and occasionally a university department are the most suitable agencies to carry them out, but the private companies can supply data and can co-operate with government geologists and geophysicists workong on research projects. Notable examples of such co-operation occurred in 1956-57and it is hoped that this will continue and be expanded to include other companies.

A tremendous field of investigation is opening up through the use of computing machines to attack problems previously considered impracticable.

TRAINING OF PERSONNEL

Facilities for training of geophysicists are gradually enlarging, but there is still a great shortage of trained personnel for teaching, research and industry. For example, Dr. J.T. Wilson, reported in a recent March 1957 paper that five deans and department heads from various universities had approached the University of Toronto to try to obtain staff for their departments, and even though the University is the largest training center for geophysicists in Canada, it could not supply any of the men needed because all its graduates were engaged.

Several Canadian universities teach geophysics and it is possible to study geophysics at the doctorate level in six Canadian universities. These geophysics departments need support from industry. Dr. Morley reports that, in general, oil companies have been forward but mining companies backward in this matter. Specifically the universities need under-graduate and graduate scholarships, grants for equipment for teaching because geophysical instruments are expensive, grants for research equipment, and help in publicity to attract students.

The use of graduates in geophysics as instrument operators is wasteful. Courses in geophysical methods and instrument maintenance could be made available to technical or high school graduates for this purpose.

A conference on Geophysics Research and Training with representatives from government, industry and universities was held in Toronto from September 13 to 15, 1956. The most striking aspect of the meeting was the great demand voiced for more geophysicists, especially those trained in the three basic subjects, mathematics, physics and geology.

GRAVITY

The usefulness of gravity information when applied to structural problems of a regional nature and as an aid to geological mapping in general, is rapidly becoming recognized. Dr. Innes reports that the ever-increasing demands by geologists from industry and federal and provincial surveys for regional gravity maps and data is evidence of the greater appreciation of the importance of gravity methods.

The principal gravity work in Canada is done by the Dominion Observatory. It makes the measurements and is the central agency in Canada for the collection and coordination of gravity data from all sources.

Lines of precise pendulum stations are being established over the latitude range of north America to provide a uniform standard for the calibration of gravimeters used for geodetic purposes. The central Canada calibration line between Winnipeg, Churchill, and Resolute, the longest line of all, is to be recalibrated during the International Geophysical year. The north-south line through Ottawa has been extended south to Washington, D.C. and north to Senneterre, Quebec. In the fall of 1956 the Dominion Observatory initiated a program to resolve remaining uncertainties of the Ottawa-Washington connection.

In the last few years special emphasis has been placed upon improving the ties within the primary national gravity network and in extending the network to include the base stations of previous regional surveys. Considerable progress has been made in this work but because of shortage of staff it must be done at the expense of increasing the gravity coverage of Canada.

The regional gravity mapping of Canada is approximately half completed, with station intervals of 10 to 50 km. The uncompleted parts are mainly in British Columbia and the northern half of the country. A few selected areas are covered in much greater detail and scattered stations are located in the northern areas as far north as Alert, in latitude 83° about 450 miles from the North Pole. More than 15,000 regional observations in Canada are available for geodetic and regional studies. As a result it has been possible to proceed with the compilation of a Bouguer anomaly map for Canada.

Dr. Innes reports that several regional reports of interest to geologists have just been completed, with the results in preparation or in press. The following summaries are from his report:

(1) Bouguer and isostatic anomaly maps of southern British Columbia are presented and the compensation of the mountain systems is discussed. Airy form of compensation appears reasonable, although certain features such as granitic batholiths show considerable isostatic anomalies. A considerable thickness of lighter fill is indicated in some sections of the Rocky Mountain Trench, but no major crustal dislocations are suggested beneath it.

(2) In Saskatchewan certain circular topographic features have associated negative gravity fields believed to reflect disturbed bed rock conditions and fracturing to great depths as a result of explosion. Topographic, geological, and geophysical evidence are consistent with the hypothesis that some of the circular features are formed by explosion of a meteorite.

(3) The results of all gravity measurements in Quebec to the end of 1956 for an area south of latitude 52° north and west of longitude 64° west are compiled and analyzed. No outstanding gravitational effects were observed along the northern boundary of the Grenville geological province to justify the presence of the presumed Huron-Mistassini fault.

(4) Gravity surveys over an extended area to the northeast of the region considered in the above report, disclosed a belt of intensely negative Bouguer and isostatic anomalies. The belt is nearly 140 miles wide and has been traced for about 300 miles. Its axis trends northeast along the height of land and parallels the northern border of the Grenville geological province. The gravity minima are believed to be controlled largely by masses of granite emplaced during a period of late Precambrian mountain building.

The University of Alberta group have extended their gravity network through the foothills into the mountains, and have traced Precambrian basement lithology as far west as Banff. The results indicate a continuation of the basement rock types at least this far, but also suggest some displacement of the basement by the

McConnell fault. This appears to be the first definite information on the extent in depth of the frontal thrusts of the Rockies.

Recently isostatic studies were resumed by the Dominion Observatory and isostatic anomalies are now available for nearly 1200 gravity stations.

Instrumental development at the Dominion Observatory includes the construction of a new type of pendulum apparatus, work on a vibration gravimeter for measuring gravity on unstable ground or in a submarine at sea, and a calibration device for North American gravimeters.

Suggested Research. Most gravity research consists of large projects. In general no useful purpose is served in recommending new research until the means for carrying it out can be made available. The demands for gravity data are already beyond the capacity of present staffs. Only expansion of research facilities and technical personnel, particularly of the Dominion Observatory, can bring about a more vigorous gravity program for Canada. The National Advisory Committee aids some of the university research by financial contributions to certain programs.

SEISMOLOGY

Recent work by the Division of Seismology of the Dominion Observatory concerning the direction of faulting has shown that the movement on the faults in the North Pacific, southwest Pacific, and South America is predominantly transcurrent (strike-slip) on steeply dipping planes. The depths of focus of the earthquakes range from less than normal to 600 km. The most notable exception to this predominantly transcurrent faulting is in the Alaska-British Columbia-Washington sector where the faulting may be normal, thrust, or transcurrent with no pattern yet apparent in the direction of strike or dip of the planes. If subsequent work should continue to give evidence of the importance of transcurrent faulting, existing theories of the earth's failure will have to be modified.

Solutions of the direction of faulting in the Ionian islands agree with field evidence of the actual movements. The faulting occurred on two planes constituting a conjugate system of faulting.

The Dominion Observatory recently published a list of earthquakes felt or centered in the western mountain region of Canada from December 1841 to August 1951, during which a total of 242 earthquakes were located in this general area. Descriptions of the major tremors are given.

Current research in several other problems is listed in the "Compilation of Current Research" (p. 111).

Dr. Uffen suggests the research problem of using shallow reflection seismic surveys to deliniate known or suspected aquifers to study the ground water resources of Southwestern Ontario. A further problem is the development of a means of obtaining reflections without the use of single explosions, using such things as "thumpers".

GEOMAGNETISM

Problems being studied include magnetic storms, paleomagnetism, relations of bedrock to aeromagnetic anomalies, and development of instruments to measure magnetic susceptibility of rocks.

Nuclear magnetic resonance is being studied at some centers. A new type of airborne magnetometer based on nuclear magnetic resonance has been developed and went into service in 1955. Research is suggested on the possibility of using the phenomenon of nuclear magnetic resonance in the analysis of rocks and minerals.

HEAT FLOW AND THERMAL HISTORY

Heat flow measurements at Resolute Bay indicate a temperature gradient at depth of 2.16°F per hundred feet. Measurements were made to 650' depth. Mean thermal conductivity of drill cores and the temperature gradient indicated a heat flow that is about twice the value hitherto accepted as normal for the earth's crust at sea level.

In Alberta the oil and geophysical companies are co-operating with the University of Alberta in the measurement of earth temperatures in dry holes. This work is in part supported by the National Advisory Committee (p.82). It is hoped to determine whether there is any variation in the outflow of heat from near the edge of the Shield to the foothills, or any other correlation with major structure. A laboratory to measure the thermal conductivity of rock samples is being set up because thermal conductivity is the other quantity required in calculating heat flow.

Work of the thermal history of the earth is continuing at the University of Toronto. Based on the assumption that objects comprising the solar system have a common origin, an examination has been carried out of possible initial conditions and consequent thermal history for such bodies as the asteroids and the moon. These provide important evidence on the initial state of the earth and its subsequent thermal history.

A paper recently published by Prof. V. Saull[1] of McGill

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(1) Chemical Energy and Metamorphism, Geochimica and Cosomochimica Acta, Vol. 8, 1955, pp. 86-106.

University revealed that fundamental studies of many aspects of metamorphism and granitization of rocks are impossible because some of the basic thermal properties of minerals are unknown. Without this knowledge broad generalizations have had to be made about some of the key aspects of mountain building. Apparatus is being constructed at the University of Toronto for the measurement of the specific heat of large single crystals in the range from 1°K to room temperatures.

RADIOACTIVE

New developments in induced radioactivity are opening up new fields in oil well logging. A neutron generator tube or "atom smasher" induces gamma radiation in elements such as hydrogen and oxygen and these gamma rays are recorded by scintillation counters. The method is giving new information on the various formations instead of merely identifying them. For example, an "Oxygen log" may be used to indicate the amount of porosity in a formation and whether the pores are filled with water or oil. The method uses the fact that rocks contain approximately 50% oxygen and variations from this amount are caused by the presence of water or oil in pores. Water contains about 90% oxygen so the oxygen content of porous formations is higher than usual, but if the pores contain oil the oxygen content will be below normal. The variation in oxygen content from normal is a measure of the amount of porosity. The information can be obtained through the casing and the influence of the drilling fluid in the well is greatly reduced because the radiation from the high energy neutron flux penetrates the rock relatively deeply.

GLACIOLOGY

In 1956 the Salmon and Leduc glaciers near the coast of British Columbia were studied mainly by seismic and gravity surveys. The depth of the ice was generally found to be from 2,000 to 2,400 feet, or about one half the width of the glaciers. Absolute movement of the glacier surface was of the order of 8 inches a day. Samples of ice were collected down to 80 feet depth for isotopic analysis.

The work will be continued this summer (1957) with expeditions to Ellesmere Island and the Salmon glacier. Properties to be studied include rates of flow, depth to bedrock, ice temperatures, and the geomorphology of the surrounding districts. Samples of ice will be collected from various layers, with the aim of determining some information on age or past climatic history from isotope studies.

A map of the glacial geology of Canada, scale 1 inch equals 60 miles, is being compiled at the University of Toronto with the Geological Survey of Canada and the Defence Research Board supporting the work. The map will show the movements of the ice sheet which formerly covered Canada. It is to be published in 1957 or early in 1958 by the Geological Association of Canada.

EARTH STRUCTURE

In a more general sense, the geophysical data on the earth's crust which is accumulating, requires a considerable revision of some of our ideas on tectonics and orogeny. For example, the work on direction of faulting in the great earthqhake belts shows a great preponderance of transcurrent (strike-slip) rather than thrust motion, whereas the latter had been predicted for shallow earthquakes. The work by Columbia University over oceanic deeps shows no evidence of a Hess-type tectogene, but an actual thinning of the crust, such as might be caused by tension rather than compression. This is certainly no time to be dogmatic or even complacent with theories of mountain building or continental formation. There is even evidence from paleomagnetism (admittedly very meager as yet), that may eventually force physicists to accept continental drift.

Professor J. T. Wilson is continuing his studies in the earth structure field. A textbook on the structure of the interior and crust of the earth is being prepared by Professors Wilson, Jacobs, and Russell of the University of Toronto.

MINING GEOPHYSICS

The most recent (first half of 1955) review of geophysical activity by Sigmund Hammer shows that geophysical exploration in the mining industry rose to new highs in the first half of 1955. Canada continues to lead the world with the highest capital investments in mining geophysics and also surpassed the United States in the number of professional geophysicists employed. In order of decreasing expenditures the nine methods ranked: magnetic, electromagnetic, resistivity and allied methods, miscellaneous methods, radioactive, gravity, geochemical, self-potential, and seismic. Use of the electromagnetic method is increasing most rapidly. In Canada government expenditures account for 3.0%, private companies for 55.5% and contracted operations for 41.5% of the total expenditure on mining geophysics. For the rest of the world, comparable figures are 13.2% government, 62.5% private company, and 24.3% contracted operations.

The advance in the effectiveness of mining geophysics in the past six years is remarkable. In the first report of the National Advisory Committee (1950-51)[1] it was stated that

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[1] National Advisory Committee on Research in the Geological Sciences, 1st Annual Report, 1950-51, p. 9

"the ore deposits that form our present reserves were comparatively well exposed" and the ore deposits to be found in the future "will require above all the application of new geological and geophysical techniques". The first quotation is no longer true after only six years, and the second quotation has been borne out already.

In this short period many orebodies have been discovered largely by geophysical methods although geology guided the location of the geophysical surveys in many places. In New Brunswick, four orebodies with published reserves aggregating 60,000,000 tons have been located. In Ontario, the Marmora iron deposit was not exposed. In Manitoba, The International Nickel Company of Canada, Ltd. located the Moak lake, and Thompson orebodies, neither of which have any surface exposure. The reserves in these two orebodies is very large. In Manitoba, and Saskatchewan, Hudson Bay Mining and Smelting Company has located ten orebodies beyond the Flin Flon mine. Seven of these have no surface exposure and three of the seven were located beneath lakes and muskeg entirely by geophysical methods. These orebodies are expected to supplement the Flin Flon mine. The role of the combination of sound geological theory and radioactive geophysical methods in the recent discovery of uranium deposits is well known. It is now well established that geophysics, is one of our important tools in mine exploration especially when directed by experts.

RECENT MINE FINDING IN MANITCBA AND SASKATCHEWAN

Because mine finding has been so successful recently in Manitoba and adjacent areas in Saskatchewan, it is an appropriate time to summarize what has been done so that the role of geophysics in exploration may be understood better.

Inco has located three orebodies in the Mystery-Moak lake section of Manitoba. The exploration was started in the area because the presence of large ultra-basic intrusions with some associated nickel mineralization was believed to be a favourable geological environment. The first areas flown with the airborne magnetometer were laid out in the office on the basis of government geological survey maps before any of the company geologists had been on the ground. For the second field season, the flying was extended northeastward and covered the area containing three orebodies--Mystery Lake, Moak Lake, and Thompson. Mystery lake, the lowest grade orebody, was found by extension of a mineralized outcrop showing. The Moak lake orebody is everywhere drift covered. It was located by drilling an aeromagnetic anomaly. The Thompson orebody, the highest grade of the three, was first indicated by a relatively weak aeromagnetic anomaly, then found to be a conductor by a ground electromagnetic survey. It is significant that the anomaly was not drilled until about six years after its discovery and confirmation by the electromagnetic survey, showing that although it was located by geophysical methods, even this very large orebody was well down on the list of anomalies to be investigated by drilling.

The ten outlying orebodies of Hudson Bay Mining and Smelting Company Ltd. may give a somewhat better sampling of how orebodies are discovered. The present system of exploration is to stake claims on the basis of good geological maps, then cover the area completely by electromagnetic surveys and drill anomalies. The following statistical information was made available:

(1) Three of the ten orebodies had mineralization connected with them outcropping at surface; four are completely covered by water; three are completely covered by muskeg, muskeg and drift, or muskeg and water.

(2) Three out of ten were actually located by geophysical methods. The others were located while drilling surface showings or structure in the vicinity of known mineralization.

(3) Of the seven orebodies not located by geophysical methods, several anomalous readings were obtained in the vicinity of surface mineralization connected with one of the mines by an electromagnetic survey previous to drilling, but were not the reason for drilling. Subsequent electromagnetic surveys located conductors over four of the remaining six mines. These four mines were located either before the electro-magnetic equipment was obtained or when a standard method

of survey was being developed. Mr. Koffman states that had the equipment been received earlier, these mines would doubtless also have been classified as actual discoveries by geophysical methods.

(4) Three of the seven completely covered mines had other surface showings in the immediate area. The three mines located by electromagnetic methods lie in ground which was taken up because of formations and structure considered favourable to economic mineralization. No mineralization has been noted in their immediate vicinity that would have otherwise attracted exploration to the areas.

(5) A magnetometer survey has been conducted over one of the orebodies only and a magnetic anomaly was not obtained.

Because the data on the ten individual mines may be of interest to some readers and is not available elsewhere, it is included below: The names of the mines have been deleted.

Saskatchewan

Mine A. Completely covered by muskeg. Located by electromagnetic equipment. No part of orebody outcrops and no known mineralization occurs on surface within a mile which would have attracted a prospector to the area.

Mine B. Orebody located as a result of drilling surface showing of connected mineralization. Subsequent electromagnetic survey did not pick up an anomaly over the orebody.

Mine C. Located while drilling structure on strike of Mine B. Surface of orebody completely covered by water. Subsequent electromagnetic survey located a conductor over the orebody.

Flin Flon Area of Manitoba

Mine A. Completely covered by water. Located while drilling structure on strike of known mineralization. Subsequent electromagnetic survey located a conductor over the orebody.

Mine B. Completely covered by water. Located while drilling non-related showing on adjacent island. Subsequent electromagnetic survey over the orebody located a conductor.

Mine C. Located as a result of drilling surface showing of connected mineralization. This mine consists of two main ore lenses. The east lens is considered to connect with the surface showing through weak mineralization. Subsequent electromagnetic survey did not pick up a conductor on the showing. The west ore lens would outcrop below a drift covered area. An electromagnetic survey subsequently picked up an anomaly in this area. Both of the ore lenses lie below 100-foot depth.

Herb Lake - Snow Lake Area, Manitoba.

Mine A. Mine completely covered by water. Located by electromagnetic equipment. No surface showings within a mile which would have attracted a prospector to the area.

Mine B. Mine completely covered by muskeg and water. Located by electromagnetic equipment. No surface showings within a mile that would have attracted a prospector to the area.

Mine C. Located as a result of drilling surface showing of connected mineralization. Several indefinite anomalous readings were obtained in the vicinity of the showing by electromagnetic survey previous to drilling but were not the reason for drilling.

Mine D. Mine completely covered by muskeg and glacial drift. Located while drilling structure in vicinity of Mine A. Orebody occurs below the 175-foot level. No anomaly picked up over orebody by electromagnetic survey.

Two facts stand out from this data. First although electromagnetic surveys may find mines and were 80% effective in detecting these 10 mines, even ground electromagnetic surveys do not eliminate favorable territory because, in two of the ten mines, anomalies were not located. Second, the orebody surveyed with magnetometer did not show an anomaly so it is unsafe to eliminate conductors by magnetic methods when searching for copper-zinc orebodies. On the other hand magnetic information is exceedingly valuable in the search for many types of orebodies as shown by Inco's success.

CURRENT RESEARCH. The C.I.M. volume on Geophysical Case Histories has been prepared and published.[1]

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[1] Case Histories in Geophysics; Can. Inst. Min. Met. for Sixth Commonwealth Min. Met. Congress; 1957.

Scale model research on the electromagnetic response of various conductors is going on at the University of Western Ontario and the University of Toronto. At Western, some progress has been made with the checking of theoretical predictions with the model, and present research concerns the problem of disseminated conductors versus massive conductors. A.R. Byers recently reported on field tests with several types of electromagnetic equipment over known sulphide bodies. The instruments were rated on the basis of sensitivity or capability of detecting these sulphide conductors. In order of decreasing sensitivity the instruments were electromagnetic-galvanic, Sharpe and Doolan vertical coil induction, and Boliden horizontal coil induction.

The physical properties of various rock types are being tested in several laboratories to aid in the interpretation of geophysical maps. This is important, because, as Dr. Morley remarks, it is one thing to gather and compile geophysical data and take shrewd guesses as to its meaning, and it is another to make a thorough interpretation. The need for research in this phase of mining geophysics is glaringly obvious.

SUGGESTED RESEARCH Much of the current research in geophysics is being done by mining and contracting companies. There is a great need, however, for somewhat costly field testing where the results may be published. Such research could best be carried out by the various government agencies. Dr. Byer's work for the Saskatchewan Government is a good example and is a start along this line. Dr. Morley has recommended that the Geological Survey of Canada concentrate its research on electrical methods, that is resistivity, radio, and electromagnetic, because these methods hold such promise and they are not being actively investigated by the Dominion Observatory which concentrates on gravity, seismic, and magnetic instrumentation and field observation.

Dr. Byer's work could be followed up by field testing the same instruments over conducting bodies which are neither sulphide nor graphite, because many workers suspect that the rating of the instruments would be reversed from the rating over the sulphide bodies. For example, Mr. Koffman states that, with the Boliden equipment, they cannot distinguish between sulphide and graphite conductors but can distinguish with reasonable certainty between these conductors and conductors due to wet shears, swamps, shore, and other topographical effects. This is done by study of the in phase and out of phase readings. On the other hand it is well known that the electro-magnetic-galvanic and the vertical loop methods locate many conductors due to wet shears and various other effects, and that many of these cannot be distinguished from sulphide conductors except by expensive drilling.

Mr. Koffman recommends that field tests be made over known conductors of various types using different frequencies to determine more certainly the depth penetration and anomaly definition at the various frequencies.

More specific information is needed on depth penetration in known field examples. Some workers suspect that little, if any, response is obtained from orebodies at depths greater than two hundred feet.

Research to improve instruments should be directed towards improvement in portability of equipment without loss of power or reliability and increased ruggedness of equipment for rough bush work. Several new highly portable magnetic and electromagnetic instruments have been brought out recently and data are needed regarding field tests of these new instruments by uninterested parties.

Research might also be directed towards improvement of methods of field location. Present line cutting and picketing methods are as expensive as many geophysical surveys. Radio location has been suggested.

GEOPHYSICS IN THE GEOLOGICAL SURVEY OF CANADA

Present geophysical services consist mainly of flying and publishing the results of aeromagnetic work. A total of approximately 400, 000 miles had been done to the end of 1956. The main policy is to work ahead of geological mapping. The research and instrumentation section does the electronic maintenance work for all divisions of the Geological Survey.

The Geophysics Division maintains a small research laboratory with one geophysicist and one technician who are working on improving various types of geophysical instruments. A geophysicist was added to the staff recently to work on paleomagnetism as an aid in solving geological problems.

Some of the many obvious ways in which the Geophysical Division could be expanded for research if funds and staff were available are noted below:

(1) A light aircraft equipped with an airborne magnetometer would be a great help for small area surveys, particularly for valley and plateau surveys in mountainous areas. A light-weight magnetometer could be taken to any area and installed in a locally hired aircraft in order to save ferry costs to remote areas.

(2) A geophysicist could visit active prospecting areas and new mines discovered by application of geophysics to discuss methods with local geologists and geophysicists. This would be analogous to economic geologists working on special projects such as a particular metal or groups of metals. The aim would be the preparation of case histories, to keep abreast of developments, and to be able to advise intelligently on mining geophysical problems.

(3) Raw aeromagnetic maps can be reduced mathematically to a form which has better correlation with surface geology. With electronic computing devices the work could probably be handled on a production basis. This work is desirable in mining areas but is essential for adequate interpretation in oil areas. The work would require a geophysicist, a technical officer assistant, and possibly three technicians.

(4) With determinations of rock conductivities and radio attenuation data a conductivity map for Canada could be compiled which would be of considerable help in airborne electromagnetic prospecting. The work would require the services of a physicist.

(5) A seismic party could be recruited and equipped with apparatus capable of being back-packed. This party could be used at key points to help solve special stratigraphic problems in connection with mapping.

(6) In most geological surveys of other countries the ground water geophysical services are important organizations. They use specialized electrical methods for measurement of the height of the water table and special seismic techniques and instruments for the location of buried river channels. A start in this could be made by one geophysicist using summer field assistants.

No doubt all government departments could make good use of extra staff and it is obviously impossible to do everything, but it is well to have in mind the possibilities and need for expansion that face us.

(12) INTERNATIONAL GEOPHYSICAL YEAR

Although much of the emphasis of the I.G.Y. is in fields of atmospheric and oceanographic physics, there will be results of importance in the study of the solid earth. For instance, the study of the earth is receiving unprecedented attention in popular journals, and this should be of value in recruiting high school students into the earth sciences.

The desire of the commercial geophysicists to participate in the I.G.Y. through the Canadian Society of Exploration Geophysicists in Calgary is noted. Professor Garland is co-operating with the Society in organizing research projects of fundamental interest. As an example, special attempts will be made to record very deep seismic reflections at points in Western Canada, for the study of basement structure, or even the thickness of the crust. The commercial seismologists will also co-operate with Dr. Willmore of the Dominion Observatory in recording the Ripple Rock explosion in 1958. This work should give definite information on crustal structure beneath the Cordillera.

Many of the companies will also release gravity information so that within about a year a first class regional gravity map of the western basin will probably be available. The oil companies are also co-operating in the heat flow measurements mentioned earlier in the report. It appears that the beneficial effect of the I.G.Y. in stimulating interest and cooperation may be almost as great as the actual results of the individual projects.

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

The Eleventh General Assembly met in Toronto from September 3-14, 1957. The meetings of the seven associations dealt with (1) Geodesy, (2) Seismology, (3) Meteorology, (4) Geomagnetism, (5) Oceanography, (6) Hydrology, and (7) Volcanology. Several sessions were of interest to geologists, including those of the Association of Vulcanology, and meetings of the Association of Seismology devoted to the crust of the earth.

THE REPORT OF THE SUBCOMMITTEE ON SCHOLARSHIP AND RESEARCH TRAINING

Presented by J.B. Mawdsley

Members of Subcommittee

J.B. Mawdsley	University of Saskatchewan, Saskatoon, Saskatchewan.
H.S. Armstrong	McMaster University, Hamilton, Ontario.
P.E. Auger	Laval University, Quebec, P.Q.
V.J. Okulitch	University of British Columbia, Vancouver, B.C.
G.S. Mackenzie	University of New Brunswick, Fredericton, New Brunswick.
J.L. Usher	Queens University, Kingston, Ontario.

NEED FOR RAPID EXPANSION IN SPACE, FACILITIES AND STAFF OF GEOLOGY DEPARTMENTS

In February, 1957, a questionnaire dealing with space, facilities and staff was sent to the 19 departments of geology of Canadian universities. The sought-for data were received from 11 of these. They comprise the institutions that graduate about four-fifths of the students specializing in geology or geological engineering, include some of the largest and some of the smallest departments, and are more or less evenly spaced across Canada. University of Toronto, the largest in Canada, had a total student enrollment of close to 12,000 and Acadia University, the smallest one returning data for this report had 735 students. Thus the results probably indicate a fair consensus of the thinking of the members of all the geology departments across Canada on the matters under consideration. Useful information for this report was also obtained from the data collected by Dr. J. L. Usher for the meeting in Calgary in September, 1956, of representatives from geology departments of Canadian universities and the oil companies.

Scholarship and research training need adequate facilities and staff for their proper implementation and it is only the questions of the needed space, facilities and staff that are dealt with in this report. The various subjects under discussion are difficult of quantitative analysis, but certain definite trends are quite evident and are of use to compare with one's own individual views, and undoubtedly will be of interest to university authorities, governments, and to the mineral industry, which is so vitally interested in the output of geologists and geological engineers by our universities.

Enrollment

The estimates of the increases in the sizes of the different universities in the next ten years vary a lot. However, it is evident that we can expect an increase that will probably average an overall of 80 per cent of present total enrollments. One small university in a section of the country where the population is rapidly increasing expects to expand by 150 per cent. On the other hand one long-established institute evidently intends to limit its growth to not more than 30 per cent. Two of the smaller universities in small towns have as a first priority new residences as otherwise a greater number of students cannot be housed.

Two-thirds of the geology departments reporting feel that the ratio of specialists in geology to those in other fields will remain about the same, the other third think there will be a modest increase in this ratio. On the other hand as far as graduate work in geology is concerned half of those reporting think there will be a relative increase. The reasons for this are that facilities for graduate work will improve with the inevitable growth of the departments, there will be less of a tendency to obtain graduate training outside Canada, and the search for mineral resources will become increasingly more difficult and important and thus place a premium on graduate study.

Space Requirements

Only one of the reporting departments considered that its present quarters are reasonably adequate, but all are thinking of expansion. In the rare case, such as the University of Alberta, the new space is now under construction. In three others more space is promised. The rest are voicing their needs. The Department of Geology at Alberta expects to occupy four times the present space in its new building. Most think than an increase of at least 100 to 200 per cent above their present quarters is necessary by 1965, amounting to 8,000 to 22,000 square feet, and a few are thinking of even more. A total of about 130,000 square feet is required for the departments reporting, or an estimated 160,000 square feet for all the universities in the country. This new space at the conservative figure of $20.00 a square foot will cost the respective universities between $160,000 and $440,000, or all of them in the country at least $3,000.000. It should be noted that this is to meet the needs for space for only one of the many departments at each of our rapidly expanding universities.

It was pointed out by a number that the needs of a geology department are special in some respects and are not always appreciated in administrative quarters. Practically all geology classes require laboratory space. Storage of specimens is essential if research programs are to be fostered. A modest museum is also a requisite in presenting to the beginning student some idea of the welter of phenomena that constitutes the nature and history of the earth's crust--a rather large and varied mass of material--and the life that has existed upon it throughout geologic time.

Equipment Requirements

All departments indicate that there will be need for extra instruments and other equipment both for the undergraduate and graduate work. On the average the estimates of costs are equal for the two purposes, but some are markedly higher for one than the other. For the five smaller universities reporting, whose present total enrolment is between 700 and 1,300 students, the total figures for extra equipment range from $16,000 to $37,000 with an average of $25,000. For the other six, whose present total enrolment is between 2,400 and 12,000 students, the equivalent figures range from $18,000 to $75,000 with an average of $50,000. The total for all the geology departments in the country would probably be close to $500,000. There is no close relationship between the present size of the institution and its estimated need for these purposes. Obviously some are a bit better prepared than others for what is coming.

Instructional Load

Including temporary lecturers supported by societies or companies, the six largest universities had, for the 1956-57 session, from 4 to 12 instructors each. The number of students in these universities taking an introductory class in geology varied from 220 to 420. The great majority of these students are not considering specialization in geology. However, these classes are important not only from which to recruit specialists, but they contribute to the public's knowledge of geology and its importance to Canada's economic life. The number of full undergraduate student-classes other than the introductory classes range from 110 to 380. Considering that each undergraduate specializing takes on the average just short of three full classes in geology a year this would correspond to roughly 40 to 130 undergraduates at the above universities in various stages of completing their training. These latter figures may be a bit high as the figures for full student-classes are believed to include some half classes.

The corresponding figures for 1956-57 for the four smaller universities under consideration are as follows: instructors, from 2 to 6; students taking an introductory class in geology, 80 to 190; post-introductory undergraduate student-classes, 55 to 150; and the estimated number of individuals these last figures indicated are approximately 20 to 50.

It is difficult to arrive at significant figures by which teaching load can be compared. As far as work with the undergraduates is concerned the number of all student-classes divided by the number of staff members per department gives quite a range. For one this figure is 33, for another 45, and for the other eight it ranges from 70 to 120 student-classes per permanent staff member, the average for this group being close to 90. If the figures for the inferred undergraduate specialists (other than the ones taking the introductory classes) are divided by the number of permanent instructors employed in each institution the range is from 6 to 18 with an average of about 11 students per instructor. And, as far as graduate students in session during 1956-57 are concerned, they were the equivalent of one and a half to a little better than two per permanent staff member in the various departments under review.

No exact estimate can be given of what constitutes an efficient load. However, any department that averages 80 or more student-classes, or more than 10 undergraduate specialists, per instructor, will vouch that they are definitely feeling the pinch.

The members of an overloaded department obviously have little time to carry out their own researches during the university session. This will reflect both on the stimulus received by the graduates and the quality of the instruction given to the undergraduates, who after all, are a very important group, for without well-trained undergraduates we would not have graduate students.

Future Instructional Requirements

It is encouraging to report that five of the eleven departments are to have their staffs increased next session by one permanent instructor a piece. However, as the enrollment is also expected to increase the relief is not going to be excessive.

All consider that definite additions to staff have to be made to cope with the numbers that will enter the geology departments in the near future. Two departments do not expect their universities to grow more than 30 per cent in the next ten years, but the rest consider the growth of the student numbers will be substantial and will average, on the whole, 80 per cent of the present enrollment. However, their specifications for increased staff are excessively modest. Only three state they consider their staffs in 10 years time should be doubled, while the others modestly suggest a 25 to 50 per cent increase. It appears that most have for so long been nurtured on adversity that they cannot now visualize adequacy. However, this outlook will doubtless change as the need becomes increasingly pressing.

The question of adequate salaries was brought up by a number. It was pointed out that competition with industry was becoming increasingly serious and that salaries had to be somewhat comparable to attract the best to the universities.

The additional yearly cost of this extra staff that will be needed will be a further addition to the budgets of the universities. This will range from $15,000 to well over $50,000 a year per institution and will aggregate at least $400,000 for the country as a whole.

Scholarships and Part Time Demonstratorships

The views taken this year differ somewhat from those taken last year regarding the need for post-graduate scholarships. Last year it was felt that the supply in most provinces was adequate. The extra numbers suggested range from 3 to 10 per university, or a total of 63 for the 11 reporting. As these constitute the departments turning out about 80 per cent of the geology specialists this would make a total of 75 for the whole country. The suggested size of the scholarships range from $800 to $2,000 with the great majority mentioning $1,000. Some suggest that a sum equivalent to between $300 and $500 should be part of such scholarships and be given to the university to meet part of the cost of extra equipment and instruction. This year, when the future is under consideration, it is realized more will be wanted, and also, as graduate students are the chief source of part-time laboratory demonstrators, many more will be needed. It is a general practice that holders of scholarships get valuable training in aiding their department for a total of not more than six hours demonstrating and correcting exercises a week.

The number of extra part-time demonstratorships suggested is somewhat smaller than for post-graduate scholarships, ranging from 3 to 6 per university and making a total of 51, or 63 for the whole country. Commonly they are involved half-time in teaching and the rest on their graduate work. If the quality of the men seeking these positions is to be kept up, their salaries should be more attractive than the average scholarship. Now the number of these desirable individuals are few and they will always be hard to obtain. Their instructional duties are greater than those assigned to scholarship holders. The salaries suggested range from $600 to $3, 000 with the majority mentioning $1, 000 to $1, 500.

The figures given indicated that it is hoped that the number of present post-graduate scholarships available to geologists, may be increased by about 75 and thus require a yearly sum of over $75, 000. Over 60 new part-time demonstrators are hoped for and this would involve an annual charge of approximately $90, 000.

The post-doctorate fellowships are not only very important to foster research but they can afford a limited but stimulating amount of instructional help. More ofthem would certainly be useful; their stipend is generally about $3, 000 or more.

Undergraduate Fellowships

Considerable interest was expressed in the need for more undergraduate fellowships or bursaries. Actually Canadian universities have few such scholarships. Compared with Britain and other countries, little is being done in Canada for the bright lads attending highschools or entering universities. Admittedly the need is not as great here owing to the many opportunities to earn money during the summers or in a year out of school or college. However, were more entrance scholarships available, many problems would be solved for good students and their families. Good students who have had a year at a university seldom drop out.

Entrance scholarships must be given without regard to any particular field of study, as at that stage, and possibly for as much as two years in university, most students have no very clear idea of what they will ultimately specialize in. The scholarships should not be too large so that the parents and students will have to pay part of the cost of the education received and thereby value it more. They should probably be about $500 and should be provided in the main by governments.

Undergraduate scholarships are distinctly valuable, but few are available. They can be usefully given to able third and fourth year undergraduate students. Owing to the excellent opportunities to date for summer employment they should not be too large as otherwise they may be partly used as the down payment on a car or a diamond ring! The amounts suggested are from $300 to $750; possibly $300 to $500 are adequate. The extra undergraduate scholarships wanted range from 3 to 10 for each university reporting, or a total of 78; or 100 for the country.

As the estimated number of undergraduate specialists in geology was about 650 for 1956, and ten years from now will be at least 80 per cent greater, or about 1, 100, then 100 extra undergraduate fellowships is not excessive especially as few are now available. The yearly cost, if they average $400 a piece, will amount to $40, 000.

Technical and Secretarial Help

All geological departments have some secretarial assistance but a few of the smaller departments have no help from a technician. All the universities consider an increase in the numbers of this very important group will be required in the next ten years. The larger universities now have a total of two to four a piece.

Geophysics and Petroleum Engineering

Geophysics and Petroleum Engineering have not been considered in the previous sections. In view of their importance they should bulk larger in the set up of Canadian universities than they do at present, and they are bound to grow in importance considerably during the next ten years.

Full undergraduate courses in geophysics are being given at McGill, Toronto and Western, with definite indications that other universities will shortly give a full or partial course in this field.

Petroleum Engineering is now given at the Universities of Alberta and Saskatchewan.

Summary and Conclusions

Practically all departments of geology in Canada expect a pronounced increase in undergraduate enrollment in the next ten years, averaging possibly 80 per cent over the present numbers. The relative increase in the graduate students will probably be somewhat greater.

All except one of the reporting departments complained of present shortage of space and all felt that substantial increases will be needed by 1965. For each department the increases generally envisioned are 100 to 200 per cent above their present sizes, and range in probable cost between $160, 000 and $440, 000 or more. For all the geology departments of the country the total cost would not be less than $3, 000, 000.

The estimated cost for extra equipment needed by 1965 ranged from $16, 000 to $75, 000 and would aggregate $500, 000 for all the geology departments in Canada.

There is little doubt that most, if not all, geology departments in the country are at present under-staffed. With a few exceptions the stated requirements for additions to staff appear to be too modest. Although the expected increase in students is 80 per cent, the increase in staff desired by most departments amounts to 25 to 50 per cent. On this basis the total cost for all departments in the country will amount to about $400, 000.

To attract first class teaching personnel salaries must be somewhat comparable to those in industry.

Increase in the number of graduate fellowships and part-time demonstratorships is considered essential, in no small part to aid in the teaching on the undergraduate level, but also to finance the increased number of graduate students. The number of new graduate scholarships required is estimated at 75 and new part-time demonstratorships at 63, the average value of the scholarships to be $1, 000 and for part-time demonstratorships closer to $1, 500. The total cost of these would amount to about $165, 000.

Many feel that university entrance scholarships should be a serious consideration of government, and should not be for any specific field of study.

Few undergraduate scholarships for students in geology are available. It is suggested that approximately 100 new ones should be available for the estimated 1, 100 undergraduate geology specialists in 1965. If they averaged $400 each, they would amount to a total of $40, 000.

To be in adequate shape for the expected increase in undergraduates and graduates by 1965 the above estimates suggest that the minimum capital expenditure across the Dominion for needed extra space is $3, 000, 000, and for extra equipment $500, 000. The yearly expenditures needed for extra staff would be upwards of $400, 000 and for demonstratorships and graduate and undergraduate fellowships more than $200, 000.

The above sums on top of what will be the overburdened budgets of the universities raise a serious problem. Where is all this money to come from? If it is not found it will dangerously curtail the much-needed increase in key personnel required by the mineral industry.

REPORT OF THE SUBCOMMITTEE ON MINERALOGY, GEOCHEMISTRY AND PETROLOGY

Presented by J.E. Hawley

Members of the Subcommittee

J.E. Hawley (Chairman)	Queen's University, Kingston, Ont.
L.G. Berry	Queen's University, Kingston, Ont.
R. Beland	Universite Laval, Quebec, Quebec
R.B. Ferguson	University of Manitoba, Winnipeg, Ma[n.]
G.S. MacKenzie	University of New Brunswick, Fredericton, New Brunswick.
J.A. Maxwell	Geological Survey of Canada, Ottawa, Ontario.
W.W. Moorhouse	University of Toronto, Toronto, Ontar[io]
S.C. Robinson	Geological Survey of Canada, Ottawa, Ontario.
D.M. Shaw	McMaster University, Hamilton, Ont.
F.G. Smith	University of Toronto, Toronto, Ontar[io]
H.V. Warren	University of British Columbia, Vancouver, British Columbia.

GENERAL

The review of current research in mineralogy, geochemistry and petrology, (p.86a) shows about the same number (150) of individual projects as last year, and about an equal division of them in the three fields.

Productive research is being carried forward in most Canadian universities and in several governmental laboratories. New contributions are noted especially from the Research Council of Alberta. There appears to be need however, for still greater expansion of research equipment and laboratories in university and governmental institutions and for an increase in the numbers of Canadian scientists trained in the fundamental aspects of mineralogy, geochemistry and petrology. The keen competition for geologists in the mining and petroleum industries, the disappearance of individual departments of mineralogy from our universities, and the lack of concerted effort to attract students into these special fields of the geological sciences, if continued, will have serious results. It should be realized more widely that, if advances are to be made in the application of our science to the further discovery and development of mineral resources, much more intensive research is vital in these basic subjects. An outstanding example is the need for a re-examination of the classical concept of the relation of ore deposits to magmatic processes. Rece[nt] advances in petrogenic concepts have been numerous; some applications of them have been suggested for certain ore deposits, but all too little attention has been devoted to this aspect of economic geology and comprehensive and authoritative works on the igneous rocks of Canada are few indeed. We are pleased to note, however, that a start in this direction has been made in the Geological Survey of Canada and other laboratories on detailed studies of ultrabasic rocks and Canadian granites. The field is large, and notable progress will be made only if these efforts are rapidly expanded and include in the not-too-distant future, a more careful differentiation of the vast areas of the Precambrian Shield now denoted as granite and granitic gneiss.

The recent founding of the Geochemical Society of America, in which 78 Canadian geologists are enrolled, the Canadian Association for Applied Spectroscopy, and the Mineralogical Association of Canada should contribute much to the inspiration and progress of research in these fields.

PROGRESS ON GENERAL PROJECTS

In the last annual report four projects of a general character embracing the fields of mineralogy, geochemistry and petrology were recommended and endorsed in principle by the National Advisory Committee. Brief statements of progress on these follow:

1. Summary of Modern Physical and Chemical Analytical Methods

Dr. W.W. Moorhouse, University of Toronto, has prepared a circular to be sent to various laboratories throughout the country to ascertain methods of analysis of rocks and minerals, and other pertinent data. A printed card system has been devised, and subject to general approval, will be used to record the data, including such facts as analysis elements, interfering elements, size of sample required, procedure, range of percentages, accuracy, mineral type or alloy.

A grant to aid printing of such cards will probably be required.

2. Sub-Committee on the Geochemistry of Canadian Rocks

At the last annual meeting the suggestion was made that the first requirement for the formation of a continuing committee for the compilation of data on the geochemistry of Canadian rocks and soils and water, was a study of the organization required to suitably handle such a project, an outline of the work involved, and possibly estimates of initial costs.

As a continuing project, it was pointed out, the work should be centralized, and we are pleased that the Geological Survey of Canada finds it possible to arrange for Dr. John A. Maxwell and Dr. K.R. Dawson to begin one phase of the work this year. Dr. Maxwell has kindly agreed to act as chairman at the request of this sub-committee. Both he and Dr. Dawson have outlined a tentative organization which will eventually have at least four divisions: rocks and minerals, soils, waters, and compilation mechanics. An executive of at least six, including a permanent secretary, seems advisable, four to act as sub-committee chairmen of the four divisions for each of which committee members will be drawn from organizations in and outside the Survey. It is suggested that the secretary be chairman of the sub-committee on the mechanics of compilation, and that this be formed as early as possible.

Compilation of geochemical data on rocks and minerals available at the Survey will begin at once with the aid of one or two summer assistants, and will be extended later to include other sources. Organization of other divisions will follow. A system of filing, cataloguing and cross-indexing will be determined, and eventually time will be devoted to an evaluation of results.

The objects of this programme will be:

(a) The collection and cataloguing of published data on Canadian rock and mineral analysis as part of the general compilation of Canadian geochemical data;

(b) The publication, as bulletins or special reports, of collected analyses by the Survey laboratories. The first of these might appear within two years, and succeeding ones at 2 to 5 year intervals;

(c) The statistical evaluation of the accumulated data for its geochemical implications.

Of importance to this project is the report that suites of hand specimens representing all areas of Canada are to be retained in systematic collections under the direction of Dr. Dawson. These will be used for geological correlation and will provide material for geochemical and geophysical analysis. Similar collections of meteorites are also being made.

3. Nomenclature of Metamorphic rocks, facies and phenomena

Dr. D.M. Shaw, McMaster University, with a sub-committee consisting of D.F. Hewitt, Ontario Department of Mines, H.W. Little, Geological Survey of Canada, W.W. Moorhouse, University of Toronto, and D.H. Williamson, Mount Allison University, has been active on this project and has submitted a tentative paper on preferred nomenclature for metamorphic rocks, facies and phenomena to a large number of Canadian geologists for their criticism. A paper on this subject was presented at a meeting of the Geological and Mineralogical Associations of Canada in April, 1957. Whether final agreement on all terms is reached or not, the discussion will do much to clarify the usage of such terms in this important field of Canadian geology, and our sincere thanks are due Dr. Shaw and his sub-committee.

4. Correlation of Age Determinations with Mineralogical and Petrological Data

Dr. S.C. Robinson, who was asked to examine this problem, has indicated progress which is understandably slow, and limited to individual occurrences.

Dr. M.V.N. Murthy, an N.R.C. post-doctorate Fellow from the Geological Survey of India, has made studies of zircons in both the Parry Sound and Preissac granites. In the former, two types of zircons are readily distinguishable, one occurring as rounded grains, likely older than the granite, the other, as clear crystals, likely syngenetic. It is suggested in such cases that ages be based even on K/A ratios in micas and feldspars would be suspect. S.C. Robinson's original work on age determinations on rocks of the Goldfields area related these to the mineralogy. Dr. Traill is endeavoring to do similar work on specimens from Blind River area, where it is fairly obvious uraninite of more than one age is present.

Currently also K/A ages for pegmatites on which uraninite dates are available are being checked.

Study at the Geological Survey of isotope ratios of sulphur extracted from petroleum, H_2S gas in petroleum, sulphates and sulphides in various strata that might be a source of petroleum or through which it may have migrated, is also well advanced.

Similar studies on sulphur from sulphides and sulphates in various country rocks in the Yellowknife district is under way. Results of investigations of the isotopic content of leads from samples of galena ore of southeastern British Columbia, suggest ores of the same period of mineralization may be correlated by this method.

NOTES AND SUGGESTIONS

Mineralogical Research

The lack of trained mineralogists to fill vacancies in different institutions is seriously handicapping mineralogical research. The growing need for university teachers in this field is already apparent and it is time that a concerted effort be made by university staff to attract students into this branch. This matter might well be referred to the newly formed Mineralogical Association of Canada.

Dr. S.C. Robinson suggests that more attention should be devoted to mineral deposits in sedimentary rocks, and to non-metallic and industrial minerals. The Mines Branch has done much useful work in this field and has a most capable staff.

He also recommends that combined team efforts be used to investigate the genesis of various mineral deposits, in which petrologists, mineralogists, geochemists and physciists would direct their talents on all the phases involved. In this way, the detailed mineralogy, spatial distribution of minerals, the partition of elements among various minerals, subtraction or addition of elements during mineralization, may be combined with detailed petrological studies to evaluate relative ages of rocks, composition, metamorphism and metasomatism and relation to igneous intrusives and/or metamorphism, with the aid of isotopic analyses. Cooperative studies on important deposits might well be carried out by groups from various universities and possibly also from the Geological Survey. (See also p. 1)

Research in Geochemistry

Research in this field is rapidly expanding and again the need for additional trained personnel in Canada is evident.

Dr. H.V. Warren reports that the Rockefeller Foundation supported a three-day symposium held by leading trace-element experts this year under the direction of Dr. Henry Koch of the Sloan Kettering Institute. A publication, of results of discussions, to be edited by Dr. Koch, is planned. He notes also that comprehensive trace element studies of rocks in British Columbia are under way, as well as of the copper and zinc contents of numerous soils and sediments.

Studies of this type are also progressing in Ontario (Toronto, Queen's, Ottawa) and will ultimately add important information to data on geochemistry.

The literature on geochemistry is rapidly growing. Attention has been called to many recent Russian publications in this field, which pose the problem of translation. An important service would be performed if some central translation agency could be found to complete this task and to distribute translations to Canadian research laboratories. Dr. Warren is having the Slavonic Department of the University of British Columbia undertake work of this kind. A grant in aid of such work is to be recommended.

A second project which will be of great assistance to geochemical studies and which this Committee should endorse, is the effort of the Canadian Association of Applied Spectroscopy to arrange for the preparation and distribution of non-metallic standards for spectrographic analysis under the direction of Mr. H. Champ and Professor H.H. Dennen. Standards of minerals or rocks in the silicate, oxide, carbonate and sulphide classes analyzed for all metals down to 1 ppm. by as diverse methods as possible, will be of inestimable value in future geochemical studies. It is hoped that such standards will be prepared by the Geological Survey and the Mines Branch in cooperation with other laboratories.

Research in Petrology

In addition to broad petrological studies of igneous rocks already referred to, some fifty projects in this field are listed in the compilation of current research (p.133).

Dr. F.F. Osborne, Universite Laval, reports seven studies being undertaken with his students. These include a continuation of studies of the chemical characteristics of Quebec Precambrian rocks of the Grenville and Abitibi types; of granites, anorthosites, anorthositic-gabbro and syenitized zones in which the feldspars of reaction rocks are peculiarly complex (Lake St. John region); of rocks on the northwest side of the Grenville "Front" along the new Chibougamau road, and also west of the Senneterre highway, about mid-way between an area of abundant limestone and an area of typical Abitibi types. Studies of metamorphic facies in the sediments of the Appalachians of Quebec in the St. Sylvestre area and the Woburn area, next to New Hampshire within the belt of Devonian granite, are also being made.

Summary and Recommendations

1. Distinct progress is reported on four projects initiated by this sub-committee.

(a) Summary of modern physical and chemical analytical methods.

(b) Assembling of data on the geochemistry of Canadian rocks and minerals.

(c) Nomenclature of metamorphic rocks, facies and pheonemena, and

(d) Correlation of age determinations with mineralogical and petrological data.

2. The pressing need for the training of additional personnel in mineralogy and geochemistry is stressed.

3. Support is recommended for the establishment in Canada of a translation and distribution centre for foreign (especially Russian) literature on geochemistry.

4. A recommendation is made that the Department of Mines and Technical Surveys (Geological Survey and Mines Branch) facilitate, in so far as possible, the preparation and distribution of non-metallic spectrographic standards.

5. It is recommended that Dr. John S. Stevenson, McGill University, be added to this sub-committee.

REPORT OF THE SUBCOMMITTEE ON STRATIGRAPHY, PALAEONTOLOGY AND FOSSIL FUELS

Presented by John F. Caley

Members of the Subcommittee

J.F. Caley (Chairman)	Geological Survey of Canada, Ottawa, Ontario.
F.W. Beales	University of Toronto, Toronto, Ontario.
W.A. Bell	Nova Scotia Department of Mines, Stellarton, Nova Scotia.
R.V. Best	McMaster University, Hamilton, Ontario.
R.W. Landes	Imperial Oil Limited, Calgary, Alberta.
E.I. Leith	University of Manitoba, Winnipeg, Man.
D.J. MacNeil	St. Francis Xavier University, Antigonish, Nova Scotia.
H.W. McGerrigle	Department of Mines, Quebec, Quebec.
V.J. Okulitch	University of British Columbia Vancouver, B.C.
L.S. Russell	National Museum, Ottawa, Ontario.
C.R. Stelck	University of Alberta, Edmonton, Alta.

INTRODUCTION

Because of the retirement of Dr. P.S. Warren from the National Advisory Committee it became necessary to appoint another chairman of the subcommittee on Non-metallic Mineral Deposits, Industrial Minerals, Coal and Oil. Consequently at a meeting of the Executive Committee held at Ottawa on December 27, 1956 it was decided that, for the present at least, oil, gas and coal, commonly referred to as the fossil fuels should be included with the fields covered by the present subcommittee on Stratigraphy and Palaeontology. Attention is therefore directed to the new title Subcommittee on Stratigraphy, Palaeontology and Fossil Fuels.

Reference to the "Survey of Current Research" (p. 86a) will inform the reader that more than 100 separate projects dealing directly with or related to stratigraphy, palaeontology, sedimentation, and the fossil fuels are under study and that, as in previous years, the geographic and geologic distribution of these projects extends throughout the length and breadth of Canada and includes almost the entire post-Precambrian sedimentary column. This research is being carried on largely by the federal and provincial geological surveys, the universities and the National Museum of Canada, but private industry, through the medium of publication by professional associations, is playing an ever-increasing role in encouraging research and disseminating knowledge of fundamental importance and mutual concern to all those engaged in the exploration for and the exploitation and conservation of the natural resources of Canada.

Foremost among the applications of the results of geologic research in stratigraphy, palaeontology and fossil fuels is that in connection with the search for petroleum and natural gas. At present, perhaps 98 per cent of Canada's production of these minerals comes from the Western Canada sedimentary basin, a total area of some 700,000 square miles in Manitoba, Saskatchewan, Alberta, northeastern British Columbia and the Northwest Territories, all of which is considered as potentially productive territory. Within this region, oil or gas or both have been found in about 30 reservoirs contained in about 7 geological systems, and at depths ranging from 1,000 feet to more than 10,000 feet below the surface. Commercial fields are scattered from Fort Norman in the Northwest Territories to the international boundary a distance of some 1,400 miles and from Fort St. John on the west to southwestern Manitoba, a distance of about 1,000 miles. However, the average density of drilling throughout this vast region is about 1 exploratory well to 150 square miles compared to 1 well per 12 square miles in the prospective area of the United States. In Eastern Canada, oil and gas in commercial amount occur in southwestern Ontario and New Brunswick. In these areas, production is from 4 geologic systems at depths from 500 to 3,500 feet.

At the end of 1956 recoverable reserves of crude oil in Canada were estimated at about 3 billion barrels, not including the Athabasca oil sands. Canada's crude oil requirements in 1956 were about 250,000,000 barrels; it is therefore sobering to reflect how short a time our domestic oil reserves would last were the search for additional reserves to cease and if Canada became solely dependent upon its own supplies and this with no consideration of the inevitable increase in demand as the years pass.

It is essential that the search for oil and gas in Canada continue unabated in order to establish reserves sufficient to support the ever-increasing demand for these fuels. Oil and gas are becoming more difficult to find as the more readily recognized and accessible structures are exploited.

Geological research provides one of the most important aids in the exploration for the fossil fuels and as these substances have their origin in, and are intimately associated with the sedimentary rocks, any addition to our knowledge of the origin, constitution, age, correlation and structure of these strata will help in the search for additional reserves.

Considerable research in stratigraphy, subsurface stratigraphy, palaeontology, sedimentation etc. is being carried on by private oil companies, particularly in western Canada. Much of this is kept confidential by the industry, but an examination of recent publications of the American Association of Petroleum geologists, the Alberta Scoiety of Petroleum Geologists, the Geological Association of Canada and others shows the high calibre, diversity and fundamental nature of many of the papers.

In view of the addition of oil and gas to the fields covered by the subcommittee this year, we were fortunate, through the good offices of the Alberta Scoiety of Petroleum Geologists, to add Dr. R.W. Landes of Imperial Oil Limited to the subcommittee. With a membership of more than 800 geologists directly concerned with finding oil and gas, this Society represents a very large and important body of geological opinion. Dr. Landes is absent from Canada for an extended period and so was unable to contribute this year.

It is difficult to single out specific examples from the long list of research projects being pursued. All are important and worth while and each is designed to contribute to the sum of geological knowledge. Private industry and government agencies are both doing research in subsurface geology, employing the vast volume of data resulting from drilling. Palaeontological research in macro and micro fossils is adding to our knowledge of the succession, age, correlation and conditions of deposition of the formations that function as source and reservoir beds for oil and gas. Projects in vertebrate palaeontology within and outside Canada are furnishing information on the distribution and methods of dispersal of early Permian vertebrate faunas of North America and are thus forming a basis for stratigraphic correlation of terrestrial red beds. The study of plant spores in coal seams has already aided in the correlation of seams in faulted and folded strata, and analysis of pollen is proving of great value in working out the chronology of the Pleistocene.

SUGGESTIONS

Dr. J.C. Sproule stresses the need for combined studies of oil forming and accumulation facies with regional and local tectonic features, such as the strong tectonic trends that pass from the Precambrian Shield across adjoining sedimentary basin areas. One of the best known examples is the Great Slave Lake tectonic trend, of which the Pine Point fault is a small element. There are also old (pre-Laramide) regional trends that pass from the present Rocky Mountain area out across the adjoining sedimentary basin, one of the best examples being the Peace River basement arch and its related Rocky Mountain feature. Both of these tectonic types are known to have controlled oil-forming environments as well as the development of reservoirs. A number of others are known and doubtless many more have yet to be recognized.

Despite the glacial drift that covers the greater part of the sedimentary basin areas, many of these tectonic trends and related features and patterns are recognizable from air photographs on the Precambrian, in the Mountains, and in the basin areas adjoining them. Such photogeologic studies to find out more about the effect of tectonic trends on oil formation and accumulation would likely prove fruitful in western and northwestern Canada and in the more restricted sedimentary basins of eastern Canada.

Dr. F.W. Beales submitted several subjects for a research, some of which follow.

1. Attention is drawn to a recent publication of the Michigan Geological Survey entitled "An Index of Michigan Geology", with the recommendation that something similar be prepared in this country on a provincial basis. This Index contains references to all published reports and maps as well as cross reference to outcrops and publications dealing with them. This general problem was referred to in 1956 by Dr. Beales in his recommendation for preparation of a Lexicon of Stratigraphic Names for Ontario. In this connection, it is noted that the chapter dealing with the St. Lawrence Lowlands for the current revision of the Geological Survey of Canada's report on the Geology and Economic Minerals of Canada contains a list of the formation names used for the Palaeozoic rocks of the region.

2. Private companies should be encouraged by every means possible to release more information for publication. Dr. Beales feels there must be many company projects on file that no longer have economic interest. Some of these could perhaps be published on a purely factual or descriptive basis. "The Geological Survey might well consider institution of a Miscellaneous Papers series similar to the existing preliminary papers series and appoint an editor whose duties would be to supervise the publication of the series".

This important subject was raised also by Professor E.I. Leith and doubtless by others in past years. It was our hope that, with oil industry representation on the subcommittee, something might be done in this regard. Due to absence of this member from the country, however, no information has yet been obtained.

3. "Encouragement of research involving correlation of surface and subsurface data".

Research directed toward this end is being carried on at the Calgary office of the Geological Survey of Canada and also in connection with the Palaeozoic formations in the oil- and gas-bearing region of southwestern Ontario. However, there is need for extension of this type of work.

Dr. C.R. Stelck makes the following suggestions:

1. "A diligent field search should be made for a well-preserved McMurray flora. This flora is at present known to be Ginkgoaceous, but the scattered fragments so far collected are inadequate for direct comparison with Blairmore floras. The new quarrying operations in the sands should provide new opportunities for collecting.

2. "The succession of Cretaceous and Jurassic Aucellas of western Canada should be monographed as a single unit. Adequate collections are now in the hands of the Geological Survey of Canada. This is an essential primary step to the dating of the so-called 'Nikanassin' sands producing oil and gas in northeastern British Columbia.

3. "Volcanics interbedded with Jurassic and Triassic in British Columbia should be accurately located stratigraphically

to allow for radioactive age dating of this portion of the stratigraphic column.

4. "A regional re-study of the Cordilleran Cambrian and early Palaeozoic to supplement the work of Walcott. Rasetti has already contributed much to initiating this re-study but the type of terrain involved demands more than one properly organized party for mapping and stratigraphic work".

Dr. V.J. Okulitch offers the following projects for consideration.

1. "The general problem of the base of the Cambrian System involving the stratigraphic position of the Windermere series.

2. "Study of Cambrian stratigraphy and palaeontology in the Mt. Robson-Sinclair Mills area on the Upper Fraser River. New collections of fossils continue to dribble to us from the area, but a systematic study to augment the now obsolete work by Lancaster Burling and C.D. Walcott is necessary. The relative inaccessibility of the area would necessitate a somewhat greater expense as at least a 3-to-4-man party would be required. This should be done by the Survey possibly as a Ph.D. thesis problem. I would be willing to assume general supervision.

"The fact that several persons have independently drawn attention to the necessity for re-study of the Cambrian system in the Cordilleran region is an indication of the importance of the problem. Rocks of this system attain great thickness and areal extent. Relatively little mapping of these rocks has been done. The early studies are of necessity quoted and re-quoted in current literature although subsequent work in specific districts points to the inadequacy and to some extent the inaccuracy of some of these older conceptions.

"It is noted that recent mapping by the Geological Survey of Canada has added significantly to existing knowledge of the base of the Cambrian system as well as to the structure and stratigraphy of these rocks in southern British Columbia, and that some major oil companies also have concerned themselves with this problem.

3. "Permian Stratigraphy and Palaeontology in British Columbia. Recent work on the Permian in northwest Washington has brought to light the presence of fossiliferous Pennsylvanian and Permian strata. It is desirable to extend these studies into British Columbia. I would suggest that the problem be assigned to a competent graduate (Ph.D.) student working with one assistant and under general supervision of myself and Mr. Danner of the University of British Columbia geology staff. Possibly this could be done under the auspices of the Geological Survey of Canada. The expenses would consist of a regular salary for one man and his assistant plus field expenses and the operation of a car. We have in the Department sufficient comparative material to facilitate identification of fossil specimens."

Dr. H.W. McGerrigle suggests the following project:

"A study of the Petrography-Stratigraphy-Palaeontology of the limestone conglomerates of the Levis and Sillery formations between Grosses Roches (Gaspe) and Levis."

REPORT OF THE SUBCOMMITTEE ON PLEISTOCENE GEOLOGY

Presented by V.K. Prest

Members of Subcommittee

V.K. Prest (Chairman)	-	**Geological Survey of Canada, Ottawa, Ontario.**
W.H. Mathews	-	**Dept. of Geology and Geography, University of British Columbia, Vancouver, British Columbia.**
C.P. Gravenor	-	**Research Council of Alberta, Edmonton, Alberta.**
W.C. Kupsch	-	**Dept. of Geology, University of Saskatchewan, Saskatoon, Saskatchewan.**
A. Dreimanis	-	**Dept. of Geology, University of Western Ontario, London, Ontario.**
R.E. Deane	-	**Dept. of Geological Sciences, University of Toronto, Toronto, Ontario.**
J.A. Elson	-	**Dept. of Geological Sciences, McGill University, Montreal, P.Q.**
R.H. MacNeill	-	**Dept. of Geology, Acadia University, Wolfville, Nova Scotia.**

The Pleistocene subcommittee is concerned with the broad field of Pleistocene and engineering geology, glaciology, water supply and geomorphology. Possibly some attention should be given to restriction of the scope of this subcommittee. The field of Pleistocene geology itself has strong affiliations with the related fields of biology, geography, pedology, and archaeology. A review of the projects listed under "Current Research in the Geological Sciences" (p.138) will indicate the inter-relationship of these studies. The study of geomorphology assuredly links geology and geography. Glaciology has considerable bearing on the study of Pleistocene geology, and also involves the field of climatology. Water supply involves the study of both groundwater and surface water resources. The latter is not ordinarily regarded as involving the field of geology and yet the nature of the surface is of prime concern in all watersheds. A thorough study of a drainage basin should also include the history of its development and this, in Canada, is largely the result of Pleistocene events. Groundwater resources in many parts of Canada are directly related to the Pleistocene deposits and elsewhere the nature and distribution of the drift has a profound bearing on the groundwater borne in the bedrock. Engineering geology likewise involves surficial materials and bedrock though the problems are more varied and numerous where the drift is concerned.

Considering the field of the Pleistocene subcommittee as it now stands, the findings and recommendations of the first Pleistocene subcommittee as presented in the first annual report of the National Advisory Committee on Research in the Geological Sciences (1950-51)(1) are worthy of attention. Most recommendations in this initial report have received some attention over the past seven years, but the need for a greater appreciation by geologists of the varied applications of Pleistocene geology is great. As there was no report on Pleistocene geology in the last report of the National Advisory Committee (1955-56), and but a fill-in report the year previous, it seems appropriate to review the achievements of the past seven years in the light of the first Pleistocene subcommittee report. This is done below in their order of presentation in the report of this subcommittee in the first annual report of the National Advisory Committee (1950-51).

(1)National Advisory Committee on Research in the Geological Sciences, 1st Annual Report, 1950-51, p. 71.

Geological Survey Policy

Considerable headway has been made along the lines recommended in the first annual report of the National Advisory Committee (1950-51). The Survey now has a group of Pleistocene geologists on its staff, and it continues to foster the study of surficial materials and of Pleistocene stratigraphy, history and chronology. Students from Canadian universities are employed as assistants on Pleistocene field parties, but few of them have continued in this branch of geology. Nevertheless, by employing students and in other ways the Survey has encouraged the study of Pleistocene geology at our universities, several of which now have organized courses in this phase of geology. The Survey has also fostered a greater interest in Pleistocene geology and in geomorphology among its geologists by encouraging the collecting of additional basic information in these fields in the course of normal bedrock mapping. This is especially true of the Cordilleran and Arctic regions where detailed Pleistocene studies by the Survey have not been possible. Provincial government agencies are also paying increased attention to pure and applied Pleistocene geology.

The Survey broadened its ground coverage of surficial materials by attaching a Pleistocene geologist to each of three helicopter operations (Keewatin, Baker, Thelon) in the Northwest Territories. They also accompanied the 1957 airborne operations, Mackenzie and Fort George. This type of operation provides a large amount of first hand factual data to aid in the scientific interpretation of air photos in the region under study and in adjoining areas.

Pleistocene Map of Canada, and Bibliography.

In the first report great stress was laid on the need for a Pleistocene (Glacial) map of Canada, together with a Pleistocene bibliography to serve as a base for much-needed research and general studies in this field. In 1954-5 a Pleistocene map of Canada was assembled by the Geological Survey, with much assistance from other organizations and individuals, on a scale of 1:10,000,000 for inclusion in the Atlas of Canada. This map was revised in the summer of 1956 but it is again out of date as a result of the great wealth of information recently assembled from air photographs by numerous workers across Canada.

Another Pleistocene map is being prepared for publication by the Geological Association of Canada, with the aid of a grant from Defence Research Board, and supported by geological information from the Geological Survey, provincial organizations and many individuals. This map will be on a scale of 1 inch to 60 miles and will complement the tectonic and bedrock maps of Canada. It is to be available for distribution in late 1957 or early in 1958. Although the preliminary studies of the air photos of Canada are now largely complete, at least for the interior, the forthcoming map will require revision in a few years as areas of special interest receive attention and ground studies permit a more interpretive Pleistocene map of Canada.

The compilation of a Pleistocene bibliography (exclusive of the Arctic Islands) is now underway by Dr. R.E. Deane with the support of Geological Survey research grants in 1956 and 1957 recommended by the National Advisory Committee. By the end of this academic year all publications of the Geological Survey of Canada will be annotated and indexed and the project should be completed on schedule early in 1958. The need for such a bibliography has long been felt by those dealing with various aspects of Pleistocene geology.

Geomorphic Map and Descriptive Geomorphology of Canada

The recommendation that a geomorphic map and a descriptive geomorphology of Canada be prepared has received but little attention. A map showing the primary physiographic regions of Canada on a scale of 1:20,000,000 and somewhat more detailed maps of the Maritimes and the Cordillera on scales of 1:5,000,000 have been prepared by the Survey and submitted to the Geographical Branch. These maps will appear together as a single-page illustration in the forthcoming Atlas of Canada. This is a far cry from the recommended map of the whole of Canada on a scale of 1:10,000,000 showing two or three orders of subdivisions.

Much valuable information on physiography lies scattered throughout numerous governmental and other reports, books, and periodicals of both geological and geographical nature. The collection of this data will require the cooperation of both geologists and geographers but the prime responsibility should be in the hands of a geomorphologist. All too often the interpretation of land forms has been based on faulty premises due to a lack of appreciation of the geological factors involved. Geologists in general should take a more active interest in the evolution of land forms and in the publication of reports and articles dealing with them. More attention should be given to the geomorphology of our great drainage systems. Comprehensive reports on watersheds have been prepared in recent years without any attention to the geological materials involved, or to the sequence of events during the Pleistocene epoch, both of which are fundamental to watershed studies.

Pleistocene Geology (Including Glacial Geology)

The first report of the Pleistocene subcommittee (1950-51) recommended a continued planned program of mapping the surficial deposits by the federal and provincial geological surveys. It was felt that this would yield valuable results in pure and applied science. The Geological Survey's small group of Pleistocene geologists continues to map the surficial deposits and interpret the glacial history of selected areas. Provincial surveys are giving increasing attention to the Pleistocene deposits. Surficial geology mapping programs have been carried out by Alberta, Saskatchewan, Ontario and Nova Scotia, and specific and applied Pleistocene problems by British Columbia and Quebec.

In the first report of the subcommittee four major Pleistocene mapping programs were listed as examples of work that should be done. One of these, involving work in the New Quebec-Labrador iron ranges, has received direct attention by the Geological Survey, and limited studies have been, or are being, made in connection with the others. Of the individual problems listed in the first report, some work has been carried out by the Geological Survey and some by the Geographical Branch and other organizations.

Glaciology

Glaciological studies as envisaged in the first report of the Pleistocene subcommittee have received some attention over the past seven years but in general this field of study has not received the attention by Canadians that it justly deserves. Air photo coverage (in part only trimetregon) of all areas in Canada where glaciers exist has been completed, and the forthcoming Glacial map of Canada will provide the first complete representation of Canada's glaciers. A smaller scale map of the Cordilleran glaciers was compiled by W.H. Mathews and published in the B.C. Resources Atlas late in 1956. Air photos of all Canada's glaciers, ice fields and ice caps now make it possible for more comprehensive studies to be made in the office and in the field. Some field work has been carried out in Canada. Studies of some of the northernmost glaciers of Ellesmere Island and of the ice shelf were made by Defence Research Board field parties in 1953 and 1954 and central Baffin Island glaciers (Barnes, Grinnel and Penny) were studied by parties sponsored by the Arctic Institute from 1950-55. In the Cordillera, in 1953, J.C. Wheeler made observations on Kaskawulsh glacier, Yukon Territory, that essentially confirmed the excellent work of Robert Sharp on nearby Steele glacier.

The most detailed glaciological work carried out in Canada is that by Meir, Rigsby and Sharp, on Saskatchewan glacier, Banff Park, Alberta. The field work, chiefly aimed at problems of glacier flowage, was begun in 1952 and continued in 1953 and '54, with office work continuing into 1956. This work involved both precise instrumental and seismological work and was made possible initially by a grant from the Arctic Institute of North America and assistance from the U.S. office of Naval Research, and later was sponsored entirely by the latter body. Saskatchewan glacier stemming in the Columbia ice field made an ideal field laboratory for this glaciological research. The glacier is about 6 miles long and one mile wide and is readily reached by motorized vehicles. The results obtained have added greatly to our knowledge of glacier flow and relevant problems.

In 1956 a field party sponsored by the Arctic Institute made observations on Salmon glacier near Stewart, B.C. This work was initiated as a training and testing program for the 1957 glaciological work planned for the Lake Hazen area of Ellesmere Island in connection with the International Geophysical Year. Some of the investigations on Salmon glacier are of such interest that they were to be continued in the summer of 1957. Dr. W.H. Mathews of the University of British Columbia also studied part of Salmon glacier, recording changes in the configuration of diamond drill holes put through the ice by a mining company, and he hoped to take readings again in the summer of 1957. This work was made possible by a National Research Council grant.

Much fundamental research on snow and ice, essential for the understanding of the mechanics of glacier flowage, is being carried on by the Division of Building Research, N.R.C., and through the Associate Committee on Soil and Snow Mechanics; a geologist is a member of the Subcommittee on Snow and Ice. It is hoped that the recent accelerated pace of research on snow and ice mechanics, and glaciology in general, will continue. There is, however, no coordinated program of glaciological research under the guidance of a trained glaciologist as suggested in the first report of the Pleistocene subcommittee. Close liaison between all the agencies interested in glaciers, snow and ice is maintained, however, through the Subcommittee on Snow and Ice of the Associate Committee on Soil and Snow Mechanics, N.R.C. Geologists should take a more active interest in glaciology.

<u>Ground-frost Phenomena</u>

The first report of this subcommittee stressed the importance of ground frost and drew attention to the many governmental and other agencies working in this field. These all increased their activities over the past seven years, and liaison is now established through the Associate Committee on Soil and Snow Mechanics, N.R.C. Geologists have played a relatively insignificant part in this important field though some contributions of merit have been made on certain ground frost features. Basic geologic studies are surely needed to establish a firm foundation for interpreting the puzzling forms developed by intense frost action and to help in solving many problems of economic importance.

<u>Water Supply</u>

Water supply problems in general and groundwater problems in particular are fundamentally linked with the character of the terrain and hence with the study of geology. Our great river and lake systems are the expression of a long chain of geological events; their appearance, behaviour and composition are controlled in large measure by the geological materials comprising the drainage basin. The great increase in the development and industrialization of some parts of Canada have already resulted in water supply and water power problems. The first report of this subcommittee recommended continued surveys of surficial deposits and the initiation of geomorphological studies to aid in the fuller understanding the development of our water resources. Some detailed drainage basin studies have been made in recent years without any attention being given to the geological setting. Studies of the drainage history of northern British Columbia and Yukon, and of the St. Lawrence-Hudson Bay Divide were recommended by the Pleistocene subcommittee but have not received attention. Possibly geological reports in general should give more attention to the wider applications of geology to water supply problems such as the planning and development of major power sites, irrigation systems, flood control, groundwater resources etc.

Groundwater studies in particular should be given greater attention by geologists with more emphasis being placed on the engineering aspects. Groundwater development offers a lucrative vocation for geological engineers. The winning of water from the ground is in many areas of great economic importance and needs to be pursued with considerable technical 'know-how'. The nature of the bedrock, its chemical and physical character, and the character, stratigraphy and depth of overburden are important geological phenomena in connection with the economics of any groundwater program. Buried valleys of pre-Pleistocene and Pleistocene age can provide ample supplies of water in otherwise arid or seasonally arid areas, and these can best be recognized in the course of Pleistocene-geomorphological work.

Over the past seven or eight years the study of groundwater has been receiving increased attention in Canada. The Geological Survey has carried on a limited program making investigations in the western end of Prince Edward Island, parts of the St. Lawrence Lowlands, southern Manitoba and the Fraser Lowland. The Quebec Department of Mines has added a groundwater geologist to its staff to assist communities and industry with the technical and engineering aspects of water supply problems. The British Columbia Department of Mines also employs a groundwater geologist and conducts geological studies in local areas where specific problems are of concern. The Alberta Research Council is now actively entering the groundwater field on behalf of that province, and placed five parties in the field in 1957 on groundwater-Pleistocene studies, one on geophysical work relating to drift thicknesses, and another studying stream gravels.

The most comprehensive and coordinated groundwater studies in Canada have been carried out by the Ontario Department of Mines. Its groundwater section has been accumulating and collecting basic geologic data compiled from well-driller's logs which are submitted in accordance with the Ontario Well Drillers Act. The Department also carries out detailed studies of surficial materials in connection with its appraisal of groundwater resources. The importance of water supply studies (both surface and groundwater) by the Ontario government is now realized, as evidenced by the recent (March 1956) enactment of the Ontario Water Resources Commission. The groundwater section of the Ontario Department of Mines was largely transferred to the Commission on April 1, 1957 and a greatly expanded field and laboratory program is in progress under the guidance of the Pleistocene and groundwater geologist.

Engineering Geology

This field of study is being largely neglected by the geologist. Geologists have participated in some major engineering programs, but all too often they have not been consulted, with a consequent waste of time and money in rectification of situations that could have been avoided. There is a need for geologists to take training in soil mechanics that they may better understand the physical properties of the materials to be dealt with and the language of the specialists in this field. Geologists with this training would be able to make real strides in engineering research.

The Geological Survey of Canada provided assistance on the Columbia Basin project, B.C., on the Mayo River Development Yukon, and on the dam sites of the St. John River Basin, and it has a geologist on loan to the St. Lawrence Seaway Authority.

Members of the Division of Building Research. N.R.C., have made important contributions over the past few years, in the study of permafrost in its relation to engineering projects, and along with other engineers, have provided valuable data on the character and behaviour of various Canadian soil types that have great bearing on engineering projects of all types. Geologists might provide valuable data on the petrography of soils. Geologists and engineers are studying the origin of varved sediments.

Recent and Current Pleistocene Research

Some aspects of recent Pleistocene work in Canada may serve to show the interest in this field and the diversity of the subject matter. This is dealt with on a regional basis.

Cordillera (Data supplied by Dr. W.H. Mathews)

In addition to the compilation of glacial maps and to the glaciological work already referred to, some specific projects have been under study. H. Nasmith of the B.C. Dept. of Mines has completed a three-year study of the sediments and land forms of the Okanagan valley, and is doing field and laboratory work on the occurrence of volcanic ash in post-glacial alluvial fans in the Arrow Lakes area. If the individual ash beds can be identified, correlation over wide areas may be possible. Furthermore, since ash is known in some peat beds in southern B.C., a precise age may be obtained by a radiocarbon analysis. The ash beds may, therefore prove to be geological horizons of great importance in regard to post-glacial geomorphological and archaeological history. Several landslide and damsite localities have also been studied by personnel of the B.C. Dept. of Mines.

A study of the submarine sediments in Dixon Entrance (between the Alaska Pan-handle and the Queen Charlotte Islands) has been made by W.H. Mathews with assistance from the National Research Council, Pacific Naval Laboratory, Royal Canadian Navy, and the University of B.C., Institute of Oceanography. The sediments consist largely of gravels with some till-like materials. The occurrence of widespread gravels in deep waters poses quite a problem. As Dixon Entrance has been glaciated, the stony bottom sediments are presumed to be modified glacial deposits, the fine materials having been largely removed at the time of deposition. Mathews also has a grant from N.R.C. to study the hydrology and sediment transport of Sunwapta River that issues from a small lake at the foot of Athabasca glacier. There is little factual data on the variations in sediment load relative to glacier melting.

Prof. Rowles, University of B.C., is continuing his studies of the physical properties of stony marine clays under an N.R.C. grant.

MacKay and Mathews have made detailed studies of the surficial deposits at an archaeological site on the Firth River at the request of R.S. MacNeish of the National Museum of Canada. Financial assistance was provided by the Banting Fund through the Arctic Institute of North America. A report on the Pleistocene stratigraphy and history is being prepared. Remarkable changes in sea-level are indicated in late-Pleistocene time, and the early migration of humans into the region may be correlated with some of the events.

In southwestern Yukon, J.E. Muller and J.C. Wheeler of the Geological Survey of Canada have made ground and air photo studies of the glacial and fluvioglacial physical features, and the extent of the last major ice body in that area. Much new data on the upper limit of this ice has been assembled.

In north-central B.C., the officers of the Geological Survey engaged on Operation Stikine under the direction of E.F. Roots have gathered much new information on ice-movements in that area, and their interpretations of the glacial events will comprise an important contribution to the Pleistocene history of the northern Cordillera. In southern B.C., H.W. Tipper, Geological Survey of Canada, has made a study of glaciation on the east side of the Coast Range of the Nechako and Anahim Lakes area and has provided a wealth of new data on the movement of the ice during the period of deglaciation. J.G. Fyles, Geological Survey of Canada, is continuing his study of the coastal lowlands of Vancouver Island and of the glacial history of the Georgia Straits.

Northwest Territories

Comprehensive publications by Geological Survey of Canada's Pleistocene geologists will soon be forthcoming on the glacial events in the region west of Hudson Bay as revealed by ground and air photo studies in connection with the Survey's helicopter operations Keewatin, Baker, and Thelon. Sketch maps of the trend and distribution of some of the glacial features have already been published. H.A. Lee, the Pleistocene specialist on Operation Keewatin, was the first to recognize the presence of an elongate divide in the Keewatin district rather than a 'center', and to point out its recessional character as opposed to the former concept of an area of dispersal.

Studies of surficial deposits and interpretations of glacial events and physiographic evolution have also been made, or are being made, by numerous geographers. The Geographical Branch, Department of Mines and Technical Surveys, has continued its work for the Defence Research Board along the northern mainland coast and nearby island shores. A memoir by J. Ross MacKay on the Anderson River sheet, east of the Mackenzie delta, is in press. All this work provides valuable information bearing on Pleistocene geology. Three recent papers by geographers at McGill are also of interest to Pleistocene and other geologists. J.B. Bird has written on the "Physiographic Evolution of Central Arctic Canada"; M. Bronhofer on the "Surficial Deposits of Southampton Island and Adjacent Areas"; and M. Marsden on the "Origin and Distribution of Eskers in Mackenzie and Keewatin Districts, N.W.T." Papers by Hare, Dunbar, and Lowther at McGill, and by Love at the University of Montreal, dealing with various aspects of organic life in northern Canada in late glacial and post-glacial time will be of much interest to Pleistocene geologists interested in biogeography and deglaciation in the Territories and in Quebec-Labrador.

Studies on sedimentation in a glacial lake in central Baffin Island were made in 1956 by Quigley, Morgan, Hood and Deane, University of Toronto.

In the summer of 1957 a Pleistocene geologist, B. G. Craig, accompanied the Geological Survey of Canada helicopter operation in the Great Slave Lake-Mackenzie River area. His studies should provide information on the direction and sequence of glacial movements, on the extent of glaciation in the mountains, on Cordilleran and Laurentide drift relations and on Pleistocene stratigraphy in general.

Considerable information on the Pleistocene deposits and events on the Queen Elizabeth Islands was gathered by the geologists engaged in Operation Franklin in 1955. Some of these observations are in press in the several reports on this Operation. Significant changes of sea-level and of climate are indicated during the Pleistocene epoch. There is a real need for extensive air photo and ground studies specifically designed to unravel the Pleistocene geology of this border region of glaciation.

Interior Plains (Data supplied by Drs. C.P. Gravenor, W.C. Kupsch and J.A. Elson)

The Prairies have been receiving considerable attention as the importance of surficial studies in relation to land use, ground water supply, engineering projects and other economic matters has become apparent. In 1956, the Alberta Research Council fielded two parties on Pleistocene mapping and will continue in 1957 with two parties in addition to the seven parties concerned with various aspects of the ground-water program. Prof. R.S. Taylor, University of Alberta, is making a study of frost-heaving in connection with his report for the United States Army Corps of Engineers on 'Patterned Ground'. D.B. Sikka, McGill University is studying the 'soils and associated radioactivity' from an area northeast of Edmonton. The Geological Survey of Canada is also continuing its Pleistocene mapping program in southern Alberta with A.M. Stalker, currently working in the Fort McLeod area, where the Cordilleran-Laurentide ice relations are receiving special attention. The Geological Survey of Canada has published a bulletin by Stalker on the phenomenal erratics train in the Foothills of Alberta. This train consists of blocks of quartzite that occur in a narrow band with a length of over 350 miles stretching from the International Boundary, northward to a point east of Jasper and possibly beyond. Valley glaciers appear to have carried these blocks eastward from the mountains and emplanted them on Laurentide ice moving southward along the Foothills. Stalker is completing a paper on "Ice-pressed Forms in Alberta" that will present essentially new theories on the origin of many glacial features in this region. He is preparing a paper on the "Surficial Geology Features of the Fort McLeod Region" for the 1957 field conference of the Alberta Society of Petroleum Geologists.

In Saskatchewan, Dr. Kupsch and E. Christiansen will continue their study and mapping in the Swift Current area. In addition, the end moraines in the Dirt Hills are receiving special attention. Bedrock disturbances were noted in this area that appear to be due to ice-push. Radiocarbon analysis continues at the University of Saskatchewan, with a switch-over in the past year from the solid carbon to the acetylene method. Standardization of the new equipment will further the advancement of a sound Pleistocene chronology for western Canada. The micro fabrics and soil mechanics of glacial deposits was the subject of study over the winter of 1956-57 by W.A. Menely, University of Saskatchewan. J. Terasmae, Geological Survey of Canada, has made a palynological study of samples supplied by W.C. Kupsch, from a buried peat deposit at Hebert, Saskatchewan, 30 miles east of Swift Current. This study indicates a former open forest cover in the area and hence, a climate appreciably more moist and possibly somewhat warmer than at present. The age of the deposit is not yet known.

Imperial Oil Limited is providing the geology department of the University of Saskatchewan will full air photo mosaic coverage of southern Saskatchewan. These will be of great value in the continued study of the regional trends of ice flow features and moraines. There is a great need for more and better contour maps in connection with Pleistocene and other geological work and related studies.

In Manitoba, little Pleistocene work is being done. J.A. Elson, McGill University, is completing his reports for the Geological Survey of Canada on areas in southwestern Manitoba and has prepared a paper on Glacial Lake Aggasiz. J.C. Richie, University of Manitoba, is starting work on pollen analyses in the Lake Agassiz basin and hopes to be able to relate the results to the deglacial events as worked out by Elson.

<u>Great Lakes Region</u> (from data supplied by A. Dreimanis and R.E. Deane)

Professor Dreimanis recently completed a paper on the Wisconsin stratigraphy along Lake Erie in southwestern Ontario. He is also studying the depth of leaching of soils and the carbonate analyses of tills in southwestern Ontario, and on the use of indicator trains as a prospecting method in Canada. A paper on the latter subject was given at the C.I.M.M. meetings in April, 1957.

D. Hurst, McMaster University, has completed a thesis on the Pleistocene geology of Hamilton and vicinity, Ontario. R.E. Deane and W. Tovell are directing work on the geology of the Lake Ontario basin, much of which pertains to Pleistocene events. A comprehensive program of study is being arranged by the Dept. of Geological Sciences of the University of Toronto and the Ontario Department of Lands and Forests. Deane is also involved in a study of the glacial geology of the Welland Canal. An Ontario Department of Mines report by A.K. Watt on the Pleistocene geology and ground-water resources of North York township has been released, and the report on "Groundwater in Ontario for 1951-2" became available in May 1957. Watt has also completed a report on "Shoreline Erosion of Pelee Island" to be published at a later date. The Ontario Research Foundation is continuing work on the character of Ontario tills and D.H. Gorman and L.J. Chapman have prepared a paper on the mineralogical composition of clay in southern Ontario. E. Mirynech, University of Toronto, is working on "Soil Profile Studies in Southwestern Ontario".

North of the Great Lakes, in the 'Clay Belt', C.L. Hughes, Geological Survey of Canada, has been investigating the problems of varve chronology and finds support for the deductions of Antevs pertinent to this region. J. Terasmae, Geological Survey of Canada, is pursuing palynological studies of the area between Lake Erie and Cochrane that are vital to the establishment of workable sequence of events during the deglacial process.

In eastern Ontario N.R. Gadd continues the study of the Pleistocene deposits along the Ottawa River valley.

Quebec-Labrador

N.R. Gadd is compiling maps and reports of the surficial deposits and Pleistocene history of the Three Rivers part of the St. Lawrence Lowlands. This work furnishes a sound stratigraphy and sequence of events on which further studies in the Lowlands may be anchored. P.F. Karrow, Geological Survey of Canada, has completed mapping the Grondine 1-mile map sheet, east of Three Rivers. Miss F.J.E. Wagner, Geological Survey of Canada, is continuing studies of the palaeontological record of the Champlain Sea deposits, and the ecological conditions of the time. C. Laverdiere and A. Mailloux, University of Montreal, have been investigating the marine transgressions in the Saguenay River area. A. Courtemanche and M. Sylvio are continuing detailed studies on pollen analyses and post-glacial history. S.V. Ermengen, McGill, has been studying the glacial geology, and the dispersion of the fine fraction of tills, in the Chibougamau District, with special attention to the dispersion of Pb, Zn and Cu in the glacial sediments. P. Crepeau, École Polytechnique, is making a detailed investigation of the geology and the proposed damsite at Carillon, Quebec on the Ottawa River. H.A. Lee accompanied the Geological Survey's helicopter operation Fort George, east of James Bay, in the summer of 1957 with responsibility for the compilation of glacial information. A glacial map of Quebec, compiled by A. Sabourin, should soon be published by the Quebec Department of Mines, E.I.K. Pollitt, Geological Survey of Canada is continuing groundwater studies in that part of Quebec west of Montreal Island.

An excellent paper on the geomorphological development of the Torngat Mts., Labrador, by J. Ives, McGill University, was submitted to 'Arctic' for publication. This work adds greatly to our concepts of the glacial events in this region. J.P. Johnston, another geographer at McGill, has been working on "The Elevated Strand-lines of Central Labrador".

'The Maritimes'

Completion of a part of the Geological Surveys' investigation of the surficial deposits and glacial events of the Saint John River Valley, was interrupted by H.A. Lee's assignment to Operation Fort George, but one-mile maps at both ends of the region under study have been published. A new glacial map of New Brunswick was assembled by Lee and the University of New Brunswick for the forthcoming glacial map of Canada.

In Nova Scotia, the reconnaissance mapping continues under the direction of R.H. MacNeill, Acadia University and Nova Scotia Research Foundation, and several map sheets are being readied for publication. C.F. Hickox, Yale, has been studying the Pleistocene geology of the Middleton (Bridgetown) area.

On Prince Edward Island the Geological Survey of Canada continues its mile-to-the-inch study of the surficial deposits and the bedrock. New concepts of the direction of ice movements in that area and of the sequence of late Pleistocene events are coming to light.

On Newfoundland, E.P. Henderson, Geological Survey of Canada, is continuing the study of Pleistocene geology on Avalon Peninsula. S.E. Jenness, Geological Survey of Canada, who studied the bedrock geology of the Terra Nova area in southern part of the island, has prepared a paper on the glacial geology of that area. It provides much new information on ice movements and of glacial features in this little known region.

Research Projects Meriting Early Attention

J.G. Fyles, Geological Survey of Canada recommends two problems on the west coast for the attention of graduate students:

(a) Study of the variation in content of soluble salts and exchangeable cations, particularly sodium, in marine and glacial-marine clays of the region surrounding the Strait of Georgia in order to relate the various deposits to salinity and hence, to environment of deposition.

(b) Re-evaluation of the concepts of the nature and origin of valleys and erosion surfaces in southwestern British Columbia as presented by Peacock (Fiord-land of British Columbia: Bull. Geol. Soc. Am., Vol. 46, pp. 633-696, 1935) in the light of new contour maps and air photographs. This would probably be best undertaken for a series of small critical areas.

W.H. Mathews recommends detailed petrographic studies of the Quadra non-glacial deposits of the Georgia Straits as a means of locating the source areas of the sands and the patterns of their distribution.

A.M. Stalker, Geological Survey of Canada, suggests four projects:

(a) A detailed field study of the Bow Valley terraces west of Calgary, in view of their location along the main line of the C.P.R. and of their economic importance in reference to constructional materials, ground-water resources and engineering projects. The origin of these terraces is of special scientific interest as both Cordilleran and Laurentide ice recession is involved.

(b) The tracing of buried valleys across the Prairies to be undertaken by someone with access to the innumerable oil well records of the many companies engaged in drilling. Geophysical data would also prove valuable in this work.

(c) A study of the Pleistocene volcanic ash beds of Alberta. There are many records of the occurrence of ash beds in widely separated areas, and as many as four horizons are known in some places. This would make an excellent thesis project. Laboratory studies might serve to differentiate these ash beds, indicate their dispersal and source areas, and throw light on the Pleistocene sequence of deposits.

(d) A laboratory study of the clay minerals or of the heavy minerals of the two or more till sheets found in many river valleys on the Prairies might readily be tackled by degree students and require but scant field work. Such work might indicate the source areas of the materials and help to differentiate the till sheets over broad areas and thereby advance our understanding of glacial events on the Plains.

C.P. Gravenor, Alberta Research Council, recommends a critical study of the Cordilleran-Laurentide glacial boundary in the Alberta Foothills, and of the inter-relations of these ice sheets.

W.O. Kupsch points out the importance of 'submask geology' on the Prairies and therefore recommends careful photo analyses, followed by detailed lithological work, in an effort to obtain information on the nature of the hidden bedrock, and of bedrock structures that may reflect underlying features of economic importance.

A. Dreimanis recommends a coordinated attack on the stratigraphy and chronology of the Canadian side of the Great Lakes. This would have to be handled by the various persons and agencies engaged in Pleistocene field work.

J. Terasmae recommends a stratigraphical study of the surficial deposits along the Grand River valley, Ontario, as a thesis problem. He also suggests the stratigraphical study and selective mapping of the Pleistocene deposits and features of parts of the North Bay - Manitoulin Island region as thesis projects. Such studies would provide valuable information on ice retreat in this region and on the history of the Great Lakes.

N.R. Gadd suggests that a statistical study of flow-type landslides in the St. Lawrence Lowlands be made by someone having access to the National Air Photo Library or other air photo coverage, and to pertinent scientific literature.

H.A. Lee points out the continuing need for detailed laboratory studies of clays and silts as regards their environment of deposition. This project was outlined by I.W. Jones in the first subcommittee report on Stratigraphy and Palaeontology[1] and it was also mentioned in the Pleistocene

[1] National Advisory Committee on Research in the Geological Sciences, 1st Annual Report, 1950-51, p. 160.

report. J.G. Fyles has advocated similar studies on the west coast. It is apparent that modern scientific knowledge should be applied to this problem.

REPORT OF THE SUBCOMMITTEE ON STRUCTURAL GEOLOGY

Presented by G.H. Charlewood

Members of Subcommittee

G.H. Charlewood (Chairman)	Manitoba Mines Branch, Winnipeg, Manitoba.
C.M. Allen	Mount Allison University, Sackville, New Brunswick.
A.R. Byers	University of Saskatchewan, Saskatoon, Saskatchewan.
J.E. Gill	McGill University, Montreal, P.Q.
W.H. Gross	University of Toronto, Toronto, Ontario.
G.S. MacKenzie	University of New Brunswick, Fredericton, New Brunswick.

CURRENT RESEARCH

The review of current research in structural geology (p.150) indicates a predominant tendency toward direct practical application. In fact the majority are field projects. A number of academic and fundamental studies are in progress, some on a continuing basis, and some of these are mentioned in this report.

Contintental Structures. At the university of Toronto, J.T. Wilson and associates continue studies of deep-seated earth movements and continental structures. Recent publications by Wilson include "The Development and Structure of the Earth's Crust."(1)

(1) In "The Earth as a Planet", G.P. Kuiper, ed., Chapt. 4, pp. 138-214, University of Chicago Press, 1954.

Dr. W.W. Moorhouse, in his studies of the structure of highly deformed rocks, has been compiling data on the interpretation of strucures of rocks deformed in or near the zone of flow. T. Stebetee and M.G. Rochester began in 1956 a study of problems of faulting and mountain building based on Volterra's Theory of Dislocation.

Scientists at the Dominion Observatory are continuing studies of the earth's crust. M.J.S. Innes and associates have been making a study of gravity anomalies in the Shield areas and their possible relation to the major geological structures. A separate report and grivity map dealing with the Shield area of Manitoba and northwestern Ontario was issued in 1957. In this category the field of structural geology overlaps that of the physical sciences.

Precambrian volcanology A research project that will have a fundamental effect on Canadian Precambrian geology is that of J.E. Thomson and associates, Ontario Department of Mines, in drawing the attention of Canadian geologists to the importance of volcanological processes and their bearing on structural interpretation. This work has produced a concept of the history of the Sudbury basin that is in part new and in part a modification of some of the earliest theories which were, for many years, almost forgotten. A volume published in 1957[1], deals with the structure of the Sudbury basin, the volcanology of the Sudbury area, and a detailed study of the Copper Cliff rhyolite. Other detailed maps and reports are being prepared dealing with the structure southeast of Sudbury between the nickel irruptive and the Grenville front.

(1)Ontario Dept. Mines, 65th Annual Report, Vol. LXV, pt. 3, 1956

Grenville front. Structural studies of the Grenville front were suggested from many sources in the past and these studies are now going forward on a major scale.

In 1956 the Ontario Department of Mines began a detailed study of the Grenville front near Sudbury and plans to conduct a continuous and concentrated study of the Grenville front from Georgian Bay to the Quebec boundary. In this connection it should be mentioned that the Grenville front is the object of much current work, not only by the Ontario Department of Mines, but by the Quebec Department of Mines, university personnel and by exploration geologists and much good structural geology is coming to light. Some of this is given in the book "Grenville Problem" sponsored by the Royal Society of Canada and published in 1956 by the University of Toronto Press.

Cross-folds. W.H. Gross at the University of Toronto is continuing his fundamental research on cross-folds and has eight undergraduates and two graduate students working on various phases of the project. An M.A. Sc. thesis "Structural Patterns in Ore Deposits" is to be completed by W.G. Brown in 1957 and a Ph.D. thesis "Origin and Significance of Cross-Folds" is scheduled for completion in 1958 by W.H. Jackson. Dr. Gross reports a start of work in collaboration with the Department of Geophysics to see how residual magnetism can be used to date orebodies with respect to the age of folding.

Tectonic Maps. An important contribution to our knowledge of the structural geology of the country is the preparation of structural maps on a systematic basis similar to geological surveys. The Ontario Department of Mines plans to compile such a set of maps covering the entire province, to be published on a scale of one inch to four miles. These maps would show geology, tectonics, and mineral occurrences.

Batholiths. The study of batholiths has been urged in the reports of this committee since its inception. Several such studies have been initiated since then and the current survey of research indicates one in British Columbia, two in Ontario and one in New Brunswick.

Gneisses. Numerous phases of the study of gneisses have been suggested from time to time and several projects are going forward in Saskatchewan. Dr. Byers reports that several Master's students have been working on the origin of gneisses in the Foster Lake, Charlebois Lake, and Amisk Lake areas. These have involved petrographic as well as structural studies. In addition, the Saskatchewan Department of Mines and Natural Resources had two field parties doing one-inch to one mile mapping in gneissic terrain.

Aeromagnetic maps. The suggestion was made in the Fourth Annual Report (1) that aeromagnetic maps be studied

(1) National Advisory Committee on Research in the Geological Sciences, 4th Annual Report, 1953-54, p. 25

in relation to known exposed bedrock and structure as a guide to interpretation. At least one such study is reported from the University of New Brunswick and it is safe to assume that similar studies have been and will be made by several agencies elsewhere.

General. Provincial geological surveys and the Geological Survey of Canada continue to add to our knowledge of the structural geology of the country. The most ambitious project of 1956 was Operation Stikine, in northern British Columbia, under the direction of E. F. Roots.

Some excellent structural geology is coming out of the oil exploration along the Rocky Mountain front and the foothills of Alberta and British Columbia. Recent papers by Dr. G.S. Hume, including his recent Presidential Address to the Geological Society of America, have been very instructive on the nature of overthrust faulting.

Much useful structural data has been compiled in the volume on ore deposits for the Sixth Commonwealth Mining and Metallurgical Congress in 1957.(2)

(2) Structural Geology of Canadian Ore Deposits, Vol. II, Sixth Commonwealth Mining and Metallurgical Congress, 1957.

SUGGESTIONS IN PREVIOUS SUB-COMMITTEE REPORTS NOT YET INITIATED

Some subjects for research, suggested in earlier committee reports and for which specific projects have not been revealed by subsequent surveys are:

1. Structural studies of well-exposed areas of high grade, medium, and low grade metamorphism to help solve foliation problems. (J.E. Gill, D.R. Derry).

2. Compilation of mapping in the Alberta and British Columbia foothills area (T.A. Link).

3. More detailed study of the Conception Bay and nearby submarine areas in Newfoundland geologically and by geophysical methods! The Geological Survey of Canada has made an aeromagnetic survey of the region.

4. Study of the Pennsylvanian basin of central New Brunswick (G.S. MacKenzie).

5. Mapping of country between Kirkland Lake and Porcupine on a scale of one inch equals 1,000 feet to aid in the better understanding of these well-studied and economically important belts. (W.A. Jones).

6. Compilation and publication of structural data recorded by private enterprise, including mining and oil exploration companies.

7. Establishment of more satisfactory classification and definition of terms in common use for the description of folds in gneisses and granitized sediments.

COMMENTS

Work has been done on most of the projects advocated by this subcommittee in earlier reports. However, some members wonder whether a form of systematic follow-up can be organized to see that worthwhile projects are implemented and carried through to a satisfactory conclusion.

Since 1950 grants have been recommended by the National Advisory Committee in support of 95 geological research projects. Of these, three projects dealt with structural geology for which the grants amounted to $2,000. These figures are disproportionatly low but are perhaps due to the fact that most structural projects are field studies and the money is obtained from other sources. With notable exceptions, less equipment is required than for research in other branches of the science.

Dr. J.E. Thomson, through his new and interesting studies in the Sudbury area and from his observations in other parts of the world, feels that lack of knowledge of volcanological process could lead to incorrect geological deductions in the interpretation of Precambrian geology. He suggests that the best way to stimulate interest in volcanological research may be through a course on the subject in the geological departments of some Canadian universities.

APPENDIX I

GEOLOGICAL SURVEY OF CANADA RESEARCH GRANTS

SUMMARY REPORTS ON PROJECTS

The Annual Reports for the past three years have contained summary reports on projects supported by grants that were completed or that were achieving results of interest. Brief reports are given below on some additional projects completed or reporting progress in the past year.

Project 1-51 - Geological Age Determinations

Under direction of Dr. J. T. Wilson, University of Toronto

Work on potassium argon age determinations were carried out in 1955 and 1956 and the results have been published. In 1956 effort was concentrated on building a fourth argon extraction line of improved design which is now completed. Much effort has been expended on obtaining accurate potassium analyses. New results will be forthcoming in the summer of 1957.

Ion exchange columns have been set up for the separation of rubidium and strontium bearing solutions. It is hoped rubidium-strontium ages may be obtained during 1957; that it will be possible to determine K-A and Rb-Sr ages for the same specimens; and that the age determinations will be of greater accuracy than those obtained previously.

Since December 1956 two isotopic analyses of lead minerals have been determined on most working days. The isotopic ratios and ages are being calculated on an electronic computer and the results placed on punched cards from which selected data can be printed by tabulation. A considerable backlog of lead ores is available and the work will be continued throughout 1957.

Papers published in 1956 recording the results of this research include:

Loss of Argon from Minerals and Rocks Due to Crushing; Stevens, J.R., and Shillibeer, H.A.; Proceedings Geol. Assoc. Canada, Vol. 8., Pt. I, Nov. 1956, pp. 71-76.

Lead Isotopes as a Key to the Radioactivity of the Earth's Mantle; Russell, R.D.; Annals of the New York Academy of Sciences, vol. 62, art. 19, pp. 435-448, February, 1956.

Radioactivity and the Age of Minerals; Wilson, J.T., Russell, R.D. and Farquhar, R.M.; Handbuch der Physik, bd. 47, pp. 228-263, 1956.

The Bearing of Age Determinations on the Relation Between the Keewatin and Grenville Province; Shillibeer, H.A., and Cumming, G.L.; Royal Soc. Canada, Special Pub. No. 1, The Grenville Problem, pp. 54-73, 1956.

Interpretation of Lead Isotope Abundance; Russell, R.D.; Nuclear Processes in Geologic Settings, Nat. Acad. Sci., National Research Council, Publication 400, 1956.
Economic Significance of Basement Subdivisions and Structures in Canada; Wilson, J.T., Russell, R.D., and Farquhar, R.M.; Bulletin Can. Inst. Mining and Metallurgy, Vol. 49, No. 532, pp. 310-318, 1956.

Project 15-52 - Relative Importance of Microfossils Tree and Non-Tree Type

Under direction of Dr. Norman W. Radforth, McMaster University.

This investigation may be divided into three parts.

The first part concerns the possibility of finding tree and non-tree pollens in non-peaty sediments and submerged peaty sediments that had not necessarily been fossilized in their original environment. The broad test concerned a study of peaty deposits in British Columbia, Ontario and Quebec. Two other aspects of this problem relate to the importance of the organic detritus in samples of sediments from the Toronto Rapid Transit Development, and to differentiation of varves and complex sedimentary configurations which simulate varves in the Don and Scarborough beds. The importance of tree and non-tree pollens is demonstrated in each case and the Pleistocene geology of the Toronto area has been clarified. The results are embodied in a thesis by Jaan Terasmae entitled "A Palnological Study Relating to the Toronto Formation" (Ph. D. thesis, McMaster University, 1955).

The second part of the investigation consists of an intensive study of palynological traits or tendencies that can be regarded as significant in separating tree and non-tree microfossils where the generic affinities of the latter are unknown. It has been demonstrated that many Mesozoic and Palaeozoic sediments contain floras much more impressive in numbers and kinds of constituents than microscopic evidence would suggest.

The third part of the investigation attempts to assess the importance of microfossils tree and non-tree type in reconstruction of past environment reflected through knowledge of mass vegetation in relation to topography of the past. Results to date are encouraging and are basic in such problems as the determination of sub-surface geological problems in the coal and petroleum industries.

Two papers have been published to date dealing with parts two and three:

Floral Transgressions of Major Geological Time Zones; Radforth, Norman W. and Rouse, Glenn E.; Trans. Royal Soc. Canada, Vol. 50, Series 3, 1956. Sect. 5, pp. 17-26.
Antiquity of Form in Canadian Plant Microfossils; Radforth, Norman W. and McGregor, Colin; Trans. Royal Soc. Canada, Vol. 50, Series 3, Section 5, 1956, pp. 27-33.

Project 1-54 - Silicate and Sulphide Phase Relationships

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

The following projects which form parts of the larger project, were completed in 1956:

(1) The Pressure-Temperature Stability of Analcite. Results are embodied in Ph.D. thesis by B.J. Burley, McGill University, 1956.

(2) Compaction of sediments by high temperature and pressure. Results are embodied in Ph.D. thesis by R.A. Cameron, McGill University, 1956.

(3) Physical stability of chrysotile. Results are embodied in Ph.D. thesis by L. Wolofsky entitled "Hydrothermal Experiments with Variable Pore Pressure and Shear Stress in Part of the $MgO-SiO_2-H_2O$ System", McGill University, 1956 (Copy available in Library, Geological Survey of Canada, Ottawa).

(4) Determination of sulphide solubility using radioactive isotopes. Results are embodied in M.Sc. thesis by B.H. Relly entitled "A Method of Determining the Solubility of Sulphides", McGill University, 1956 (Copy available in Library, Geological Survey of Canada, Ottawa).

During 1956-57 the following projects were initiated:

(1) Deposition of sulphides from solution or suspension by changing P-T conditions.

(2) Rheomorphism of sulphide bearing rocks.

(3) Stability relations of pyrrhotite.

(4) Sphalerite and pyrrhotite as temperature indicators.

Project 2-54 - Geochemical studies

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

Five graduate students are working (1956-57) in association with Dr. Shaw. Present studies include

(1) Xenotime Studies - A quantitative spectrographic method was set up for the anlaysis of xenotime for yttrium, thorium, and uranium. The method has been applied to uraniferous xenotime from St. Simeon, Quebec and a complete mineralogical study was made of the sample.

(2) Skarn Minerals in Quebec and Ontario - Rocks rich in Ca-silicates are common in the Grenville Province and some containing scapolite, pyroxene, calcite, etc., pose special problems of genesis. Samples collected during 1954 and 1956 in Quebec and Ontario were studied petrographically in 1956 and described. The results will not be published at present, but are available to others working in the same field. About 50 samples were chosen for analysis, crushed, and separated to mineral fractions. Geochemical study is now proceeding by analysis of mineral series; where possible optical and X-ray studies will also be made. The aim of these studies is to provide definitive data on these minerals, some of which are poorly known; to provide data on minor element distribution in metamorphic environments; and to search for understanding of how the minerals formed.

Recent publications include:

Xenotime from St. Simeon, Charlevoix County, Quebec; Shaw. Denis M.; Canadian Mineralogist, Vol. 6, Pt. 1, 1957, pp. 61-67.

Project 3-54 - Mineralogy of the Sudbury Ores

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

Considerable progress has been made in 1957. The participation of Dr. R.L. Stanton, a National Research Council post-doctorate fellow, in this study is particularly welcome. Additional suites of ore minerals were obtained recently from Sudbury and 100 polished and thin sections were examined. Twenty-nine ore minerals have been identified, including stannite, bornite, native bismuth, bismuthinite, schapbackite (Ag_2S, Bi_2S_3), vallerite, petzite or hessite, and four others are still unidentified, two of which are possibly heazelwoodite and millerite. Palladium rich niccolite is still being studied to try to isolate a rare palladium mineral. Also discovered in a few specimens are the so called L and B phases of pyrrhotite, identified in the Insizwa ores but hitherto not noted at Sudbury.

Other studies include spectrographic determinations of Co:Ni ratios in pyrrhotite and pentlandite over the area and at depth. Trace element studies of different types of ore, both massive and disseminated, are also under way and heat treatment of ore specimens with varying sulphur and arsenic pressure are planned.

Recent publications include:

Intergrowths of Pentlandite and Pyrrhotite; Hawley, J.E., and Haw, V.E.; Economic Geology, vol. 52, No. 2, 1957.

Project 1-55 - Igneous and Metamorphic History of the Yellowknife Continental Nucleus

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

The principal results of this investigation are included in the following paper:

Archaean Monazite in Beach Concentrates, Yellowknife Geologic Province, Northwest Territories, Canada; Folinsbee, R.E.; Trans. Royal Society of Canada, 3rd Ser., Sect. IV, Vol. XLIX, 1955, pp. 7-24.

Project 4-55 - Weathering of Ores Under Surface and Underground Conditions

Under direction of Dean H.C. Gunning, University of British Columbia.

Crushed copper ore samples from the Britannia mine were leached by solutions percolating through 90 cm. tubes of 15 mm. diameter. The ore contains pyrite, chalcopyrite and sphalerite with negligible quantities of secondary copper sulphides in an "inert" gangue that is chiefly quartz, sericite, and chlorite. The importance of pyrite was demonstrated by tests with distilled water on pyritic and non-pyritic ore, the former leaching much more readily. The rate of leaching of copper is increased by the addition of sulphuric acid to a concentration of .001 N. Increased acidity has practically no effect.

There is an optimum concentration of ferric sulphate (around 0.01 M) above which increased concentration not only promotes no increased solution but hinders the reaction by deposition of "insoluable" salt. Ferric sulphate is probably involved in a catalytic cyclic reaction with pyrite or chalcopyrite resulting in the deposition of acid insoluable oxide or hydroxide. The existance of such an oxide has been demonstrated, but determinative studies are required.

Maximum solubility of copper (580 P.P.M.) was obtained at 0.01 N $H_2 So_4$ and 0.01 M. ferric sulphate. Many tests showed the extent of decreasing solubility above and below these concentrations. The conditions for maximum solubility approximate those of natural mine waters going to the leaching plant at the Britannia mine. The hindering effect of excessive ferric sulphate, with precipitation of ferric hydroxide (?) emphasizes the need for caution in any plan to recirculate mine waters as leaching solutions.

The results are embodied in a thesis by John A. Hansuld entitled "An Experimental Investigation of Some Factors Influencing the Rate of Leaching of the Britannia Copper Ore", M.Sc. thesis, University of British Columbia, 1956.

Project 1-56 - Dating Cordilleron Orogenies

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

The results are embodied in the following paper:

Dating Cordilleran Orogenies; Beveridge, A. J., and Folinsbee, R.E.; Trans. Royal Society of Canada, Vol. 1, Section IV, June 1956, pp. 19-43.

Project 3-56 - Vedder Mountain-Silver Lake Area, B.C.

Under direction of Dr. V.J. Okulitch, University of British Columbia.

This project has been completed and the results embodied in a M.Sc. thesis by Douglas N. Hillhouse entitled "Geology of the Vedder Mountain - Silver Lake Area", University of British Columbia, 1956.

APPENDIX II

GEOLOGICAL SURVEY OF CANADA RESEARCH GRANTS TC CANADIAN UNIVERSITIES 1957-58

NIVERSITY OF ALBERTA

Heat Flow Measurements in Western Canada

Applicant - G.D. Garland **Amount $1,000.00**

The aim of this project is to provide measurements of the outflow of heat from the earth's interior over that part of Western Canada where deep bore holes are avilable. It is hoped to determine if there are regional variations in heat flow, especially from the vincinity of the Precambrian Shield toward the Cordilleran Mountains.

The rate of outflow of heat from the earth's interior is important because present theories of mountain building and orogenesis are based on assumptions regarding the thermal state of the earth's interior which, in turn, are based on heat flow measurements.

Problems in Nuclear Geochronology

Applicant - R.E. Folinsbee **Amount $4,200.00**

For the past two years Dr. Folinsbee has been studying the history of the Yellowknife nucleus and of the Cordillera and related sedimentary rocks of the Western Canada basin, using the potassium-argon, lead alpha, and strontium-rubidium methods to date the ages of the rocks. He will continue this work of attempting to date and relate significant events in the orogenic and sedimentary history of the rocks of Western Canada.

NIVERSITY OF BRITISH COLUMBIA

Trace Element Study of Some rocks in Western Canada

Applicant - H.V. Warren **Amount $3,800.00**

This project involves the study of trace element relations existing between soils and rocks. The investigation involves the development of special chemical techniques supplemented by spectroscopy.

ECOLE PCLYTECHNIQUE

Mineralogy and Petrography of the Oka Alkaline Intrusions

Applicant - Guy Perrault **Amount $1,000.00**

The alkaline rocks of the Cka district of Quebec are of particular interest because of the deposits of columbium associated with them, which are presently under active development.

This project includes a detailed study of the mineralogy and petrography of these intrusions including study of the common rock forming minerals and the columbium minerals of the ore deposits. It is hoped the study may give some insight into the genesis of the alkaline rocks and the associated columbium deposits.

UNIVERSITY OF MANITOBA

Basic Intrusions in the Kenora-Fort William Area

Applicant - H.D.B. Wilson Amount $2,500.00

This project will involve fundamental petrographic and geochemical studies of the basic intrusions of this area. These rocks are of particular interest because of the nickel deposits associated with them at Gordon Lake, north of Kenora.

McGILL UNIVERSITY

Silicate and Sulphide Phase Relationships

Applicants - J.E. Gill, E.H. Kranck, V.A. Saull
Amount $3,600.00

This project was initiated in 1954. It involves experiments on the behaviour of silicates and sulphides at high pressures and temperatures to find out more about the formation of ores and the metamorphism of rocks.

Current work involves study of (1) deposition of sulphides from solution or suspension by changing P-T conditions (2) rheomorphism of sulphide bearing rocks (3) stability relations of pyrrhotite and (4) sphalerite and pyrrhotite as temperature indicators.

McMASTER UNIVERSITY

Greywackes of the Northern Appalachians

Applicant - G.V. Middleton Amount $1,200.00

The objective is to learn more about the petrography and geochemistry of this type of sedimentary rock of which relatively few petrographic, and still fewer geochemical studies have been made. The geochemical work will include study of the trace elements and selected major elements using spectrographic techniques. The ratio of Na to K is high in most greywackes. It is hoped these combined petrographic and chemical studies may indicate the reason for this and to what extent it is caused by the presence of fragments of Na rich volcanic rocks.

Geochemical Studies

Applicant - Denis M. Shaw Amount $3,800.00

A program of spectrochemical research on the distribution of minor elements in metamorphic rocks and minerals has been supported at McMaster University for the past six years. Investigation currently underway include (1) major and minor elements in the skarn minerals of the Quebec Grenville region (2) the relation of alkali contents to refractive index in scapolites (3) minor elements in pyroxenes (4) distribution of lithium in minerals of the Lacorne region, Quebec and (5) minor elements on the White Mountain magma series, N.H.

QUEEN'S UNIVERSITY

Publication of "Canadian Mineralogist"

Applicant - L.G. Berry, Editor   Amount $2,400.00

The Mineralogical Association of Canada was organized in 1954 and will publish the "Canadian Mineralogist" annually (the first number was published in September, 1957). Mineralogical studies are of interest to a relatively small group of readers in Canada and this makes it difficult to publish such a periodical without financial support for the first few years. This support will be on a diminishing scale as circulation, particularly outside Canada, is built up.

X-Ray Spectrographic Analysis of Minerals and Rocks

Applicant - L.G. Berry   Amount $2,200.00

The basic equipment for this research which was initiated in 1955 has been provided by a grant of $20,000 from the Atkinson Charitable Foundation. The Geological Survey of Canada grant will provide operating costs, including the services of a technician.

The research includes exploration of the application of the equipment to determination of Ti, Ca, K, Cl, P, Si and Al in rocks and minerals; determination of sulphur in minerals; and development of methods of sample preparation that will be applicable to qualitative and quantitative analysis of small samples of minerals. Some success has been attained in the determination of Cl, Ti, Ca, and K in minerals and rocks using the helium path attachment with the X-ray spectrograph.

Spectrographic and Geochemical Research on Rocks Minerals and Cres

Applicant - J.E. Hawley   Amount $4,600.00

This project has been supported for the past five years during which a scheme has been developed for the accurate analysis of siliceous rocks. Emphasis is presently being placed on the analysis of granites of the Grenville provinces of southeastern Cntario, including major constituents and trace elements. It is hoped the results of this study will assist in distinguishing granitic rocks formed from magmas from those produced by metamorphic processes. Similar geochemical studies are being made of the granitic basement rocks in the Algoma uranium area and on several granitic bodies in the Sudbury area. Geochemical study of the Grenville paragneisses, limestones, and basic intrusions is planned.

UNIVERSITY CF TCRONTC

Formation of Clay Minerals in Weathering

Applicants - A. Gorman and R.E. Deane   Amount $2,400.00

Although much is known about the properties and composition of the clay minerals, nothing is known of the time required for clays to form from minerals and rocks, and little is known about the genetic relationships between parent minerals and clays.

In this project, which was initiated in 1956, weathering effects on 25 minerals and six rock types will be investigated. Samples will be crushed and ground, separated into sized fractions, placed in natural environments above and below ground surface, and examined at intervals to find out the mineralogical changes that take place. The project, although of prime importance to the clay mineralogist, will be of interest to others in various fields of geology, pedology, and soil mechanics.

Annotated Bibliography and Index of Pleistocene Geology of Canada

Applicant - R.E. Deane | Amount $1, 050.00

No comprehensive bibliography exists, and a sound program of Pleistocene geology cannot be undertaken without knowledge of what has been done. The bibliography will supplement the Pleistocene map of Canada which is currently being compiled and the two will summarize our knowledge of Canadian Pleistocene geology and provide a framework for the detailed information that is accumulating.

Geological Age Determination

Applicant - Dr. J.T. Wilson | Amount $5, 000.00

This project has been supported by Geological Survey of Canada grants for the past six years. Work on potassium-argon age determinations was carried on in 1955 and 1956 and the results have been published. An argon line of improved design has now been completed and preliminary experiments have been successful. Ion exchange columns were set up to separate rubidium and strontium bearing solutions. It is hoped rubidium-strontium ages can be determined by the summer of 1957.

UNIVERSITY OF WESTERN ONTARIO

Scale Model Experiments of Electro-Magnetic Prospecting

Applicant - Robt. J. Uffen | Amount $1, 000.00

Several airborne electromagnetic prospecting devices developed in Canada are in use by the larger mining companies. Interpretation of the field results is difficult and largely empirical.

This project, which was initiated in 1954, will continue work involving scale model experiments of the electromagnetic response of typical geological structures, as an aid to the interpretation of field surveys. Measurements of amplitude and phase using good conducting sheets of various sizes and attitudes will be continued. The applicability of the theoretical treatment of disseminated metallic minerals will also be tested by using assemblies of closely packed metal spheres of various sizes.

Microfauna of the Kettle Point, Port Lambton, and Other Devonian Black Shales in Southern Cntario.

Applicant - G.C. Gordon Winder Amount $250.00

The age of these shales is in doubt--they may be Devonian or Mississippian. It is hoped that the differentiation, description, and correlation of the microfauna, particularly the conodonts, will aid in determining their correct stratigraphic position.

CURRENT RESEARCH IN THE GEOLOGICAL SCIENCES IN CANADA, JUNE, 1956 - MAY, 1957

Compiled by J. F. Henderson

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INTRODUCTION

The lists of research projects in the bibliography have been obtained from the universities, federal and provincial departments of mines, and other non-industrial institutions carrying on research in geological sciences in Canada; it does not include research by mining and oil companies. The survey was made from December 1956 to April 1957 and the bibliography records research in progress for about the period June 1956 to May 1957.

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

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 co-operation, many projects on which no information was received have not been recorded. So that succeeding compilations may be more complete, any reader doing research projects or knowing of projects that have been omitted, is requested to send information of them to the Secretary, National Advisory Committee on Research in the Geological Sciences, Victoria Museum, Ottawa.

The assistance of Dr. J. F. Wright in preparing the bibliography is gratefully acknowledged.

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. Gravenor, C. P., Bayrock, L. A. and Ellwood, B., Research Council Alberta:
   Mapping of Surficial Deposits in East-Central Alberta, 1954-
   Publications - Glacial Geology of Castor District, Pub. 56-2, Research Council of Alberta; Stream Trenches in East-Central Alberta, Pub. 56-5, Research Council of Alberta.

2. Norris, D. A., and Greiner, H. R., Geol. Surv., Canada:
   Livingstone Map-area, 1 inch to 1 mile, 1955-56.

3. Price, R. A., Geol. Surv., Canada (part time):
   Flathead North Map-area, (East Half), 1 mile to 1 inch, 1956-57.

4. Stalker, A. M., Geol. Surv., Canada:
   Geological Study and Mapping of the Surficial Deposits, MacLeod Map-area, (West Half), 1 inch to 4 miles, 1956-57.

5. Godfrey, John D., Research Council of Alberta:
   Geological Mapping Precambrian Shield area of Northeastern Alberta, 1957.

British Columbia

6. Brown, A. Sutherland, B. C. Dept. of Mines:
   Geological Reconnaisance of the Cariboo Mountains, 1954-

7. Carr, J. M., B. C. Dept. of Mines:
   Detailed Mapping of Eastern Part of Iron Mask Batholith near Kamloops, 1956;
   Highland Valley Area, 1956-

8. Christie, R. L., Geol. Surv., Canada:
   Plutonic Rocks of the Coast Range Batholith in the Bennett Area, 1951-57; Ph. D. thesis, Univ. of Toronto.

9. Danner, Wilbert R.; Univ. of B. C.:
   Regional Geology of Southeastern British Columbia and Northwestern Washington, 1948-
   Publication - Geology of Olympic National Park, Univ. of Washington Press, 1955.

10. Eastwood, G. E. P., B. C. Dept. of Mines:
    Detailed Studies of Ferguson Area, Lardeau District 1953-57.

11. Fyles, J. G., Geol. Surv., Canada:
    Surficial Deposits of the Coastal Lowland along East Coast of Vancouver Island, 1 inch to 2 miles, 1956-58

12. Fyles, J. T., and Hewlett, C. G., B. C. Dept. of Mines:
Geological Reconnaissance of Kootenay Lake Area, 1956.
Structure and Stratigraphy of the Salmo Lead-Zinc Belt, 1951-56.

13. Hughes, J. E., B. C. Dept. of Mines:
Geologic Section through the Rocky Mountains and Foothills along the Hart Highway, 1954-57.
Field work in 1956 completed the structural mapping of Commotion Creek anticline and detailed stratigraphy of Lower Cretaceous formations east of the Rocky Mt. overthrust at upper Pine River bridge.

14. Irish, E. J. W., Geol. Surv., Canada:
Charlie Lake Map-area, 1 inch to 4 miles, 1955-58.

15. Leech, G. B., Geol. Surv., Canada:
Fernie Map-area, 1 inch to 4 miles, 1956-58
Canal Flats Map-area, 1 inch to mile, 1953-56.

16. Little, H. W., Geol. Surv., Canada:
Kettle River Map-area, 1 inch to 4 mile, 1952-56.

17. Price, R. A., Geol. Surv., Canada (part time):
Flathead North Map-area, 1 inch to 1 mile, 1956-57.

18. Reesor, J. E., Geol. Surv., Canada:
Lardeau Map-area, 1 inch to 4 miles, 1953-56.

19. Roots, E. F., Christie, R. L., Gabrielse, H., Green, L. H., McCartney, W. D., Roddick, J. A., and Souther, J. G., Geol. Surv., Canada:
"Operation Stikine", 1 inch to 4 miles, 1956
The geological study and mapping of six 4 mile to 1 inch map areas in northwestern British Columbia using helicopters.

20. Thompson, R. M., White, W. H., and McTaggart, K. C., Univ. of B. C.
Geology of Highland Valley, 1955-57.

21. Tipper, H. W., Geol. Surv., Canada:
Anahim Lake Map-area, 1 inch to 4 miles, 1954-57.

22. Vail, J. R., Univ. of B. C.:
Racing River Area, 1956-57
Reconnaissance of part of Rocky Mts. of northeastern B. C. See abstract M. Sc. thesis, Canadian Mining Journal, June, 1957, p. 163.

23. White, W. H., Univ. of B. C.:
Mineral Deposits of Highland Valley Area, 1955-56
A field and laboratory study of the geology and mineralization in the area.
Structural Map of British Columbia.

Manitoba

24. Allen, C. M., Manitoba Mines Branch (part time):
Central Oxford Lake Area, 1956-57
Carghill Island Lake Area, 1956-57.

25. Davies, J. F., Manitoba Mines Branch:
Winnipeg River Area, 1956-57

26. Heywood, W. W., Geol. Surv., Canada:
Detailed Geological Study and Mapping of
Schist Lake Map-area, 1954-56.

27. Milligan, G. C., Manitoba Mines Branch:
Metamorphism and Structure, Lynn Lake Area, 1954-57.

28. Mulligan, R., Geol. Surv., Canada:
Split Lake Map-area, 1 inch to 4 miles, 1955-56.

29. Quinn, H. A., Geol. Surv., Canada:
Big Sand Lake Map-area, 1 inch to 4 miles, 1955-56.
Island Lake Map-area, 1 inch to 4 miles, 1956-57.

New Brunswick

30. Anderson, F. D., Geol. Surv., Canada:
Big Bald Mountain Map-area, 1 inch to 1 mile, 1956-57

31. Dawson, K. R., Geol. Surv., Canada:
Sevogle Map-area, (West Half), 1 inch to 1 mile, 1956.

32. Patterson, J. A., and McCallister, A. L., Univ. of New Brunswick
Canterbury Map-area, (West Half), 1956-57

33. Petruck, Wm., McGill University:
An Area Along Clearwater River, 1956-58; Ph. D. thesis.

34. Poole, W. H., Geol. Surv., Canada:
Burtt's Corner Map-area, 1 inch to 1 mile, 1956-57

35. Sharpe, J. I. and MacKenzie, G. S., Univ. of New Brunswick.
Variation and Structural Relationships of
Mt. Champlain Granitic Rocks in
Hampstead Map-area, 1956-57

36. Smith, C. H., Geol. Surv., Canada:
California Lake Map-area, 1 inch to 1 mile, 1955-56.

Newfoundland and Labrador

37. Bahyrycz, George D., McGill University:
Grey River, Nfld., 1956-57; M.Sc. thesis.

38. Baird, D. M., Newfoundland Dept. Mines and Resources:
Fogo Island Map-area, 1955-56
Deer Lake Map-area, 1954-57.

39. Henderson, E. P., Geol. Surv., Canada:
Surficial Deposits of Conception Bay Map-area, 1 inch to 4 miles, 1956-57.

40. Jackson, Garth D., McGill University
Geology of Area West of Wabash Katsao Lake, Labrador, 1954-57; Ph.D. thesis.

41. Jenness, S. E., Geol. Surv., Canada:
Terra Nova Map-area, Nfld., 1 inch to 4 miles, 1955-56.

42. McCartney, W. D., Geol. Surv., Canada:
Dildo Map-area, Nfld., 1 inch to 1 mile, 1954-57
Western Avalon Peninsula Map-area, 1 inch to 4 miles, 1954-57.

43. Mann, E. L., McGill University:
Seal Lake Area, Central Labrador, 1956-57; Ph.D. thesis.

44. Neale, E. R. W., Geol. Surv., Canada:
Nippers Harbour, Nfld., 1 inch to 1 mile, 1956-57.

45. Riley, G. C., Geol. Surv., Canada:
Victoria Lake Map-area, 1 inch to 4 miles, 1954-56.

46. Williamson, D. H., Newfoundland Geological Survey (part time)
Mt. Allison Univ.:
Geology of St. Lawrence Area, Newfoundland, 1955-57.

Northwest Territories.

47. Blackadar, R. B., Geol. Surv., Canada
Geological Reconnaissance in Northwest Baffin Island, 1956-57.

48. Fraser, J. A. and Davison, W. L., Geol. Surv., Canada:
Hardisty Lake (West Half), 1 inch to 4 miles, 1956-57

49. McGlynn, J. C., Geol. Surv., Canada:
Marion River, 1 inch to 1 mile, 1955-56.

50. Riley, G. C., Geol. Surv., Canada:
Cumberland Sound Area, Baffin Island, 1952-57; Ph. D. thesis, McGill University.

51. Taylor, F. C., Geol. Surv. Canada:
Snowbird Lake Map-area, 1 inch to 4 miles, 1955-56.

52. Thorsteinsson, R. and Tozer, E. T., Geol. Surv., Canada:
Reconnaissance Geological Survey of Eureka Sound, Nansen Sound, and Greely and Canyon Fiords, 1956-57.

Nova Scotia

53. Cameron, H. L., Nova Scotia Research Foundation:
Geological and Tectonic Map of Nova Scotia, 1 inch to 4 miles.
Memoir to accompany map is underway.
See "Airphoto Interpretation of a Province", Canadian Surveyor, April 1956, pp. 100-102.

54. Kelley, D. G., Geol. Surv., Canada:
Whycocomagh Map area, 1 inch to 1 mile, 1955-56.

55. Kline, Nova Scotia Research Foundation (part time), University of Kansas:
Wolfville Area, 1956-57
An intensive study of the Triassic sediments and volcanic rocks of the Blomidan. Fossil confirmation of the Newark age of these sediments has been found. Heavy and other mineral analyses are being carried out.

56. Smitheringale, W. G., Geol. Surv. Canada (part time):
Nictaux and Torbrook Map-areas, 1 inch to 1 mile, 1956-58.

57. Stevenson, I. M., Geol. Surv., Canada:
Kennetcook Map-area, 1 inch to 1 mile, 1955-56.

Ontario

58. Abraham, E. M., Ontario Dept. Mines:
Blind River Area, District of Algoma, 1 inch to 1/2 mile, 1953 -

59. Appleyard, E. C., Grad. Student, Queen's University:
Wolf Nepheline Belt East of Bancroft, 1956-58.

60. Armstrong, H. S., Ont. Dept. Mines (part time), McMaster University:
Glamorgan and Monmouth Townships, 1 inch to 1/2 mile, 1952-57.

61. Evans, A. M., Ont. Dept. Mines (part time):
Ashby Township, Lennox and Addington Counties, 1 inch to 1/2 mile, 1956-67.

62. Ferguson, S. A., Ont. Dept. Mines:
Tisdale Township, District of Cochrane, 1956-57.

63. Frarey, M. J., Geol. Surv. Canada:
Huronian Rocks North of Lake Huron Commencing in Echo River Map-area, 1 inch to 1 mile, 1956-57.

64. Gadd, N. R., Geol. Surv., Canada:
Surficial Geology of Ottawa Map-area, 1 inch to 1 mile, 1956-57.

65. Ginn, R. M., Ont. Dept. Mines (part time):
Porter Township, District of Sudbury, 1 inch to 1000 ft., 1956-57.

66. Hewitt, D. F., Ont. Dept. Mines:
Methuen Township, Peterborough County, 1 inch to ½ mile, 1956-57.

67. Hughes, O. L., Geol. Surv., Canada:
Surficial Geology of Iroquois Falls Map-area, (East Half), 1 inch to 4 miles, 1955-56.

68. James, William, McGill Univ.:
Dungannon and Mayo Townships, 1954-57;
Ph. D. thesis.

69. Johnston, W. G., Ont. Dept. Mines:
Kakagi Lake Area, District of Kenora, 1 inch to ½ mile, 1956.

70. Langford, F. F., Ont. Dept. Mines, (part time):
Levack Township, District of Sudbury, 1 inch to ½ mile, 1956-58.

71. Liberty, B. A., Geol. Surv., Canada:
Manitoulin Island, 1 inch to 4 miles, 1954-56.

72. Moorhouse, W. W., Ont. Dept. Mines (part time), University of Toronto,
Gunflint Iron Formation in the Port Arthur Region, 1950-57.

73. Pye, E. G., Ont. Dept. Mines:
Georgia Lake, District of Thunder Bay, 1 inch to 1 mile. 1956.

74. Stevenson, John S., McGill University:
Problems of Sudbury Geology, 1952 -

75. Thomson, J. E., Ont. Dept. Mines:
Geology of Interior of the Sudbury Basin, 1953-58
See "Geology of Sudbury Basin", Jas. E. Thomson, Ont. Dept. Mines, 65th Annual Report, Vol. LXV, Pt. 3, 1956, pp. 1-56.
Falconbridge Township, District of Sudbury, 1 inch to 1 mile, 1954-56.

76. Thomson, R., Ont. Dept. Mines:
Cobalt Area, District of Temiskaming, 1948-58.

Prince Edward Island

77. Prest, V. K., Crowl, C. H. and Frankel, L., Geol. Surv., Canada:
Geological Mapping and Study of Prince Edward Island, 1953-56.

Quebec

78. Beland, Jacques, Quebec Dept. Mines:
Ste. Felicite-Grosses Roches Area, Gaspe, 1 inch to 1 mile, 1956-57
See Preliminary Report, Quebec Dept. Mines, P.R. No. 339, Map. No. 1166, 1957.

79. Benoit, Fernand, Quebec Dept. Mines (part time), Laval Univ.:
St. Sylvestre Area, Eastern Townships, 1 inch to 1 mile, 1956-57; D.Sc. thesis.

80. Berard, Jean, Quebec Dept. Mines (part time), Yale University:
Bones Lake Area, New Quebec, 1 inch to 1 mile, 1956-57; Ph.D. thesis; See Prel. Report Quebec Dept. Mines, P.R. No.342, Map 1170, 1957.

81. Bergeron, Robert, Quebec Dept. Mines:
Brochant-De Bonnard Area, New Quebec, 1 inch to 1 mile, 1956-57
Late Precambrian Rocks of North Shore of the St. Lawrence River and Mistassini and Otish Mountain Areas, Quebec; Paper read at Annual Meeting, Royal Society Canada, Montreal, June, 1956.
Proterozoic Rocks of the Northern Part of the Labrador Geosyncline, the Cape Smith Belt, and the Richmond Gulf Area; Paper read at Annual Meeting, Royal Society of Canada, Montreal, June, 1956.

82. Blais, Roger, Quebec Dept. Mines:
Geology and Mineral Deposits on the North Shore of the St. Lawrence River; Paper presented Annual Meeting, Prospectors and Developers Association, Toronto, March, 1956.

83. Deland, A. N., Quebec Dept. Mines:
Duquet Area, Mistassini Territory, 1 inch to 1 mile, 1956-57; Preliminary Report Quebec Dept. Mines, P.R. No. 331, Map No. 1158, 1957.
Boundary Between Temiskaming and Grenville Subprovinces in Surprise Lake Area; Geol. Assoc. Canada, Proceedings, Vol. 8, Pt. I, Nov., 1956.

84. de Romer, Henry, Quebec Dept. Mines (part time), McGill Univ.:
St. Etienne de Bolton Area, Eastern Townships, 1 inch to 1000 feet, 1956-57; Ph. D. thesis; Preliminary Report, Quebec Dept. Mines, P.R. No. 344, Map No. 1171, 1957.

85. Duffel, S., Geol. Surv., Canada:
Mount Wright Map-area (West Half), 1 inch to 4 miles, 1956-.

86. Dugas, Jean, Quebec Dept. Mines:
Compilation of Geology of Rouyn-Noranda District, 1 inch to 1000 feet; a continuing program.

87. Eade, K. E., Geol. Surv., Canada:
Preliminary Geological Reconnaissance of the Fort George River and Kaniapisku River (West Half) Map-areas, 1 inch to 8 miles, 1956-57.

88. Emo, Wallace B., Quebec Dept. Mines (part time), McGill University:
Duprat Township (Part of Northwest Quarter), Rouyn-Noranda, 1 inch to 1000 feet, 1956-57; Ph.D. thesis.

89. Freeman, P. V., Quebec Dept. Mines (part time), McGill Univ.:
Beraud-Mazerac Area, Rouyn-Noranda County, 1 inch to 1 mile, 1954-57; Ph.d. thesis
Darlens-Chabert Area, Rouyn-Noranda, 1 inch to 1 mile, 1956-57; Preliminary Report, Quebec Dept. Mines, P.R. No. 341, Map 1168, 1957.

90. Gadd, N. R., Geol. Surv., Canada:
Surficial Geology of Ottawa Map-area, 1 inch to 1 mile, 1956-57

91. Gelinas, Leopold, Quebec Dept. Mines (part time), Princeton Univ.:
Thevenet Lake Area (East Half), New Quebec, 1 inch to 1 mile, 1956-57; Ph.D. thesis.

92. Gillett, L. B., Quebec Dept. Mines (part time), Princeton Univ.:
Vienne Area, Abitibi Territory and Abitibi East, 1 inch to 1 mile, 1956-57; Preliminary Report, Quebec Dept. Mines, P.R. No. 337, Map 1164, 1957.

93. Gorman, W. A., Quebec Dept. Mines (part time), Queen's Univ.:
Botsford-Robinson Area, Temiscouata County, 1 inch to 1 mile, 1956-57.

94. Horscroft, F. D., Quebec Dept. Mines (part time), McGill Univ.:
Part of Southeast Quarter of Roy Township, Abitibi East, 1 inch to 1000 feet; 1956-57; Ph. D. thesis.

95. Jenkins, J. T., Quebec Dept. Mines (part time), McGill Univ.:
Manitou Lake Area, Saguenay County, 1 inch to 1 mile, 1956-58; Ph.D. thesis.

96. Karrow, Paul F., Geol. Surv., Canada:
Pleistocene and Recent Deposits of Grondines Map-area, 1 inch to 1 mile, 1955-56.

97. Kretz, R. A., Quebec Dept. Mines (part time), Univ. of Chicago:
Litchfield-Huddersfield Area, Pontiac Co., 1 inch to 1 mile, 1956-57; Prel. Rept. Quebec Dept. Mines, P.R.338 Map No. 1165, 1957.

98. Klugman, M. A., Quebec Dept. Mines (part time);
Doncaster Area, Terrebonne and Montcalm, 1 inch to 1 mile; Prel. Rept. Quebec Dept. Mines, P. R. No. 335, Map No. 1162, 1957.

99. Latulippe, M., Quebec Dept. Mines:
Compilation of Geology of the Val d'Or District, 1 inch to 1000 feet; a continuing program.

100. Laurin, A. F., Quebec Dept. Mines, Laval University:
Lorne-Avaugour Area, Roberval, 1 inch to 1 mile, 1956-57; D. Sc. thesis; Prel. Rept. Quebec Dept. Mines, P.R. No. 329, Map 1157, 1956.

101. Lyall, H. B., Quebec Dept. Mines (part time), Laval University:
Hainaut-Champagne Area, Pontiac, 1 inch to 1 mile, 1956-57; D. Sc. thesis; Prel. Rept., Quebec Dept. Mines, P. R. No. 345, Map 1172, 1957.

102. Marleau, R. A., Quebec Dept. Mines, (part time), Laval Univ.:
Woburn Area, Frontenac, 1 inch to 1 mile, 1956-57; D. Sc. thesis, 1958; Prel. Rept., Quebec Dept. Mines, P. R. No. 336, Map 1163, 1957.

103. Mattinson, C. . ., Quebec Dept. Mines (part time), McGill Univ.:
Parts of Boutet and Mount Logan Areas, Gaspe 1 inch to 1 mile, 1956-57; Ph.D. thesis, 1958.

104. Morin, Marcel, Quebec Dept. Mines:
Labrieville Area, Saguenay Co., 1 inch to 1 mile, 1955-57; D. Sc. thesis, Laval Univ.; Prel. Rept. Quebec. Dept. Mines, P.R. No. 333 Map No. 1160, 1956.

105. Maurice, O. D., Quebec Dept. Mines:
A New Look at the Geology of the Oka Hills;
Paper presented at Annual Meeting,
Prospectors and Developers Association,
Toronto, March, 1956.

106. Osborne, F. F., Laval University:
Transition Zone Between Grenville and Keewatin Sub-provinces, 1956-57.

107. Pollack, D. W. T., Quebec Dept. Mines (part time),
McGill University:
Labelle-Preston Area, Labelle and Papineau,
1 inch to 1 mile, 1955-57; Ph.D. thesis;
Prel. Rept., Quebec Dept. Mines, P.R. No. 334,
Map 1161, 1957.

108. Rejhcn George, McGill University:
Study of the Ordivician Breccias Near Matane,
1955-57; M.Sc. thesis.

109. Remick, J. H., Quebec Dept. Mines (part time), Univ. of Michigan:
Guercheville-Lapparent Area, Abitibi East,
1 inch to 1 mile, 1956-57; Ph. D. thesis;
Prel. Rept. Area, Dept. of Mines, P.R. No. 343,
Map No. 1169, 1957.

110. Sauve, Pierre, Quebec Dept. Mines:
De Freneuse Lake Area (West Half), New Quebec,
1 inch to 1 mile, 1956-57; Prel. Rept.
Quebec Dept. Mines, P.R. No. 332, Map No.
1159, 1956.

111. Skidmore, W. B., Quebec Dept. Mines (part time),
Princeton Univ.:
Mourier-Vondenvelden Area, Gaspe,
1 inch to 1 mile, 1956-57

Saskatchewan

112. Bell, C. K., Geol. Surv., Canada:
Milliken Lake Map-area, Athabaska Lake,
1 inch to 1000 feet, 1954-59.

113. Cheesman, R. L., Saskatchewan Dept. Mineral Resources:
Mari Lake Area, 1 inch to 1 mile, 1955-56;
Sask. Dept. Mineral Resources, Rept. No. 23,
Wapus Bay Area, Reindeer Lake,
1 inch to 1 mile, 1956-57.

114. Fahrig, W. F., Geol. Surv., Canada:
Wollaston Lake Map-area, 1 inch to 4 miles, 1956-57

115. Kirkland, S. J. T., and Budding, A. J., Saskatchewan Dept. Mineral Resources:
Reindeer River Area, 1 inch to 1 mile, 1955-56.

116. Kirkland, S. J. T., Saskatchewan Dept. Mineral Resources,
Manawan Lake Area, Northern Saskatchewan, 1 inch to 1 mile, 1956-57.

117. Kupsch, W. O. and Wild, J., Univ. of Saskatchewan:
Submask Geology, 1956-; Submask Geology in Saskatchewan, International Willeston Basin Symposium, Vol. I (in press).

118. Pearson, W. J., Saskatchewan Dept. Mineral Resources,
Geology Around Deep Bay Crater, Reindeer Lake, 1956-
An investigation in co-operation with W. Innes, Dominion Observatory, to discover possible evidence for the meteoric origin of Deep Bay.

119. Tremblay, L. P., Geol. Surv., Canada:
Beaverlodge Area, Athabaska Lake, 1 inch to 1000 feet, 1952-57.

120. Taylor, F. C., Geol. Surv., Canada:
Pelican Narrows Map-area, 1 inch to 4 miles, 1956-57.

Yukon Territory

121. Green, L. H., Geol. Surv., Canada
McQueston Lakes Map-area, 1 inch to 1 mile, 1955-57.

122. Muller, J. E., Geol. Surv., Canada:
Kluane Lake Map-area, 1 inch to 4 miles, 1950-56.

123. Wheeler, J. O., Geol. Surv., Canada:
Quiet Lake Map-area, 1 inch to 4 miles, 1956-58.

ENGINEERING GEOLOGY

124. Bozozuk, M., Div. of Building Research, National Research Council:
Swelling and Shrinkage of Clays, 1956-
There has been extensive damage to houses due to swelling and shrinkage of clays. One area in central Ottawa has been observed for 3 years for (1) relation, if any, between damage and soil type (2) observation of ground movements and correlation of climatic data and (3) laboratory study of swelling and shrinkage of clays; See "Seasonal Movements in Some Canadian Clays", A. Baracos and M. Bozozuk, Proceedings of Fourth International Conference on Soil Mechanics and Foundation Engineering, London, 1957.

125. Beland, Jacques, Quebec Dept. Mines:
Nicolet Landslide, Quebec
Geol. Assoc. Canada, Proceedings, Vol. 8, Pt. I, 1956.

126. Brown, R. J. E., Div. of Building Research, National Research Council:
Permafrost Boundary in Canada, 1953-
Field observations in the provinces of Manitoba, Ontario, and Quebec were carried out during 1956. Current literature on permafrost distribution has been tabulated.

127. Crawford, C. B., and Eden, W. J., Div. of Building Research National Research Council:
Quebec North Shore and Labrador Railway, 1953-
The performance of various soil formations encountered by the railway are under observation particularly the slopes cut in the surface clays of the Moisie valley. The work is being done in conjunction with railway officials.

128. Crepeau, Pierre, Grad. student, Ecole Polytechnique:
Geology of Proposed Damsite at Carillon, Quebec, 1956-59.

129. Eden, W. J., Crawford, C. B., Burn, K. N. and Hamilton, F. J., Div. of Building Research, National Research Council,
Geotechnical Properties of Eastern Marine Clay, 1957-
In conjunction with other investigations, geotechnical data from borings is being assembled and correlated. See "Geotechnical Properties of Leda Clay in the Ottawa Area", Proc. Fourth Internat. Conference on Soil Mechanics and Foundation Engineering, London, 1957.

130. Holland, Stuart S., B. C. Dept. of Mines:
Studies of Landslides along the P.G.E. Railway at Peace River Bridge and elsewhere along the Line; Preliminary Investigation of Geology at Proposed Moran Damsite.

131. Legget, R. F., Crawford, C. B., and Penner, E., Dir. of Bldg. Research, National Research Council:
Ground Temperatures and Frost Action, 1948-
Ground temperatures are being measured at several locations across Canada and, with the co-operation of municipal authorities, data is being collected in several cities. See "Climate in Relation to Frost Action", Technical Paper No. 28, D.B.R., N.R.C., No. 3746, Jan. 1956; "Protection of Utilities Against Permafrost in Northern Canada", Research Paper 24, D.B.R., N.R.C., No. 4056, Sept. 1956; Ground Temperature studies on Canada Engineering Journal of Canada (in press).

132. Leggett, R. F. and Eden, W. J., Div. of Building Research, National Research Council:
Clays of Steeprock Lake, Ontario, 1948-

133. MacFarlane, Ivan C., Div. of Building Research, National Research Council:
Muskeg Research, 1954-
A survey of relevant literature on peat and muskeg is continuing, with the ultimate view of compiling a comprehensive annotated bibliography. Laboratory investigations will include the measurement of physical and mechanical properties of peaty material. Appropriate field tests will be carried out in an attempt to correlate the classification system which has been developed for muskeg, with the strength characteristics of peaty material. See "Preliminary Annotated Bibliography on Muskeg", Bibliography No. 11, D.B.R., N.R.C., 1955"; Techniques of Road Construction over Organic Terrain", Roads and Engineering Construction, vol. 94, No. 7, 1956.

134. Nasmith, H. W., B. C. Dept. of Mines:
Studies of Landslides Along the P.G.E. railway and the Reeves MacDonald Mine near Salmo
Geological Study of Damsite on Fraser River near Pavilion.

135. Owen, E. B., Geol. Surv., Canada:
St. Lawrence Seaway Investigations, 1953-57
Geological engineering problems in the planning and construction of the Seaway.

136. Pihlainen, J. A., and Johnston, G. H., Div. of Building Research, National Research Council:
Northern Research Station, Norman Wells, N.W.T: 1952-
Continued observations on evapotranspiration installation.
Aklavik Relocation Project, 1954-
Soil temperature measurements are continuing. Observations on the rate of annual thaw was carried out in selected areas during July, August and September, 1956. See - "Soils in Some Areas of the Mackenzie River Delta Region", Technical Paper No. 4096, N.R.C., Oct. 1956.

137. Taylor, R. S., Univ. of Alberta:
A Study of Frost Heaving, 1956-57.

GEOCHEMISTRY

138. Anderson, D. J., Univ. of Manitoba:
Distribution of Cu, Ni, Co, and S in the Copper-Nickel Deposits of Northwestern Ontario and Southeast Manitoba, 1956-58; M.Sc. thesis.

139. Assad, R.J. McGill Univ.:
Geology of Sullivan Copper-Zinc Deposits, Quebec with Special Reference to Temperature of Sulphide Formation, 1955-57; Ph.D. thesis.

140. Berrange, Jevan P., McGill University:
Dispersion of Certain Metals from Mineralized Zones in Glaciated Precambrian Terrain as Indicated by Humus and Moss, 1955-57; M.Sc. thesis.

141. Boyle, R. W., Wanless, R. K., and Lowdon, J.A., Geol. Surv., Canada:
Isotope Chemistry of Sulphur in Rocks and Ore Deposits, 1955 -

142. Bradshaw, B. A., Grad. Student, Univ. of Toronto:
Petrographical Comparison of Lake Superior Iron Formations, 1954-57.

143. Bright, N. F. H., Mines Branch, Dept. Mines and Technical Surveys:
High Temperature Phase Equilibrium of Titania Slag Constituents (System FeO-TiO_2 or Fe-Ti-O), 1954-
The extent of solid solution in the ilmenite-titanite series is being examined by chemical metallographic, and X-Ray diffraction methods.

144. Buchanan, R. M., Mines Branch, Dept. Mines and Technical Surveys:
Distribution of Lithium in spodumene-bearing Pegmatites, 1956-57.

145. Byers, A. R., Univ. of Saskatchewan:
Geochemistry of the Heavy Metals as related to Soils and Waters, 1954-57.

146. Claisse, Fernand, Quebec Dept. Mines:
Accurate Analysis by X-Ray Fluorescence Without Internal Standard, 1955-56.
See - "Accurate X-ray Fluorescence Analysis Without Interval Standard", Quebec Dept. Mines, Prel. Rept. 327.

147. Clark, Lloyd A., McGill Univ.:
Thermal Study of the Hexagonal Orthorhombic Transition in Pyrrhotite, 1955-57; Ph.D. thesis.

148. Czamanske, Gerald, Grad. Student, Queen's Univ.:
An Ultrabasic Mass, Birchy Lake, Newfoundland, 1956-57.
A geochemical study of serpentinized ultrabasic rock and its alteration in the vicinity of granitic intrusions, 1956-57.

149. Cumberlidge, John T., McGill University:
Surface and Strain Energy in Minerals, 1954-57; Ph.D. thesis.

150. Delavault, R. E., Univ. of B. C.:
Biogeochemical Exploration, 1947-
See "Biogeochemical Prospecting in Northern Latitudes", Trans. Roy. Soc. Canada, Sec. IV, Vol. 49, 1955.

151. Emslie, R. F., Univ. of Manitoba:
Age Determination of Granites in Northwest Ontario by the Zircon Method, 1956-57; M.Sc. thesis

152. Ermengen, S. V., Quebec Dept. Mines (part time):
Investigations of Geochemical Prospecting Methods in the Chibougamau Region, Quebec, 1955-57; Ph.d. thesis, McGill University.

153. Farquhar, R. M., Univ. of Toronto:
Determination of Geological Ages of Rocks and Minerals, 1951-
See "Economic Significance of Basement Subdivisions and Structures in Canada", Bull. Can. Inst. Min. and Met., vol. 49, No. 352, 1956.

154. Filby, R. H., and Shaw, D. M., McMaster University:
Establishment of Spectroscopic Methods for Quantitative Analysis of the Major Elements of Minerals and Rocks, 1956-57.

155 Folinsbee, R. E., Univ. of Alberta:
Dating Cordilleran Orogenies, 1954-
See Royal Soc. of Canada, Vol. L, Sect. IV, 1956 and "Potassium Argon Dating" Geochimica et Cosmochimica Acta, Vol. 10, No. 1/2, 1956.

156. Gravenor, C. P., and Godfrey, J. D., Research Council of Alberta:
Low Temperature Silicate Growth, 1956-60.

157. Gorman, D. H. and Deane, R. E.; Univ. of Toronto:
Weathering of Rocks and Minerals, 1956-61.

158. Gill, J. E., Kranck, E. H., and Saull, V. A., McGill University:
Silicate and Sulphide Phase Relationships, 1954-
Work to date has been chiefly the study of the behaviour of minerals at high temperatures and pressures. This has involved the design and construction of new apparatus for applying shear stress to samples at high temperature and pressure, and development of a new method for determining solubilities of minerals using radioactive tracers.

159. Hawley, J. E., and MacDonald, G., Queen's Univ.:
Spectrographic Analysis of Rocks and Minerals, 1950-,
Present work includes analyses of serpentines, investigation of use of argon and oxygen in the determination of the rare earths, using the Stallwood air-jet, and fluorescence methods using a helium path attachment. See "Quantitative Spectrochemical Analyses of Some Silicate and Carbonate Rocks using the Stallwood Air-Jet", Geochemica et Cosmochimica Acta, 1956, Vol. 10, pp. 197-223.

160. Hawley, J. E., Pearson, G. R., Robertson, J., Brett, S. and MacDonald, G., Queen's University:
Geochemistry of Granitic Rocks in the Grenville Sub-Province, Ontario and in the Basement Rocks of the Blind River Area, 1954-58.
Comparative studies of bulk composition of granitic rocks in the Grenville Clare River syncline with some in the Superior sub-province.

160. Jones, R. E., Univ. of Toronto:
A Critical Study of Phase Relations at the Pegmatite Stage, 1953-57; Ph. D. thesis.
Silicate-Water Phase Relations, 1955-57
A quantitative restudy of a selected silicate-water system (simulating granite-pegmatite composition) with minor variations of composition and variations of temperature, but keeping the degree of filling of the system comparable to that in depth in the earth.

161. Kidd, Donald J., Research Council of Alberta:
Geochemistry of Beryllium, 1956-60
An extension of an investigation commenced at the Univ. of Toronto of the system H_2O-BeO-Al_2O_3-SiO_2-NaF-P_2O_5 into the region of high temperature and pressure.

162. Lapkowsky, W. W. and Shaw, D. M., McMaster Univ.:
Geochemical Study of Calcites, 1956-57.
A study, by spectrographic methods, of the composition of calcites associated with radioactive deposits in the Grenville province.

164. Maynes, A. D., Univ. of Toronto:
Determination of Trace Amounts of Metals in Rocks and Minerals, 1956 -

165. McNeice, D. G., Queen's Univ.:
Geochemistry of Cobalt in Sulphide Ores, 1956-58.

166. Maxwell, J. A., Geol. Surv., Canada:
Analyses of Rocks and Minerals and Investigation of New Methods of Analysis.

167. Montgomery, D. S., and Goodspeed, F., Dept. Mines and Technical Surveys:
The Infra-red Absorption of Bituminous Substances, 1951 -

168. Morse, A. S., McGill University;
Chemical Variations in Metamorphic Rocks, 1955-57; M.Sc. thesis.

169. Nichol, Ian, Grad. student, Queen's Univ.;
Trace Elements in Contemperaneous Sulphides of Canadian Copper Ores, 1956-58.

A comparative study to determine partition of trace elements in pyrite, pyrrhotite, and chalcopyrite of sulphide deposits.

170. Palmer, H. C., Moxham, R. L., and Koeller, G. F., Geol. Surv., Canada:
Geochemical Exploration of Southwestern Nova Scotia, 1956-57.

Exploration by geochemical means in an effort to locate and outline areas likely to contain valuable deposits of base or other metals.

171. Prince, A. T., and Bright, N.F.H., Mines Branch, Dept. Mines and Technical Surveys:
High Temperature Phase Equilibrium Studies in the System $CaO-Nb_2O_5-SiO_2$, 1956-57.

The range in composition and temperature stability of niocalite, a Ca-Nb silicate is being studied by quench techniques.

172. Prince, A. T., Mines Branch, Dept. Mines and Technical Surveys:
High Temperature Phase Equilibrium Studies in the System $MgO-TiO_2-Fe_2O_3-SiO_2$, 1955-57

The system $2MgO.\ TiO_2-2MgO.\ SiO_2-MgO,\ Fe_2O_3$ has been studied by the cone diffusion and X-Ray diffraction methods and the ternary system $MgO-TiO_2 - SiO_2$ is being studied by quench techniques.

173. Relly, B.H., McGill University:
A Technique for Determining the Solubility of Sulphides, 1955-57; M.Sc. thesis.

174. Ritchie, W. D., University of Alberta:
Kneehills Tuff of Alberta, 1956-57
Zircon separates have been extracted for dating from this well established late Cretaceous marker.

175. Saull, V. A. and Cumberledge, J. T., McGill Univ.:
Enthalpy Changes in Metamorphic Reactions and their Geological Significance, 1953-
This project involves determination and interpretation of enthalpy changes in metamorphic processes such as chemical reaction, recrystallization, and devitrification, using the heat of solution method. See "Chemical Energy in Metamorphism", Geochimica and Cosmochimica Acta, 8, 86, 1955, and "A New Method of Calorimetric Investigation of Silicates", Ph.D. thesis by T. H. Moore, McGill Univ., 1956.

176. Schwellnus, J. E. G., Queen's Univ.:
Structure and Trace Element Study of Iron Ores and Protons, Knob Lake Deposits, Labrador, 1954-57; Ph.D. thesis.

177. Shaw, D. M., McMaster Univ.:
Geochemical Study of Scapolite Minerals, 1956-
Includes spectrographic analysis of minor and major elements and petrographic study of environment and origin.

178. Shaw, D. M. and Moxham, L., McMaster Univ:
Geochemical and Petrographic Study of Pyroxenes Developed in Skarn and Hybrid Rocks Associated with Radioactive Deposits in the Grenville Province, 1956-

179. Shaw, D. M. and Denton, B. E., McMaster Univ.:
Geochemistry of the White Mountain Magma Series, New Hampshire, 1956-
A study of the minor and major element distribution by spectrographic analysis.

180. Siroonian, H., Shaw, D. M. and Jones, R. E., McMaster University:
Spectrographic Study of Lithium Distribution in Rocks of the LaCorne Area, Quebec, 1955-56.

181. Smith, C. H., Wanless, R. K., and Maxwell, J.A., Geol. Surv., Canada:
Study of Magnesium Isotopes, 1957-
A study of the variation in abundance of magnesium isotopes from different geologic environments to find out if a fractionation of isotopes takes place and whether distinctive abundances are indicative of distinctive environments.

182. Smith, F. G. and Azzaria, L. J., Univ. of Toronto:
Distribution of Heavy Metals in the Minerals of a Metamorphic Rock Sequence.

183. Smith, F. G. and Mlosewski, M. J., Univ. of Toronto:
Solubility of Metallic Sulphides in Water at Elevated Temperatures and Pressures, 1956-58.
A quantitative study of the change of solubility of thio-acids of the heavy metals in H_2S-H_2O solutions with change of temperature, keeping the volume of the system constant.

184. Traill, R. J., Abbey, S., Wanless, R. K., and Robinson, S. C., Geol. Surv., Canada:
Age Determinations of Rocks and Minerals, 1954-
To make concentrations of radioactive minerals from bulk samples of rocks and ores, to analyse the concentrations by chemical or spectrographic means for specific elements, to make chemical concentrations of specific elements for isotope analysis, by means of the mass spectrometer to make isotope analyses of these chemical concentrations, and from the data so secured to compute the age of minerals and enclosing rocks.

185. Trost, W. R., Mines Branch, Dept. Mines and Technical Surveys:
Geochemistry of Manganese Deposits, 1957-58
The chemistry of the formation of manganiferous deposits from the decomposition of igneous rocks.

186. Wanless R. K., and Lowdon J. A., Geol. Surv., Canada:
Isotopic Study of Canadian Ore Leads, 1956-
Includes investigation of lead isotope distribution in Canadian lead ores, age of the deposits and possible isotope variation with depth, type of mineralization and geological occurrence.

187. Warren, Harry V. and Delavault, R. E., Univ. of B. C.
Trace Elements in British Columbia Rocks, 1954-
Hydrogeochemistry and geochemistry of Stream Sands and Belts and of Soils and Peats, 1945.
Biogeochemistry of Molybdenum, Cobalt and and Nickel, 1945.

188. Webber, G. R., McGill University:
The Application of Instrumental Methods to the Quantitative Chemical Analysis of Geological Material, 1955-59.

189. Wilson, H.D.B., Univ. of Manitoba:
Age Determination of Granites by the Zircon Method, 1956-

190. Wolofsky, Leib, McGill University:
Hydrothermal Experiments with Variable Pore Pressures and Shear Stress in Part of the MgO-SiO_2-H_2O system, 1955-57; Ph.D. thesis.

GEOPHYSICS

Electrical

191. Blanchard, J. E. and Robinson, D. K., Nova Scotia Research Foundation:
Theoretical Studies of Electromagnetic Methods of Geophysical Interpretation, 1956-
The effect of overburden on the resolving power of the different field techniques is being investigated.

192. Byers, A. R., Univ. of Saskatchewan:
Study of Electromagnetic Methods of Prospecting over Known Conductors, 1956-57.

193. Uffen, R. J. and Surkin, Alvin, Univ. of Western Ontario:
Scale Model Experiments of Airborne Electromagnetic Prospecting, 1956-59
Involves scale model experiments of the electromagnetic response of typical geological structures for airborne prospecting techniques, as an aid in the interpretation of field surveys.

Gravity

194. Garland, G. D., and Tanner, J. G., Dominion Observatory:
Gravity Measurements in Southern British Columbia, 1954-57.

195. Innes, M. J. S., Dominion Observatory:
Gravity Measurements for the Canadian Shield in Northern Manitoba and Ontario, 1948-57
Gravity and Isotasy in Central Quebec, 1954-57
See Trans. Amer. Geophysical Union, 1957 (in press).
Geophysical Investigation of Fossil Craters, 1953-
Circular topographic features have been investigated near Holleford and Brent, Ontario and Reindeer Lake, Saskatchewan. See "A Possible Meteoric Crater at Deep Bay, Saskatchewan", to be published in 1957 by the Royal Astronomical Society of Canada.

196. Oldham, C. H. G., Dominion Observatory:
Gravity and Magnetic Investigations Along the Alaska Highway, 1953-57
A geological interpretation of a gravimeter traverse along the Alaska Highway between Edmonton and Whitehorse.

197. Tanner, J. G., Dominion Observatory:
Geological Interpretation of Gravity Anomalies in Gaspe, Quebec, 1956-57; M. Sc. thesis, Univ. of Western Ontario.

198. Thompson, L. D. G., and Garland, G. D., Dominion Observatory:
Gravity Measurements in Quebec, South of Latitude 52^{o} N., 1951-57.
Project has been completed and report will appear as publication of Dominion Observatory in 1957.

199. Thompson, L. D. G., and Miller, A. H., Dominion Observatory:
Gravity Measurements in Southern Ontario, 1951-57
<u>See</u> "A Gravity Survey in Vicinity of Ottawa" Pub. of Dom. Obs. Vol. XVIII, No. 11, 1955, and "Gravity in the Sudbury Basin and Vicinity" Pub. of Dom. Obs. Vol. XVIII, No. 2, 1956.

Magnetic

200. Collett, L. S., Geol. Surv., Canada:
Experimental Electromagnetic Surveys in the Field, 1956-57.

201. Collett, L. S., and Knapp, H. W., Geol. Surv., Canada:
Portable Magnetic Susceptibility Meter, 1956
The construction of a portable meter capable of measuring the magnetic susceptibility of rocks in situ to assist in the correlation of aeromagnetic data with bedrock formations.

202. Collett, L. S., Ling, T. G. and Morley, L. A., Geol. Surv., Canada:
Remanent Magnetometer, 1954-56
The construction of a remanent magnetometer to measure the direction and magnitude of remanent magnetic moments of oriented rock samples to give data useful in the interpretation of aeromagnetic maps.
Laboratory and Field Susceptibility Meters, 1955-57.
To develop both field and laboratory instruments capable of measuring the magnetic susceptibility of rocks.

203. Dawson, E., Dominion Observatory:
Detailed Isogenic Charts of Manitoba, Saskatchewan and Alberta, 1956.
Charts are in press.

204. Potter, R. R., and MacKenzie, G. S., Univ. of New Brunswick:
Correlation of Aeromagnetic Surveys and Geology in New Brunswick.

205. Hood, P. S., Univ. of Toronto:
Rock Magnetism, 1955-58; Ph.D. thesis.
A remanent magnetometer of the spinner type has been built. This instrument measures the direction of magnetism of rocks having a minimum magnetic moment of 10^{-6} cgs. units/cc to within a few degrees. Palaeomagnetism of rocks in Canada will be studied.

206. Jacobs, J. A., Univ. of Toronto:
Study of Magnetic Transient Fluctuations, 1954-58
See "The Average Electrical Current System for the Sudden Commencement of Magnetic Storms", Geofisica Pura e Applicata, 34, pp. 21-35 (1956), and "Behaviour of Sudden Commencement of Magnetic Storms at Agincourt", Canadian Jour. of Physics, vol. 34, No. 8, pp. 876-883, 1956.

207. MacLaren, A. S., Geol. Surv., Canada:
Typical Aeromagnetic Anomalies Patterns of Rocks, 1955 -
The objective is to assemble a series of typical aeromagnetic anomalies that correspond to various rock types.

208. MacLaren, A. S., and Larochelle, A. L., Geol. Surv., Canada:
Relations of Bedrock Geology to Aeromagnetic Anomalies, 1955-56.
This study in the Eastern Townships of Quebec aims at securing data useful in making geological interpretations of aeromagnetic maps, explaining aeromagnetic anomalies, and correlating anomalies with economic geology.

209. Morley, L. W., Geol. Surv., Canada:
Fossil Magnetism Studies, 1955 -
The accumulation of data that may reveal the direction of the earth's magnetic field during geologic history; the ultimate aim is to use this information to throw light on the age and structural relationships of rock formations.

210. Obayashi, T., Univ. of Toronto:
Study of Geomagnetic Temporal Variations, 1955-57.

211. Roy, J. L., Dominion Observatory:
Rock Magnetism, 1955 -
A study of the palaeomagnetic history of the earth's magnetic field.

212. Small, G. R., Dominion Observatory:
Earth Currents, 1955 -
A study of the relationship of conductivity of crust and mantle of magneto-telluric methods.

213. Smellie, D., Geol. Surv., Canada:
Quantitative Interpretation of Aeromagnetic Maps, 1956.

214. Washkurak, S., Geol. Surv., Canada:
Airborne Magnetometer and Scintillation Counter Surveys in Nova Scotia, New Brunswick and Northern Manitoba, 1956-57.
To aid future geological mapping by the Geological Survey, and prospecting.

Radioactivity

215. Blanchard, J. E., Nova Scotia Research Foundation:
Carbon-14 Dating, 1956-57
Solid carbon counting has been discontinued because of airborne contamination; apparatus for proportional counting is being constructed.

216. Collett, L. S., Morley, L. W., and Knapp, H., Geol. Surv., Canada:
Development of a Satisfactory Reconnaissance Airborne Scintillation Counter, 1954-56.

217. MacCallum, D. S. L., Geol. Surv., Canada:
Compilation of Gamma Radiation Maps, 1954
The compilation of gamma scintillation records from airborne surveys to compare the radioactivity of rock types, and the general background activity of the various geological provinces.

218. Mair, J. A., Univ. of Toronto:
Solid Source Mass Spectrometry With Application to Age Determination of Common Rocks, 1956-58; Ph.D thesis.

219. Murthy, M. V. N., Geol. Surv., Canada (N.R.C. Postdoctorate Fellow):
Evaluation of the Zircon Method of Age Determination of Granites, 1956-58

It has been shown that some granites contain more than one type of zircon and from physical characteristics the origin of each type may be inferred. Age is being determined by several methods to check the relative accuracy of each; and petrographic studies will assist in the interpretation of the apparent ages.

220. Russell, R. D., Univ. of Toronto:
Geochronology, 1951-
See "Regularities Among Discordant Lead Uranium Ages", Geochemica et Cosmochimica Acta (in press).

221. Sikka, D. B., McGill Univ.:
Radioactivity Associated with Oilfields, 1955-58; Ph.D. thesis.

222. Smith, C. H., Wanless, R. K., Maxwell, J. A.; Geol. Surv., Canada:
Study of Magnesium Isotopes, 1957-58
A study will be made of the variation in abundance of magnesium isotopes from different geologic environments to find out if a fractionation of isotopes takes place, and whether distinctive abundances are indicative of distinctive environments.

223. Uffen, R. J., and Massey, Norman, Univ. of Western Ontario:
Multiple Scattering and Absorption of Gamma Rays, 1955 - 57
It is proposed to extend the measurements of the attenuation of gamma rays of various energies to include the effects of multiple scattering on the total intensity and energy spectrum of the scattered radiation. The information will aid in the interpretation of surveys being made with scintillation gamma ray spectrometers in bore holes and in aircraft.

224. Washkurak, S., Geol. Surv., Canada:
Airborne Magnetometer and Scintillation Counter Surveys in Nova Scotia, New Brunswick and Northern Manitoba, 1956-57
To aid future geological mapping by the Geological Survey, and prospecting.

Seismic

225. Blanchard, J. E., Nova Scotia Research Foundation:
A Study of the Energy Released by Bumps in the Springhill Coal Mine Area, N. S., 1956-57
This work is being done in co-operation with the Dept. of Mines and Technical Surveys.

226. Duwalo, G., Univ. of Toronto:
Diffraction of Seismic Waves at the Boundary Between the Core and Mantle of the Earth, 1955-57; M. A. thesis.

227 Hodgson, J. H., Cock, J. I. and Adams, W. M., Dominion Observatory:
Fault Plane Project, 1950-
Using a method devised by Byerly and extended by Hodgson the direction of faulting in large earthquakes is determined by examination of seismograms. It has been found that tranocurrent faulting is prominent in Pacific earthquakes. See "The Nature of Faulting in Large Earthquakes", Bull. Geol. Soc. of America, (in press).

228. Hodgson, J. H. and Smith, W. E. T., Dominion Observatory:
Seismicity of Eastern Canada, 1951-
The seismograph records for the past 30 years are to be re-examined to provide a catalogue of the earthquakes of Eastern Canada.

229. Jacobs, J. A., Univ. of Toronto:
Flow Properties and Internal Regime of Glaciers, 1956-57
In the summer of 1956 eleven men made an expedition to the Salmon and Leduc glaciers in northern British Columbia and shot 354 seismic profiles and completed an extensive gravity survey. The results are being prepared for publication.

230. Milne, W. G. and White, W. R. H., Dominion Observatory:
Earthquakes of Western Canada, 1951-
See - "Seismic Activity in Canada West of the 113th Meridian, 1841-1951", Pub. of Dominion Observatory, Vol. 18, No. 7., 1956.

231. Scheidegger, A. E., Dominion Observatory:
Theoretical Tectonics, 1950-
A study of the Mechanics of the earth's failure, including consideration of the importance of the "Fault Plane Project" findings and of basic rheological questions concerning the earth.

232. Willmore, P. L., Scheidegger, A. E. and Hodgson, J. H., Dominion Observatory:
Seismic Investigations of Circular Features, 1952-
See "Seismic Observations in the St. Lawrence Gulf", Trans. Royal Society of Canada (in press).

General Problems

233. Blanchard, J. E., Nova Scotia Research Foundation:
Application of Seismic Methods of Geophysical Exploration to Geological Problems in Nova Scotia, 1956.

234. Beall, George H., McGill University:
Some Aspects of Atmosphere-Earth-Energy Relationships, 1956-57; M.Sc. thesis.

235. Burwash, R. A., Univ. of Alberta:
Precambrian Basement of Alberta, 1951-
See "Reconnaissance of the Subsurface Precambrian of Alberta", Bull. American Assoc. Petroleum Geologists, Vol. 41, No. 1, 1957, pp. 70-103.

236. Etherington, W., Univ. of Toronto:
Geophysical Applications of Migration Rates of Various Substances, 1956-57; M.A. thesis.

237. Hogg, W. A., Quebec Dept. Mines (part time), McGill Univ.:
Geophysical Investigations, Argenteuil, Quebec 1956-57.

238. Innes, M. J. S., Dominion Observatory:
Geophysical Investigations of Fossil Craters, 1953-
Circular topographic features have been investigated near Holleford and Brent, Ontario, and Reindeer Lake, Saskatchewan. See "A Possible Meteorite Crater at Deep Bay, Saskatchewan", to be published in 1957 by Royal Astronomical Soc. of Canada.

239. Blanchard, J. E., Nova Scotia Research Foundation:
Gravity and Magnetic Studies of the Sedimentary Basins of Nova Scotia, 1952-
Because of large 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.

240. West, G., University of Toronto:
Some Physical Properties of Rocks, 1956-57; M. A. thesis.

241. Wilson, J. T., University of Toronto:
Continental Structure
See - "The Development and Structure of the Earth's Crust" in "The Earth as a Planet", edited by G. P. Kuiper, Univ. of Chicago Press, Chapt. 4, pp. 138-214 (1956)

MINERALOGY

X-Ray, Crystal Structure, Specific Minerals

242. Berry, L. G., Queen's University:
X-Ray Study of Freidelite from the Sullivan Mine, B.C., 1956.
This study was started by A. C. Freeze, C. M. & S. Co., by optical methods.

243. Berry, L. G., and Culver, K. B., Queen's Univ.:
X-Ray Study of Flinkite, 1956-57.

244. Berry, L. G., and Herr, R. L., Queen's Univ.:
X-Ray Study of Bornite from Copper Corporation, 1956-57.
X-Ray Study of Safflorite.
Part of a continuing investigation of loellengite, safflorite, and arsenopyrite-glaucodot, 1950-

245. Burberry, Brian J., McMaster University:
Investigation of Zeolite Stability and Occurrences, 1954-56.
A continuation of work for doctorate thesis at McGill University on the physical stability of natrolite under elevated temperature and pressure.

246. Claisse, Fernand, Quebec Dept. Mines:
Accurate Analysis by X-Ray Fluorescence Without Interval Standard, 1955-56.
See "Accurate X-Ray Fluorescence Analysis Without Interval Standard", Quebec Dept. Mines, Prel. Rept. 327.

247. Clark, Lloyd A., McGill University:
Thermal Study of Hexagonal Orthorhombic Transition in Pyrrhotites, 1955-57; Ph.D thesis.

248. Ferguson, R.B., Univ. of Manitoba:
Structural Studies of Feldspar Minerals, 1951.

249. Girault, J. P., Quebec Dept. Mines:
Mineralogical Study of Britholite from Province of Quebec, 1953-
A study of apatite from the Oka district containing silica, thorium and rare earths.
Mineralogical Study of a Titanium and Iron Spinel, 1953-
A description of a microscopic aggregate of magnetite, hercynite, and ulvo-spinel, with some ilmenite; thermomagnetic studies are contemplated. See "Sur un Spinelle Titanifere de Formule $Fe_2 TiO_4$, Provenant du Lac de la Blache, Comte du Saguenay", Le Naturaliste Canadien, Vol. LXXX, No. 12.

250. Kaiman, S., Mines Branch, Dept. Mines and Technical Surveys:
The Ideal Composition of the Mineral Brannerite and Preparation of the Synthetic Compound, 1956-

251. Morris, Peter G., McGill University:
Correlation of the Optical and X-Ray Properties of Natural Zeolites with their Chemical Compositions, 1955-57, Ph.D thesis.

252. Nickel, E.H., Mines Branch, Dept. Mines and Technical Surveys:
Microscopic and X-Ray Study of Ulvospinal From a Canadian Deposit of Titaniferous Iron Ore, 1956-57.
This mineral has been identified in a deposit of titaniferous iron ore from Rouville, Que.; it is intimately intergrown with magnetite in grains less than a micron in diameter.

253. Nickel, E. H. and Rowland, J. F., Mines Branch, Dept. Mines and Technical Surveys:
The Constitution and Crystallography of Niocalite, A New Calcium Niobium Silicate Mineral, 1956-57.
Mineralogical and X-Ray single crystal techniques are being used to study this new mineral from Oka, Quebec.

254. Robinson, S. C., and Sabina, A. P., Geol. Surv., Canada:
Investigation of the Variation in the Lattice Parameter of Specimens of Pitchblende from Various Localities, 1949-
To ascertain whether the variations can be attributed to (1) different mineralogical provinces (2) degree of alteration or (3) variations in solid solution series.

255. Stanton, R. L., Univ. of Western Ontario
Double Refraction of Pyrite in Finely Polished Surfaces and Some of Its Implications, 1955-57.
See - "Anistropism of Pyrite", Australian Journal of Science, December, 1955.

256. Traill, R. J. and Sabina, A. P., Geol. Surv., Canada:
Preparation of a Reference Collection of X-Ray Powder Photographs, 1949-
The objective is to have at hand the most efficient means for the identification of minerals. The preparation of such a collection requires the accurate identification of the type material by chemical or other means, as well as the development of new techniques in powder photography.

Radioactive Minerals

257. Emslie, R. F., Univ. of Manitoba:
Age Determination of Granites in Northwestern Ontario by the Zircon Method, 1956-57; M.Sc. thesis.

258. Gorman, D. H., Univ. of Toronto:
Uranium Silicate Minerals, 1952-56
See - "Uranophane and Beta-Uranophane" American Mineralogist, Vol. 40, No. 7-8, 1955, p. 634.

259. Kaiman, S., and Hughson, M. R., Mines Branch Dept. Mines and Technical Surveys:
Mineralogical Reports on Radioactive Ore Samples
The main purpose is to supply mineralogical information in connection with ore treatment of radioactive ores and mill products.

260. Patchett, J. E., University of Toronto:
A study of the Accessory Minerals of the Uraniferous Conglomerate and Associated Sediments of the Blind River Area, 1956-58; Ph. D. thesis.

261. Robinson, S. C., Geol. Surv. Canada:
Mineralogy of Radioactive Deposits in the Bancroft-Wilberforce Region, Ontario, 1954-56.

262. Underwood, E. O., and Hale, W. E., Univ. of New Brunswick:
Occurrences of Radioactive Minerals in New Brunswick, 1955-57.

263. Wilson, H. D. B., University of Manitoba:
Age Determination of Granites by the Zircon Method, 1956 -

General Problems

264. Byrne, P. J. S., Research Council of Alberta:
Mineralogy of Carbonate Rocks, 1955-56
A joint project with Imperial Oil Ltd.
Mineralogy of the Bearpaw Formation, 1954-57.

265. Champ, W. H., White, W. F., and Church, K. A., Geol. Surv., Canada:
Spectrographic Analysis of Minerals, Rocks and Ores, 1953-
Calibration and standardization necessary to permit quantitative spectrographic analyses.

266. Freeman, E. B., Edward, B., and Stanton, R. L., Univ. of Western Ontario:
Investigation of Double Refraction by Some Cubic Minerals in Finely Polished Surfaces, 1956-58.

267. Godfrey, J. D. and Gravenor, C. P., Research Council of Alberta:
Density, Surface Area, and Solubility Measurements on Minerals, 1956-58.

268. Gorman, D. H., University of Toronto:
Alteration of Minerals to Clay Minerals, 1956.

269. Gravenor, C. P., and Godfrey, J. D., Research Council of Alberta:
Low Temperature Silicate Growth, 1956-60.

270. Hawley, J. E., Queen's University:
Mineralogy of Nickeliferous Sulphide Ores, 1954-57
See "Intergrowths of Pentlandite and Pyrrhotite", Economic Geology, Vol. 52, No. 2, 1957, pp. 133-139.

271. Haycock, M. H., Mines Branch, Dept. Mines and Technical Surveys:
Research in Ore Microscopy
The first part of a project to apply recent developments in electronics to the microscopic study of certain ores and mill products. The establishment of spectral reflectivity as a diagnostic property of ore minerals in polished sections is a first step.

272. Hogarth, Donald D., McGill University:
Mineralogy of Columbium Deposits in Eastern Canada, 1955-58.

273. Jones, G., University of Toronto:
Specific Heats of Minerals at Low Temperatures, 1956-57; M.A. thesis.

274. McTaggart, K. C., and Greenwood, H., University of British Columbia:
Study of Zoning in Plagioclase, 1956-57.

275. Murthy, M. V. N., Geol. Surv., Canada (N.R.C. Post-doctorate Fellow):
Evaluation of the Zircon Method of Age Determination of Granites, 1956-58.
It has been shown that some granites contain more than one type of zircon and from physical characteristics the origin of each type may be inferred. Age is being determined by several methods to check the relative accuracy of each; and petrographic studies will assist in the interpretation of the apparent ages.

276. Ross, J. V., Univ. of British Columbia:
Plagioclase Twinning, 1956-
Crystals of plagioclase feldspars accumulating in a welt tend to combine in various "twin relations" which appear to be governed by the temperature gradient and viscosity of the melt.

277. Shepherd, N. and Moorhouse, W. W., Univ. of Toronto:
Mineralogy of Metamorphosed Iron Formation from Northern Quebec, 1955-57
A mineralogical study of certain unusual silicates rich in iron from metamorphosed iron formation in the Labrador Trough.

278. Stanton, R. L., Univ. of Western Ontario:
Study of Chemical and Mineralogical Features of some New Brunswick Copper-Zinc-Lead Ores, 1956-57.

279. Stevenson, John S., McGill University:
Mineralogy of the Residue Found in the Lungs of Silicosis Patients, 1944.

280. Stevenson, John S., and Caira, E. G., McGill University:
Structure and Mineralogy of Gallstones, 1956-

MINERAL DEPOSITS

Base Metals

281. Anderson, D. J., Univ. of Manitoba:
Distribution of Cu, Ni, Co, and S in the Copper-Nickel Deposits of Northwestern Ontario and Southeast Manitoba, 1956-58; M.Sc. thesis.

282. Assad, R. J., McGill University:
Geology of the Sullivan Copper-Zinc Deposits, Quebec with special Reference to Temperature of Sulphide Formation, 1955-57; Ph.D. thesis.

283. Benson, David G., McGill University:
Mineralogy of the New Brunswick Sulphide Deposits, 1956-58; Ph.D. thesis.

284. Burton, A. D. K., Univ. of British Columbia:
Structure of Yreka Property, Quatsino, B. C. 1956-57; M.Sc. thesis.

285. Carr, J. M., B. C. Dept. of Mines:
Detailed Mapping of Eastern Part of Iron Mask Batholith Near Kamloops, 1956
The majority of copper occurrences are close to steep, faulted, elongate bodies of serpentinized picrite within the batholith.

286. Carswell, H. T., Univ. of British Columbia:
Geology and Ore Deposits of Summit Camp, B. C., 1956-57; M.Sc. thesis.
See abstract in Canadian Mining Journal, June, 1957, p. 164.

287. Chown, E. H. M., Univ. of British Columbia:
Geology of Willroy Property, Manitouwadge Lake, Ontario, 1955-57; M.A.Sc. thesis.
See abstract in Canadian Mining Journal, June, 1957, p. 163.

288. Fyles, J. T. and Hewlett, C. G., B. C. Dept. Mines:
Detailed study of Structure and Stratigraphy of Salmo Lead-Zinc Belt, 1951-56.

289. Hawley, J. E., Queen's University;
Mineralogy of Nickeliferous Sulphide Ores, 1954-57.
See - "Intergrowths of Pentlandite and Pyrrhotite", Economic Geology, Vol. 52, No. 2, 1957 pp. 133-139.

290. Hawkins, W. McGill University:
Geology of Goshen Copper Prospect, Goshen, New Brunswick, 1956-57; M. Sc. thesis.

291. Holland, Stuart S., B. C. Dept. of Mines:
Copper Deposits of Highland Valley Area, B. C., 1956.

292. Jeffery, W. G., McGill University:
Geology of Campbell-Chibougamau Mines, Quebec, 1956-58; Ph. . thesis.

293. MacDougal, John F., McGill University:
Experiments Bearing on the Genesis of Sulphide Deposits, 1952-57; Ph. . thesis.

294. McKechnie, N. D., B. C. Dept. Mines:
Copper Deposits in Vicinity of Nitinat River, Vancouver Island, 1956.

295. Miller, R. J. M., Laval University:
Geology of Cedar Bay Mine, Quebec, 1956-57.

296. Nichol, Ian, Queen's University:
Trace Elements in Contemporaneous Sulphides of Canadian Copper Ores, 1956-58.
A comparative study to determine partition of trace elements in pyrite, pyrrhotite and chalcopyrite of sulphide deposits.

297. Petruk, William, McGill University:
Study of an Area Along Clearwater River, New Brunswick, Including a Copper-Lead-Zinc Deposit, 1956-58; Ph.D. thesis.

298. Rose, E. R., Geol. Surv., Canada:
Timagami Island Copper-Nickel-Cobalt Deposits, 1956-57.
Gordon Lake-Werner Lake Nickel-Copper-Cobalt Deposits 1956-57.
A study of the mineralogy and geochemistry of these deposits and their associated rocks by means of ore and petrographic microscope, X-Ray diffraction patterns, spectrographic and chemical analysis.

299. Sawyer, J. B. P., Univ. of Western Ontario:
Study of Porphyritic Rocks Found in Association with the Base Metal Orebodies, Bathurst, New Brunswick, 1956-57; M. Sc. thesis.
See abstract in Canadian Mining Journal, June, 1957, p. 162.

300. Slipp, Robert M., McGill University:
Base Metal Deposits in the Labrador Trough Between Harving and Aubreque Lakes, 1953-57; Ph.D. thesis.

301. Stanton, R. L., Univ. of Western Ontario:
Comparative Study of Chemical Features of Some Large, Conformable Base Metal Orebodies in Australia and North America, 1954-58.
Chemical and Mineralogical Features of Some New Brunswick Copper-Zinc-Lead Ores, 1956-57.

302. Stockwell, C. H., Geol. Surv., Canada:
Detailed Geological Study of the Sulphide Ore Deposits and their Host Rocks in the Bathurst District, N. B., 1955-57.

303. Thompson, R. M., and Jambor, J., Univ. of British Columbia:
Alteration Products at Calumet Mine, Galena Hill, Yukon Territory, 1955-56.

304. Trettin, H. P., B. C. Dept. of Mines:
Stratigraphy and Structure of Silver Cup Mine, Ferguson Area, Lardeau District, B. C.

305. White, W. H., Univ. of British Columbia:
Mineral Deposits of the Highland Valley Area, B. C., 1955-56.

Ferrous Metals

306. Auger, P. E., Laval University:
Mineralographic Study of the Iron Formation of New Quebec, 1956-57.

307. Bacon, W. R., B. C. Dept. of Mines:
Magnetite Deposits of British Columbia, 1952-56
Examinations were made of contact metamorphic deposits on Moresby Island, Porcher Island, Texada Island, and Vancouver Island; of taconite deposits in the Sicker sediments of Saltspring Island and the Ladysmith Area, Vancouver Island; and of the deposits contained in the pyroxenite of the Tulameen area.

308. Giblin, P. G., Queen's University:
Magnetite Ores in Mayo Township, Ontario, 1956-58.

309. Gross, W. H. and Baldwin, A. B., Univ. of Toronto:
A Study of the Leaching of Iron Formations, 1954-57.

310. Mawdsley, J. B. and Pyke, M., Univ. of Saskatchewan:
Some Iron Occurrences in Northwestern Saskatchewan, 1956-58.

311. McCrea, Charles, J., Queen's University:
Some Metamorphic Iron formations in Ungava, 1956-58.

312. Peach, P. A. and Spring, V., Univ. of Toronto:
Development of a Free Fall Magnetic Mineral Separation Equipment, 1956-57.

313. Remick, J. H., Quebec Dept. Mines (part time), Univ. of Michigan:
Stratigraphy and Petrography of the Iron Formation at Ross Mountain, Quebec.
See abstract Bull. Geol. Soc. America, Vol. 67, No. 12, P. 1727, 1956.
Petrography of the Cherty Magnetic Iron Carbonate Iron Formation of Northern Quebec.

314. Shepherd, N., and Moorhouse, W. W., Univ. of Toronto:
Mineralogy of Metamorphosed Iron Formation from Northern Quebec, 1955-57
A mineralogical study of certain unusual silicates rich in iron from metamorphosed iron formation in the Labrador Trough.

315. Schwellnus, J. E. G., Queen's University:
Structure and Trace Element Study of Iron Ores and Protores, Knob Lake Deposits, Labrador, 1954-57; Ph. D thesis.

316. Usher, John L. Queen's University:
Wood Fragments in an Iron Ore Deposit in Labrador, 1956-57
See "Brown Coal in the Labrador Trough", Proc. Geol. Assoc. Canada, Vol. 6, Pt. II, 1954, pp. 99-101.

Other Metals.

317. Gill, J. E., McGill University:
The Columbium-Uranium Deposits at North Bay, Ontario, 1950-
See "Niobium-Uranium Deposits at North Bay, Ontario", XXth Meeting, Inter. Geol. Congress, Mexico City, 1956 (in press).

318. Gross, W. H. and Elliot, W. J., Univ. of Toronto:
Geological Occurrences of Columbium and Tantalum-bearing Minerals.

319. Hodder, R. W., Geol. Surv., Canada (part time):
Columbium Deposits and Associated Intrusive Rocks in Nemegos Area, Ontario, 1956-57.

320. Hogarth, Donald D., McGill University:
Mineralogy of Columbium Deposits in Eastern Canada, 1955-58; Ph. D. thesis.

321. Mulligan, R., Geol. Surv., Canada:
Geological Study of the Lithium-Beryllium Pegmatites of Manitoba, 1953-56.

322. Sacuta, A., Research Council of Saskatchewan:
Germanium and Uranium in Lignite, 1957
An investigation of the amount of Uranium and Germanium present in Saskatachewan lignites.

323. Trost, W. R., Mines Branch, Dept. Mines and Technical Surveys:
Geochemistry of Manganese Deposits, 1957-58.
The chemistry of the formation of manganiferous deposits from the decomposition of igneous rocks.

Radioactive Deposits

324. Abraham, E. M., Ontario Dept. Mines:
Blind River Area, Ontario, 1953-
A continuing project of areal mapping and study of radioactive occurrences.

325. Bell, C. K., Geol. Surv., Canada:
Detailed Geological Study and Mapping of the Milliken Lake Area, Sask., with Special Reference to the Occurrence of Radioactive Deposits, 1954-59.

326. Evans, A. M., Queen's University:
Geology of Centre Lake Uranium Deposit, Bancroft Area, Ontario, 1955-57.

327. Gross, G. A., Geol. Surv., Canada:
Study of Uranium Deposits in the Appalachian Region of Canada, 1956-57.

328. Lang, A. H., Steacy, H. R. and staff, Geol. Surv., Canada:
Laboratory Investigations of Samples of Radioactive Substances, 1945-
To maintain a complete inventory of all occurrences of uranium and thorium deposits in Canada; field examinations of radioactive deposits; and the laboratory examination of samples of radioactive minerals and ores.

329. Lang, A. H., and Griffin, J. W., Geol. Surv., Canada:
Geology of Canadian Deposits of Uranium and Thorium, 1956-58.

330. Patchett, J. E., Univ. of Toronto:
Study of the Accessory Minerals of the Uraniferous Conglomerate and Associated Sediments, Blind River, Ontario, 1956-58; Ph. D. thesis.

331. Piennar, P. J., Queen's University:
Uranium Deposits in the Mississagi Formation, Blind River Area, Ontario, 1955-58.

332. Roscoe, S. M., Geol. Surv., Canada:
Investigation of Radioactive Deposits Between Sault Ste. Marie and Cobalt, Ont., 1954-57.

333. Satterly, J., Ont. Dept. Mines:
Radioactive Mineral Occurrences in The Haliburton-Bancroft Area, 1954-56
<u>See</u> - "Some Radioactive Mineral Occurrences in The Bancroft Area", Dept. Mines, Geol. Circ. No. 2, 1955.

334. Shaw, D. M., and Grad. Students, McMaster Univ.:
Radioactive Deposits of Quebec, 1954-
Study of the origin and nature of radioactive deposits in the Grenville province, with particular reference to (a) the distribution of U and Th and (b) the formation of various suites of lime rich hybrid rocks. Various mineral groups are being studied by individual graduate students.

335. Tremblay, L. P., Geol. Surv., Canada:
Detailed Geological Study and Mapping of the Beaverlodge Area, Saskatchewan, With Special Reference to Radioactive Mineral Deposits, 1952-57.

336. Underwood, E. O. and Hale, W. E., Univ. of New Brunswick:
Occurrences of Radioactive Minerals in New Brunswick, 1955-57.

Industrial Minerals

337. Baird, D. M., Lee, B. W., and others, Newfoundland Dept. of Mines and Resources:
Industrial Limestones of Newfoundland, 1955-57.

338. Baird, D. M., and Gillespie, C. R., Newfoundland Dept. of Mines and Resources:
Pyrophyllite Deposits of Manuals District, Newfoundland, 1956-57.

339. Baird, D. M. and McKillop, J. H., Newfoundland Dept. of Mines and Resources:
Gypsum Deposits of Southwestern Newfoundland, 1955-57.

340. Bourret, P.E. and Lachance, Leopold, Quebec Dept. Mines:
Industrial Minerals Investigations
A continuing program with the purpose of advising owners as to the value of industrial mineral deposits and to furnish information regarding the developing, mining, milling and marketing of their product.

341. Buchanan, R. M., Mines Branch, Dept. Mines and Technical Surveys:
Distribution of Lithium in Spodumene-bearing Pegmatites, 1956-57.

342. Clifford, P., Geol. Surv., Canada (N.R.C. Postdoctorate Fellow):
Relation of Granite to Formation of Asbestos in the Eastern Townships of Quebec, 1956-57).
Work is largely petrographic; it suggests that apparent parallel distribution of asbestos and granite bodies is fortuitous and that the granites are the product of metasomatism of arenaceous sediments.

343. Dean, R. S., McGill University:
Study of the Limestones of the Lorraine and Richmond Groups, Quebec, 1956-58; M.Sc. thesis.

344. Deane, R. E., Univ. of Toronto;
Origin, Properties and Uses of Varved Clays, 1955-58.

345. Gill, J. E., McGill University:
Quartz Deposits at St. Donat, Quebec, 1952-

346. Haw, V. A., Mines Branch, Dept. Mines and Technical Surveys:
Behaviour of Volatiles on the Expansion of Clays, Shales and Perlite, 1955-
Petrographic Studies of Rock for Use as Aggregate, 1956-

347. Hogg, W. A., McGill University:
Building and Industrial Stones of Eastern Canada, 1954-57; Ph. D. thesis.

348. Kupsch, W. O., and Thorvaldson, T., Saskatchewan Research Council:
Sturgeon Lake Marl Deposit
The geology, quantity and quality of the deposit and the use of the marl as a raw material for the manufacture of Portland cement; completed 1956.

349. McCammon, J. W., B. C. Dept. of Mines:
Limestone Occurrences of Southern Vancouver Island and the Lower Mainland between Powell River and Hope, 1956.

350. Sacuta, A., Saskatchewan Research Council:
Lightweight Aggregate From Saskatchewan Clays, 1956
An investigation of the suitability of clays from various parts of the province for the production of lightweight aggregate.

351. Sanford, Bruce, Geol. Surv., Canada:
Geology of Salt Deposits at Ojibway, Ont., 1956.

352. Sund, J. O., and Greiner, Hugo, Univ. of New Brunswick:
Sedimentology and Stratigraphy of the New Brunswick Gypsum Deposits, 1956-57.

353. Williamson, D. H., Newfoundland Dept. Mines and Resources:
St. Lawrence Fluorspar Deposits, 1955-57.

Petroleum

354. Belyea, H. R., Maxwell, J. A., Wanless, R. K., Geol. Survey, Canada:
Isotopic Studies of Sulphur from Canadian Petroleum Deposits, 1955-
To determine whether systematic variations in the isotopic composition of sulphur derived from petroleum bearing strata, oilfield waters, and petroleum can be used to aid (1) in correlation and dating of strata at, and near petroleum bearing horizons and (2) in determining the source rock from which petroleum in various fields was originally derived.

355. Belyea, H. R., Geoll. Surv., Canada:
Petrographic Study of the Upper Devonian Reef-bearing Woodbend Group of Central Alberta, 1953-57.
A study of the micro features of reef and non-reef deposits to obtain information on type porosity and other characteristics needed for a better understanding of the causes of accumulation of oil and gas.

356. Caley, J. F., and Sanford, Bruce, Geol. Surv., Canada:
Geology of Oil and Gas Deposits in Eastern Canada.
Presented at International Geological Congress, Mexico City, 1956.

357. Clark, T. H., Quebec Dept. Mines (part time), McGill Univ.:
Oil and Gas in the St. Lawrence Lowlands of Quebec
See Bull. Can. Inst. Min. Metallurgy, Vol. 49, No. 531, July 1956.
Stratigraphy, Structure and Economic Resources of the Palaeozoic Rocks of the St. Lawrence Lowland, 1938.

358. DeBlois, R., Roy, R. and Clark, T. H., Quebec Dept. Mines:
Deep Borings Investigations in the Province of Quebec.
A continuing program of the logging of deep borings for oil and gas in various parts of the province.

359. Flenniken, W. R., Univ. of Western Ontario:
Monographic Study of the Lithologic Character of the Viking Sandstone of Alberta, 1956-57; M.Sc. thesi

360. Francis, D. R., Saskatchewan Dept. Mineral Resources:
Jurassic and Cretaceous Oilfields of Southwestern Saskatchewan, 1953-57.
See "Jurassic Sediments of Saskatchewan", Sask. Dept. Min. Resources, Report No. 13, and "Jurassic Stratigraphy of the Williston Basin Area", Sask. Dept. Min. Resources, Rept. No. 18.

361. Hayes, E. W., Saskatchewan Dept. Mineral Resources:
Geology of Mississippian Oilfields in Saskatchewan, 1956-

362. Kupsch, W. O. and Wild, J., Univ. of Saskatchewan:
Submask Geology, 1956-
See "Submask Geology in Saskatchewan", First International Williston Basin Symposium, Vol. I (in press).

363. Rogan, D., Univ. of Saskatchewan:
Reservoir Characteristics of the Viking Sand of the Smiley-Dewar Field, 1956-57.
Measurement of air and liquid permeabilities, capillary pressures using mercury injection.

364. Sanford, Bruce, Geol. Surv., Canada:
Elevations of Wells Drilled for Oil and Gas in Southwestern Ontario, 1951-
To assist in the interpretation of the structure and stratigraphy of the productive oil and gas formations.
Oil and Gas Fields of Southwestern Ontario, 1952.

365. Sikka, D. B., McGill University:
Radioactivity Associated with Oil fields, 1955-58; Ph.D. thesis.

366. Stansberry, Gerald F., Univ. of Alberta:
Viking Sand of Alberta, 1956-57; M. Sc. thesis.

Coal and Peat

367. Blanchard, J. E., Nova Scotia Research Foundation:
Energy Released by Bumps in the Springhill Coal Mine Area, N.S., 1956-57.
Being done in co-operation with the Dept. Mines and Technical Surveys.

368. Brown, A., Hacquebard, P.A., and Norris, D. K., Dept. of Mines and Technical Surveys.
Investigation of Sudden Release of Stress in Coal Mines, and Ore Extraction Problems in Metal Mines, 1950-
See "Rock Pressure Studies in the Mines of Springhill, N. S.", Bull. Can. Inst. Min. and Metallurgy, June, 1956.

369. Hacquebard, P. A., Geol. Surv., Canada:
Petrography and Spore Analysis of Coal, Mainly from Nova Scotia, 1948-

370. King, L. H., Geol. Surv., Canada:
Briquetting Studies, 1955-
By use of suitable solvents and pressures, to develop an economical method of making commercially acceptable briquettes from Nova Scotia or other slack coal.

371. Montgomery, D. S., and Goodspeed, F., Mines Branch, Dept. Mines and Technical Surveys:
Infra-red Absorption of Bituminous Substances, 1951-

372. Sacuta, A., Saskatchewan Research Council:
An Investigation of the Amount of Uranium and Germanium in Saskatchewan Lignites, 1956-57.

373. Swartzman, E., Burrough, E. and Hacquebard, P. A., Dept. Mines and Technical Surveys:
Study of Coking Characteristics on Laboratory and Plant Scales of Coal Sections in Relation to Petrographic Constituents, 1956-

374. Usher, John L., Queen's University:
Wood Fragments in an Iron Ore Deposit in Labrador, 1956-57
See "Brown Coal in the Labrador Trough", Proc. Geol. Assoc. Canada, Vol. 6, Pt. II, 1954, pp. 99-101.

375. Winer, A., Saskatchewan Research Council:
Study of Yields of Low Temperature Tars from Saskatchewan Lignites.

General Problems.

376. Assad, R. J., Que. Dept. Mines (part time), McGill Univ.:
Examination of Mining Properties in the Chibougamau District, Que.

377. Berrange, Jevan P., McGill Univ.:
Dispersion of Certain Metals from Mineralized Zones in a Glaciated Precambrian Terrain, as Indicated by Humus and Moss, 1955-57; M. Sc. thesis.

378. Blais, Roger, Quebec Dept. Mines:
Geology and Mineral Deposits on the North Shore of the St. Lawrence River, Que.
Paper presented to Prospectors and Developers' Association, Annual Meeting, Toronto, 1956.

379. Dugas, Jean, Quebec Dept. Mines:
Examination of Mining Properties and Development in Rouyn-Noranda District, Que.
A continuing program of investigation of mining properties and development work carried out from year to year.

380. Compilation of Geology of the Rouyn-Noranda District, Que.
A continuing program; maps are issued on the scale of 1 inch to 1000 feet.

380. Ermengen, S. V., Quebec Dept. Mines (part time), McGill University:
Investigations of Geochemical Prospecting Methods in the Chibougamau District, Quebec, 1955-57.

381. Gilbert, J. E., Quebec Dept. Mines:
Examination of Mining Properties and Development in the Montreal District, Que.
A continuing program of investigation of mining properties and development work being carried out from year to year.

382. Grenier, P. E., Quebec Dept. Mines:
Examination of Mining Properties and Development in Quebec District, Que.
A continuing program carried out from year to year.

383. Gross, W. H., and Jackson, W. H., Univ. of Toronto:
Origin and Significance of Cross Folds as a Fundamental Geological Structure and Guide to Ore, 1955-58.

384. Latulippe, M., Quebec Dept. Mines:
Examination of Mining Properties and Development in the Val d'Or District, Que.
A continuing program being carried out from year to year.

Compilation of Geology of the Val d'Or District
A continuing program; maps are issued on the scale of 1 inch to 1000 feet.

385. McGlynn, J. C., Geol. Surv., Canada:
Mineral Industry of the Mainland of the Northwest Territories, 1954-

386. Palmer, H. C., Moxham, R. L., and Koeller, G. F., Geol. Surv., Canada (part time):
Geochemical Exploration of Southwestern Nova Scotia, 1956-57.
Exploration by geochemical means to locate and outline areas likely to contain valuable deposits of base or other metals.

387. Pearson, W. J., Saskatchewan Dept. Mines and Resources:
Detailed Mapping of Mineral Deposits North of Lac La Ronge, Sask., 1956-57.
A compilation of structural and mineralogical data over small areas that show promise as base metal prospects.

388. Thompson, R. M., Univ. of British Columbia:
Mineralogical Studies of New Mineral Discoveries in British Columbia - a continuing project.

389. Trottin, H. P., Univ. of British Columbia:
Regional Framework and Structural Ore Control at Silver Cup Mine, Lardeau Area, B.C.; M. Sc. thesis.
See abstract in Canadian Mining Journal, June, 1957, p. 164.

INVENTORIES, ETC.

390. Division of Fuels and Stratigraphic Palaeontology, Geol. Surv., Canada:
Maintenance of Palaeontological Collections.
The cataloguing, care, and storage of fossils collected by officers of the Geological Survey or acquired from other sources; and the preparation of exchange material sent to and received from other institutions.

391. Faessler, C., Universite Laval:
Cross Index of Geological Illustrations of Canada, 1944-
See "Gross Index to the Maps and Illustrations of the Geological Survey and Mines Branch of Canada, 1843-1946", Vol. I and II published 1946 by Laval University; First supplement, 1946-56 published 1956; Vol. III Geological Illustrations Published by Ontario Dept. Mines, 1891-1955; Vol. IV- Geological Illustrations published by Quebec Dept. Mines, 1898-1956 (in preparation).

392. Lang, A. H., Steacy, H. R. and Staff, Geol. Surv., Canada:
Laboratory Investigation of Samples of Radioactive Substances and Filing of Information on All Known Occurrences in Canada.
The objective is (1) to maintain a complete inventory of all occurrences of uranium and thorium deposits in Canada obtained under the regulations of the Atomic Energy Control Board, by field Examination by officers of the Geological Survey, and the laboratory examination of samples submitted and (2) to aid in the discovery and exploitation of deposits by supplying information gained from the laboratory examination of samples.

393. Mineral Deposits Division, Geol. Surv., Canada:
Economic Geology Files, 1940-
The objective is to file all published authentic geological information on all Canadian occurrences of economic metals or minerals; to cross index these files so that the information is readily accessible; to file all geological maps; and to prepare for publication maps and reports showing the distribution and mode of occurrence of specific metals or minerals.

394. Sinclair, G. W., Geol. Surv., Canada:
Preparation of Catalogue of the North American Devonian Fossils Conularidae, Tentaculitidae, Hyolithidae, 1956-

PALAEOBOTANY

395. Bell, W. A., Geol. Surv., Canada
Cretaceous Floras of Western Canada, 1953-56.
A study based on collections gathered by officers of the Geological Survey between 1883 and 1950.

Age of the Union Formation of the Canso Group in the Area from Truro to New Glasgow, Nova Scotia, as Determined from a Study of Fossil Plants, 1954-56.

396. Fry, W. L., Geol. Surv., Canada:
Tertiary Flora and Stratigraphy of Southern British Columbia, 1954-56.

397. Fry, W. L., and McLaren, D. J., Geol. Surv., Canada:
Study of Certain Cellulosic Filaments Within Various Devonian Limestones from Alberta, 1954-56.

PALAEONTOLOGY

398. Best, R. V., McMaster University:
Revision of Olenellid Trilobites of North America, 1956-57.

399. Carter, G. F. E., McGill University:
Palaeozoic Ostracoda of the St. Lawrence Plain, 1955-57; Ph.D. thesis.

400. Copeland, M. J., Geol. Surv., Canada:
Ostracoda from the Upper Silurian Stonehouse Formation, Arisaig, N.S., 1957.

401. Fritz, M. A., University of Toronto:
Bryozoa (mainly Trepostomata) from the Ottawa Formation of the Ottawa - St. Lawrence Lowlands, 1954-56.

402. Fritz, M. A., and Waines, R. R. H., Univ. of Toronto:
Stromatoporoids from the Upper Abitibi River Limestone, Coral Rapids, Ont., 1954-56
See Proceedings Geol. Assoc. Canada Vol. 8, November, 1956.

403. Green, Robert, Research Council of Alberta:
Microfaunas of the Mississippian of Alberta, 1956-
Present work is confined to the Banff area; it is hoped to extend it across the Plains region.

404. Greggs, Robert and Okulitch, V. J., Univ. of B. C.:
Archaeocyatha from Colville, Washington and South Fork of the Salmo River, B. C. 1949-57.
The study of the Archaeocyatha from the Lava Cambrian of the Cordilleran Region is a continuing project. See abstract in Canadian Mining Journal, June 1957, p. 163.

405. Kawase, Yoshio and Okulitch, V. J., Univ. of British Columbia:
Archaeocyatha from the Cambrian of the Yukon, 1955-56.

406. Langston, Wann, National Museum of Canada:
Shell of Basilemys Varialosa (Cope), 1954-56
A description of an unusually complete shell of a large upper Cretaceous turtle from Alberta and a review of the previously described species of Basilemys; published in Bull. Nat. Museum, Canada, No. 142, pp. 155-165, 1956.

Sebecosuchia, Cosmopolitan Crocodilians?
A review of the older literature suggests that this order of crocodiles was widely distributed on several continents during the Tertiary and not confined to South America; published Am. Jour. Science, November, 1956.

Upper Cretaceous Dinosaurs of Alabama, 1955-56.

Permean Vertabrates of New Mexico, 1949-57
The results of this study are expected to provide a basis for stratigraphic correlation of terrestrial Permian redbeds both in and outside North America.

Tertiary Crocodilians of South America, 1953-57
A study of the collection of fossil crocodilian material from South America at the University of California is expected to place South American Tertiary crocodilian systematics on a firm basis. A history of neotropical crocodilians based on the palaeontological record should result.

An Armoured Dinosaur Skull from Alberta, 1956-57.
Study of the most perfect known skull of the giant Upper Cretaceous armoured dinosaur Ankylosaurus should increase our knowledge of the detailed cranial anatomy of these creatures.

407. McLaren, D. J., Geol. Surv., Canada:
Revision of the Type Species Synatophylum Simpson, 1956-57.

408. Rice, H. M. A., Geol. Surv., Canada:
Study of the Geological Survey of Canada collection of Fossil Insects to Identify the Species, Describe them and Consider their Stratigraphic Significance, 1955-

409. Russell, Loris S., National Museum of Canada:
The Cretaceous Reptile Champsosaurus Natator Parks, 1954-55.
A detailed description of the skull and other skeletal parts of this fossil reptile, based on specimens from the Cretaceous of Alberta, in National Museum of Canada. See Bull. Nat. Mus. Canada (in press).

Mollusca from the Tertiary of Princeton, B. C., 1955-56.
Non-marine Mollusca from the North Park Formation of Saratoga, Wyoming, 1955-56
Manuscript submitted to Journal of Palaeontology, March, 1956.
Paleocene Mammal Teeth from Alberta, 1955-56.
A description of fossil teeth from the Poskapoo formation of Alberta; Bull. Nat. Mus. Canada (in press).
Cretaceous Non-marine Faunas of Northwestern North America, 1956
A review of the non-marine molluscan and vertebrate faunas with the proposal of provincial stage terms for the stratal equivalents; presented at the Int. Geol. Congress, Mexico City, 1956.
Tertiary Mammalian Faunas of Southern Saskatchewan, 1948-58.
A collaborative project between the University of Toronto, Royal Ontario Museum and National Museum of Canada involving the systematic treatment of the Eocene, Oligocene and Miocene mammalian faunas.
Age of the Hand Hills Conglomerate, Alberta, 1956-57.

410. Sinclair, G. W., Geol. Surv., Canada:
Catalogue of the North American Devonian Fossils Concularidae, Tentaculitidae, and Hyolithidae, 1956 -

411. Stearn, Colin W., McGill University:
Stromatoporoids of the Fairholme Formation, Alberta, 1955-57.

412. Stelck, C. R., University of Alberta:
Albian Microfauna, 1950-57
See "Middle Albian Foraminifera"
Rept. No. 75, Research Council of Alberta.

413. Tozer, E. T., Geol. Surv., Canada:
Triassic Pelecypod and Ammonite Faunas from Southern Yukon and Southwestern British Columbia, 1954-56.

414. Wall, J. H., Research Council of Alberta:
Microfauna of the Exshaw Formation; 1956-58.

PETROLOGY AND PETROGRAPHY

Alberta

415. Belyea, H. R., Geol. Surv., Canada:
Petrographic Study of Upper Devonian Reef-bearing Woodbend Group of Central Alberta, 1953-57.
To obtain information on types of porosity and other characteristics.

416. Flenniken, W. R., Univ. of Western Ontario:
Lithological Character of the Viking Sandstone of Alberta; M.Sc. thesis.

417. Ritchie, W. D., Univ. of Alberta:
Kneehills Tuff of Alberta, 1956-57; M.Sc. thesis.
Zircon separates have been extracted for age dating.

418. Usher, John L., Queen's University:
Petrography of Upper Devonian Rocks in the Rocky Mts. of Alberta, 1956-57.

419. Zwartendyk, Jan, McGill University:
Petrographic study of the Granite Wash in the Clear Hills Area, Alberta, 1955-57; M. Sc. thesis.

British Columbia

420. Christie, R. L., Geol. Surv., Canada (part time), Univ. of Toronto:
Plutonic Rocks of the Coast Range Batholith in the Bennett Area, B. C., 1951-57; Ph.D. thesis.

421. McTaggart, K. C., White, W. H., and Thompson, R. M.,
Petrology of Rocks of the Highland Valley, B. C., 1956-57.

Manitoba

422. Milligan, G. C., Manitoba Mines Branch:
Metamorphism and Structure, Lynn Lake, Manitoba, 1954-57.

New Brunswick

423. Loudon, J. R., and Moorhouse, W. W., Univ. of Toronto:
Porphyries and Porphyry-like Rocks from New Brunswick, 1955-58.
See abstract in Canadian Mining Journal, June, 1957, p. 162.

424. Sawyer, J. B. P., Univ. of Western Ontario:
Some Petrogenic Aspects of the Porphyritic Rocks of the Bathurst Area, N.B., 1956-57; M.Sc. thesis.

425. Sharpe, J. I. and MacKenzie, G. S., Univ. of New Brunswick:
Variation and Structural Relationships of Mt. Champlain Granitic Rocks, Hampstead Area, N. B., 1956-57.

Newfoundland and Labrador

426. Bahyrycz, G. S., McGill University:
Geology of Grey River Area, Newfoundland with Special Reference to Metamorphism, 1956-57; M.Sc. thesis.

427. Czamanske, Gerald, Queen's University:
Ultrabasic Mass, Birchy Lake, Newfoundland, 1956-57.
A geochemical study of a serpentenized ultrabasic rock in the vicinity of granitic intrusions.

428. Williams, A., Memorial University of Newfoundland:
Basic Complex at Tilting, Newfoundland, 1956-57.

Ontario

429. Allen, C. M., Mount Allison University:
Geology of Gooderham Nepheline Pegmatites, 1951-57.

430. Appleyard, E. C., Queen's University:
The Wolf Nepheline Belt East of Bancroft, 1957-58.

431. Armstrong, H. S., and Grad. Students, McMaster Univ.: Medina Sandstones in the Niagara Peninsula, 1951-57.
A study of the early Silurian sedimentation of this region to ascertain the nature of the source rocks.

432. Ginn, R. M., Ont. Dept. Mines (part time), Univ. of Toronto.
Granites Between Sudbury and Blind River, 1956-58; Ph.D. thesis.
A study of the petrography and accessory minerals of the granites and their mineralogical and structural relationships to the Bruce Series.

433. Hodder, R. W., Geol. Surv., Canada (part time)
Columbrium Deposits and Associated Intrusive Rocks in the Nemegos Area, 1956-57; Ph.D. thesis.

434. Moorhouse, W. W., Univ. of Toronto:
Mineralogical, Textural and Spectrochemical Study of the Gunflint Iron Formation of the Port Arthur Region, 1950-57.
Concretions from the Rove slate, 1951-57
A chemical and petrographic study of an unusual series of calcareous concretions, 1951-57.

435. Neczkar, E., Univ. of Toronto:
Paragenesis of the Rock Forming Minerals of the Nephaline Syenite and Adjacent Wallrocks Near Memegos, 1955-57; M.A. thesis.

436. Peach, P. A., Univ. of Toronto:
Relationships of Grenville Gneisses and Migmatites to Pegmatites, 1953.

437. Phemister, T. G., Ont. Dept. Mines (part time), Aberdeen University, Scotland:
Metamorphism at the Grenville Contact in the Sudbury Area, 1956-

438. Sadler, J. F., Queen's Univ. :
The Onwatin slate, Sudbury Area, 1956-57;
A detailed petrographic and chemical study based on drill core from the formation.

439. Saha, A. K., Univ. of Toronto:
Studies on the Mode of Emplacement of Some Granitic Plutons, Hastings County, 1955-57, Ph.D. thesis.

440. Smith, F. G. and Hopkins, J. R., Univ. of Toronto:
Petrographic Study of Intrusive Diorite from Lake Temagami, Ont., 1956-57.

441 Wynne-Edwards, H. R., Queen's Univ.;
Structure and Petrogenesis of the Westport and other Plutons in the Grenville Subprovince, Ontario, 1955- 58.
The study of the Westport pluton has been completed; study of other plutons will continue.

Quebec

442. Beland, Rene and Miller, Robert, Universite-Laval:
Petrography of the Chibougamau Anorthosite, 1956-57.
Feldspar will be cooked in various solutions at temperatures around 500° C and pressures of 100 to 500 atmospheres in an attempt to reproduce alterations observed in anorthosite near ore zones.

443. Clifford, P., Geol. Surv., Canada (N.R.C. Postdoctorate Fellow):
Relation of Granite to Formation of Asbestos in the Eastern Townships of Quebec, 1956-57.
Work is largely petrographic; it suggests that apparent parallel distribution of asbestos and granite bodies is fortuitous and that the granites are the product of metasomatism of arenaceous sediments.

444. Emo, W. B., McGill University:
Gneisses of the Wocouno Lake Area, Quebec, 1955-57; Ph.D. thesis.

444-a Ezeani, Chuba, Universite Laval:
Petrology of Some Anorthosites and Gabbros of the Lake St. John Area, 1956-58; Ph. D thesis.

445. Forrester, M. R., Univ. of Western Ontario:
The Ultrabasic Mineralized Body at Lake Renzy, Quebec, 1956-57; M. Sc. thesis.
See abstract in Canadian Mining Journal, June, 1957. p. 162.

446. Godard, J. D., McGill University:
Igneous Rocks of St. Hilaire, Quebec, 1954-57; Ph.D. thesis.

447. Horscroft, F. D., McGill University;
Petrology of the Gabbros in the Volcanic Assemblage at Chibougamau, Que. 1955-57; Ph. D. thesis.

448. Marleau, R. A., Universite Laval
Geology and Petrography of the Woburn Area, Quebec, 1956-58; Ph.D. thesis.

449. Remick, J. H., Quebec Dept. Mines (part time), Univ. of Michigan:
Stratigraphy and Petrography of the Iron Formation at Ross Lake, Quebec
Petrography of the Cherty Magnetic Iron Carbonate of Northern Quebec.

Saskatchewan

450. Cumming, A. D., and Francis, D. R., Saskatchewan Dept. Mineral Resources:
The Cantuar Marker Bed, 1956-57
A lithologic and facies study of this marker bed in southwestern Saskatchewan.

451. Froese, Edgar, Univ. of Saskatchewan:
Metamorphosed Sediments in the Foster Lake Area, Northern Sask., 1955-56; M.Sc. thesis.
A petrographic study of biotite and hornblende granulites, calcareous metamorphics, and garnet-cordierite-sillimanite gneisses, and their granitized equivalents.

452. Fuller, J. G., Saskatchewan Dept. Mineral Resources:
Mississippian Petrology and Stratigraphy, 1954-57.
See "Mississippian Rocks and Oilfields in Southeastern Saskatchewan", Rept. 19, Sask. Dept. Mineral Resources.

General Problems

453. Bradshaw, B. A., Univ. of Toronto:
Petrographical Comparison of Lake Superior Iron Formations, 1954-57; Ph.D. thesis

454. Gorman, D. H., and Deane, R. E.,; Univ. of Toronto:
Weathering of Rocks and Minerals, 1956-61.

455. Hacquebard, P. A., Geol. Surv., Canada:
Petrography and Spare Analysis of Coal, Mainly from Nova Scotia, 1948-
The spore assemblage in coal from the South Nahanni River area was studied in 1955-56.

456. Haw, V. A., Mines Branch, Dept. Mines and Technical Surveys:
Petrographic Studies of Rock for Use as Aggregate, 1956.

457. Hoffer, A. A., Univ. of Toronto:
Comparative Study of Textures in Orthoquartzites, 1956-57; M.A. Sc. thesis.
To determine the relative importance of recrystallization in situ and addition of silica from external sources in the development of typical quartzite textures.

458. McTaggart, K. C., and Greenwood, H., University of British Columbia:
Study of Zoning in Feldspars, 1956-57.

459. Murthy, M.V.N., Geol. Surv., Canada (N.R.C. Post-Doctorate Fellow):
Evaluation of the Zircon Method of Age Determination of Granites, 1956-58.
It has been shown that some granites contain more than one type of zircon and from physical characteristics the origin of each type may be inferred. Age is being determined by several methods to check the relative accuracy of each; and petrographic studies will assist in the interpretation of the apparent ages.

460. Shaw, D. M., McMaster University:
Geochemical Study of Scapolite Minerals, 1956
Includes spectrographic analysis of minor and major elements and petrographic study of environment and origin.

461. Shaw, D. M., and Moxham, L., McMaster Univ.:
Geochemical and Petrographic Study of Pyroxenes Developed in Skarn and Hybrid Rocks Associated with Radioactive Deposits in the Grenville Province, 1956.

462. Thompson, R. M. and Jambor, J., Univ. of British Columbia:
Alteration Products at Calumet Mine, Galena Hill, Yukon Territory, 1955-56.

PLEISTOCENE GEOLOGY AND WATER SUPPLY

Alberta

463. Farvolden, R. N., Research Council of Alberta:
Groundwater Surveys in Alberta, 1956-
To assemble data on the groundwater resources of Alberta and supply information to communities short of water.

464. Gravenor, C. P., Bayrock, L. A., and Ellwood, B., Research Council of Alberta:
Mapping of Surficial Deposits in East-central Alberta, 1954-
See- "Glacial Geology of Castor District, Alberta", Pub. 56-2, Research Council of Alberta and "Trenches in East-central Alberta", Pub.56-5, Research Council of Alberta.

465. Stalker, A. M., Geol. Surv., Canada:
"Dead Ice" Plateaux in Alberta, 1955-56
Surficial Deposits of the McLeod Map-area (West-Half) 1 inch to 4 miles, 1956-57.

British Columbia

466. Fyles, J. G., Geol. Surv., Canada:
Surficial Deposits of the Coastal Lowland Along the East Coast of Vancouver Island, 1956-58.

467. Holland, Stuart, S., B. C. Dept. of Mines:
Studies of Landslides Along the P.G.E. Railraod at Peace River Bridge and Elsewhere Along the Line; Preliminary Investigation at Proposed Moran Damsite.

468. Nasmith, H. W., B. C. Dept. of Mines:
Groundwater Investigation in Okanogan Valley, 1955-56.
Much of 1956 was spent in completing studies of the glacial geology. A recent fall of volcanic ash may prove a useful marker in studies of soil development, rates of sedimentation, climatic changes as indicated by pollen analyses, and possibly in the study of archaeological sites.

Manitoba

469. Elson, J. A., McGill University:
Surficial Geology of Southwestern Manitoba, 1948-57
Studies include history of Lake Agassiz and glacial features such as washboard moraines and boulder pavements.

New Brunswick

470. Lee, H. A., Geol. Surv., Canada:
Pleistocene and Recent Deposits of the St. John River Valley Between Edmunston and Fredericton, 1953-58.

Newfoundland

471. Henderson, E. P., Geol. Surv., Canada:
Surficial Deposits of Conception Bay Map-area, 1 inch to 4 miles, 1956-57

472. Jenness, S. E., Geol. Surv. Canada
Study of Late Pleistocene Phenomena in East Central Newfoundland, 1956-57.

Nova Scotia

473. Cameron, H. L. and MacNeil, R. H., Nova Scotia Research Council Foundation:
Preliminary Pleistocene Land Form Map of Nova Scotia, 1951-57.
Map compiled from 1 inch to 4 mile and 1 inch to 1/2 mile maps and submitted as contribution to Pleistocene Map of Canada being compiled by Geological Association of Canada.

Ontario

474. Caley, J. F., and Sandford, B. V., Geol. Surv., Canada:
Drift thickness and Bedrock Topography in Southern Ontario - a continuing project.
By means of data obtained from bore holes, to determine the Pre-Pleistocene topography of the bedrock and the nature and thickness of the overlying drift. From these studies the pre-glacial drainage may be deduced and the probable location of reservoirs of groundwater located. Because the pre-Pleistocene topography reflects, in many places, the underlying structure of the bedrock, knowledge of the topography will also assist in the intelligent search for oil and gas.

475. Gadd, N. R., Geol. Surv., Canada:
Surficial Geology of the Ottawa Map-area, 1 inch to 1 mile, 1956-57.

476. Hughes, O. L., Geol. Surv. Canada:
Surficial Geology of Iroquois Falls Map-area (East Half), 1 inch to 4 miles, 1955-56.

477. Hurst, Donald L., McMaster University:
Pleistocene Geology in Vicinity of Hamilton, Ont., 1956-57; M. Sc. thesis.

478. Legget, R. F., and Eden, W. J., Div. of Building Research, National Research Council:
Clays of Steeprock Lake, 1948-
Includes detailed investigations of the nature of the varved structure and performance of large slopes cut in the clays. See "Engineering Study of Glacial Deposits at Steeprock Lake", Economic Geologist V. 48, No. 7, pp. 513-540, 1953 and "Laboratory Study of Varved Clays from Steeprock Lake", Amer. Jour. Science, V. 253, pp. 659-574, 1955.

479. Mirynech, E., Univ. of Toronto:
Soil Profile Studies in Southwestern Ontario, 1956-58; M. A. thesis.
Field work under auspices of Ontario Research Foundation.

480. Terasmae, J., Geol. Surv., Canada:
Pleistocene Pollen Studies in Southern Ontario and James Bay, 1956-57

Palynological Study of the Pleistocene Toronto Formation, 1956-57
To establish the chronologic position, supported by stratigraphical observations.

Palynological Study of Interglacial Deposits Along the Missinabi River to Establish their Stratigraphic Position, 1955-56

481. Tovell, W. M., and Deane, R. E., Univ. of Toronto:
Geology of Lake Ontario Basin, 1956-61
Project will include investigation of bedrock, thickness of drift under Lake Ontario, erosion and transportation along shore lines, and currents in the lake.

482. Watt, A. K , Ontario Department of Mines:
Groundwater Supplies in Southwestern Ontario - a continuing project.

Quebec

483. De Blois, R., and Roy, R., Quebec Dept. Mines:
Groundwater Investigations in the Provinces of Quebec, 1949-
A long term program of investigation of water supply problems in various parts of the province and accumulation of information on surface geology that will be useful for engineering and other purposes.

484. Ermengen, M. S., McGill University:
Glacial Geology and Glacial Dispersion in the Chibougamau District, 1955-57; Ph.D. thesis.

485. Gadd, M. R., Geol. Surv., Canada:
Surficial Deposits of the Upton Map-area, 1 mile to 1 inch, 1955.

486. Henderson, E. P., Geol. Surv., Canada:
Large Nivation Hollows Near Knob Lake, Quebec, 1955.
The distribution, character and origin of large fossil nivation basins, some of cirque-like form, some 30 miles west Knob Lake. See Jour. of Geol. Vol. 64, No. 6, 1956, pp. 607-616.

487. Karrow, Paul, F., Geol. Surv., Canada (part time)
Pleistocene and Recent Deposits of Grondines Map-area, 1 inch to 1 mile, 1955-56.

488. Pollitt, E. I. K., Geol. Surv., Canada:
Groundwater Survey Adjacent to St. Lawrence Seaway, Quebec, 1955-56.

489. Sabourin, R. J. E., Universite Laval:
Glacial Map of Quebec, 1951-57
Compilation of glacial striae, eskers, boulder trains, etc., to indicate direction of movement of glacial ice as an aid to prospecting.

490. Terasmae, J. and Gadd, N. R., Geol. Surv., Canada:
Palynological Study of Interglacial Deposits of St. Lawrence Lowland to Establish their Stratigraphic Position and the Climatological Conditions During their Deposition, 1954-56.

Saskatchewan

491. Kupsch, W. O., Univ. of Saskatchewan:
Pleistocene Geology of Swift Current Area, 1956-58

Yukon

492. Muller, J. E., Geol. Surv., Canada:
Airphotographic Reconnaissance of Glaciation in Southwest Yukon, 1955-
An interpretation of the glacial and fluvioglacial morphology as seen in aerial photographs.

General Problems

493. Brown, R. J. E., Div. of Building Research, National Research Council:
Permafrost Boundary in Canada, 1953-
Field observations in the provinces of Manitoba, Ontario and Quebec were carried out during 1956. Current literature on permafrost distribution has been tabulated.

494. Deane, R. E., Univ. of Toronto:
Annotated Bibliography of the Pleistocene Geology of Canada (exclusive of the Arctic Archipelago), 1956-58.
Origin, Properties and Uses of Varved Clays, 1955-58.

495. Jacobs, J. A., Univ. of Toronto:
Flow Properties and Internal Regime of Glaciers, 1956-57.
In the summer of 1956 eleven men in an expedition of the Salmon and Leduc Glaciers in southern B. C. shot 354 seismic profiles and completed an extensive gravity survey. The results are being prepared for publication.

496. Meneley, W. A., Univ. of Saskatchewan.
Microfabrics and Soil Mechanics of Glacial Deposits, 1956-57; M.Sc. thesis.
An attempt will be made to relate the microfabric and applied load found by soil mechanics to determine the origin of some glacial features.

497. Quigley, R. M., Univ. of Toronto:
Occurrences, Properties and Origins of Varved Clays, 1955-56; M. A. thesis.
See abstract in Canadian Mining Journal, March, 1957, p. 91.

498. Taylor, R. S., Univ. of Alberta:
Study of Frost Heaving, 1956-57.

499. Terasmae, J., Geol. Surv., Canada:
Palynological Study of Post-glacial Deposits in the St. Lawrence Lowland, 1957.
To establish by these studies the end of the Champlain Sea interval in the lowland and to date by the radiocarbon method recognizable levels in the standard pollen diagram of the region.
An Outline of the Principles of Pollen and Spore Analyses and their Application to Problems of Pleistocene Geology, 1955-56.

500. Wagner, F. J. E., Geol. Surv., Canada:
Geological and Palaeontological Study and Mapping of the Unconsolidated Deposits Laid Down by the Champlain Sea in Ontario and Quebec, 1953-57.

501. Wilson, J. T., Univ. of Toronto:
Glacial Map of Canada
Dr. Wilson is Chairman of the Committee of the Geological Association of Canada responsible for the compilation.

SEDIMENTATION

502. Armstrong, H. S., McMaster University:
Medina Sandstones in the Niagara Peninsula, Ont., 1951-57.
A study of the early Silurian sedimentation of this region to ascertain the nature of the source rocks.

503. Baird, D. M., Memorial Univ. of Newfoundland and Newfoundland Dept. Mines and Resources:
Rhythmic Banding in Basal Mississippian Limestone of Western Newfoundland, 1956-58.

504. Beales, F. W., University of Toronto:
Stratigraphy and Sedimentation of the Late Palaezoic Rocks of Southwestern Alberta, 1948-
Limestone Research with Particular Reference to Precipitated Limestones, 1948-
See "Conditions of Deposition of Palliser (Devonian) Limestone of Southwestern Alberta", Alberta Assoc. Petroleum Geologists, May, 1956.

505. Byrne, P. J. S., Research Council of Alberta:
Mineralogy of Carbonate Rocks, 1955-56
Mineralogy of the Bearpaw Formation, 1954-57.

506. Fry, W. L., and McLaren, D. J., Geol. Surv., Canada:
Study of Certain Cellulosic Filaments Found Within Various Devonian Limestones from Alberta, 1954-
To describe and discuss the ecologic significance of the filaments and assess their significance in relation to depositional environment.

507. Kidd, Donald J., Research Council of Alberta:
Diagenesis of Ferruginous Sediments, 1956-61
Includes field and laboratory study of oolitic iron sandstones, ferruginous shales and titaniferous magnetite placers of beach-placer origin.

508. McDowell, J. P., Ont. Dept. Mines (part time):
Direction of Sedimention in the Huronian North of Lake Huron, 1956.

509. Mellon, G. B., Research Council of Alberta:
Sedimentation Studies of the Blairmore Formation, 1955-58.

510. Mountjoy, E. W., Univ. of Toronto:
Structure, Stratigraphy and Sedimentation in the Miette Area, Alberta, 1956-58; Ph. D. thesis.

511. Patchett, J. E., Univ. of Toronto:
Accessory Minerals of the Uraniferous Conglomerate and Associated Sediments of the Blind River Area, Ont., 1956-58; Ph. D. thesis.

512. Quigley, R. M., Univ. of Toronto:
Occurrences, Properties and Origins of Varved Clays, 1955-56; M. A. thesis.

513. Sund, J. O. and Greiner, Hugo, Univ. of New Brunswick:
Sedimentology and Stratigraphy of the New Brunswick Gypsum Deposits; 1956-57.

514. Wagner, F. J. E., Geol. Surv., Canada:
Geological and Palaeontological Study and Mapping of the Unconsolidated Deposits Laid Down by the Champlain Sea in Ontario and Quebec.

STRATIGRAPHY and PALAEONTOLOGY

Precambrian

515. Bergeron, Robert, Quebec Dept. Mines:
Late Precambrian Rocks of the North Shore of the St. Lawrence River and of the Mistassini and Otish Mountain Areas, Quebec, 1956.
Proterozoic Rocks of the Northern Part of the Labrador Geosyncline, the Cape Smith Belt, and the Richmond Gulf Area, 1956.
Both papers read to the Annual Meeting, Royal Society of Canada, Montreal, June 1956.

516. Remick, J. H., Quebec Dept. Mines:
Stratigraphy and Petrography of the Iron Formation at Ross Mountain, Quebec, 1956.

Cambrian to Silurian

517. Armstrong, H. S., and Graduate Students, McMaster University:
Medina Sandstones in the Niagara Peninsula, Ont. 1951-57
A study of the early Silurian sedimentation of the region to ascertain the nature of the source rocks.

518. Byrne, A. W., McGill University:
The Beekmantown Group in the St. Lawrence Lowland of Quebec, 1955-57; Ph.d. thesis.

519. Cumming, L. M. Geol. Surv., Canada:
Stratigraphic and Palaeontological Studies of the Silurian Rocks of the Notre Dame Bay District, Newfoundland, 1954-56.

520. Dean, R. S., McGill University:
Limestones of the Lorraine and Richmond Groups, Quebec, 1956-58; M. Sc. thesis.

521. Liberty, B. A., Geol. Surv., Canada:
Geological Study and Mapping of Manitoulan Island, 1954-56.

522. Sinclair, G. W., Geol. Surv., Canada:
Stratigraphic Palaeontology of Ordivician Strata, Southern Quebec, 1955-56.

523. Zwartendyk, Jan, McGill University:
Petrographic Study of the "Granite Wash" in the Clear Hills Area, Alberta, 1955-57. M.Sc. thesis.

Devonian to Permian

524. Angold, D., University of British Columbia:
Permian Rocks and Fossils of Southern British Columbia, 1956-57; M.Sc. thesis.

525. Baird, D. M., Memorial University of Newfoundland:
Rhythmic Banding in Basal Mississippian Limestones of Western Newfoundland, 1956-58.

526. Beales, F. W., Univ. of Toronto:
Stratigraphy and Sedimentation of the Late Palaeozoic Rocks of Southwestern Alberta, 1948 -

527. Belyea, H. R., Geol. Surv. Canada:
Cross-sections through the Devonian of the Alberta Plains, 1951-
To show correlations and facies changes from study of cores, samples, electric and radioactive logs from wells drilled for oil and gas. See "Correlation of Devonian Subsurface Formations, Southern Alberta", Geol. Surv., Canada, Paper 55-38.
Cross-sections of Devonian Formations in Northern Alberta and the Southern Part of the Northwest Territories, 1955-56.

528. Cumming, A. D. and Francis, D. R., Saskatchewan Dept. Mineral Resources:
The Cantuar Marker Bed, 1956-57
A lithologic and facies study of this marker bed in southwestern Saskatchewan.

529. Fuller, J. G., Saskatchewan Dept. Mineral Resources:
Mississippian Petrology and Stratigraphy, 1954-57.
See "Mississippian Rocks and Oilfields in Southeastern Saskatchewan" Rept. 19, Sask. Dept. Mineral Resources.

530. Harker, P., and Thorsteinsson, R., Geol. Surv., Canada:
Stratigraphy and Fauna of the Permian Section at Grinnell Peninsula, Devon Island, N.W.T., 1957.
A general account of the sequence of faunas, correlation with other regions of the world, and descriptions of key fossils.

531. Hayes, E. W., Saskatchewan Dept. Mineral Resources:
Geology of Mississippian Oilfields in
Saskatchewan, 1956 -

532. McCabe, H. R., Manitoba Mines Branch (part time):
Mississippian System of Manitoba, 1953-57;
Ph.D. thesis, Northwestern University.

533. McLaren, D. J., and Belyea, H. R., Geol. Surv., Canada:
Surface and Subsurface Stratigraphy and
Correlation of the Devonian Rocks of
Southern Alberta, 1956-57.

534. Norris, D. K., Geol. Surv., Canada:
Permian and Pennsylvanian Stratigraphy,
Alberta Rocky Mountains, 1957.
The correlation of a section measured
at Beehive Pass, Alberta, with sections at
Storm Creek and the type section at Banff,
Alberta.

535. Meneley, R. A., Univ. of Saskatchewan:
The Upper Devonian Nisku Formation in
Saskatchewan, 1956-57; M.Sc. thesis

536. Nelson, Samuel J., Univ. of Alberta:
Faunal Zones of the Rundle Formation of the
Rocky Mountains, 1955 -

537. Usher, John L., Queen's University:
Petrography of Upper Devonian Rocks in the
Rocky Mts., Alberta, 1956-57.

Triassic to Cretaceous

538. Edwards, A. G., Univ. of Saskatchewan:
Stratigraphy of the Spinney Hill Formation,
West Central Saskatchewan, 1956-57;
M.Sc. thesis.

539. Frebold, H., Geol. Surv. Canada:
Jurassic Fauna and Stratigraphy of British
Columbia, 1955-56.
Stratigraphy and Fauna of the Jurassic Rocks
on Prince Patrick Island, N.W.T.,
1955-56.
A study based on Dr. E. T. Tozer's collections
made in the Canadian Arctic in 1954.

540. Francis, D. R., Saskatchewan Dept. Mineral Resources:
Jurassic and Cretaceous Oilfields of South-
western Saskatchewan, 1953-57.

541. Jeletzky, J. A., Geol. Surv., Canada:
Stratigraphic and Palaeontological Study of the Cretaceous and Uppermost Jurassic Strata Southwest of the Mackenzie River Delta and Arctic Coast, 1955-57.
Cretaceous Marine Zones of the Canadian Western Interior and their Correlation with the Western Interior of the United States and Europe, 1956-58.
Paper presented International Geological Congress, Mexico City, 1956.
Study of Geological Survey of Canada collections of Scaphites Faunas from the Bearpaw Formation of Alberta, Saskatchewan and Equivalents in Manitoba, 1949-57.
The objective is to correlate these formations throughout the Prairie Provinces.

542. McLearn, F. H., Geol. Surv. Canada (retired):
Stratigraphy and Ammonoid Fauna of the Upper Triassic Pardonnet Beds, Peace River Foothills, 1952-57.

543. Price, L. L., Geol. Surv., Canada:
Study of Lower Cretaceous Formations of Southern Saskatchewan Based on Electric Logs and Well Samples, 1954-56.

544. Ritchie, W. D., University of Alberta:
Kneehills Tuff of Alberta, 1956-57; M.Sc. thesis.
The mineralogy, petrology, and geochemistry are being investigated and zircon separates have been extracted for age dating.

545. Stansberry, Gerald F., Univ. of Alberta:
Viking Sand of Alberta, 1956-57; M.Sc. thesis.

546. Stott, D. F., Geol. Surv., Canada:
Stratigraphic Studies of the Upper Cretaceous Alberta Group, 1955-56.

Tertiary

547. Russell, Loris S., National Museum of Canada:
Age of the Hand Hills Conglomerate, Alberta, 1956-57.

General Problems

548. Clark, T. H., McGill University:
Stratigraphy, Structure, and Economic Resources of the Palaeozoic Rocks of the St. Lawrence Lowland, 1938-
<u>See</u> "St. Jean-Beloeil Area", Quebec, Dept. Mines, Geol. Report 66, 1955 and "Oil and Gas in St. Lawrence Lowland of Quebec", Trans. Can. Inst. Min. and Metallurgy, Vol. LIX, 1956, pp. 278-282.

549. De Blois, R., Roy, R., and Clark, T. H., Quebec Dept. of Mines:
Deep Borings Investigations in the Province of Quebec
A continuing program of the logging of deep borings for oil and gas in various parts of the province.

550. Fyles, J. T. and Hewlett, C. G., British Columbia, Dept. Mines:
Detailed Study of Structure and Stratigraphy of the Salmo Lead-Zinc Belt, B. C., 1951-56.

551. Gill, J. E., McGill University:
Precambrian History, 1945-
See "Precambrian Nomenclature in Canada" Trans. Roy. Soc. Canada, Vol. XLIX, Sec. IV, 1955, pp. 25-29.

552. Hughes, J. E., McGill University:
Stratigraphy and Structure of Coronation Creek Area, B. C., 1956-58; Ph.D. thesis.

553. Liberty, B. A., Geol. Surv., Canada:
Palaeozoic Outliers in Canada, 1957

554. Norris, A. W., Geol. Surv., Canada:
Fauna and Stratigraphy of Lower Palaeozoic Rocks Along Valleys of the Clearwater, Athabasca and Peace Rivers, 1956-57.

555. Nunes, Arthur D., L'Universite Laval:
La Tectonique et la Stratigraphie de l'Ile d'Orleans, 1956- ; D. Sc. thesis.

556. Mountjoy, E. W., University of Toronto:
Structure, Stratigraphy and Sedimentation of the Miette Area, Alberta, 1956-58; Ph.D. thesis.

557. Pugh, D. C., Geol. Surv., Canada:
Pennsylvanian, Permian, Triassic and Jurassic Formations of Northeastern British Columbia, 1954-57.
Based on the study of samples, cores, and electric and radioactivity logs of wells drilled for oil and gas.

558. Sund, J. O. and Greiner, Hugo, Univ. of New Brunswick:
Sedimentology and Stratigraphy of Brunswick Gypsum Deposits, 1956-57.

559. Terasmae, J., and Gadd, N. R., Geol. Surv., Canada:
Study of Palynology of Interglacial Deposits of St. Lawrence Lowland to Establish their Stratigraphic Position, 1954-56.

560. Terasmae, J. and Hughes, O. L., Geol. Surv., Canada:
Palynological Study of Interglacial Deposits Along the Missinabi River, Northern Ontario, to Establish their Stratigraphic Position, 1955-56.

STRUCTURAL GEOLOGY

Alberta

561. **Burwash**, Ronald, A., University of Alberta:
Alberta Precambrian Basement Study, 1951- See "Reconnaissance of the Subsurface Precambrian of Alberta", Bull. American Assoc. Petroleum Geologists, Vol. 41, No. 1, 1957, pp. 70-103.

562. Mountjoy, E. W., Univ. of Toronto:
Structure, Stratigraphy and Sedimentation of Miette Area, Alberta, 1956-58; Ph.D. thesis.

British Columbia

563. Eastwood, G. E. P., British Columbia Dept. Mines
Structural Control of Ore at Spider Mine, North of Ferguson Area, 1956.

564. Fyles, J. T. and Hewlett, C. G., British Columbia Dept. Mines:
Detailed Study of Structure and Stratigraphy of Salmo Lead-Zinc Belt, 1951-56.

565. Hughes, J. E., B. C. Dept. Mines:
Structural Mapping of Commotion Creek Anticline and Detailed Stratigraphy of Lower Cretaceous in Foothill Belt, at Upper Pine River Bridge, 1956; Ph.D. thesis, McGill University.

566. Trettin, H. P., B. C. Dept. Mines (part time), Univ. of British Columbia:
Structure of Silver Cup Mine, Ferguson Area, Lardeau District, 1956; M.Sc. thesis.

567. White, W. H., Univ. of British Columbia:
Structural Map of British Columbia.

Manitoba

568. Milligan, G.C., Manitoba Mines Branch:
Metamorphism and Structure, Lynn Lake, Manitoba, 1954-57.

New Brunswick

569. Sharpe, J. I., and MacKenzie, G. S., Univ. of New Brunswick:
Variation and Structural Relationships of Mt. Champlain Granitic Rocks of Devonian Age in the Hampstead Map-area, 1956-57.

Nova Scotia

570. Cameron, H. L., Nova Scotia Research Foundation:
Geological and Tectonic Map of Nova Scotia, 1 inch to 4 miles.
Memoir to accompany map is underway.
See "Airphoto Interpretation of a Province", Canadian Surveyor, April 1956, pp. 100-102.

Ontario

571. Ginn, R. M., Univ. of Toronto:
Granites Between Sudbury and Blind River and their Relation to the Bruce Series, 1956-58; Ph.D. thesis.

572. Saha, A. K., Univ. of Toronto:
Studies of Mode of Emplacement of Some Granite Plutons in Hastings County, Ontario, 1955-57; Ph.D. thesis.
A structural and petrographic study of the Chandos, Coe Hill and Delaro Granites.

573. Wynne-Edwards, H. R., Queen's University:
Structure and Petrogenesis of the Westport and other Plutons, 1955-58; M. Sc. thesis.

Quebec

574. Laurin, A. F., Quebec Dept. Mines (part time), Universite Laval:
Relationship Between Temiskaming and Grenville Sub-provinces, 1955-57.

575. Nunes, Arthur D., Universite Laval:
La Tectonique et la Stratigraphie de l'Ile d'Orleans.

576. Osborne, F. F., Universite Laval:
The Transition Zone Between the Grenville and Keewatin Sub-provinces, 1956-57.

577. Rejhon, George, McGill University;
Study of the Ordivician Breccias Near Mantane, Quebec, 1955-57; M. Sc.

578. Schwellnus, J. E. G., Queen's University:
Structure and Trace Element Study of Iron Ores and Protons, Knob Lake Deposits, Labrador, 1954-57.

Saskatchewan

579. Cumming, A. D., Fuller, J. G., and Sawatzky, H. B., Saskatchewan Dept. Mineral Resources:
Alleged Fault Structures in the Avonlea District of Saskatchewan, 1956-57.

580. Pearson, W. J., Saskatchewan Dept. Mineral Resources:
Geology Around Deep Bay Crater, Reindeer Lake, Saskatchewan, 1956-
An investigation in co-operation with Dr. W. Innes, Dominion Observatory, to discover possible evidence for the meteoric origin of Deep Bay.

Detailed Mapping of Mineral Deposits North of Lac La Ronge, 1956-57
A compilation of structural and mineralogical data over small areas that show promise as base metal prospects.

581. Wild, J., University of Saskatchewan:
Physiographic Expression of Structure Elements of Southern Part of Saskatchewan, 1956-57; M.Sc. thesis.

General Problems

582. Brown, A., Hacquebard, P. A., and Harris, D., Dept. Mines and Technical Surveys:
Investigation of Sudden Release of Stress in Coal Mines, and Ore Extraction Problems in Metal Mines, 1950-
See "Rock Pressure Studies in the Mines of Springhill, N. S.", Bull. Can. Inst. Min. and Metallurgy, June 1956.

583. Cameron, H. L., Nova Scotia Research Foundation:
Tectonics of the Maritime Area of Eastern Canada, 1955-56.
A compilation was made of all tectonic information available for the area including the subsea work of Ewing, Warzel, Officer, and others. An analysis led to the conclusion that the Appalachian geosyncline is defined by the Logan fault and the shelf fault. The development of early welts which supplied sediments to local basins is discussed. See Trans. Royal. Soc. Canada, Vol. L, Ser.III, Sec. IV, June 1956, pp. 45-51.

584. Gross, W. H., and Jackson, W. H.; Univ. of Toronto:
Origin and Significance of Cross Faults as a Fundamental Geological Structure and Guide to Ore, 1955-58.

585 Kranck, E. H., McGill University:
Deformation in Metamorphic Rocks, 1956-57
See "Rock Structures and Fabric in the Zone of Plastic Deformation", presented at Int. Geol. Congress, Mexico City, 1956.

586. Moorhouse, W. W., University of Toronto:
Structure of Highly Deformed Rocks, 1953-58
A compilation of existing data on the interpretation of structures of rocks deformed in, or near the zone of flow.

587. Mumtazuddin, M., McGill University:
Structure of a Field in Pakistan, 1956-57

AUTHOR INDEX

APPENDIX

SURVEY OF GEOLOGICAL STUDENTS ATTENDING UNIVERSITIES IN CANADA 1956-57

SUMMARY

Canada

	Arts and Science	Engineering	Total
Graduated 1956	124	57	181
Expected to graduate 1957	120	48	168
Expected to graduate 1958	148	66	214
Graduates			
Masters' degrees granted, 1956	24	11	35
Ph.D. degrees granted, 1956			15
Master's degree candidates	82	31	113
Ph.D. degree candidates			17

GEOLOGICAL STUDENTS IN CANADIAN UNIVERSITIES 1956-57

Undergraduate

University	Art and Science			Engineering		
	Degrees Granted 1956	4th Year (Graduate 1957)	3rd Year (Graduate 1958)	Degrees Granted 1956	4th Year (Graduate 1957)	3rd Year (Graduate 1958)
Acadia	16	8	12			
Alberta	25	20	20		1	1
British Columbia	20	18	17	9	10	12
Dalhousie						
Ecole Polytechnique	5	6	13	0	4	8
Laval				2	3	5
Manitoba	3	5	4	10	0	3
McGill	13	19	18			
McMaster	11	4	14			
Memorial	6	6	13			
New Brunswick	6	13	13			
Queens	2	5	8	11	6	10
Saskatchewan	6	-	12	15	6	18
St. Francis Xavier						
Toronto	3	2	0	10	18	9
Western Ontario	8	14	4			
	124	120	148	57	48	66

GEOLOGICAL STUDENTS IN CANADIAN UNIVERSITIES 1956-57

Graduate

University	Masters' Degrees						Ph.D. Degrees		
	Arts and Science			Engineering					
	Granted 1956	Expected 1957	Expected 1958	Granted 1956	Expected 1957	Expected 1958	Granted 1956	Expected 1957	Expected 1958
Acadia	1	1							
Alberta	5	3	3						
British Columbia	4	9	10	3	2	3			
Dalhousie									
Laval				1	4	3			
Manitoba	3	0	1		1				
McGill	7	10	11				7		
McMaster	0	5	2						
New Brunswick	0	5	5						
Queens	1	4	3	2	2		2	5	3
Saskatchewan	0	1	3		9	2			
St. Francis Xavier									
Toronto	3	1		5	5		6	5	4
Western Ontario	0	4	1						
	24	43	39	11	23	8	15	10	7