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NATIONAL ADVISORY COMMITTEE ON RESEARCH IN THE GEOLOGICAL SCIENCES

TWENTIETH ANNUAL REPORT
1969 - 1972

ANNUAL REVIEW AND REPORTS OF SUBCOMMITTEES

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601 Booth Street,
Ottawa, September, 1973.

The Honourable D.S. Macdonald,
Minister of Energy, Mines and Resources,
Ottawa, Ontario.

Sir:

I have the honour to submit to you the Twentieth Annual Report of the National Advisory Committee on Research in the Geological Sciences covering the period September 1, 1969 to August 31, 1972.

Respectfully submitted,

Y.O. Fortier,
Chairman

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THE NATIONAL ADVISORY COMMITTEE ON RESEARCH IN THE GEOLOGICAL SCIENCES

1969-1972

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Dr. Thomas E. Bolton, Secretary (1970-72)	Geological Survey of Canada Ottawa, Ontario

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Professor R.A. Blais	Ecole Polytechnique Montreal, Quebec
Dr. E.A. Christiansen	Saskatchewan Research Council Saskatoon, Saskatchewan
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Mr. C.B. Crawford	National Research Council Ottawa, Ontario
Professor A. Dreimanis	University of Western Ontario London, Ontario
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Dr. P.E. Grenier	Department of Natural Resources, Quebec, Quebec
Dr. J.M. Harrison (ex-officio)	Department of Energy, Mines and Resources Cttawa, Ontario
Dr. M.E. Hriskevich	Banff Oil Co. Ltd. Calgary, Alberta
Dr. E. Irving (ex-officio)	Earth Physics Branch Ottawa, Ontario
Dr. C.S. Lord	Geological Survey of Canada Ottawa, Ontario

Professor G.V. Middleton	McMaster University Hamilton, Ontario
Mr. C.S. Ney	Kennco Explorations (Western) Ltd. Vancouver, British Columbia
Dr. B.R. Pelletier	Bedford Institute of Oceanography Dartmouth, Nova Scotia
Professor R.A. Price	Queen's University Kingston, Ontario
Professor R.D. Russell	University of British Columbia Vancouver, British Columbia
Mr. Dennis A. Sharp	Department of Energy and Resources Toronto, Ontario
Dr. A. Sutherland-Brown	Department of Mines and Petroleum Resources Victoria, British Columbia
Professor A.C. Turnock	University of Manitoba Winnipeg, Manitoba

Meetings: February 7-8, 1972.

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Dr. Y.O. Fortier, Chairman	Geological Survey of Canada Ottawa, Ontario
Dr. E.W. Best	BP Oil and Gas Ltd. Calgary, Alberta
Professor R.A. Blais	Ecole Polytechnique Montreal, Quebec
Mr. H.K. Conn	Canadian Johns-Manville Co., Ltd. Asbestos, Quebec
Dr. C.S. Lord	Geological Survey of Canada Ottawa, Ontario
Dr. A. Sutherland-Brown	Department of Mines and Petroleum Resources Victoria, British Columbia
Professor A.C. Turnock	University of Manitoba Winnipeg, Manitoba
Dr. Thomas E. Bolton, Secretary	Geological Survey of Canada Ottawa, Ontario

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Professor G.V. Middleton	McMaster University Hamilton, Ontario
Professor R.W. Blais	Ecole Polytechnique Montreal, Quebec
Professor R.D. Russell	University of British Columbia Vancouver, British Columbia
Dr. Thomas E. Bolton, Secretary	Geological Survey of Canada Ottawa, Ontario

Meetings: May 31, 1970; June 6, 1971; February 5, 1972.

CHAIRMAN'S COMMENTS

Prepared by Y.O. Fortier, Chairman 1964-73

The National Advisory Committee on Research in the Geological Sciences (NACRGS) was instituted at the 1946 initiative of a group of geologists within the Canadian Institute of Mining and Metallurgy, to promote the development of geological research, as it was then practically non-existent in many sectors. Faculty members, outside of teaching commitments, devoted their professional activities to consulting; such necessities were imposed on them by conditions evolving from the Great Depression years, and from the Second World War. The initial research fund of the Geological Survey of Canada (GSC), to be granted annually under the advice of the NACRGS, amounted to $10,000, and first went begging for takers. The National Research Council (NRC) offered no research grants in geology, for whatever philosophical or pragmatic reason, except for some $5,000 in mineralogy, as a result of the interest of chemists in this subject matter.

A generation or so after the activities leading to the creation of the NACRGS, geoscientific members of Canadian faculties had access to federal sources of grants exceeding well over $3,000,000. Faculties had greatly enlarged in size and numbers, industry had become the major employer of geologists, and government services at the federal and provincial levels employed geologists for a diversity of purposes beyond the field of mineral resources. Geophysicists became more concerned with research in geology and with the application of geophysics to the location of resources. Geochemistry followed similar paths. Physical geographers, in increasing numbers, dealt with physical geology under the banner of geomorphology. Engineers formalized their concerns for contending with geology under the professional name plate of geotechnology. An effervescent research effort had grown in many directions, substantially discipline oriented: the NACRGS, essentially constituted to perform along lines of disciplines, was part of the movement and contributed to its growth. Indeed, a research capability in the geological sciences, and other geosciences, had been established.

The question arose: should the increasing support for research in the geological sciences, and the growing capability for research, continue to be measured substantially by the scientific curiosity, the academic craving for knowledge for its sake? Or, should the newly acquired and growing capability for research not be, in part, directed toward national goals, should it not equally serve missions other than academic, other than basic research substantially related to the welfare of one's discipline? The question was directed, among others, to the NACRGS. This committee, sponsored by GSC, has had the same national function toward the development of geological disciplines through research as the Associate Committee of the NRC for geodesy and geophysics. The research funds granted by GSC, under advice by NACRGS, were managed under similar philosophy and practice as those of the NRC funds for earth sciences, the latter presently being about a scale of magnitude larger. The Chairman of the NACRGS, acting for some time as a convenor on the NRC screening committee on earth sciences grants, provided one element of coordination.

Evidently, the possibility of duplication existed when both NRC and GSC entered the field of granting in the earth sciences. It should be remarked here, that the NRC Associate Committee on Geodesy and

Geophysics did not maintain direct links with the NRC screening committee on earth sciences grants, whereas a subcommittee of the NACRGS has screened grant applications to the Geological Survey of Canada.

Since NRC earth sciences granting policy was based primarily on personnel excellence, whereby the choice of research project of scientific merit was left to the researcher, a similar policy for NACRGS led to duplication. The NACRGS, when screening grant applications, did give priority to cooperative projects it sponsored; to wit, the Coronation Mine project, the southern Cordillera structural section project, and the development of a national system for data storage and retrieving. However, these were the exceptions. In late years, NACRGS failed in attempts to identify topics worth national consorted efforts. Possibly the failure was due, in part, to its structure and composition, probably mainly because original goals had been achieved. The ultimate result was duplication in granting between GSC and NRC in geology: GSC funds, granted under the advice of NACRGS and at a later date than those granted by NRC on the basis of screening by its committees, became mainly supplements to the latter. Members of NACRGS serving on its grant examination committee, were in recent years, confronted with this untenable situation.

For those who consider a granting function as the essence of an advisory committee on research, the experience of the last few years has put the NACRGS under questionable light. For the Department of Energy, Mines and Resources (EMR), of which GSC is one of many branches that have granted research funds, need for change in this state of affairs became evident. Preoccupied as it is with national matters of energy, mineral resources, and needs to provide knowledge on the Canadian landmass for various national purposes, EMR seeks among other things, advice on problems presented by the above topics, and on research needs to solve them. Consequently, EMR recosted its process of external research support, and the system of Research Agreements was installed in 1972 and related to departmental mission. This in no way affected the granting system of NRC for geology, where research for strictly academic purposes still finds its main granting support.

The NACRGS, as the instar of the Associate Committee on Geodesy and Geophysics, developed its subcommittee activities mainly along lines of disciplines. Meetings of such subcommittees enabled experts in particular fields of geology to have specialists' workshops and seminars; these experts could then define the status of knowledge in their fields, and identify domains of research, all with proper expert concentration, and without the dilution of scientific tourists. Yet, NACRGS could sponsor multidiscipline symposia of specific topics, with broad participation. Such activities took place when societies were either too timid to structure themselves so as to recognize the specialized interests of experts in particular fields, or did not have membership support to initiate such activities. Some of the committees' activities eventually resulted in the creation of similar groupings within societies, notably, the Subcommittee on Structural Geology, which has been a most active one. This subcommittee sponsored, within the NACRGS, the southern Cordillera structural section, a coordinated and cooperative research project that involved participation by many specialists from many universities, and from provincial and federal agencies.

To facilitate exchange of research results, the NACRGS has also assisted societies in their formative years in publishing periodicals, and

later on in helping to publish results of symposia, as it had for symposia held under its own sponsorship. The support of the GSC to the NACRGS permitted at times either entities to sponsor special publications of general interest to earth sciences, such as reports of the Upper Mantle Project and the background papers on earth sciences disciplines resulting from the activities of the Task Force on the Solid Earth Sciences of the Science Council of Canada.

Yearly, GSC published for the NACRGS, a best seller: the annual review of research in the geological sciences. This has been compiled with the collaboration of scientists in Canada by the Secretary of the NACRGS, among his many GSC duties. Also published yearly were the results of the annual deliberation of NACRGS and of its subcommittees, with reviews of needs, state of the science, and recommendations. These have been submitted to the Minister of EMR, who transmitted them to his provincial counterparts. Such annual reporting may well have inspired the provision of background papers by various disciplines for the Science Council of Canada Study on the Solid Earth Sciences.

The Executive Committee of the NACRGS has acted as the National Committee for Geology, especially in international matters. To support this function, the GSC paid the annual adhesion fee of Canada to the IUGS, providing for geology what the NRC did for geophysics and other disciplines. The Executive Committee of the NACRGS, when acting as the National Committee for Geology, augmented its number by individuals selected for the purpose at hand. Thus, in 1967, activities preliminary toward the holding of the International Geological Congress in Canada in 1972, and toward its eventual management, were undertaken by the National Committee for Geology. In this instance, and others related to the holding of the Congress, the Executive Committee asked to be joined in the National Committee for Geology, by the Chairman or a representative of the Geological Association of Canada, the Mineralogical Association of Canada, the then Alberta Society of Petroleum Geologists, the Geology Division of the Canadian Institute of Mining and Metallurgy, and the Geology Subject Division of the Royal Society of Canada.

All of the above activities were that more easily carried by the NACRGS and the GSC because of the ready mutual support they could give to each other. If, on the one hand, support of the NACRGS was based in the focal institution of federal geological activities, that special relationship permitted the GSC, on the other hand, to have closer relations with academic, provincial geological services, and parts of the industry, than would be otherwise the case. This resulted in an added exposure of the GSC to other institutions, and to activities extramural to it.

Canadian societies in the earth sciences have grown in recent years in size, numbers, capabilities, awareness, and cohesiveness. National debate on science policy and related style of science performance and organization in Canada has been intensive, and earth sciences partook early in the national self-examination. As a result, a strong body of opinion has developed that geological societies should, preferably, perform the above various activities, and take a substantial part in advising government departments about their missions. The arguments invoked are: better democratic process, better representation, greater participation, effective harmonization of divergent interests among disciplines and sectors of performance, greater mobilization of relevant talent, and greater potential for political impact and, for some, for lobby practices as in other countries.

The Geological Survey of Canada found the NACRGS a very valuable counsel in days when geological debate was concerned not so much with how to assign limited financial resources, but as to how everyone should put one's foot forward, in view of the unlimited task in post-war economic reconstruction and northern development. The value of NACRGS was not only in the advice and support it gave as a body to the GSC, but also derived from the fact that members of NACRGS were well informed about the objectives and needs of the GSC in its national mission, and could bring to bear this knowledge in their other activities. Widely separate instances of valuable direct NACRGS advice led to the adoption by the GSC of a formal program of activities in Quaternary geology in the forties, and to the use in the sixties of the GSC intramural scheme for data storage and retrieval as a springboard toward the development of a national system. Examples of action by members of NACRGS, as participants in other endeavours, are the appeals to departmental authorities for proper housing of the GSC, and to governmental authorities for increasing the capacities of the GSC as a major pathfinder in northern development.

Since the forties, an inherent academic research capability has been established with a well developed fabric permitting the pursuit of research for knowledge sake. Industrial development in mineral and petroleum resources has brought with it a development of investigative capacities. The intellectual welfare of the geological sciences, in the ever progressing sciences, has become but one of the preoccupations of geologists, and of those who expect geological contribution to the progress of Canada. Education, resource needs, environmental concerns, planning services requirements, engineering preoccupations, conservation of energy, mineral resources and soils, the interaction of disciplines in consideration of the above topics, are so many missions and concerns geologists and other geoscientists are facing. Advice on these topics can take many forms and may be obtained from many sources. The Science Council of Canada, in its recommendations on the 'Solid Earth Sciences', has indicated one formal advisory structure for the development of mineral resources. The National Advisory Committee on Research in the Geological Sciences, in its annual meeting in 1972, gave its support to the above recommendation. But it also recognized the need for advice in other fields of geological endeavours in the two formal resolutions it passed, and cited elsewhere in this report. The debate on national geoscience advisory responsibilities is now widespread and properly nurtured in the Canadian Geoscience Council. It is questionable that one, overall, national advisory committee will capably meet the needs for all missions. The rapidity with which concerns change in any one field puts into question whether one monolithic, mastodont body can be adequate, and provide advice with effective timing and proper discernment.

DISCUSSION ON THE FUTURE OF THE NATIONAL ADVISORY COMMITTEE ON RESEARCH IN THE GEOLOGICAL SCIENCES, IN THE LIGHT OF THE RECOMMENDATIONS OF THE SCIENCE COUNCIL OF CANADA AND OF ITS TASK FORCE ON THE EARTH SCIENCES

February 8, 1972

Reference is made to the section on "A National Committee on Mineral Resources Research" in "Earth Sciences Serving the Nation - Recommendations", Science Council of Canada, Report No. 7, April 1970, pages 18 and 19, and to appendix B on "Some suggestions regarding operation of the proposed National Advisory Committee on Mineral Resources Research", page 33 of the same volume.

Reference is also made to the section on "A National Committee on Mineral Resource Research" in "Earth Sciences Serving the Nation", Science Council of Canada, Special Study No. 13, 1971, pages 94 and 95 and to conclusion II.10 on pages 95 and 96 of the same volume. Conclusion II.10 states: "The National Research Council and the Department of Energy, Mines and Resources should review the roles of their Associate and Advisory Committees with a view to clarifying their mission orientation and transferring increased responsibility for the coordination of discipline-oriented research to the appropriate professional societies".

The discussion was so structured as to permit each attendant at the meeting to make a statement. The participants were thus grouped:

mining and petroleum industries
universities
provincial government departments and agencies
federal government departments and agencies
national geological societies

New members on the NACRGS were so chosen as to provide a balanced representation of the above sectors except for chairmen of national geological societies who were specially invited to partake in the discussion.

The structured discussion and the participants were as follows:

A. The Department of Energy, Mines and Resources objectives and its view on advisory committees: Mr. Jack Austin, Q.C., Deputy Minister, EMR; Dr. C.H. Smith, Assistant Deputy Minister, Science and Technology, EMR.

B. Types of existing advisory committees dealing with Earth Sciences: The Associate Committee on Geodesy and Geophysics, sponsored by the National Research Council - by Dr. J.H. Hodgson; The Associate Committee on Quaternary Research, sponsored by the National Research Council - by Professor W.H. Mathews; The National Advisory Committee on Research in the Geological Sciences, sponsored by EMR - by Dr. Y.O. Fortier; The Science Council Study on the Earth Sciences and its recommendations on advisory committees - by Professor R.A. Blais;
Dr. C.H. Smith; Aspects and dimensions of the problem to be discussed - by Dr. Y.O. Fortier.

C. Points of view by NACRGS members from industry. Participants were: Mr. H.K. Conn, Dr. E.L. Evans, Mr. C.S. Ney, Mr. J. Andriuk, Dr. M.E. Hriskevich. Mr. R.L. Slavin was invited to make a statement in view of the impossibility of Dr. Best to attend and the necessity for Dr. Hriskevich to leave early.

D. Points of view by NACRGS members from universities. Participants were: Professor F.W. Beales, Professor A. Dreimanis, Professor G.V. Middleton, Professor R.A. Price, Professor R.D. Russell, Professor A.C. Turnock.

E. Points of view by NACRGS members from provincial government departments and agencies. Participants were: Dr. A. Sutherland-Brown, Dr. A.F. Laurin (for Dr. P.E. Grenier), Mr. D.A. Sharp, Dr. E.A. Christiansen.

F. Points of view by NACRGS members from federal government departments and agencies. Participants were: Mr. C.B. Crawford, Dr. B.R. Pelletier.

G. Points of view by invited chairmen of national geological societies. Participants were: Dr. D.R. Derry (GAC, CGC), Mr. R.L. Slavin (ASPG), Dr. A.R. Graham (MAC).

A. Excerpts from Informal Address by
Mr. J. Austin, Q.C., Deputy Minister, Department
of Energy, Mines and Resources

EMR Objectives

A very significant change has taken place in the affairs of EMR in the last two years. Its foundation is based on the Glasgow Commission Report.

In 1966 the government had established the Department of Energy, Mines and Resources in the place of Mines and Technical Surveys. It saw Energy, Mines and Resources at that time as its comprehensive resource manager. The former Department of Mines and Technical Surveys, in contrast, was largely concerned with the provision of services to other users, informational services, scientific and technical services, maps, geological services, earth physics and many other activities.

The Department received a very definite new direction from the government in the Fall of 1970. It was asked to become competent as the government's senior mineral and energy policy manager. It was to develop an integrated competence to advise in terms of energy and mineral resource policy for Canada, integrated economics, social objectives supported by and integrated with the science and technical activities within the department. In other words, EMR was assigned the central role in these activities and asked to mobilize and marshal its competence all the way from basic geological definition right through to end use:

(a) How do you discover it? What do you have?
(b) How can you produce it?
(c) What does it cost? Where are your markets?

EMR became a user of a very substantial amount of information which it produced, while, of course, it continued in a service role to other departments – National Defence, the Department of the Environment, Indian Affairs and several other departments.

EMR has three programs: a Mineral program, an Energy program, and an Earth Sciences or Landmass Management program. One of EMR's objectives is to ensure that adequate information is available about the Canadian landmass so that all of its resources and its physical attributes can be known and intelligently and, hopefully, beneficially used.

EMR and Advisory Committees

Advisory committees are extremely useful to EMR; they bring to it the insights of men who are operating in the commercial and business area and also at the universities. These insights are necessary to continue to make EMR objectives and mission identification a practical and valid exercise.

EMR has really two types of advisory committees – one is concerned with policy and the other, policy in the integrated sense of economic policy, industry policy.

The National Advisory Committee on Petroleum and the National Advisory Committee on the Mining Industry are both composed of Senior or

Chief Executive Officers of Oil and Mining Companies respectively and are chaired by the Minister. The purpose of both committees is to deal with the economic and social problems which are faced by those two industries – both nationally and internationally – and to focus both government and business thinking on key issues.

Another kind of committee is NACGRS; this is an advisory committee to EMR's specific missions, whether it be science or technology or some other activity within the department. EMR presently has: the National Advisory Committee on Research in the Geological Sciences, chaired by Dr. Y.O. Fortier; a National Advisory Committee on Mining and Metallurgical Research which the Deputy Minister chairs and which relates in a large way to the program of the Mines Branch and its priorities; a National Advisory Committee on Controlled Mapping and Surveys chaired by Dr. Sam Gamble, the Director of the Surveys and Mapping Branch; a Canadian Advisory Committee on Remote Sensing chaired by Dr. Larry Morley, the Director of the Canada Centre for Remote Sensing; and various advisory committees on special status subjects, such as the Canadian Committee on Coal Research, the Canadian Committee on Rock Mechanics, and the Advisory Board for Geoscience Data.

The Science Council in its report on Earth Sciences stated clearly that National Advisory Committees must be concerned with reaching the goals of the mission rather than the welfare of the discipline of the science per se. There is no question but that the government has adopted that particular philosophy; it is also being urged to implement radical new structures with respect to it.

Comments on Urban Affairs

EMR has an important role in urban geology in terms of our ability to assess as a service the physical foundations for the establishment and development of urban communities.

Comments on EMR Resource Management Role

It should not be conceived that EMR's role is to manage the business of running oil companies and mining companies as such, but there is a clear need as established by government for a better coordination of investment of national capital in various sectors and of Canadian economic activity and, basically, the government wants the balance sheet on the performance of resource industries and a better value for the national dollar in terms of its performance. There is no problem that emerges in Canada whether it's social, energy or industrial that the people of Canada believe could be dealt with elsewhere than in government. If there is a problem, government has to provide the answer and that's become a modern concept of activity in Canada. The government has the responsibility, it has to mobilize national policies in order to direct itself towards that responsibility. There is the environmental pollution – the government has to mobilize to deal with the problem of pollution; the government will have to mobilize to deal with problems relating to sufficient energy at reasonable prices in the nation.

Comments on Time Frame and Whose Mission

If the premise is set that departments of government exist for the purpose of serving the national policy managers who are elected, then they should be responsible to the will of the elected representatives of the people. Then, basically, EMR is here to produce for them what it is they ask us to do. That is only a beginning in terms of the request because we have a lot of the insights within the discipline in enlarging the specifics of the question "what should we do in the geological sciences?". Questioned as to the range of options, the geological scientist will ask "in what time frame?". The politician will say "I'm concerned with a maximum of what you would call quite a short term". Governments are elected on a four to five-year basis. If there is a problem in the gold mining communities, it needs to be solved within a year or two if it can be solved, or if you have a Department of Regional Economic Expansion, it is anxious to alleviate economic and social suffering in a short term. So, it is necessary to ask what kinds of demands will be placed on the geological sciences from the political community; a social problem affecting the geological sciences would require a short-term answer. For economic problems affecting the geological sciences, the time frame is a little larger, but it isn't large. For disciplinary problems, a longer time frame still. Those who are in the discipline can best advise how long the time frame is in the disciplinary sense, but those who are responsible to give advice to people who have money to spend to alleviate the social and economic problems that are their responsibility have to say the time frame is short. In some cases, it's a day here, in some cases, it's a year – some cases, three or four or five years, or ten years.

On National Versus Federal Concepts

The effort of the federal government and its responsibility under the constitution is for peace, order and good government in the nation and, therefore, the nation is all parts of Canada equally. Its responsibility then is to ensure that in advisory committees people from each part of the nation are represented, all particular interests are represented, all outlooks are represented in order that a concept of action which is national in scope can be developed. That is the essential view of the department's use of the word National Advisory Committee. This committee is not national in the sense of constitutional – it's national in the sense that it's drawn nationally from the nation. It is essential to view National Advisory Committees in terms of what is a responsible policy for the nation – national in that sense.

On Mission-Oriented Research

It has never been considered whatsoever either that mission-oriented research excluded basic research or that by undertaking mission-oriented research or sponsoring certain activities in mission-oriented fields, basic research, that is research carried out in universities, would be neglected or set aside. It was with due consideration to all the mechanism existing in Canada that the Science Council presented its recommendation; naturally the National Research Council has a very fundamental responsibility towards the academic research.

One of the kinds of focus that a committee of this type is expected to have is the role of the department and its spending power in terms of the

Geological Sciences Program here, in other words, one of the goals for such a committee is assistance in terms of the department's particular programs. A second goal relates to its view of the national role for Geological Sciences, that is an objective for the discipline and a definition of where the department and universities fit.

Members Comments

The function of the department of EMR has been expanded over that of the former Department of MTS, and the original objectives remain intact somewhere within the new framework. As constituted, this Advisory Committee was concerned with research in the geological sciences. It was oriented towards scientific objectives. The new responsibilities described are Resource Management responsibilities; most scientists are not fully conversant with the problems in Resource Management, and thus not the professionals to advise on Resource Management. EMR still retains within the department a purely scientific function, however, and in this context this type of committee still has a function, a service to provide to the department and to the various people it represents. It is desirable to see the development of this committee to assist EMR in the interface between the varied facets of its mission and science. But the committee should not abandon its previous role; it ought to enlarge it, but what counts is what the members of the committee believe they want to be.

The committee has a role to play, a very large role to play in advising EMR how to develop a better knowledge of our resource phase, how science can assist us in understanding what resources are present. A number has to be put on them – the number decides whether a rock is a rock or a rock is a profit – and so science and technology are amongst the most vital assets to Canada in developing our insights into our resource base. Our resource base depends on how our national capital is applied, what the trade policies develop, what the bargaining posture could possibly be, and what regional development programs ought to be introduced. There is a tremendous interaction between what this committee does and the world of resource policy in general. While the policy makers are reaching out for assistance on the interface, it's up to the scientist to know how to mobilize his insights not only for science, but for his community.

B. The Associate Committee on Geodesy and Geophysics of the National Research Council by Dr. J.H. Hodgson

As applied herein, geophysics encompasses those aspects of geophysics which relate to the functions of the International Union of Geodesy and Geophysics. It was the intention that the Associate Committee on Geodesy and Geophysics, founded in 1945, would be involved with the exploration side of geophysics. Since late 1947, the Associate Committee on Geodesy and Geophysics has, at the same time, been the National Committee for Canada of the International Union of Geodesy and Geophysics. The subcommittee structure was changed so that the subcommittees related to the member associations of the IUGG. With this new organization the committee very rapidly lost touch with exploration geophysics.

Eight or ten years ago, however, it was felt that the Associate Committee should re-establish a much closer relationship to exploration and accordingly a subcommittee was set up on exploration geophysics; it has proved a very active subcommittee. At the time of the Upper Mantle Project, a special committee was set up on the Upper Mantle Project as a joint committee with the Associate Committee.

In the early days the ACGG did have money at its disposal, the amounts now seem ridiculously small, but they were very substantial at the time. Very early on the NRC set up its proper Granting Committees and ACGG lost that function.

ACGG is largely university-oriented. The provinces have not had very much interest in physics of the earth and that field of geophysics, and therefore there is no provincial representation as such.

Approximately fifteen years ago the subcommittees increased in importance. They sponsored symposia, some of them relatively small, some of them very large sessions which were attended by many outside persons. They also were very effective in coordinating work in geophysics in Canada. An example is the Seismic Subcommittee that coordinated all the work on crustal seismology. They acted on an annual basis, but they had plans for several years ahead. The Gravity Subcommittee moved toward the standardization of gravity observation throughout Canada and the setting up of the data bank. The Meteorological Subcommittee has had a very important impact in their lobby for improvement acts.

All subcommittees met during the week of the main committee. As the orientation was not toward practical problems of mission-oriented research but rather the other way, these meetings also became little seminars. A number of professional societies, however, were dissatisfied with such strong national activities.

All of these factors, the fact that the government had to re-examine its Associate Committee structure, that NRC had to cut down on the committee's budget and that there was criticism of use of the Associate Committee essentially as a national society, has caused in the recent year or two a very serious critical re-examination of the role of the Associate Committee. In addition, about a year ago, the establishment of a national society – a National Geophysics Society – was investigated. The results showed that there was little chance of establishing such a viable organization.

Within geophysics, there are at least three groups – the solid earth group including oceanographers, but excluding meteorologists and aeronomists, pure geophysicists, and exploration geophysicists. A number of suggestions have been made concerning a national organization and they're being explored at the moment. One is that the Geological Association of Canada should set up a Geophysics Division. This would encompass the solid earth people. The CAP (the Canadian Association of Physicists) has a section of geophysics – it has been proposed that the section should take over the fluid boys and leave the solid earth people with the GAC. This means that the very careful coordination of all these roles which have existed over the last 30 years would be lost. Another suggestion is a separate geophysics association be established to include both interests. NRC has suggested that an association be formed within two years and that this association take over the national responsibilities, the domestic responsibilities of the ACGG. It will be restructured, made smaller, transferred from that part of NRC that looks after Advisory Committees to that part of NRC that looks after international affairs, and made responsible for the interface with the IUGG.

The Associate Committee has never in recent years addressed itself to problems of economic priorities. It has been involved in studies in the best direction of scientific work, but has undertaken nothing directly towards the betterment of training of university graduates. The committee will point out the needs in a certain discipline, for example, the Seismic Committee arranged an excellent symposium a few months ago called "Seismology in the Seventies" in which they tried to anticipate the direction which seismological research would go in the next decade. This could be considered a guide to universities of the direction in which training would be necessary.

The Associate Committee on Geodesy and Geophysics is clearly the focal point for all geophysicists in Canada. According to most university geophysicists in Canada, the centre of geophysics is the ACGG. The NACRGS differs in this aspect. In the past, if the ACGG felt strongly that some aspect of geophysical research was not properly funded and it needed some coordination and some extra drive, it would make this recommendation to the NRC Granting Committee.

The Dominion Observatory or Earth Physics Branch has never had an Advisory Committee. When this Advisory Committee disappears, the Branch undoubtedly will have to set up a National Advisory Committee.

The Associate Committee on Quaternary Research of the National Research Council
by Professor W.H. Mathews

The committee was established under the auspices of the National Research Council in 1966 with the objective of bringing together a variety of disciplines concerned with the history of our environment during an interval of geological time referred to as the Quaternary Period – essentially the last two or three million years of geological history during which there was extensive glaciation in North America. As a result of this glaciation, there have been some very major disruptions in our environment; when the ice retreated, the barren terrain was repopulated by plants and animals and by

man himself. People who are concerned with this problem include geologists, notably glacial geologists, those who are concerned with geological processes that are going on up to the present time, physical geographers, zoologists who are concerned with how and why animals migrated to their present sights, botanists who are concerned for the same reason in plants, archeologists concerned with the early migration of man himself, and some smaller groups of pedologists concerned with the evolution of soils, people concerned with permafrost – how and when permafrost developed – and paleo-climatologists.

The function of this committee was to encourage investigations in the field and to foster better communication between the diverse disciplines that are represented. This has been accomplished through such media as a Directory of Quaternary Scientists, an annual newsletter, by periodic symposia and distinguished speakers on lecture tours to different universities and different scientific groups. The representation on the committee is three geologists, three geographers, three zoologists, three botanists, three archeologists, and one member each representing pedology, permafrost, paleo-climatology. Members have been drawn in part from government, principally the federal government, and in part from universities; in addition, representation by geographic and disciplinary distribution also has been attempted. There are neither permanent subcommittees nor funds to grant. The rather limited budget is allotted strictly for travel of the university members of the committee, for the publication of the directory, the newsletter, the report of meetings, and for the support of the symposia.

The Associate Committee also represents Canada in deliberations with the International Association for Quaternary Research. For example, the committee has made representation on behalf of archeologists concerning the reclamation or salvage of archeological sites.

The Associate Committee on Quaternary Research contrasts with the Associate Committee on Geodesy and Geophysics. The latter is made of related disciplines, each of which is concerned with its own welfare, whereas the former committee is an assemblage of varied disciplines concerned with the one subject matter. Another similar committee is the National Committee on the International Hydrologic Decade. In the past, the Associate Committee on Quaternary Research and the Subcommittee on Quaternary Geology frequently held meetings on successive days or even arranged joint lectures.

Remarks on Advisory Committees
by Professor R.A. Blais

The study of the Solid Earth Sciences in Canada on behalf of the Science Council was concerned with the overall situation and not only the NAC or the NRC Associate Committees. It was concerned with the overall interface between the three major sectors of industry, government and universities, with the interface between research and the other scientific activities that are related to it.

A number of major changes have occurred since NACRGS foundation in 1945. First, NRC discharges now the major responsibility for the funding of university research in the Earth Sciences through its Grant Selection Committee. The liberal support there is approximately three and a half

million dollars; contrast this amount with the $278,000 allocated specifically by EMR to grants for which this committee is responsible to provide advice on. A second change is that the committee has also more or less experienced an evolution along disciplinary lines of endeavour. This is a natural outcome of the degree of sophistication that science has experienced and, for good reasons also, it answers to a need for looking in depth into the activities. Thirdly, there has been a remarkable growth in the overall university effort in Canada in terms of faculty and students, in the proliferation of departments, and in the various fields of specialization. There has been a fourth major change – the growth of disciplines themselves. There has been also a fifth evolution – a growing number of major national and international programs of which the International Geological Correlation project is certainly an outstanding example. There also have been other changes such as the new EMR research agreements replacing grants-in-aid and the awarding of contracts not only to universities but also to industry and Provincial Research Councils, the actual or contemplated changes within NRC as outlined by Dr. Hodgson, and the Senatorial Commission on Science Policy recommendations. Finally, the Canadian society as a whole is taking a new look at many of the things we have been doing.

It is now time to reconsider the way this committee has been acting, some of its major functions and its organic organization, and also to restore perhaps some of its initial objectives. Certainly, people in the industries and the universities would like to contribute to the major missions and the objectives and provide advice to EMR. Thus the role of this committee in respect to the missions or the major objectives and the major tasks that are asked of the Department of Energy, Mines and Resources should be examined. In addition, other mechanisms should be developed to encompass the science-oriented activities formerly included in this committee's responsibilities.

Mineral resource development as viewed by the Study Group is a very essential component of the scientific activities in Canada and indeed requires considerable top quality research. Much of this research would be carried out in the field and, obviously, this research would include the entire spectrum of the semantically expressed basic research, applied research, etc. There has not been a sufficient amount of this type of research to develop the proper base of information and to provide government and its agencies with the proper framework of information upon which wise decisions could be based. Accordingly, any Advisory Committee tied directly to EMR – at least one committee – should have, should be regarded, and should be considered for its input in terms of quality and quantity within the mineral resources development field. One component should be on 'mineral exploration', a multi-disciplinary effort, with very much of an interface between geology, geophysics, geochemistry, etc. Properly charged, this committee could pass on judgments also as to what industry and universities were doing. The role would be global, but it would be very much project-oriented and naturally would answer to one very important mission of this department.

What happens then to the other missions and interests of geological sciences is an important question. In order to have a very healthy scientific community in Canada we must talk to each other, determine the collective efforts we want undertaken, and also take a critical look at some of our activities. It was the Study Group's belief that much of these responsibilities could be assigned to the professional, technical and scientific societies. It was not considered that the scientific societies in performing this science-oriented function should work alone, indeed it would be most preferable that

they be grouped or even tied very effectively to such an agency as NRC which has a very fundamental responsibility towards the health of science in Canada, or perhaps to the Ministry of Science and Technology. The grass-root scientists must have ways and means of communicating with government and such might best be achieved through the scientific societies.

Because Advisory Committees do have a vital role in the formulation of any national science policy and its implementation, we must look very closely now at the possibility of revitalizing this committee in order that it will fulfill a very essential social and economic function, and at the same time look at the ways and means of also fulfilling the other major national function that this committee is concerned with, mainly the education component – the research training component. Any success in this field depends upon the people involved and the amount of money allotted. To date, the financial support has been pitiful and the results have not contributed significantly to our research effort in Canada, although the grants have provided added needed resources to the universities. The major projects that this committee has supported, however, have been the exceptions and should be continued.

Finally, EMR has a mission other than mineral and energy resources. This is a major program in the earth sciences: a survey of the physical characteristics of Canada, starting with a geodetic measurement of the position, surface and relief of Canada, the shape of its surface, its gravity and geomagnetic field, its seismicity, its geological foundations, and the natural processes that constitute natural assets or real or potential hazards. Those surveys, in their applications, go much beyond the domain of mineral resources, and will touch many aspects of Canadian life.

C. Opinions Expressed by Industry Members of NACRGS

1. A National Advisory Committee on Mineral Resource (Mineral Exploration Research) should have members chosen among exploration managers in industry.

   (a) Twenty-five to fifty individuals in exploration management today direct the expenditures of fifty to seventy million dollars throughout Canada. They formulate company policies as to where to look, what to look for, and how much to spend. The present Mineral Deposits Subcommittee of NACRGS is, handicapped by a lack of such people among its members.
   (b) The learned, technical and science societies are not, by their nature, inclined to give blunt and sometimes political opinions as situations arise. Industrial managers speak out without the conventional constraints of these societies. They are needed on a committee dealing with mineral exploration.
   (c) Mineral exploration industry invests in data collection and in basic research enabling interpretation of these data. A national committee with senior industrial representatives would be able to make decisions on data exchange that could result in much data reaching the public domain (through the committee reports).

2. A NACMR (Mineral Exploration Research) should be multi-discipline and multi-science in its approach and outlook.

   (a) Depth limitations of most technological methods in use demand a greater effort by all disciplines.
   (b) Scientific extrapolation from the surface to great depths will make increased demands on all specialties of geology and related fields.
   (c) Geological mapping, a very fundamental base of mineral exploration, will ever be necessary, increasing in scope as the science expands.
   (d) There should not be any separation by an advisory committee on mineral exploration between applied research and basic research concerns, as it is the experience of mineral exploration that today's pure research is often applied in a few years. For instance, the yesterday conceptual exploration in metallogenesis provides today's exploration guidelines, and the test of the validity of a concept is often in the hands of those carrying out exploration. As a matter of fact, industry has substantially contributed to metallogenesis.
   (e) On the other hand, there is an imbalance between curiosity-oriented basic research presently supported and research as needed for industrial purpose. A committee with a strong industrial segment could correct this imbalance.

3. A National Advisory Committee on Mineral Resource (Mineral Exploration Research) should be instrumental in the exploration industry providing full support to exploring the full mineral potential of Canada.

   (a) The exploration industry is finding it increasingly difficult to identify in Canada regions which it regards as metallogenetically favourable but which have not been explored by known methods. As a result a tendency has developed among Canadian companies to apply the known exploration technology on foreign ground, which it judged metallogenetically proper but unexplored by Canadian standards. This has contributed to a decrease in rate of 'discoveries' in Canada.

(b) This state of affairs should be remedied by the Canadian development of technology comparable in impact to such development as EM and geochemistry. An NAC could focus research towards such development.

(c) An NAC should be capable to promote studies, including statistical analysis, on fields of endeavour which will produce methods for finding orebodies.

4. A National Advisory Committee on Mineral Resource (Mineral Exploration Research) should include representatives from professional and technical societies.

   (a) Societies who count in their membership the majority of professionals involved in both industrial and research activities represent a concentration of talent that should play a role in any NAC concerned with mineral resources.

   (b) Societies have not exercised major advisory roles: major suggestions and recommendations to the Federal Governments are rare.

5. A National Advisory Committee on Mineral Resource (Mineral Exploration Research) should discuss with universities their curriculums, industrial requirements, and types of professional manpower required.

6. A sector of National Advisory Committee on Mineral Resource that concerns itself with mineral economics should include in its membership technical representatives from industry.

7. A National Advisory Committee on Mineral Resource (Mineral Exploration Research) should have the following objectives:

   (a) To advocate and stimulate basic and applied research.

   (b) To devise and recommend methods and procedures to further exploration.

   (c) To promote education in mineral exploration.

   (d) To reduce duplication of effort and increase the efficiency of mineral exploration.

D. Opinions Expressed by Representatives of Universities

1. A National Advisory Committee on Mineral Resource (Mineral Exploration Research) would:
   (a) have a restricted function and cover only a small part of the spectrum of interests of geologists;
   (b) not promote individual excellence in basic research;
   (c) not be a necessary central national body formulating policy on basic geological research;
   (d) represent a very substantial reduction of the field of activities of the present NACRGS;
   (e) limit itself to only one mission among a number in which geology has a role to play;
   (f) not extend to the total realm of geological activities of EMR, let alone all of its geoscience activities.

2. It must be accepted that advice on geological research may be given by various agencies, be they government sponsored and appointed for the purpose of research promotion per se or for the solution of problems confronting mission-oriented departments, or be they scientific and professional societies accepting the responsibilities of providing advice. Accordingly one must expect many sources of research funding.

3. A national body is needed that is capable of independent, political pronouncement, of seeking out "sacred government cows", of debating priorities of concern in the geological sciences, for instance debating the apparent priority in geological research on mineral resources rather than on the environment or debating the policy of cultivating the expensive centres of excellence rather than recognizing and giving substantial support to research of excellence by individuals. The NACRGS has had broad and diverse interests but it has not been capable of acting fully in accordance with the above requirements; its political independence has been curtailed through the Director of the Geological Survey being ex-officio its chairman.

4. Societies constitute logical bodies to provide advice on the welfare of the discipline of geology and the various roles it can play in national affairs. Young people with enthusiasm and hopefully new ideas are directly involved in their activities and in their decision-making processes. They are in contrast with the NACRGS where conflict of interest reigns. Societies must be funded by governments to fully play their role.

5. The NACRGS was framed in a context entirely different than the present:
   (a) its sponsor, the Geological Survey of Canada, was operating in a departmental environment whose mission has since greatly enlarged;
   (b) geological research, especially in laboratories, was minimal in contrast to present activities;
   (c) societies had their own small membership led by still smaller establishments;
   (d) the NRC did not recognize geological sciences;
   (e) the trend towards specialization in research and mission had hardly started.

The NACRGS made an annual inventory of research activities, examined the state of the science and the art, the needs of Canada, and made recommendations. Among other things it engaged in the following activities:

(a) promoted basic research to enhance geological disciplines besides the special consideration it always gave to research related to mineral resources;
(b) sponsored cooperative research among individuals and agencies, symposia and workshops by specialists, constituted specialist committees which eventually gave rise to discipline divisions in some societies;
(c) assisted societies either in launching journals or publishing special volumes;
(d) enabled Canadian representatives to travel and meet nationally;
(e) acted internationally as the Canadian National Committee for Geology.

It undertook many of these activities because it was nationally representative as to disciplines, sectors of endeavour, and regions of Canada, had a national overview, was related to its federal in-house geological spokesman, was moving immediately into evident voids where other agencies or societies could not act or were not inclined to act. Many of these pioneering fields of endeavours are now considered the mien of today's progressive societies.

6. Specific concerns of advisory committees are:

(a) they should have a role in the allocation of grants to give substance to their recommendations;
(b) application for mission-oriented research grants should be appraised by independent bodies, not internally by departments;
(c) geology and geophysics should be considered as a continuum;
(d) a logical follow-up in the establishment of national data banks should be the securing of valuable information which could be lost forever as in the mining out of orebodies with singular characteristics;
(e) it is realized that there are many sources of granting in geology and that this is logical if one recognizes that geology can serve many missions. Yet a mechanism must be found whereby various granting agencies are not duplicating support for the same projects, a difficulty that has plagued NACRGS in recent years;
(f) agencies sponsoring research with regional connotations know best the financial requirements of such research and are effective sources of funding.

E. Opinions Expressed by Representatives of Provincial Agencies

1. Converting the present NACGRS into a NACMR (Mineral Exploration Research) and possibly a few such other mission-oriented advisory committees will not cover the field covered by the NACGRS as presently constituted and certainly will not fulfill the comprehensive role of a Canadian Committee for Geology.

2. On the other hand, Canadian geology must be aware of the danger of putting itself into the one and relatively narrow box as is done institutionally in university. Geology must relate to other sciences in defining and monitoring the physical environment, in analyzing the impact of various dynamic factors in hydrology, in identifying the compositional variations and dynamic systems obtaining in engineering soils, in relating landforms, materials, and soils properties in potential land use for resource development, etc. The multi-discipline Associate Committee on Quaternary Research is an attractive committee that gets geologists out of their institutional boxes. If, on the other hand, there is a need for various disciplinary groupings according to mission, there is also a need for a national geological advisory body more encompassing than mineral resources.

3. Provincial representation, even to include every province, is a must on a national advisory committee on mineral resources as provincial activities in these resources differ from federal involvement. There was a feeling in provincial circles, in industry, and in university, that NACRGS was a federal tool, but a national body owned by all sectors and advising all sectors. The chairman of a national advisory committee should not necessarily be either the Director of the Geological Survey, or an EMR representative, or a federal civil servant.

4. An advisory committee seemingly accomplishes more and its members feel more involved if, as a working committee, it participates in the implementation of its recommendations and in a way becomes operative, almost managerial.

5. Before accepting a NACRGS role reduced to advise only on applied research related to mineral resources exploration, we should consider:

   (a) other aspects of mineral resource research involving geoscientists;
   (b) other missions open to geologists;
   (c) the basic geological information needed before geologists can act on specific missions – exclusive support of research immediately concerned with specific missions is shortsighted and unrealistic.

6. Among the many things it should do, a NACMR (MER) more specifically should:

   (a) stimulate, coordinate, suggest and aid research;
   (b) have an input into grants;
   (c) stop the overfeeding of small science;
   (d) emphasize data banks;
   (e) accentuate applied research.

F. The Associate Committee on Geotechnical Research of the National Research Council by Mr. C. B. Crawford

The NRC established associate committees right from the beginning – way back in 1917 – and this was a unique Canadian device for communication, fully as necessary then as it is now. The Associate Committee on Geotechnical Research began really during World War II as a special committee with military implications on trafficability. At the end of the war it was called the Associate Committee on Civilians – Salt and Snow Mechanics; recently it was renamed Geotechnical Research. Its purpose is to coordinate research on the engineering and physical aspects of the "terrain" of Canada and to provide communication. It has a membership at the moment of twenty-two – nine from the federal government, three from the other levels of government. The Chairman is the only member from NRC. There are five or six consultants, and five from universities. It operates a series of subcommittees; their membership is quite variable. Subcommittees normally are limited to twelve members – the Pipeline Subcommittee established in 1970 is at least twenty with two-thirds drawn from industry. A new subcommittee on civil engineering problems in urban areas is being formulated.

The committee communicates through its own committee meetings, seminars, and conferences. It has fostered local groups at no cost to NRC – there are very active groups in about eight centres in Canada now. The present budget for the Associate Committee is about the same as that for the Associate Committee on Geodesy and Geophysics – about $15,000.

NRC is reconsidering Associate Committee roles. A few years ago there were more than forty committees – there are now twenty-eight. NRC undoubtedly will continue with Associate Committees. The Associate Committee on Geotechnical Research is of considerable help in particular to NRC's Division of Building Research. However, the Associate Committee is attempting to divert all society activities to the responsible societies despite their past performances in the advisory field.

This Associate Committee did provide grants until 1960. The National Research Council proper now provides grants to universities in the geotechnical area of about a half a million – about 3 1/2 million total in the earth sciences. Recently, the Associate Committee was asked to provide advice to the Grants Committee which is the more favourable procedure. Similarly, the National Committee for the National Hydrologic Decade recommends certain projects to the Grants Committee for financial support.

The Canadian Committee on Oceanography by Dr. B.R. Pelletier

The Canadian Committee on Oceanography is a coordinating and programming body involving senior representatives of Federal Government departments and representatives of oceanographic centres in universities. Input from the industry is lacking.

Essentially, it coordinates the usage of ships. Although this body does not provide grants for research, it does make ships available for

research. Geology and geophysics both are involved in its activities. Its annual meeting is a three-day technical conference, rotated across Canada. The committee has also been responsible for installing Canada on international bodies.

G. Opinions Expressed by Society Representatives Specially Called to Partake in NACRGS Meeting

1. The activities of the Science Council, the Senate Special Committee on Science Policy, and of the new Ministry of State for Science and Technology extend to all sectors of scientific and technical endeavour. Were these bodies to speak for all science, earth scientists would have no ready direct communication with government. Canadian geoscience can speak out with more authority if those of its various specialized societies are fully harmonized; this is the potential benefit of a Canadian Geoscience Council.

2. There is a limit to which Canadian geoscience can communicate with government through the staff side of EMR. Access to EMR Minister may be easier on a number of topics by direct representation from without the department rather than through its officers. That holds more so if the access is to be to other ministries. A Canadian Geoscience Council that can dialogue with anyone without the trappings of hierarchy could advise governments and be a power lobby for geoscience. The Council is hoping to acquire the mandate and the resources to speak for Canadian geoscience at large.

3. The Council, being a grouping of Canadian earth science societies, could take over many preoccupations of NACRGS, fulfill the role of a National Committee for Geology, act domestically in the interest of geology and externally relate to such bodies as the International Union of Geological Sciences. It also could sponsor domestically such internal cooperative undertakings as the International Geological Correlation Program.

4. A scientific society, now a member of the Canadian Geoscience Council, frequently was nurtured into existence with the moral and financial support of NACRGS. Hopefully that kind of support will be available to scientific grouping from whatever committee will succeed NACRGS.

5. A scientific society, industry-oriented, stresses the need for (mission-oriented) basic research covering such topics as the fundamentals of paleo-marine environments, the mechanics of shelf sedimentation, the physio-chemical biological processes along shorelines, organic productivity of various zones of the continental shelf, diagenetic changes and their influence on permeability development and maturation of organic material, etc. These research needs as expressed by those who must locate resources could be regarded by pontifiers on science as esoteric basic research.

THE YEARS IN REVIEW

Presented by Thomas E. Bolton (August, 1972)

The National Advisory Committee on Research in the Geological Sciences, established in 1949, has a threefold purpose: to stimulate and coordinate geological research in Canada; to suggest research projects that should receive attention; and to aid in having these projects undertaken. Its function is to stimulate research by the universities, federal and provincial departments of mines and by other organizations equipped for the work.

The committee, chaired by the Director, Geological Survey of Canada, is composed of twenty-one (21) members, each invited by the Minister, Department of Energy, Mines and Resources, to serve a 3-year term. Representation is equally divided between universities, federal and provincial governments and research councils that undertake geological research, and mining and petroleum industries. An officer of the Geological Survey of Canada, J. F. (Fen) Henderson, acted as Secretary of the Committee until December 15, 1970, at which time Thomas E. Bolton assumed the secretarial duties.

The Nineteenth annual report of the National Advisory Committee for 1968-69 was published in January, 1970, as Geological Survey of Canada Paper 69-6. The annual compilation of current research in the geological and related earth sciences in Canada for the 1969-70 period was published in February, 1971 (Geol. Surv. Can., Paper 70-5), for the 1970-71 period in February, 1972 (Geol. Surv. Can., Paper 71-5), and for the 1971-72 period in September, 1972 (Geol. Surv. Can., Paper 72-5). Current research projects included in these compilations were contributed mainly by the universities, federal and provincial departments of mines and other non-industrial institutions, although a few contributions were provided by some of the larger oil companies. Such documentations inform research workers not only as to whom are working in similar fields and on similar problems, but also indicate lines of research receiving the greatest attention and, by inference, those being neglected.

Other publications of the National Advisory Committee include Background Papers on the Earth Sciences in Canada (Geol. Surv. Can., Paper 69-56, 318 pages, 1971) and Earth Science Symposium on Offshore Eastern Canada (Geol. Surv. Can., Paper 71-23, 652 pages, 1973).

The National Advisory Committee and its subcommittees has supported the Third Canadian Conference on Research in Tectonics at the University of Manitoba in March, 1970, the Fourth Canadian Symposium on Research in Tectonics in conjunction with the Seventh Canadian Symposium on Rock Mechanics at the University of Alberta in March, 1971 (see Report of the Subcommittee on Structural Geology), and the 2 1/2 day Earth Science Symposium on Offshore Eastern Canada at Ottawa in February, 1971.

Research Grants to Universities

Grants by the Geological Survey of Canada were initiated in 1951 at the instigation of this committee to stimulate and support geological research in Canadian universities. Applicants were required to hold an academic staff appointment at a Canadian university. Applications were received by the Director, Geological Survey of Canada, Ottawa, to May 1st of each year and reviewed by the Projects Subcommittee of the National Advisory Committee each June.

The National Research Council of Canada also annually awards grants-in-aid in the geological (earth) sciences and on a much more substantial scale (Annual Report on Support of University Research, National Research Council, Nos. 10784, 11476, 12057, 12724). Applicants for NRC grants apply by December 1st and are notified of awards in April of each year. To assure full coordination in the award of grants by the two organizations, each year the Secretary of the National Advisory Committee has attended the review of applications by the NRC award committee as an observer.

For 1970-71, 164 applications (131 in 1969-70), and for 1971-72, 180 applications were received by the Geological Survey for general grants-in-aid of research; the total of the grants applied for was $704,646 ($563,929 in 1969-70) and $748,557 respectively. One hundred and sixty-one and 160 grants, totalling $228,000 each year, were awarded to 23 universities. The names of the recipients, the titles of their research projects and the amounts awarded are listed in the Appendix (p. 93, 108).

In addition, up to $50,000 was provided yearly by the Geological Survey of Canada for special grants for research in the development of computer-processable files of geological data. Applications for these grants which were received up to March 31 of each year were reviewed each April by the Subcommittee on Computer Applications. On the basis of the subcommittee's recommendations, and with the approval of the National Advisory Committee, 7 grants were awarded to 6 universities in 1970-71, and 8 grants to 7 universities in 1971-72. The names of the recipients, titles of the projects and amounts awarded are listed in the Appendix (p. 107, 123).

EMR Research Agreements

In November, 1971, the Department of Energy, Mines and Resources introduced a consolidated programme of support for extramural research and development. All Branch funds were combined within a Departmental Research Agreement programme. Eligibility was extended to any established Canadian research organization undertaking research activities in engineering or the natural, physical or social sciences that could contribute toward the achievement of the Departmental objectives. Any member or members of such organizations could, with the concurrence of their organization's management and executive, apply for a research agreement.

The Geological Survey of Canada evaluated 159 Research Agreements requesting $1,638,528.26; 36 projects were recommended for support in 1972-73 within the $278,000 available, 35 to Universities and 1 to the Royal Ontario Museum (see Appendix, p. 124).

CANADIAN NATIONAL COMMITTEE FOR GEOLOGY

A meeting of the Canadian National Committee for Geology, composed of the Executive of the Advisory Committee, presidents of the Geological Association of Canada, Mineralogical Association of Canada, Alberta Society of Petroleum Geologists, Chairman of the Geology Division, Canadian Institute of Mining and Metallurgy, and convenor, Earth Science Subject Division, Royal Society of Canada, and invited representatives of the Canadian Geoscience Council, was held in Ottawa, February 6, 1972. At

this meeting, it was recommended that a strong, highly representative committee of Canadian scientists be established by May 31, 1972, to represent Canada on the International Geological Correlation Programme. In addition, it was recommended that the Canadian Geoscience Council undertake immediately a study of, and prepare a report on, the feasibility of the preparation of a Canadian text-book on Earth Sciences for the secondary school level.

ANNUAL MEETING

At the Annual Meeting of the National Advisory Committee in Ottawa, February 7 - 8, 1972, in line with the conclusions of The Solid-Earth Sciences Study Group (Background Study for the Science Council of Canada, 1971, Special Study No. 13, Earth Sciences Serving the Nation), it was recommended that "A National Committee on Mineral Resources Research be established by the Department of Energy, Mines and Resources to coordinate a national program of mineral resources research" and in addition "A National Committee on Geoscientific Environmental Research be established to advise the Department of Energy, Mines and Resources on programs of national interest to the Canadian Landmass". Redirection and structuring of the National Advisory Committee is still under consideration.

NACRGS ANNUAL REPORTS

All annual reports of the NACRGS have been published by the Geological Survey of Canada, commencing with the 1950-51 report of activities. The Fourth, Fifth, and Seventh to Fourteenth reports included the annual survey of Current Research in the Geological Sciences. The Fifteenth annual report was issued in two parts: 1 - annual review and reports of subcommittees; 2 - survey of current research. Commencing with the Sixteenth, the annual report of activities have been issued as part of the GSC Paper Series: Sixteenth - Paper 66-61, Seventeenth - Paper 67-71, Eighteenth - Paper 68-73, and Nineteenth - Paper 69-6.

REPORT OF THE SUBCOMMITTEE ON STRUCTURAL GEOLOGY

Presented by R.A. Price (April, 1971)

Members

R.A. Price (Chairman)	Queen's University, Kingston, Ontario.
K. Barron	Mining Research Centre, Calgary, Alberta.
W.C. Brisbin	University of Manitoba, Winnipeg, Manitoba.
H.A.K. Charlesworth	University of Alberta, Edmonton, Alberta.
J.B. Currie	University of Toronto, Toronto, Ontario.
G.H. Eisbacher	Geological Survey of Canada, Vancouver, British Columbia.
M.J. Kennedy	Memorial University, St. John's, Newfoundland.
H. Morris	Cominco Limited, Kimberley, British Columbia.
D.K. Norris	Geological Survey of Canada, Calgary, Alberta.
W.C. Morgan	Geological Survey of Canada, Ottawa, Ontario.
E. Dimroth	Ministère des Richesses Naturelles, Québec, Québec.
M.R. Stauffer	University of Saskatchewan, Saskatoon, Saskatchewan.

INTRODUCTION

Structural geology in Canada, as elsewhere, is on the threshold of a new era. An oftimes confusing array of divergent specialized interests from its various sub-disciplines has come to share a common focus in the concept that large-scale displacements along the surface of the globe, among a few relatively undistorted spherical plates that make up the Earth's lithosphere, are ultimately responsible for most of the deformation recorded in the rocks of the Earth's crust. The international "Geodynamics Project" that has been proposed as a successor to the "Upper Mantle Project" can be expected to enhance these developments. An appraisal of the current status of the solid earth sciences and of the goals of a national science policy have provided new perspectives on the role of structural geology in Canada's social and economic development. Structural geology is forging new bonds in interdisciplinary projects with mining engineering, geotechnical investigations and other environmental studies, and regional tectonic analyses appear to be assuming an increasingly important role in mineral and petroleum exploration, where in the past the contribution from structural geology was often limited to the definition of local geometric form of rock units. All of these factors point to an upsurge in activity and to new perspectives in structural geology in Canada.

This broad review of the current status of structural geology in Canada makes no attempt to duplicate the much more detailed information in the listing of individual research projects that is published each year by the National Advisory Committee. However, it has formed the background for discussions at meetings of the Structural Geology Subcommittee in Winnipeg, on March 20th, 1970, and in Edmonton, on March 26th, 1971, and for the recommendations which were adopted at these meetings.

CURRENT STATUS OF STRUCTURAL GEOLOGY IN CANADA

Regional tectonics.

The major part of the Canadian effort in structural research is still concentrated in regional studies where it is commonly an adjunct to stratigraphic, petrologic and other objectives. A shift in emphasis following near completion of the systematic reconnaissance coverage of the whole of the country, to studies focused on specific structural or tectonic problems, which has been forecast for many years, now seems to have taken place. In the Canadian Shield, there are regional tectonic studies of Archean greenstone belts and of the interfaces between adjacent pairs of structural provinces. Basins defined by thick assemblages of supracrustal rocks have become objects for study on the basis of their implications for the deformation of the crust. The Midwest Superior Geotraverse, a cooperative project by staff in the Geology and Geophysics groups at the University of Toronto and the Geology group at Lakehead University, constitutes one such study. The Traverse extends from Shebandowan in the Lake Superior Region northward for 250 miles to Pickel Crow. It crosses five juxtaposed Archean Belts of metavolcanics and metasedimentary gneiss which in this region have been the basis for tectonic subdivision of western Superior Province. One broad objective of the study is that of evaluating proposed models of evolution of Archean crustal segments.

Parts of the Appalachian Structural Province are being investigated from the perspective of their bearing on concepts of geosynclinal evolution, continental drift, and plate tectonics. Large faults have been singled out as objects of study, both in their own right, and for their bearing on regional structural evolution. In the Arctic Archipelago projects are underway that are concerned with the role of continental drift in regional tectonic evolution and with the basic framework of the Franklinian geosyncline. In the Cordillera several projects are concerned with the regional tectonic evolution of various large segments of the province, while other studies involve a consideration of tectonic phenomena associated with large-scale igneous emplacement or progressive metamorphism, geotectonics and the petrogenesis of volcanic rocks, and tectonic factors in metallogenesis. There are also studies involving comparisons among different orogens or different parts of the same orogen and of the intercontinental relationships among orogenic belts. Research effort is becoming more strongly focused on specific geologic problems. Many of these problems, although they do not fall solely within the domain of structural geology, do have the advantage of demanding an integrated multidisciplinary approach that enhances opportunities for cross-fertilization in the development of new concepts and techniques. It is probably worth noting here that a common product of most of the regional studies that are directed primarily toward basic geologic objectives is a better definition of the regional geologic framework which ultimately forms the basis of scientific programs of exploration for mineral resources or of planning for land utilization and development.

Structural analysis.

Much of the Canadian research activity that is concerned primarily or exclusively with problems in structural geology constitutes a type of structural analysis that, while deeply concerned with the basic concepts of geometry and mechanics, still finds its ultimate use in elucidating the broad historical framework of regional tectonics. This kind of study documents the present deformed state of a rock body, and attempts to reconstruct its structural evolution using principles of geometry and mechanics, the data from experimental rock mechanics, and the geologic setting.

A wide variety of projects falls into this category, and many of these are of particular significance for applied structural geology. Some are field-based studies contributing heavily to the descriptive aspect of structural analysis, on various scales of observation from that of microscopic textures in penetratively deformed rocks, to the form and fabric of deformed sulphide and other mineral deposits and of coal measures, and to the relationships of large fault structures. Others draw heavily upon existing descriptive data to provide interpretations of the origin of structural phenomena ranging from microscopic fabrics to regional fault systems. The number and variety of such studies attest to the growing vigour of structural research in Canada. However, it is worthwhile to reassert the view that studies of this type can make a more substantial contribution to the progress on structural research in Canada if they are integrated with other types of projects in terms of a common theme.

Experimental studies.

There are well established programs of experimental investigation of the geological deformation of rocks at several Canadian universities. Those at the University of Toronto and McMaster University are concerned primarily with the phenomena of brittle failure such as jointing and fracturing and the influence of sedimentary fabric on deformation mode. Experimental investigations in rock mechanics at the University of Saskatchewan at Saskatoon include measurements of elastic moduli, experimental deformation of evaporites and studies of the mechanism of rock failure. At the University of New Brunswick experimental studies are focused on deformation of models simulating anisotropic rock masses. Other projects based on the experimental modelling of processes of geological deformation are being developed at the University of Saskatchewan at Saskatoon and at Queen's University.

Applied structural geology.

Although there are still only a few structural projects that are reported as studies in applied structural geology by virtue of having an immediate social or economic problem as their primary objective while remaining primarily structural in scope, the number is growing steadily. Moreover, the major part of the effort in field-based structural research in Canada continues to make a very substantial contribution of structural and tectonic data and concepts to the exploration for and development of mineral resources, and to geotechnical investigations and other environmental studies.

Programs of exploration for petroleum and metallic mineral deposits rely increasingly on information from regional tectonic syntheses. Broadly based multidisciplinary regional projects, such as the Geological Survey of Canada's Beaufort-Mackenzie Program, which is intended to provide a complete analysis of the structure, stratigraphy and geological evolution of the Arctic Plateau, Coastal Plain and southern Beaufort Sea, provide a logical framework for scientific exploration for petroleum and mineral resources. Projects of this general type are part of the normal exploration activity of many of the corporations involved in petroleum and mining exploration. Although much of the proprietary information generated in this way is held confidentially, there are important contributions of scientific information to the public domain. Recent papers on structural phenomena of basic scientific interest by C.D.A. Dahlstrom of Chevron Standard Limited are good examples of these. Moreover, the Rocky Mountain Foothills Project, involving contributions of seismic and other information from industry that are to be incorporated into a compilation by N.C. Ollerenshaw of the Geological Survey of Canada (Institute of Sedimentary and Petroleum Geology), represents an important opportunity for the release of basic scientific information to the public domain. Nevertheless, the relative amount of published information in this field emanating from industry is not a meaningful indication of the economic significance of this type of scientific research in industry. The high level of interest generated among mining and petroleum companies by the recent Geological Association of Canada symposium on "The Canadian Pacific Margin and Global Tectonics" is particularly noteworthy in this context.

There is a growing interest in the influence of regional tectonics on the distribution of mineral deposits and a promising field for research has developed on this basis. Factors such as the influence of major deep-seated structural trends, and the patterns of sedimentation, volcanism and plutonic activity related to orogenic evolution have been selected as particularly important. Many of the critical data for this type of regional tectonic investigation require a collaborative effort on the part of a broad spectrum of specialized disciplines in geology and geophysics.

Thorough structural investigations of individual ore deposits, combined with comparable studies of other aspects of their geologic setting, continue to offer the promise of fresh insight into the factors controlling their development. The present vogue in economic geology leans toward geochemical and geophysical studies as being the most likely profitable route to new ore discoveries. To some extent structural geology is being neglected because of disillusionment with the results of the naive and over-simplified concepts and applications that were developed during its peak of popularity from about 1930 to 1955. It is gratifying to note a gradual renewal of interest in fundamental structural work on ore deposits that may mark the beginning of a new trend. Several new projects are underway on the deformation of sulphides. There are studies of the structural control of sulphide mineralization and the deformation of coal measures, and recommendations for comprehensive structural studies of whole mining camps. High quality research in these areas is deserving of support.

Basic data on the nature and origin of the form and fabric of deformed rocks has important applications in mining and petroleum exploration and development, and particularly, in the future expansion of engineering in rock. It provides the framework for extrapolating structural conditions in orebodies, petroleum reservoirs and rock masses in general. Accurate documentation of the form and fabric of a rock mass is a necessary prerequisite to a meaningful appraisal of its mechanical properties in an engineering context. The Mining Research Centre of the Mines Branch and the Geological Survey of Canada recently initiated a program of systematic structural mapping to aid in the interpretation of in situ elastic strain recovery measurements and the stability of pit slopes. Further cooperative projects will undoubtedly be developed following the establishment of a western office of the Mining Research Centre at the Institute of Sedimentary and Petroleum Geology in Calgary. Any attempts to develop closer cooperation between structural geology and rock mechanics and geological engineering deserve strong support.

Mathematical techniques in structural geology.

Structural studies commonly generate large quantities of numerical data relating to the orientation of geologic features and their position in space. These data usually require statistical analysis and are particularly amenable to computer-based techniques of storage, retrieval, numerical analysis and display. Canadians have been at the forefront of this area of structural research. An active program of research at the University of Alberta has contributed new techniques for the statistical manipulation of mesoscopic fabric data in the analysis of jointing and folding in unmetamorphosed rock, and is now focused on the spatial filtering of data for structure-contour maps to outline intermediate-scale structure in the Interior

Plains of Western Canada that is important in petroleum exploration. Research at Queen's University on the development of computer-processable files of structural and other geological field data has led to automated procedures which combine basic geologic interpretation of raw field data with the normal processes of storage and retrieval to produce machine-generated structural, tectonic and lithologic maps, as well as fabric diagrams.

Realistic mathematical modelling of processes of progressive geological deformation has become a practical possibility with modern computing facilities. This approach involves analyzing the effects of small increments of displacement or of stress on an interlocked network of different small finite elements which simulates the variations in mechanical properties within a rock mass. Programs of research in this general field are being developed at the Geological Survey of Canada (Institute of Sedimentary and Petroleum Geology, Calgary), the University of Saskatchewan at Saskatoon, and at Queen's University.

COMMUNICATION AMONG STRUCTURAL GEOLOGISTS

Conferences.

Several recent and forthcoming conferences, workshops, and symposia in Canada provide some measure of the increased level of activity and communications among Canadian structural geologists:

1. Second Canadian Conference on Research in Tectonics, Hamilton, March, 1969. This conference, organized by P.M. Clifford and M. Stauffer on behalf of the Subcommittee on Structural Geology of the National Advisory Committee, consisted of some thirteen papers by invited speakers from Canada, Britain, and the United States. These covered a broad range of perspectives in rock deformation from plastic strain in crystals to regional patterns of flow in mountain belts, and corresponding variety of analytical techniques, including computer-based mathematical modelling of progressive deformation in rocks. This highly successful meeting drew a large attendance and generated enthusiastic discussion. Many of the papers presented at it have been published in the Canadian Journal of Earth Sciences.

2. Field excursion of western structural geologists, Calgary, Banff, and Revelstoke, May, 1969. An informal conference and field excursion for structural geologists in western Canada was organized by P.S. Simony in response to the need for improved communications which had been outlined at the meeting of the structural subcommittee in 1968. Participants from universities in Alberta, Saskatchewan and Ontario, and from the British Columbia Department of Mines and Petroleum Resources and the Geological Survey of Canada at Calgary and Vancouver met at the University of Calgary for one-half day. This was followed by a one and one-half day trip through the Rocky Mountains and eastern Selkirk Mountains to view the regional structural geology and phenomena associated with the development of joints and cleavage.

3. "The Canadian Pacific Margin and Global Tectonics", Vancouver, February, 1970. This symposium was organized by the Cordilleran Section of the Geological Association of Canada, with the aim of communicating new concepts of plate tectonics and of examining their compatibility with models of evolution of the Canadian Cordillera. Formal papers and prepared discussion were presented over a period of two days by invited speakers representing a broad spectrum of earth science disciplines in the United States and various parts of Canada. These generated great interest and lively discussion among several hundred participants drawn from the mining and petroleum industries, Canadian and American universities and government research agencies. The new framework for geological thought on the structural evolution of the Cordilleran region discussed at the conference has already led to new ideas and new perspectives for structural research.

4. Basins and Geosynclines of the Canadian Shield, Ottawa, March, 1970. A workshop on evolution of a variety of sedimentary-volcanic tectonic units in the Canadian Shield has been organized for the Precambrian Subdivision of the Geological Survey of Canada by A.M. Goodwin and co-workers. The proceedings, comprising nine papers, as well as discussions from invited participants, have been published by the Geological Survey of Canada (Paper 70-40, 1971).

5. The Third Canadian Conference on Research in Tectonics, Winnipeg, March, 1970. A symposium on "Cataclastic Deformation and Shear Zones in Metamorphic Terranes", organized by M. Stauffer, W.C. Brisbin and D.K. Norris for the Structural Subcommittee of the National Advisory Committee to coincide with its annual meeting, consisted of seven papers embracing the results of experimental, field and theoretical studies.

6. The Evolution of Deformed Belts, Banff, May, 1970. A week-long symposium under the leadership of Professor V.V. Beloussov, Dr. R. Trunty, and Dr. P.B. King was presented by the Department of Extension of the University of Alberta and the Alberta Society of Petroleum Geologists as part of their program of continuing professional education. The symposium embraced a broad spectrum of topics in tectonics and structural geology and generated enthusiastic discussion. It ended with a field trip across the Eastern Cordillera led by A.W. Bally, C. Dahlstrom, and J.O. Wheeler.

7. Fourth Canadian Conference on Research in Tectonics and Seventh Canadian Symposium on Rock Mechanics, Edmonton, March, 1971. This conference on "Applications of Structural Geology to Rock Mechanics Problems", organized by H.A.K. Charlesworth, H.U. Bielenstein and K. Barron on behalf of the Structural Geology Subcommittee and N. Morgenstern and T. Patching on behalf of the Canadian Advisory Committee on Rock Mechanics was focused on three main themes: "In Situ Stress", "The Role of Effective Stresses in Earth Behavior", and "Structural Mapping and Prediction of Engineering Properties in Rock Masses". It was eminently successful in generating lively discussions amongst specialists from a wide variety of fields ranging from mining engineering and foundation engineering through seismology to structural geology.

8. The Foreland Thrust and Fold Belt of the North American Cordillera, Calgary, May, 1971. This symposium organized by R. A. Price for the Rocky Mountain Section of the Geological Society of America will include eleven papers describing all the various segments of the foreland margin of the Cordillera from northern Alaska to eastern Mexico.

9. Variations in Tectonic Style in Canada, Montreal, August, 1972. A symposium on the nature and significance of the basic character and tectonic evolution of ten structural provinces, making up the whole of Canada, will be the Geological Association of Canada's principal contribution to the program of the XXIV International Geological Congress. Each tectonic province will be the subject of a separate paper prepared by a group of up to twenty specialists. Each province will be appraised in terms of a single common set of attributes that will be the basis for assessing the nature and fundamental significance of variations among them. The project involves a broad range of fields of specialization within the earth sciences and can be expected to lead to new concepts in tectogenesis and crustal evolution, and to disclose new avenues for future research (Geol. Assoc. Can., Sp. Paper Number 11, 688 pages, 1972).

Future conferences.

The Subcommittee on Structural Geology has agreed that it would be inappropriate to plan a Fifth Canadian Conference on Research in Tectonics during the year of the International Geological Congress in Montreal. However, there is a firm consensus that every effort possible should be made to continue the conferences on research in tectonics in future years. With this in mind, the subcommittee proposes to investigate the suggestion that a conference be held in Saskatoon in 1973 to coincide with the Annual Meeting of the Geological Association of Canada.

Cooperative journal abstracting.

Further experimentation on the development of a cooperative scheme for reviewing and abstracting papers on structural geology was deferred during 1969-70 because of changes in personnel on the structural geology subcommittee. The need for cooperation amongst structural geologists to ensure adequate coverage of the ever increasing volume of literature is greater now than when this experiment was proposed in 1968. The subcommittee has agreed that the reviewing process should be continued on an expanded basis. An effort will be made by H. Morris to enlarge the reviewing group to include interested structural geologists outside of the subcommittee. The format which has been proposed will consist of a brief statement of the reviewer's opinion of the significance, merit, and value of paper, together with comments on the paper as a whole, and finally, a copy of the author's abstract.

Continuing education.

The problem of obsolescence in the academic training of practising geologists continues to hold the interest of the structural subcommittee. The report of the special subcommittee established by the National Advisory

Committee to investigate the desirability and feasibility of establishing a centre for continuing education in the Earth Sciences is of particular interest, and there is a general concern that there may be other aspects which also require some consideration. The need for better communication among geologists from industry, government and the universities is a matter of concern to the Structural Subcommittee, and several suggestions for meeting this need have been offered. Conferences, workshops, and field trips have produced some good results and might be expanded in number and variety. The response to the conference on "The Canadian Pacific Margin and Global Tectonics" held in Vancouver is indicative of the need for this kind of activity. An evening refresher course on "Recent Developments in Structural Geology for Exploration Geologists" offered by the University of Calgary was received enthusiastically with the suggestion that it be expanded to include field trips as well as more classroom time. Internal refresher courses are increasingly more common in many of the larger companies and there is a growing interest in sabbatical leave for geologists employed in government and industry. Research projects involving joint participation from all three sectors of the scientific community may provide one of the best solutions to both academic obsolescence and a better definition of research objectives.

INTERNATIONAL GEODYNAMICS PROJECT

The Geodynamics Project, an international multidisciplinary study of the dynamics of the Earth, and a successor to the Upper Mantle Project, was proposed to the International Council of Scientific Unions (ICSU), by a joint committee of the International Union of Geodesy and Geophysics (IUGG) and the International Union of Geological Sciences (IUGS), and accepted by the ICSU. The nature and scope of this project lead to the obvious conclusion that it can profoundly affect the future development of structural geology in Canada.

The Geodynamics Project is concerned with the dynamical evolution of the Earth. It requires systematic integrated thorough studies of the geologic structure of the seismically active belts, to determine the movements that occur at the present time, and the relationships these bear to the tectonic history of these belts. It also requires a thorough appraisal of the paleokinematic and paleodynamic history of the older orogenic belts which will outline their present structure and the nature of the deformation which produced them, as well as the sources of energy and energy requirements for the deformation and the igneous and metamorphic activity related to it. In brief, the Geodynamics Project embraces much of the research activity that has traditionally fallen within the realm of structural geology. However, it demands that this research be integrated in a coordinated multidisciplinary program with contributions from many of the other special fields of the Solid Earth Sciences, and furthermore it is visualized as a broad approach to the problems of "basic science, practical economic problems and human welfare".

The potential of the Geodynamics Project as a catalyst in research in structural geology in Canada and as a stimulus for new research perspectives is obvious. It also offers a unique opportunity for effectively bridging the gaps between structural geology and some of the other branches of solid earth science, as for example the hiatus between structural geology

and tectonics as practised by geologists, and tectonics and tectonophysics as practised by geophysicists. The matter of how participation of Canadian structural geologists in the Geodynamics Project can be developed most effectively deserves careful consideration.

There are several integrated multidisciplinary projects in regional tectonics underway now in Canada that fall within the scope of the Geodynamics Project. Perhaps the most obvious of these is the Cordilleran Structure Project which was initiated at the recommendation of the Structural Subcommittee. The project on "Variations in Tectonic Style in Canada" of the Geological Association of Canada, and the Beaufort-Mackenzie program of the Geological Survey of Canada may also be considered in this context. The objectives of these established projects should be reassessed in terms of the goals of the Geodynamics Project, and consideration might be given to supporting them as an established nucleus for Canada's contribution to the Geodynamics Project.

CORDILLERAN STRUCTURE PROJECT

The Cordilleran Structure Project developed from a recommendation of the Subcommittee on Structural Geology, in 1963, for a comprehensive program of structural research that would integrate some of the scientific effort of the limited number of structural geologists in Canada in terms of a common set of scientific objectives and provide better opportunities for cooperation and continuity in structural research. The youthful structures that are relatively well-exposed and easily accessible across the breadth of the Southern Cordillera were selected as most suitable for the project. The most important result of the project to date has been the publication in February, 1970, of Geological Association of Canada Special Paper Number 6, "Structure of the Southern Canadian Cordillera", edited by J.O. Wheeler, coordinator for the project. This reports on twelve projects on which field work had been completed in 1967. Two additional studies have become available since then as Ph.D. theses. Both are to be published by the Geological Survey of Canada. Two more Ph.D. theses are due to be completed in 1970 and field work is continuing on two other projects in the eastern Cordillera. There are also two new Ph.D. theses projects and one new M.Sc. thesis project.

The objectives of the first phase of the project, the determination of the basic geometry of the structures and their mutual relationships in space and time have been met over about two-thirds of the profile across the Cordillera. The precision of the data varies with the complexity of the structure, the availability of stratigraphic markers, the degree of rock exposure, and the calibre of the work. Studies of the second phase involving phenomena such as the pattern of movement within individual thrust sheets have begun in the Rocky Mountains where stratigraphy is well known and structural patterns are predictable. However, there is an urgent need to meet the objectives of the first phase of the project.

The first priority for additional work is to fill in the remaining gaps so that a physically continuous structural profile can be constructed across the southern Cordillera. It is essential that the distribution and configuration of the rock units and the nature of the structures be accurately shown and essentially reproducible. This, together with structural and stratigraphic

data provides the basic information for any interpretation of the structural evolution of this segment of the Cordillera. Some of the most pressing problems relating to an accurate portrayal of the geologic structure across the southern Cordillera and an understanding of the structural evolution of the region will not be solved by structural studies alone. Assistance is needed from geophysicists, paleontologists, and others. When the proposed studies are completed and combined with the results of current and future studies of crustal structure by the Dominion Observatory and others, the southern Canadian Cordillera will be one of the best known mountain belts in the world.

RECOMMENDATIONS

The Subcommittee on Structural Geology on the basis of its meetings in Winnipeg on March 20th, 1970 and in Edmonton on March 26th, 1971 adopted two recommendations to the National Advisory Committee:

1. That the National Advisory Committee express its continued support for the Cordilleran Structure Project by assigning a priority to applications for research support that will expedite completion of the remainder of the profile across the Cordillera.

2. That the National Advisory Committee endorse the objectives of the Geodynamics Project, and express to the Canadian Subcommittee for Geodynamics, its recommendation that every effort be made to integrate the activities of all relevant branches of Earth Science in Canada when formulating new projects for the Canadian contribution to the International Geodynamics Project.

REPORT OF THE SUBCOMMITTEE ON STRATIGRAPHY, PALEONTOLOGY AND SEDIMENTOLOGY

Presented by G.V. Middleton (May, 1972)

G.V. Middleton (Chairman)	McMaster University, Hamilton, Ontario.
W.J. Braun	University of Saskatchewan, Saskatoon, Saskatchewan.
Paul Copper	Laurentian University, Sudbury, Ontario.
R.P. Glaister	Imperial Oil Company, Calgary, Alberta.
H.J. Hofmann	University of Montreal, Montreal, Quebec.
R.W. Macqueen	Geological Survey of Canada, Calgary, Alberta.
G.B. Mellon	Alberta Research Council, Edmonton, Alberta.
P.E. Schenk	Dalhousie University, Halifax, Nova Scotia.
H. Williams	Memorial University, St. John's, Newfoundland.

Sedimentary rock suites

Eleven suites of Canadian sedimentary rocks were prepared by members and past members of the subcommittee. Twenty sets of each suite were prepared by the Geological Survey of Canada, and almost all have been purchased by Canadian universities.

Geological Survey of Canada grants

The subcommittee recommended changes in the procedure for distributing GSC grants in aid of research. In the light of proposed revisions of the structure of advisory committees, the specific recommendations may no longer be relevant. The general import of the recommendation was to increase selectivity and institute a system of expert reviews of proposals.

Field institutes

The subcommittee recommended that funds be made available to help finance an annual field institute for geologists, similar to institutes sponsored by NSF in the United States.

Current research (1969-1971)

A detailed summary of current research is given in the annual surveys of Current Research in The Geological Sciences in Canada (Geol. Surv. Can., Papers 69-5, 70-5). The data in Table 1 are taken from these reports. The data illustrate the increasing number of projects in sedimentology, already commented on in earlier reports.

Table 1

Number of Research Projects

Year	Stratigraphy and Paleontology	Paleontology	Sedimentology	Total
1966-67	91	51	48	190
1967-68	116	73	92	281
1968-69	134	102	119	355
1969-70	114	91	128	333

A major event of 1970 was the American Association of Petroleum Geologists meeting, held in Calgary in June, 1970. Featured symposia at this meeting included "Future Oil Provinces", "Deltaic Sedimentation and Petroleum Occurrences", "Exploration Geochemistry", and "Reef Complexes in Time and Space". The National Conference on Earth Sciences jointly sponsored by the Alberta Society of Petroleum Geologists and the University

of Alberta was held at Banff in May, 1969 on the theme "Diagenesis and Geochemistry of Carbonate Rocks". The ASPG also sponsored a seminar series in February and April, 1970, by R.J. Weimer on "Stratigraphic Petroleum Exploration of Detrital Sequences" and has supported the publication in July, 1970, of "The Face of Time" by S.J. Nelson, a popular historical geology of western Canada featuring fossil plates and paleogeographic maps.

In 1971, symposia sponsored by ASPG included an international conference on the Permo-Triassic (see abstracts in Bull. Can. Petrol. Geol., vol. 19, p. 313-376, 1971) and a major symposium on "Canadian Exploration Frontiers". The 9th National Conference on Earth Sciences, jointly sponsored by the University of Alberta and ASPG was on the timely topic "The Geology and Evolution of Continental Margins". In 1972 the 10th Conference will be on "The Geology of Arenaceous Deposits". Further details of ASPG activities may be found in the annual reports of the President (Bull. Can. Petrol. Geol., vol. 19, p. 1-23, 1971; vol. 20, p. 1-23, 1972).

The Geological Association of Canada meeting in Montreal in June, 1969, featured a symposium on "Flysch Sedimentology in North America" and a field trip to examine outcrops of flysch formations exposed along the south shore of the St. Lawrence River northeast of Quebec. The symposium has now been published as Special Paper No. 7 of the GAC.

Besides the papers in this symposium, there were two important papers on Quebec flysch by Paul Enos published in 1969. One was published in the Journal of Sedimentary Petrology, where it won the Outstanding Paper Award, and the other appeared as a Special Paper of the Geological Society of America.

Interest in Precambrian stratigraphy is running high. An "in-house" symposium on the topic was organized by the GSC in the spring of 1970, and attended by selected representatives of Canadian universities. The papers presented have been published as GSC Paper 70-40. In April another symposium on "Precambrian Sedimentation in the Canadian Shield" was organized at University of Western Ontario and in the fall of 1970 there was a Penrose Conference on the Precambrian held at the University of Wyoming and attended by several Canadian representatives. A symposium on "Precambrian Fossils" was held at Laurentian University in Sudbury in October, 1970, and a symposium on "Huronian Stratigraphy and Sedimentation" was held at the annual GAC meeting in Sudbury, 1971 (Geol. Assoc. Can., Sp. Paper 12, 1973).

Significant papers on Precambrian stratigraphy and sedimentology were published during 1969, by several authors including S.M. Casshyap, Paul Hoffman, D.A. Lindsay, and G.M. Young. Precambrian and other stromatolites were described in two GSC publications by H.J. Hofmann.

In March, 1972 a successful symposium on "Glacial Sedimentology" was organized by the eastern section of SEPM and held at the annual meeting of the eastern section of GSA in Buffalo, New York.

REPORT OF THE SUBCOMMITTEE ON COMPUTER APPLICATIONS

Presented by D. A. Sharp (April, 1972)

Members

D. A. Sharp* (Chairman)	Department of Mines and Northern Affairs, Toronto, Ontario.
L. S. Beck	Department of Mineral Resources, Regina, Saskatchewan.
R. Bergeron	Department of Natural Resources, Quebec, Quebec.
F. C. Brechtel	Pan Canadian Industries Limited, Calgary, Alberta.
W. C. Brisbin*	University of Manitoba, Winnipeg, Manitoba.
C. F. Burk, Jr.	Geological Survey of Canada, Ottawa, Ontario.
R. G. Garrett	Geological Survey of Canada, Ottawa, Ontario.
J. A. Gower	University of British Columbia, Vancouver, British Columbia.
W. W. Hutchison	Geological Survey of Canada, Vancouver, British Columbia.
J. F. Jones	Department of Mines, Halifax, Nova Scotia.
F. Raynes	Cominco Limited, Vancouver, British Columbia.
P. G. Sutterlin	University of Western Ontario, London, Ontario.
H. R. Wynne-Edwards*	Queen's University, Kingston, Ontario.

*Executive Committee

INTRODUCTION

The subcommittee met twice during 1969-71, in Quebec City, February, 1970, and in Calgary, February, 1971. The executive committee met on two occasions in July and October, 1969. Five meetings were held by the four working committees. A list of these working committees and their membership is attached as Appendix 1 to this report (p. 58).

The work of the subcommittee during the period since the last meeting of the NACRGS in April, 1969, has been directed towards the continued implementation of the concepts and recommendations contained in the 1967 ad hoc committee report, "A National System for Storage and Retrieval of Geological Data in Canada".

As recommended by the National Advisory Committee, the subcommittee broadened its field of interest to include all computer applications in the earth sciences.

The following report is separated into three parts. Part I deals with the general activity of the subcommittee and its working committees; Part II discusses geoscience information in Canada; Part III reviews additional areas of study.

PART I - GENERAL ACTIVITY

1969 Conference of the Provincial Ministers of Mines

Prior to the 26th Annual Conference of the Provincial Ministers of Mines, C.F. Burk, Jr., Secretariat for Geoscience Data, visited most provincial geological departments across Canada and discussed with them the question of the proposed Canadian Geoscience Data Institute and related matters. These visits were very well received and all provinces visited supported the concept as proposed.

After considerable discussion at the conference, it became apparent that, although provincial governments favoured the concept, a joint Federal-Provincial funding procedure for its support could not be agreed upon. As a result, it was resolved by the Provincial Ministers of Mines,

> "That the Ministers of Mines accept in principle the concept of a coordinated nation-wide system of Geoscience data storage and retrieval, and that the Government of Canada, through the Geological Survey of Canada, should maintain a National Index for that purpose".

This resolution was placed before the committee in a communique presented at the closing plenary session and was conveyed to the Honourable J.J. Greene, Minister, Energy, Mines and Resources.

It is the view of the subcommittee that the Ministers of Mines Conference represents an excellent forum wherein matters of national interest requiring both federal and provincial legislative action or implementation of common policies may be discussed and resolved and close liaison with the body should be maintained in the future.

Secretariat for Geoscience Data

In response to recommendations contained in the 1967 report published by the National Advisory Committee and further, as recommended by the 25th Conference of Provincial Ministers of Mines, the Secretariat was established in October, 1968. It was subsequently terminated 31 March 1970.

Throughout the existence of the Secretariat, the many inquiries pertaining to the Canadian System received by the subcommittee from across Canada and abroad were forwarded to the Secretariat for reply. The services provided during this period clearly established a growing need for a permanent body to provide information, coordination and direction in computer applications in the earth sciences.

Canadian Centre for Geoscience Data

Following the Conference of Provincial Ministers of Mines in September, 1969, the Geological Survey of Canada took steps to initiate the Canadian Centre for Geoscience Data to fill the role planned for the Canadian Geoscience Data Institute. As a result, the Centre was established in April, 1970, as a national coordinating and referral service of the Geological Survey of Canada. Its principal function is to develop the Canadian System for Geoscience Data, a national information network, to consist of computer-based data files and a national index to sources of data on Canada.

Staff of the Centre, presently (1972) comprising two professionals and a secretary, assists public agencies, university departments and mineral exploration companies in building computer-based data files and indexes, coordinates development of standards for geoscience data and assists scientists and explorationists in locating needed data concerning the geology of Canada. Policy for operation of the Centre will be provided by its Advisory Board, which has the following representation:

1.	Federal Government	3
2.	Provincial Government	3
3.	Petroleum Industry	1
4.	Mining Industry	1
5.	National Advisory Committee on Research in the Geological Sciences	1
6.	University	1
	Total	10

The Canadian Centre for Geoscience Data, in collaboration with Geofond Praha (Czechoslovakian Geoscience Information Centre), has compiled a world-wide bibliography of available information concerning the application of computer technology to geoscience information storage and retrieval[1]. The bibliography will assist Canadian workers in taking advantage

[1] "Computer-based storage and retrieval of geoscience information: bibliography 1946-69", by J. Hruska and C. F. Burk, Jr.; GSC Paper 71-40, Canadian Centre for Geoscience Data, Ottawa.

of other work in this field which has been carried out mainly in the United States, Canada, U.S.S.R., France, United Kingdom, East and West Germany, and Czechoslovakia. It includes 336 references, which have been thoroughly indexed. Publication by the Centre is expected in 1971.

The Canadian Centre for Geoscience Data has installed the SAFRAS system[1] developed by the Department of Geology, University of Western Ontario. Use of this generalized storage and retrieval system is now available to the public through the Centre. It is hoped that this service will facilitate and encourage the creation of computer-based files in Canada. Cost of using the SAFRAS system will be recovered by paying for required computer time supplied by an Ottawa service company. It is a condition of using this service that the data files created must include whatever national data standards have been adopted at the time the data were compiled.

Canadian Index to Geoscience Data

The first edition (70-1) of the Index was published in May, 1970 by the Canadian Centre for Geoscience Data. It consists of ten individual volumes of major political divisions in Canada with an accompanying thesaurus of authorized keywords and terms. Sales to April, 1971 were 1,000 volumes, valued at $25,000. Although including contributions from only four agencies and mainly from the Geological Survey of Canada, the Index cites approximately 17,000 documents which cover most parts of Canada and is a first step in developing a comprehensive index. At present, seven geoscience agencies have contributed or are contributing to the indexing effort (Geological Survey of Canada, Mineral Resources Branch, Department of Indian Affairs and Northern Development, Newfoundland Department of Mines, Quebec Department of Natural Resources, Ontario Department of Mines and Northern Affairs and Saskatchewan Department of Mineral Resources). A paper outlining progress on the Index was published in Oilweek, 9 February 1970.

The second edition (71-1) will be published in February 1972 and will include reference to about 23,000 titles. In addition to printed books, the Index will be available in magnetic tape form and microfiche.

Working Committees

During the past two years, the importance of the working committees in relation to the overall development of the Canadian System has become more apparent. The subcommittee, in its report to the National Advisory Committee in April, 1969, acknowledged at that time the need for user committees or groups of persons actively engaged in the collection and utilization of computer-processable files. Presently, there are four working committees (University Grants, Mineral Deposits, Geologic Field Data and Geochemical Data), and these committees formally report to the Subcommittee on Computer Applications. The importance of maintaining liaison with the Canadian Centre for Geoscience Data is fully recognized, and the National Coordinator, C.F. Burk, Jr., has been invited to attend all committee meetings as an active participant.

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[1]Self-adaptive Flexible Retrieval and Storage system.

University Grants Working Committee.

Again during 1969-70, up to $50,000 was provided by the Geological Survey of Canada as special grants for research in the development of computer-processable files for geological data. Six grants were made in 1969, for a total of $50,000 and these were reported in the NACRGS 1968-69 Nineteenth Annual Report (p. 56).

At the 1970 meeting, the Subcommittee on Computer Applications concluded that the earth sciences and development of the Canadian System for Geoscience Data could be served best by broadening the general terms of reference to include, in addition to research in mineral deposits, geochemical and geological field data - paleontological, stratigraphic and diamond drill-hole data.

In the spring of 1970, the University Grants Working Committee forwarded its recommendations to the National Advisory Committee in respect of those applicants for the 1970-71 special grants. Applications were received from fourteen professors requesting a total of $137,584, more than double the amount requested the previous year. The grants committee felt that there were several projects worthy of support which could not be recommended because of the limited funds. The subcommittee was subsequently advised by the NACRGS that seven grants in the amount of $50,000 were awarded (see Appendix, p. 107). A brief review of each of these projects is included as Appendix 2 of this subcommittee report (p. 61).

Mineral Deposits Working Committee.

The working committee met twice during the two-year period, in Ottawa, January, 1971 and in Toronto, April, 1971.

During the deliberations of this committee, it was agreed that three main areas should be investigated. Firstly, to promote the concept of standards insofar as mineral deposit files are concerned; secondly, to compile a set of recommended standards; and thirdly, to demonstrate by the adoption of these standards the usefulness of a prototype mineral deposit file network.

The ad hoc committee report of 1967 contained an extensive list of data items which would normally be found in most mineral deposit files, and most workers involved in the construction of mineral deposit files utilized the suggestions contained in the report. It has, however, become apparent that although the suggestions attempted to be very comprehensive and all inclusive, each organization applying these to mineral deposit files found it necessary to make extensive modifications. The concept becoming most popular today is more in keeping with those of COGEODATA (International Union of Geological Sciences), which recommends a small group of basic data items. This list can be expected to gradually increase in number, while at the same time, the applicability of such standards over a wider base should become apparent. In development of standards, the working committee is focusing its attention on content, notation and file structure. Present efforts are being directed toward standards with respect to file content and sub-studies include a collection of definitions in current use for the term "mineral deposits", methods used to identify mineral deposits, existing requirements of all mining jurisdictions of Canada regarding the location of

mineral deposits or claims, compilation of current usage in identifying commodities, including industrial minerals and fossil fuels, and compilation of parameters generally used in the detailed description of individual mineralized zones.

Geologic Field Data Working Committee.

The working committee met in March, 1971 to discuss the progress during the sixteen months since the previous meeting.

Highly successful systems have been developed and put into use by three government groups:- Quebec Department of Natural Resources (Grenville system), Manitoba Department of Mines (system developed for Operation Pioneer), and Geological Survey of Canada, Vancouver (Coast Mountain system). The widely acclaimed Grenville system has evolved so that various types of geological maps can be produced by using a drum plotter. The Operation Pioneer system has evolved in a similar manner in that a programmer has been hired to process and manipulate the field data for compilation and production of maps. The Coast Mountain system has also evolved and now provides the capability of plotting geologic data directly on a stable topographic or other base (to go directly for printing), and of rapid retrieval, not only for data but for all information (descriptive comments) required for report preparation.

A field project of the New Brunswick Department of Natural Resources and a Pleistocene project of the Quebec Department offer highly promising systems which will be used in the field in 1971.

Several companies (Placer Development, Rio Tinto and Canadian Pacific Oil and Gas), have put systems into use although little processing of the data has yet been done. The most intriguing aspect of these three is the flexibility of Rio Tinto's system, such that each user may design his own input document provided he uses terms available in a "dictionary".

Some organizations have indicated lack of support at the management level in developing field data systems. Other difficulties relate to developing a viable system whereby data and information can be recorded in analogue form (e.g., structural mapping in Rocky Mountain-type terrain or detailed mapping where contacts and changes in rock types are being recorded continuously in three dimensions). On the other hand, all Quebec Department geologists use the Grenville system for mapping in the Grenville and on a voluntary basis fourteen out of nineteen geologists at Manitoba Department of Mines are using the Pioneer system.

Although progress made by the working committee has been substantial, encouraging and rewarding, a variety of field situations do not lend themselves to satisfactory study with systems developed to date. It is hoped that appreciable progress will be made in those areas in the near future.

Geochemical Data Working Committee.

Geochemical data are generally easily amenable to computer handling. The standard items to be recorded are simply those elements which are determined and the data are inherently numerical. However, of equal

importance are the field data associated with each sample without which a full and correct interpretation of the data is difficult, if not impossible.

The computer as an aid to geochemistry, finds application in several fields, including storage, retrieval, reduction and simulation.

1) Basic geochemical data, i.e., analyses, nature of sample, location with specific precision and accuracy by a specified method.
2) Essential field observation data, i.e., nature of sample, location and whatever geological or other parameters of the sample and sample site that are important in terms of the interpretation.

It is these first two items combined together in pairs which make up the working file of a field geochemical investigation.

3) The reduction and synthesis of the working file to provide insight into the geochemical processes acting in the environment.
4) The simulation of geochemical processes and phenomena through modelling based on thermodynamic principles.
5) The generation, maintenance and searching of indexes so that data of specific interest can be identified quickly and efficiently.

Traditionally, the work of the committee has been in the first two fields and certain recommendations will be made as to the items which should be recorded and how this should be done. However, such a file of data is of little use in solving the problems of Canadian geoscience unless reduction and synthesis are encouraged and carried out.

Large amounts of money are currently being spent on the collection of data and in some cases on the storage of these data in computer-processable form, but insufficient monies are being spent to realize their full potential. This will become increasingly important as more subtle features of the data are searched for.

The concept of a "geochemical data index" has been proposed and the initial reaction from the mineral exploration industry is most encouraging. The index would be a directory of surveys carried out in the public, university and private sectors. In universities, there is a general unawareness of what work is being done in other universities in similar fields; in industry, there is considerable duplication of effort to the extent that many surveys are repeated. The geochemical index would serve to make people aware of what work had been carried out and so direct them to one another for their mutual benefit.

Currently (July, 1971), a questionnaire on the acceptibility of the index is being circulated to Canadian members of the Association of Exploration Geochemists. The majority of the members are working in the fields of applied and exploration geochemistry and the results will indicate the willingness to cooperate of the holders of the vast majority of geochemical data. A tentative index document has been prepared, and has been the basis for much constructive criticism.

A list of recommended standard items of field data which should be recorded is presently being prepared by the working committee, together with suggestions on how accuracy and precision should be recorded.

Publications

During November, 1969, the Executive Committee and the Secretariat for Geoscience Data commenced preparation of a publication to summarize activities in computer-based storage and retrieval in Canada for the period 1967 to 1970. This report would have contained contributions from about twenty authors but was subsequently cancelled. Significant progress has resulted during the four years since publication of the NACRGS Report, "A National System for Storage and Retrieval of Geological Data in Canada". The excellent case histories which have been submitted to the Centre will be published at the earliest possible date, although the format has not as yet been decided upon.

24th International Geological Congress, 1972

To assist the Exhibits Subcommittee of the 24th International Geological Congress, the subcommittee prepared a background paper on the proposed computer exhibit for the exhibit consultants, Southex Limited.

The subcommittee has recommended that the exhibitors demonstrate the application of computers and related equipment in the solution of geological problems utilizing geological data and information sources provided by government agencies, service bureaus, universities and others. Emphasis should be given to demonstration of computer-based methods presented at Technical Section 16 and to the Canadian System for Geoscience Data. The exhibits will have as their primary objective the demonstration of equipment, programs or systems in a geological context.

Computer-based techniques now available in Canada include:

1. Creating data files;
2. Selective retrieval from data files;
3. Searching bibliographic files;
4. Statistical analysis of data sets;
5. Graphic displays of data and analytical results;
6. Simulation and modelling; and
7. Integration and data reduction.

Every effort will be made to include the most recently developed methods in addition to the many proven techniques developed during the past four years, which should be of wide interest, particularly to delegates from outside North America.

A comprehensive census of Canadian computer-based geoscience data files is presently being undertaken by the Canadian Centre for Geoscience Data, and upon completion these data will be provided to those companies interested in exhibiting at the Congress.

Report on Solid Earth Science Study Group

On behalf of the subcommittee, C.F. Burk, Jr. and D.A. Sharp prepared for the Science Council of Canada a background paper on computer applications in the Earth Sciences. This paper included comment on the significance and history of research and development, present level of

activity, need for increased activity, training, practical applications, objectives and future trends. This paper forms part of the recent Geological Survey of Canada publication, Paper 69-56.

The background paper recommended that:

1. Industry, government and university should reappraise current policies and practices for managing their Earth Science data, especially with regard to adequacy for conservation of these data as costly and potentially reusable resources.

2. Immediate collective action should be taken to ensure development and application of standardized methods for the future collection and storage of Earth Science data.

3. A National Index to the existence and location of Earth Science data should be developed as an essential first-step in the proper management of our data resources.

4. A permanent body, such as the proposed Canadian Geoscience Data Institute, should be established to implement the national system for storage and retrieval of geological data and to help ensure an orderly development of computer applications in the Earth Sciences in Canada.

PART II - GEOSCIENCE INFORMATION IN CANADA

In 1969, the subcommittee expressed its concern to the National Advisory Committee on Research in the Geological Sciences regarding the problems of disseminating the increasing amount of scientific and technical information in the geosciences. This concern was acknowledged by the committee, and it was recommended at the last NACRGS meeting that:

> "An ad hoc multidisciplinary committee be formed composed of representatives of N.A.C. and various other Earth Science Associate Committees, including a National Science Library representative, to appraise the whole subject of scientific and technical information in Canada, commencing with the Special Study No. 8 of Science in Canada, (sic) publication".

As this committee was not formed, the Subcommittee on Computer Applications has undertaken a general review of the problems and here offers several comments in respect of geoscience information in Canada.

At the present time, there are available in Canada, numerous computer-based information files and activities of potential value to Canadian geoscientists. The following is a listing of major files and activities which are computer-based or computer-oriented:

FILES:

1. GeoRef File - World-wide bibliographic coverage by American Geological Institute, Washington.
2. Geotitles File - World-wide bibliographic and other coverage provided by Geosystems, London.
3. Bulletin Signaletique - The French world-wide file produced by Centre Nationale de Recherches Scientifiques.
4. Bibliographie des Sciences de la Terre - World-wide coverage produced by Bureau des Recherches Geologiques et Minieres.
5. Abstracts of North American Geology - Produced by U.S. Geological Survey. Computer file not yet publicly available.
6. Petroleum Abstracts - World-wide coverage of petroleum industry produced by University of Tulsa.
7. Canadian Index to Geoscience Data - Canadian coverage of published and unpublished documents containing original observations and measurements.
8. CAN/SDI Project - Not a file as such, but system searches bibliographic tapes of interest to geoscientists for a "Selective Dissemination of Information" (SDI) service.

ACTIVITIES

1. Committee on Geoscience Information - Established by American Geological Institute to develop a U.S. information system.
2. Committee on Geological Documentation - An IUGS committee, including an "Automation Board" now building a multi-lingual thesaurus.
3. COGEODATA (Committee on Storage, Automatic Processing and Retrieval of Geological Data) - An IUGS committee similar in most aspects to the NACRGS Subcommittee on Computer Applications, but with an international outlook.

4. Advisory Board on Scientific and Technical Information – Appointed by the National Research Council of Canada to develop a national STI (Scientific and Technical Information) system.
5. Abstracting Board – International Council of Scientific Unions (ICSU).
6. Subcommittee on Computer Applications – NACRGS.

No agency in Canada is presently responsible for ensuring that Canadian geoscientists obtain maximum benefit from these services. Most earth scientists are, in fact, generally unaware of their existence.

During the past four years, there have been five major studies dealing with the establishment of science information policies in Canada (Science Council Report No. 6, Tyas Report, Bonn Report, Downs Report, and MacDonald Report). Two additional studies, one by a Special Senate Committee, the other by the Organization for Economic Cooperation and Development (OECD), also have been completed. Each of these studies recognized that immediate action must be taken to ensure that all scientific and technical information now available in the public domain is fully exploited by those having a need for it. The studies show less unanimity when it comes to proposing how this goal might be achieved.

It was recommended in the Tyas Report, Special Study No. 8, "Scientific and Technical Information (STI) in Canada" that:

1. The government of Canada define a national policy with respect to scientific and technical information to stimulate and guide the evolution of nation-wide information services.
2. A central agency be established to implement government policy with regard to scientific and technical information.
3. Where appropriate, federal government departments and agencies be designated as responsible agents for information activities that are relevant to their missions.
4. The central agency review the many assessments made in this report and take appropriate action to develop an effective national network.
5. Government departments accepting the role of responsible agents should assess the significance of scientific and technical information to their operations and take action to improve its generation, handling and use.
6. An advisory committee for scientific and technical information, representative of all groups concerned with information, be established to advise the central agency.

In June, 1969, the Science Council established a committee, under the chairmanship of Dr. Leon Katz, to examine the aforementioned reports and make specific recommendations regarding the establishment of a national policy of dissemination of scientific and technical information.

The "Katz Report", published in September, 1969, made these basic recommendations on behalf of the Science Council of Canada:

1. That a national STI system should be based on existing expertise and linked into a network operated under decentralized control.
2. That the National Research Council be designated as the agency responsible for promoting federal participation in the development of an STI network.

Following publication of the Katz Report, NRC appointed a task force to determine how the Council might carry out the role proposed for it. The findings of this task force were submitted for consideration to the government, which in December, 1969, directed that NRC should:

1. Under the general direction of the National Librarian, develop in concert with existing information organizations, a national STI system to encompass the natural sciences and engineering.
2. Appoint an Advisory Board responsible for formulating general policies for STI services and guidelines for their implementation.
3. Establish a separate parliamentary vote for the funding of these STI operations.

In keeping with the government directive, NRC appointed an Advisory Board on Scientific and Technological Information in July, 1970. The membership of this Board consists of twenty leaders in the fields of science, industry and education and represents the users, producers and processors of information. In order to facilitate the essential liaison between the National Library and the National Science Library, the National Librarian and the National Science Librarian are ex-officio members of the Board.

The Advisory Board, in addition to its major role of formulating guidelines for the continuing development of a national STI system, has been assigned several supplementary duties. These include the responsibility for advising NRC on:

1. Priorities necessary to undertake or promote the dissemination of STI.
2. Expenditures for grants in aid of research, scholarships to promote the training of information specialists and contracts to further an STI system.
3. Arrangements for international collaboration in the field of STI.
4. The best use of existing STI resources in Canada.
5. The development of existing and new scientific and technical publications and other means of disseminating STI.

It is important to note that the earth sciences are not presently represented on this Board.

The feasibility of a world science information system has been under study by the United Nations Scientific and Cultural Organization and the International Council of Scientific Unions. Its recently released report – "UNISIST" – contains several important recommendations which are relevant to the development of Canadian systems.

At the present time, the Geological Survey of Canada is investigating the possibility of providing a selective dissemination of information (SDI) service to earth scientists, utilizing one or more of the bibliographic files listed. The subcommittee is also pleased to note that the matter of information is being given a higher priority in the Geological Survey of Canada as evidenced by the establishment of a Geological Information Processing Division.

In its deliberations, the subcommittee has concluded that information must be recognized as a primary resource and considerably more effort and personnel must be directed towards the systematic and orderly development of a scientific and technical information system for the dissemination of geoscience information in Canada.

PART III - ADDITIONAL AREAS OF STUDY

Assessment Reports

It is the general practice throughout Canada that a holder of a mining claim shall perform or cause to perform specific commitments in respect of exploring or developing a claim. In all instances, proof of performance is required, along with submission of certain data and reports. However, there appear to be no specific recommendations or requirements on content and format of the documents which are submitted for expenditure credits. Most of these data are filed in a manner not conducive to easy storage or rapid retrieval.

During the past several years, the matter of assessment credits has been discussed at the Conference of Provincial Ministers of Mines and an ad hoc committee of government and industry representatives is presently active and will present a report at the forthcoming conference in September, 1971. The subcommittee recognizes the great potential of assessment reports, but is concerned that much of this potential is lost as a result of the low priority given format and content. As a first step in improving the quality of the geological aspects of these data, it is recommended that a new working committee of this subcommittee be established to investigate and report upon the problems associated with the adoption of minimum standards for the reporting and filing of geological data in assessment work.

Foreign Aid

The development of the Canadian System for Geoscience Data and the development of standards associated with such a system has been viewed with considerable interest by numerous countries. Efforts are being made through the International Union of Geological Sciences to develop and encourage the use of such standards internationally and it is apparent that Canada and its representatives are playing a major role in this program.

Through the Canadian International Development Agency, Canada makes available to developing countries funds to support or carry out earth science programs. Although present and proposed levels of expenditures in the earth sciences are not great, it is recommended that available standards for the collection of computer-processable data be used when Canadian funds support in whole or in part geological programs in developing countries. It is further recommended that this could best be accomplished through liaison with the Canadian Centre for Geoscience Data.

RECOMMENDATIONS

1. Although the subcommittee should continue to provide advice and assistance with respect to computer-based storage and retrieval of geoscience data, the newly established Canadian Centre for Geoscience Data should be expected to assume a major portion of this responsibility.
2. Recognizing the central role of the National Research Council in promoting federal participation in the development of a national scientific and technical information network, the subcommittee should examine the ways and means available to systematically develop and implement a scientific and technical information system for the dissemination of geological information in Canada and should report, within twelve months, its findings to the National Advisory Committee on Research in the Geological Sciences.
3. A working committee of the subcommittee should be established to investigate and report upon the problems associated with the adoption of minimum standards for the reporting and filing of geological data in assessment work submitted to government agencies.
4. Available standards for the collection of computer-processable data should be used where Canadian funds support in whole or in part geoscience programs in developing countries.
5. Should the terms of reference and objectives of the National Advisory Committee on Research in the Geological Sciences be significantly modified as a result of the Solid Earth Science Study Report, the need for a body similar to that of the Subcommittee on Computer Applications and its working committees should be recognized and provision should be made for continuing this work.

APPENDIX A

MEMBERSHIP OF WORKING COMMITTEES

1. University Grants Working Committee

W.C. Brisbin (Chairman)	University of Manitoba, Winnipeg, Manitoba.
C.F. Burk, Jr.	Canadian Centre for Geoscience Data, Ottawa, Ontario.
D.A. Sharp	Department of Mines and Northern Affairs, Toronto, Ontario.

2. Mineral Deposits Working Committee

C.F. Burk, Jr.	Canadian Centre for Geoscience Data, Ottawa, Ontario.
(Mrs.) K. Edmond	Geological Survey of Canada, Ottawa, Ontario.
K.A. Ewing	Department of Energy, Mines and Resources, Ottawa, Ontario.
S.A. Ferguson	Department of Mines and Northern Affairs, Toronto, Ontario.
C.J. Hodgson	Amax Exploration Inc., Vancouver, British Columbia.
A.M. Kelly	Geological Survey of Canada, Ottawa, Ontario.
P. Laznicka	University of Manitoba, Winnipeg, Manitoba.
R.V. Longe	Rio Tinto Canadian Exploration, Vancouver, British Columbia.
A.D. Oliver	Department of Indian Affairs and Northern Development, Ottawa, Ontario.
P.G. Sutterlin (Chairman)	University of Western Ontario, London, Ontario.
G.D. Williams	University of Alberta, Edmonton, Alberta.

3. Geochemical Data Working Committee

J.A. Coope	Newmont Mining Corp. of Canada Ltd., Vancouver, British Columbia.
R.G. Garrett (Chairman)	Geological Survey of Canada, Ottawa, Ontario.
C.F. Gleeson	C.F. Gleeson and Associates, Ottawa, Ontario.
B.M. Gunn	University of Montreal, Montreal, Quebec.
N.C. Wardlaw	University of Saskatchewan, Saskatoon, Saskatchewan.
W.J. Woolfe	Department of Mines and Northern Affairs, Toronto, Ontario.

4. Geologic Field Data Working Committee

C.F. Burk, Jr.	Canadian Centre for Geoscience Data, Ottawa, Ontario.
P.P. David	University of Montreal, Montreal, Quebec.
J.A. Donaldson	Carleton University, Ottawa, Ontario.
K. Eccles	Canadian Pacific Oil and Gas, Calgary, Alberta.
J.M. Grant	Labrador Mining and Expl. Co. Ltd., Montreal, Quebec.
W.W. Hutchison (Chairman)	Geological Survey of Canada, Vancouver, British Columbia.
A.F. Laurin	Department of Natural Resources, Quebec, Quebec.
V.G. Milne	Department of Mines and Northern Affairs, Toronto, Ontario.
W.D. McRitchie	Department of Mines and Natural Resources, Winnipeg, Manitoba.

E. W. Reinhardt	Geological Survey of Canada, Ottawa, Ontario.
A. A. Ruitenberg	Department of Natural Resources, St. George, New Brunswick.
H. R. Wynne-Edwards	Queen's University, Kingston, Ontario.
C. J. Yorath	Geological Survey of Canada, Calgary, Alberta.

APPENDIX B

SPECIAL GRANTS FOR RESEARCH IN THE DEVELOPMENT OF COMPUTER-PROCESSABLE FILES FOR GEOLOGICAL DATA - 1970-71

1. J.A. Donaldson – Initiation of a computer-processable file of geological data for Precambrian strata of the western Canadian Shield ($4,500).

This project is being undertaken as an M.Sc. study by Mr. Michael Cecile and involves computer processing of data for areas underlain by sedimentary rocks of the Dubawnt, Hornby Bay and Coppermine River Groups, Northwest Territories. To date, emphasis has been placed on acquiring and developing programs to process station data in relation to geographic locations.

2. J.A. Gower – Techniques and applications of digitizing drill-core information ($5,500).

Work on this project is progressing well under the supervision of Drs. J.A. Gower and A.J. Sinclair. Mr. Colin Godwin, a Ph.D. candidate, has been working on the project and has developed a drill log document for porphyry-type deposits, amenable to computerization. The drill log form has passed through several stages of change as a result of practical experience with the logs. The present form of the log is probably close to the final form that will be tested in detail by Mr. Godwin, using diamond-drill hole information from the Casino Silver deposit (porphyry type molybdenum deposit), Yukon. A part-time technical assistant has been employed to code the drill-hole information.

3. I. Nichol – The interpretation of exploration oriented geochemical data in computer-processable data files ($9,000).

The overall objective of the investigation is to establish a data file applicable to the storage of exploration oriented geochemical data and to evaluate the applicability of selected computer techniques to the interpretation of data relating to a variety of problems. The basic structure of the data file will have facilities for the inclusion of data on (a) field information, (b) sample processing, (c) analytical techniques/type and precision of analyses, (d) analytical information, and (e) interpretational computations. Geochemical data are presently being interpreted and future work will include the conversion of currently available data to a format acceptable to the file.

4. P.G. Sutterlin – Development and application of an integrated data processing system for geological data and the development of a geochemical data file ($14,000).

The storage and retrieval aspect of SAFRAS as well as the merge and file augmentation capability of the system has been completed. The

system has been fully tested and has been installed at four locations other than the University of Western Ontario. One major modification to the system which is presently being implemented is the ability to search within a character string comprising a data item in the file. This should extend the capabilities of the system considerably, and make the system amenable to applications such as document indexing. In this regard, Dr. Sutterlin is working with the University of Western Ontario school of library and information science to test this particular application. Future work on the system will involve integrating analytical and display routines as part of an overall data processing system. This work was commenced in May, 1971, when Mr. Jerry DePlancke was hired as part-time systems analyst.

Mr. R.A. Olsen, graduate student in the Department of Geology, has in the past year built a file containing data from 2200 exploration geochemical analyses of soil samples. Manipulation of these data, utilizing the SAFRAS system, has been most successful.

5. G.D. Williams – Characteristics of oil and gas pools relative to structure and stratigraphy of Alberta ($7,000).

A thorough examination was made of all the data collected during the past year on Cretaceous and Jurassic oil and gas pools in Alberta, and as a result the initial standards and forms used in data collection were substantially revised. Additional data items were added to the file and collected so that the test file now contains a possible maximum of 543 data items on each of approximately 1,200 pools. Most of the data have been transferred to punch cards for construction of a master file, utilizing SAFRAS, although the data are not yet completely punched. The project is being continued by Mr. G. Dickie and numerous retrievals have been made from the interim fixed format file, containing mainly engineering and geometrical data on the pools.

6. H.D.B. Wilson – The geologic, geographic and temporal significance of the distribution of base metal and precious metal deposits of the world ($4,000).

The collection of data from the literature has been completed to date. The data have been coded and the file now contains data covering 4,000 ore deposits, districts and the larger geographic area. The file covers the bulk of ore deposits of Au, Ag, Cu, Zn, Pb, Cr, Sn, W, Mo, Sb and Hg of the world. The file consists of approximately 20,000 punched cards, and is ready for computer processing upon completion of the implementation of the SAFRAS system at the University of Manitoba. A final topical manual describing the file, giving the classification of subjects and listing codes has been completed and it forms Part II of Mr. Peter Laznicka's Ph.D. thesis.

7. H.R. Wynne-Edwards – Electronic data processing of field data from the Grenville province in Quebec ($6,000).

The outcrop data from the seasons of 1968, 1969 and 1970 has now been recorded on tape files. Twelve preliminary lithological retrieval

programs have been written, allowing various parameters to be specified by the geologist and the outcrops satisfying these to be identified as to rock type and retrieved from the file. Secondary programs display lithological data on outcrop maps. Structural data can be retrieved from the file, compiled at will into foliation diagrams on equal-area nets, and counted as to density ready for hand contouring. Structural maps showing attitudes of bedding, foliation, and various types of lineation can be drawn on a CALCOMP Drum Plotter from data retrieved from the file, using conventional geological symbols. The machine generates a display comparable to that produced by a draftsman.

REPORT OF THE SUBCOMMITTEE ON QUATERNARY GEOLOGY

Presented by A. Dreimanis (March 5, 1972)

Members

A. Dreimanis (Chairman)	University of Western Ontario, London, Ontario.
L.A. Bayrock	Research Council of Alberta, Edmonton, Alberta.
E.A. Christiansen	Saskatchewan Research Council, Saskatoon, Saskatchewan.
C.B. Crawford	National Research Council, Ottawa, Ontario.
J.A. Elson	McGill University, Montreal, Quebec.
J.G. Fyles	Geological Survey of Canada, Ottawa, Ontario.
J.F. Jones	Nova Scotia Department of Mines, Halifax, Nova Scotia.
P.F. Karrow	University of Waterloo, Waterloo, Ontario.
L.H. King	Bedford Institute of Oceanography, Dartmouth, Nova Scotia.
P. LaSalle	Quebec Department of Natural Resources, Quebec City, Quebec.
W.H. Mathews	University of British Columbia, Vancouver, British Columbia.
S.C. Zoltai	Department of the Environment, Edmonton, Alberta.

This report is a condensed version of an interim report discussed at the subcommittee's meetings in Ottawa on March 31, 1970, and March 29, 1971, supplemented by recommendations adopted at these meetings and additional data supplied by the members. A report of an ad hoc committee on regional Quaternary mapping and urban geologic studies, chaired by E. A. Christiansen, is added as an Appendix.

RESEARCH: 1968-69, AND COMPARISON WITH 1966-67 AND 1967-68

Research projects and grants. As most of the Quaternary research is interdisciplinary, many geologic projects transgress not only into other branches of earth sciences, but they overlap with related fields outside of earth sciences, such as biological sciences, civil engineering, hydrology, archeology. Therefore it is difficult to determine the exact number of those research projects where main emphasis has been on Quaternary studies, and equally difficult to estimate the amount of research grants awarded in support of them. When searching through titles of research projects in related disciplines, only those were considered which are closely related to Quaternary studies.

The number of research projects dealing with various aspects of Quaternary geology has not changed much, if compared with 1967-68. Detailed accounts on currently active Quaternary research projects, divided by provinces and institutes, are published in the Newsletter of the NRC Associate Committee on Quaternary Research (No. 2 - 1969; No. 3 - 1971) and will not be repeated here. Information on related fields may be found in the following publications: on soil mechanics and engineering geology in the Annual Report of the Canadian section of the International Society for Soil Mechanics and Foundation Engineering for Year Ending December 1969 ... prepared by W. J. Eden, Miss. J. Butler and Miss M. Gratten, and published as Technical Memorandum No. 97 of NRC Associate Committee on Geotechnical Research in 1970, and on groundwater in the Federal Groundwater Program Annual Project Catalogue 1969-70, published as Report Series No. 8, by Inland Waters Branch in 1970.

Grants in support of research in Quaternary geology and related fields are awarded by National Research Council (NRC), Geological Survey of Canada (GSC), National Advisory Committee on Geographical Research (NACGR) and, since 1968, National Advisory Committee on Water Resources Research (NACWRR). If the last three years, up to 1968-69, are compared (Table 1), an increase in the number and total value of grants is noticeable, thus suggesting also an increase in research activities, both in the Quaternary geology in a narrower sense, and in the related disciplines. It may be observed also, that the greatest increase has been in those related fields, which are of particular significance in Canadian economy, such as hydrogeology, hydrology, soil mechanics and engineering geology (Table 2).

Those Research projects which deal with the Quaternary geology, geomorphology and sedimentation (including oceanographic investigations of Quaternary sediments), have received about 10 per cent of the earth science operating grants, awarded by either NRC or GSC in 1968-69. (Note: a few NRC grants in the above fields, for paleontologic and ecologic investigations, are listed by NRC under biology.) Studies in geomorphology have been supported particularly by the National Advisory Committee on Geographical

Table 1

RESEARCH GRANTS IN SUPPORT OF PROJECTS DEALING WITH QUATERNARY DEPOSITS

(Awarded by National Research Council, Geological Survey of Canada, National Advisory Committee on Water Resources Research, and National Advisory Committee on Geographical Research)

A. Number of research grants

	1966-67	1967-68	1968-69
Quaternary geology, geomorphology, sedimentation*	46	58	69
Engineering geology, soil mechanics	31	42	50
Pedology	11	19	20
Hydrogeology and hydrology	21	25	46
Archeology	3	8	7
Total number	112	152	192

B. Amount of money awarded (in thousands of dollars)

	1966-67	1967-68	1968-69
Quaternary geology, geomorphology, sedimentation*	186	248	307
Engineering geology, soil mechanics	154	251	354
Pedology	102	119	133
Hydrogeology and hydrology	146	152	316
Archeology	23	62	58
Total amount	611	832	1,168

* Including those research projects in sedimentology, marine geology, physical geology and biological sciences which deal with Quaternary deposits.

Table 2

INCREASE IN THE AMOUNT OF RESEARCH GRANTS FROM 1966-67 TO 1968-69

	Increase by
All Quaternary and related fields	90%
Quaternary research in narrower sense	65%
Soil mechanics, engineering geology, hydrogeology and hydrology	123%
Pedology and archeology	53%
Total NRC grants in earth sciences	33%

Research (about 30 per cent of their total amount of grants for the year 1968-69). About a half of the recipients of the NRC, GSC and NACGR operating grants for studies in Quaternary geology, geomorphology and sedimentation are geologists, and the next largest group is geographers (not in the reverse order as it was mentioned erroneously in previous year's report).

Some idea of the number of Canadian investigators who have been engaged in work on the most common Quaternary deposit – till, may be obtained from the questionnaires which were distributed by the writer of this report, two other subcommittee members (L. A. Bayrock and J. A. Elson) and three U. S. A. co-workers in 1968 on behalf of the INQUA Commission of Genesis and Lithology of Quaternary Deposits. The answers indicate that at least 338 investigators have dealt with till in Canada during the last five years (more than in United States). Studies of tills have been done at seventeen Canadian institutions (thirteen in U. S. A.), most of them conducting geologic investigations, particularly at various universities, the Geological Survey of Canada, Research Council of Alberta and Saskatchewan Research Council.

The Geological Survey of Canada dealing with the various aspects of Canadian geology reflects the role of Quaternary geology and geomorphology in Canada: about one-fifth of the GSC projects were in this field in 1969. Most of them were conducted at the Division of Quaternary Research and Geomorphology: in addition to its regular scientific staff of thirty-five, some fifty students and several university professors have participated.

Publications, 1969 and 1970. In comparison with the previous year, the number of publications in Quaternary geology and closely related fields has increased substantially, totalling at least 340 papers, reports, notes, discussions and maps in 1969. Most of them have been published in Canadian journals and government series: more than half – in GSC Papers, Canadian Journal of Earth Sciences, and Canadian Geotechnical Journal.

Among the publications, several proceedings of conferences, symposia and seminars may be mentioned; some of them appeared in special issues of journals, others as separate volumes, for instance:

(a) Canadian Journal of Earth Sciences, vol. 6, No. 4, part 2, 1969: 27 papers presented at the seminar on the causes and mechanics of glacial surges, and the symposium on surging glaciers in 1968.

(b) Canadian Geotechnical Journal, vol. 6, Nos. 1 and 2, 1969: 25 papers and discussions presented at the 21st Canadian soil mechanics conference in 1968.

(c) La Revue De Géographie de Montreal, vol. XXIII, No. 3, 1969: Travaux du 1er Colloque sur le Quaternaire du Québec (14 papers and notes).

(d) S. Pawluk (ed.) – 15 pedology and Quaternary Research Papers and discussions presented at the symposium held at Edmonton, Alta. in 1969: NRC and University of Alberta, 1969.

(e) Geological Survey of Canada Paper 68-53: Proceedings of the Earth Science Symposium on Hudson Bay (5 papers among them on Quaternary geology), 1969.

(f) T. L. Péwé (ed.) – The periglacial environment: past and present; 25 papers presented at the symposium on cold climate environment and processes in 1965: McGill-Queen's U. Press, 1969.

(g) Canadian Journal of Earth Sciences, vol. 7, No. 2, part 2, 1970: 17 papers and 4 discussions presented at the symposium on recent crustal movements, in 1969.

(h) Canadian Geotechnical Journal, vol. 7, No. 2, 1970: 9 papers and 7 discussions presented at the 22nd Canadian soil mechanics conference in 1969.

(i) Proceedings of the 22nd Canadian soil mechanics conference, theme: geology and engineering: Dept. Civ. Engin., Queen's University, C.E. Res. Rept. No. 67, 1970 (23 papers, abstracts and discussions).

(j) C. Lafleur and J. Butler (ed.) – Proceedings of the 3rd International peat congress, Quebec, 1968, NRC, 1970.

From the many papers or their compilations outside of conference proceedings, a few larger publications may be mentioned which appeared in 1969 and 1970.

(a) Short papers on Quaternary research in Canada – a compilation of 13 papers published by Geological Survey of Canada, as a contribution to the 8th International Quaternary (INQUA) Congress in Paris, with a foreword by J.G. Fyles, 1969, 213 p.

(b) S. Pawluk and L.A. Bayrock. Some characteristics and physical properties of Alberta tills: Res. Counc. Alta. Bull. 26, 1969, 72 p.

(c) V.K. Prest. Quaternary geology of Canada, in R.J.W. Douglas (ed.) Geology and economic minerals of Canada, GSC Economic Geology Report No. 1, 1970, p. 673-764.

(d) R.J.E. Brown. Permafrost in Canada: U. Toronto Press, 1970, 234 p.

(e) E.A. Christiansen (ed.). Physical environment of Saskatoon, Canada: NRC publ. 113788, 68 p.

(f) E. Kahn. Biostratigraphy and paleontology of a Sangamon deposit at Fort Qu'Appelle, Saskatchewan, Nat. Mus. Natur. Sci., Paleontol. Publ. No. 5, 1970, 82 p.

Conferences. The results of Canadian Quaternary investigations have been presented at more than fifteen conferences, symposia and seminars in 1969. Particularly active was Canadian participation at the 8th International Quaternary Congress in Paris, France, where twenty-eight Canadians, mostly geologists and paleontologists, reported on their research; the Canadian exhibit also attracted considerable interest.

In 1970 the number of conferences organized by Canadians or with active Canadian participation, was about the same, but it is regretful that two of the very significant meetings – GAC at Winnipeg and AMQUA at Bozeman – have occurred at the same time.

HIGHER EDUCATION

During the last couple of years an increase is noticeable at the universities in interest towards Quaternary studies by applying interdisciplinary approach.

Two Ontario universities are offering new programs of specialization in Quaternary and environmental geology. A post-graduate program in environmental geology began at the Earth Science Department at University of Waterloo in the fall of 1970, providing specialized studies in groundwater geology, engineering geology, industrial minerals, construction materials, Quaternary geology and the geology of the Great Lakes. The Department of Geological Sciences at Brock University, St. Catharines, is also oriented towards the teaching of Quaternary geology and related fields. It presently offers only a B.Sc. honours program. The principal aspects of Quaternary geology on which the department is focusing are: physical geology, environmental and urban studies, water resources. Dalhousie University at Halifax, Nova Scotia, is offering specialized training in Quaternary research with an emphasis on the biologic aspects; the departments of Biology, Geology and Oceanography participate in this program, in close cooperation with Bedford Institute. The University of Winnipeg, Manitoba, has formed a vigorous group in geomorphology. McGill University, Montreal, Quebec, is advertising a twenty month program in engineering geology, leading to a M.Sc. degree. The program will commence every September, and the courses will be given by the Department of Geological Sciences and the Faculty of Engineering. Presently, the greatest number of postgraduate students (nine) specializing in various aspects of Pleistocene geology is at the Geology Department of University of Western Ontario.

Interdisciplinary Quaternary discussion and study groups have become established in four places (Winnipeg, London, Waterloo, Ottawa); geotechnical discussion groups have been active for some time at ten centres (Vancouver, Edmonton, Calgary, Regina, Saskatoon, Toronto, Ottawa, Montreal, Quebec City and Halifax).

Though the universities offer good special courses in Quaternary geology and related disciplines, many students lack field training. The number of educational films on Quaternary geology is also low. E.A. Christensen has been asked to continue his efforts to produce a film on test-drilling. It

was noted that the tours of outstanding speakers for the Geology Departments of the Canadian Universities have included experts in all major fields of geology, except for the Quaternary geology.

EMPLOYMENT

Though the employment in Quaternary geology and in closely related fields varies considerably from one province to another, there are considerably more vacancies, particularly in Quaternary geology and hydrogeology, than can be filled by Canadian graduates specializing in these disciplines. Considering the above two fields only, in 1970 twenty-five permanent positions and in 1971 even thirty-three have been offered.

Summer employment in mapping surficial deposits, hydrogeology, investigation of marine Quaternary deposits, glaciology, and indicator tracing, all of them requiring some knowledge in Quaternary geology, have been increasing noticeably during the last three years (from less than 100 in 1969 to at least 141 in 1971). Following minimum numbers of employment offers, both permanent plus long term, and seasonal, in Quaternary geology, hydrogeology and Quaternary oceanography have been available during the last years:

1968 ..... at least 145
1969 ..... at least 100
1970 ..... at least 134
1971 ..... at least 174

RECOMMENDATIONS OF THE ASSOCIATE COMMITTEE OF QUATERNARY RESEARCH AND OUR SUBCOMMITTEE TO THE SCIENCE SECRETARIAT SOLID EARTH SCIENCE STUDY GROUP

Following recommendations have been submitted:

Quaternary geology mapping. Appropriate federal and provincial governmental agencies are urged to increase the rate of three-dimensional mapping of unconsolidated deposits, landforms, and terrain conditions, in order to meet the increasing need for such Quaternary information in connection with intensified resource and land development and planning throughout Canada. This increase should involve both initial reconnaissance surveys and re-mapping; mapping should be concerned with recent features as well as those related to glaciation and with features beneath water as well as those on land.

Urban-environmental geology and engineering geology. To meet the evergrowing need for geological information (including Quaternary information) in and around high-population areas, it is recommended that investigations of distribution, properties, and behaviour of near-surface materials within such areas be substantially increased, with the cooperative support of municipal, provincial and federal agencies. Of particular concern is the need for knowledge of the engineering behaviour of materials both in their natural state and when used in construction.

Dynamics and stability. Greatly increased knowledge of the dynamics and stability relationships of the landscape of today is required for effective planning of resource development and environmental maintenance. Geologists and other scientists are urged to meet the challenge of this need by applying the combined principles of sedimentology, geomorphology, soil and rock mechanics, and hydraulics in quantitative research on the dynamics of sedimentary and geomorphic processes and on the factors controlling behaviour of natural materials at the surface of the earth.

Mineral exploration. The application of knowledge of unconsolidated deposits and geomorphology to mineral exploration deserves increased attention in view of its potential value to the mineral industry. A closer association of Quaternary science and geochemistry in this connection is recommended.

Quaternary biology. Greatly increased attention should be directed to biological topics of a Quaternary nature, and in particular those bearing upon management and maintenance of environment (e.g., in relation to water pollution, urban expansion, disruption of tundra landscape, etc.). It is recommended that universities and/or governmental agencies most closely concerned with Quaternary research should set up continuing paleoecological and paleontological programs in a number of pertinent biological fields.

RECOMMENDATIONS (adapted at the subcommittee's meeting of March 31, 1970.)

1. Considering the success of the few instances where mapping of all geologic deposits (bedrock and surficial deposits) of a certain area was performed at the same time by a group of people, such practice shall be encouraged in the future.
2. The Geological Survey of Canada is asked to prepare and distribute a map of Canada showing all of the areas for which maps of surficial deposits have been prepared (such a map is now published, and it accompanies the GSC Map 1-1970 and 1-1971). A bibliographic list in addition to this index map would be of great assistance for finding the maps.
3. In order to coordinate and streamline the work on regional mapping of surficial deposits, meetings of the Geological Survey of Canada with provincial agencies would be of great value.
4. When planning lecture tours of outstanding scientists at Canadian Universities, one speaker on Quaternary geology shall be selected each year.

APPENDIX C

REPORT OF THE AD HOC COMMITTEE ON REGIONAL QUATERNARY MAPPING AND URBAN GEOLOGY

INTRODUCTION

On March 31, 1970 an ad hoc committee including E. A. Christiansen, Chairman, L. A. Bayrock, C. B. Crawford, and L. H. King was appointed and charged: (1) to obtain examples of regional geologic maps which would serve as a geologic framework for geotechnical investigations and (2) to obtain examples of urban geologic studies.

On April 27 and May 4, 1970 letters were sent to the following: L. A. Bayrock, J. A. Cherry, G. B. Crawford, A. Dreimanis, J. G. Fyles, P. LaSalle, and W. H. Mathews requesting the information on the above two items.

DISCUSSION OF REGIONAL MAPS

The regional geologic maps fall into three main categories: (1) surficial geology maps, (2) surficial and stratigraphic maps, and (3) stratigraphic maps. Surficial geology maps are being published by the Geological Survey of Canada and most provincial geological agencies. Most of these maps depict form and lithology of the surficial deposits (e.g., Bayrock, 1967), and other maps, in addition to form and lithology, show the history of the last deglaciation (e.g., Greer and Christiansen, 1963). These maps are useful for locating gravel deposits and are being used extensively by highway departments. For geotechnical studies, which require subsurface data, however, these maps are of little value.

Surficial geologic and stratigraphic maps have been published by a number of workers (e.g., Fyles, 1963; Karrow, 1967; King, 1970). These maps not only define the surficial deposits but give an indication of the subsurface stratigraphy as well. Most of these stratigraphic studies are based on sections only and consequently the stratigraphic picture is incomplete.

The introduction of test drilling, electric logging and side-wall coring has permitted the stratigraphic investigation of glacial and bedrock sediments (e.g., Christiansen, 1970; Klassen et al., 1970) without having to rely entirely on exposures. Drilling not only permits the geologist to obtain information at any point in an area but to obtain information to any depth.

DISCUSSION OF URBAN GEOLOGIC STUDIES

The Geological Survey of Canada pioneered geological investigations in urban areas. The work of Armstrong and Brown on the Highbury Street Tunnel, Vancouver, the studies of Watt (1954) in Toronto, and the study of the surficial geology and soils of the Montreal area (Prest and Keyser, 1961) are among the early studies of geology in urban areas.

A comprehensive atlas on the physical characteristics of Montreal (Gravel, 1966) was published by that city. This investigation was based mainly on studies of the surficial features and sediments. During the same year, the results of a stratigraphic study in the city of Edmonton was published (Bayrock and Berg, 1966).

The joint NRC-SRC folio on the Physical Environment of Saskatoon (Christiansen, editor, 1970) is the only publication available that deals with the total physical environment. The stratigraphic presentation is based almost entirely on test drilling done specifically for this investigation.

Geological investigations are in progress in Calgary, Edmonton, Kitchener, London, Montreal, Ottawa, and Vancouver. The Geological Survey of Canada has set up an "Engineering Geology and Geodynamic" section under J.S. Scott to promote research in urban geology. The Ontario Department of Mines have also established a division dealing with environmental geology under D.F. Hewitt.

The folio on the Physical Environment of Saskatoon, Canada was published jointly by the Saskatchewan Research Council and the National Research Council which attests to their concern about the need for physical environmental studies.

CONCLUSIONS

1. An adequate geological framework for geotechnical studies is lacking for most of Canada. Such a framework requires extensive test drilling and should be done in conjunction with surficial geological studies.
2. More emphasis should be placed on stratigraphic studies in regional and urban geology.
3. Considerable activity in urban geology is being carried out by individuals and governments but much more money must be committed if useful results are to be obtained.

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REPORT OF THE SUBCOMMITTEE ON MINERALOGY, GEOCHEMISTRY AND PETROLOGY

Presented by A.C. Turnock (December, 1971)

Members

A.C. Turnock (Chairman)	University of Manitoba, Winnipeg, Manitoba.
W.G. Smitheringale	Memorial University, St. John's, Newfoundland.
G.E. Pajari	University of New Brunswick, Fredericton, New Brunswick.
G. Valiquette	Ecole Polytechnique, Montreal, Quebec.
L.A. Clark	McGill University, Montreal, Quebec.
A.R. Graham	Falconbridge Nickel Mines Limited, Thornhill, Ontario.
H. Baadsgaard	University of Alberta, Edmonton, Alberta.
H.J. Greenwood	University of British Columbia, Vancouver, British Columbia.
J.M. Moore	Carleton University, Ottawa, Ontario.

The status quo of MGP research in Canada

The amount of research done increased slightly during the report years. There was a good increase in basic research, due to enlargement of faculty and graduate students in the universities. Departments of the federal government were somewhat cut back on funds, and were generally unable to increase their research activities. Mineral Industry companies, with some notable exceptions, do nothing but collect data. This is a short-sighted attitude on their part, which they rationalize on the basis of short-term economics, plus the argument that the governments should use their tax money for research. Dans certains cas de petites compagnies ont confié les recherches minéralogiques à des organismes déja en place ou aux Universités (Niobium à Oka). Certain compagnies seraient intéressées, sinon à ouvrir des centres de recherche, au moins à subventionner dans les universités certains projets de minéralogie et de pétrologie appliqués à leurs champs d'intérêt.

The quality of research done continues to be good. Basic research suffers from the national characteristic of not going after novel, spectacular, and/or expensive new programs. Applied research, what little bit of it there is, is very good.

The subject matter remains mostly classical in petrology, for the very good reason that petrologists are making great advances in understanding the complex origins of the rocks of the Precambrian Shield, the Appalachians, and the Cordilleran Regions. They are cooperating with people who make geophysical and geochemical studies to great advantage, and studies on the development of the crust over large areas of the earth are in progress. Money for scientific drilling is needed. Studies of a more topical interest, such as mapping the ocean floors or the moon, are neither active nor recommended.

Mineralogists are slowly acquiring modern instruments for the determination of physical and chemical properties. There is not available to the universities anywhere near enough money for this purpose.

Geochemists are only just started on the necessary coverage of the distribution of trace elements, isotopes, isotopic ages of rocks, and the stabilities of minerals. In this area of science, the distressingly slow progress can usually be traced to lack of funds for technical help.

Research topics which were neglected in Canada include: exploration geochemistry, mineral (especially sulphide) – liquid solution chemistry, applied mineral identification, environmental (including groundwater + atmospheric) geochemistry, mineral stability studies at high pressures and shearing pressures, clay mineralogy.

Ideas for the stimulation of research

(a) Shortages of the best modern equipment and technicians to run them, emigration of top-flight graduate students, all point up the fact that lack of money is the most important brake on research progress.

(b) The quality of research is improved by communication and collaboration. In view of this, the previous subcommittee (NACRGS 19th Annual Report) recommended a larger type of grant which would enable an investigator to finance participation by a group of collaborators. This year's

subcommittee supports this recommendation, with the following comments. They are readily applicable to applied research. In the field of basic research, there is a fundamental objection to any type of direction or "bandwagon philosophy"; however, we want to take a small step in this direction because we think that overall, the benefits accruing to a research project from enhanced collaboration are especially attractive in a spread-out nation. These benefits are a greater advance in the specific subject of the project, with a greater sense of achievement that will not only be shared by the investigators and our scientific community, but also transmitted to the public.

Similar advantages in collaboration are expected to accrue from (1) growth of Geology Departments, (2) association of Federal research stations and universities.

(c) Research is stimulated by meetings. We recommend that the meetings of these subcommittees should be tied to some scientific convention, so that the limited travel funds could be used to better advantage.
(d) Research is stimulated by guest lecturers. We recommend that the NAC ask the Geological Survey of Canada to enlarge any programs that would send its officers on speaking tours across the country.
(e) Research is stimulated by top-flight graduate students. We must conspire to prevent the present deadly cycle of exporting good students and importing bad ones.

Conservation of interesting rock and mineral sites

We ask the NAC to consider new ways of preserving, in the long-range public interest, rock and mineral sites of interest.

Recommendations

The subcommittee, with hesitation, recommends that the grant committee favour the following type of research: The application of geochemistry and mineralogy (plus collaboration with other disciplines) to field problems, especially mineral deposits, also studies of a regional scale. Also, more isotopic age determinations of rocks in the Precambrian Shield are needed.

Addendum:

This committee has not met for two years; therefore at this time (December, 1971) we can only reaffirm our statement and recommendations, support the conclusions of the Solid-Earth Sciences Study Group (Blais, R. A. et al., Earth Sciences Serving the Nation; Information Canada, Ottawa, 1971), and express our confidence that research in petrology, mineralogy, and geochemistry is making valuable contributions to the culture and economy of the nation.

Problems of funding and application of research have been identified by Blais et al. Research in mineralogy, petrology, and geochemistry is especially applicable in the following fields which they conclude to be

exceptionally suited for special Canadian studies: Cordilleran studies, Precambrian studies, mineral deposits and mineral exploration. In addition, research is an important method of education, for use both here and in developing nations.

We think that it is important for the NACRGS (or any successor committee) to continue its policy of making grants-in-aid for research. These grants have not only supported a lot of good research, but contributed to the education of many good geologists who participated in the research as students.

REPORT OF THE SUBCOMMITTEE ON MINERAL DEPOSITS

Presented by H.K. Conn (February, 1972)

Members

H.K. Conn (Chairman)	Canadian Johns-Manville Company, Limited, Asbestos, Quebec.
M.K. Abel	Falconbridge Nickel Mines Limited, Onaping (via Sudbury), Ontario.
G.L. Colgrove	The International Nickel Company of Canada, Toronto, Ontario.
Gilles Duquette	Ste-Anne-des-Monts, Gaspe North, Quebec.
R.M. Ginn	Vangulf Exploration Company, Toronto, Ontario.
P.M. Kavanagh	Kerr-Addison Mines Limited, Toronto, Ontario.
E.T. Kimura	Endako Mines Limited, Endako, British Columbia.
A.J. Naldrett	University of Toronto, Toronto, Ontario.
I.S. Parrish	Brunswick Tin Mines Limited, St. Stephen, New Brunswick.
Mousseau Tremblay	1035 Dijon Street – Ste-Foy, Quebec, Quebec.

INTRODUCTION

Several subcommittee meetings focused on the petroleum of under utilization of advanced scientific equipment in universities, and the many unsolved geologic problems related to ore finding in the mineral industry. Many geologists of small exploration and mining companies are relatively unaware of the precipitous technologic advances in instrumentation during the past decade.

To reduce these inefficiencies in communication of knowledge the concept of a "Clearing House" letter was developed. Simultaneously, Canadian universities were contacted and supplied a list of available special equipment for geologic studies.

This information was despatched to nearly eight hundred Canadian exploration and mining companies, and Provincial Departments of Mines.

It was suggested that the companies survey their geologic problems, contact the Geology Departments of the universities to arrange for utilization of the equipment and, hopefully, employ students to undertake theses related to solving the companies' geologic problems.

The subcommittee offered to act as a liaison of "Clearing House" if the companies so desired.

The direct communication suggested between the universities and the mining companies was proposed to retain the obvious and necessary confidentiality of many geologic studies.

A copy of the "Clearing House" letter and list of universities and equipment available is reproduced as part of this report.

A brief summary of the concepts of the subcommittee was published on the editorial page of the Northern Miner on March 25, 1971. This arrangement was made to reach interested individuals, or companies inadvertently omitted from the original distribution list.

The subcommittee realizes that this initial project is only a first step in attempting to solve the communication – utilization problems with successful results. A follow-up program to the companies, describing the measurable parameters obtainable from the scientific instruments and their direct value in the solution of specific problems in geologic studies, is a probable necessity. Publication and circulation of actual case histories is an essential and continuing requirement to upgrade the quality and success ratio of geologic investigations within the mineral industry.

"CLEARING HOUSE" LETTER

For several years there has been a growing tendency for student researchers to shy away from the more pragmatic problems of mineral exploitation and exploration. A partial explanation for this situation may be found in the natural gap that exists between the university and the mineral industry. Students have too little contact with the mineral industry and its problems. To bridge the gap and effect closer contact would enhance the well-being of the entire Earth Science Community.

The Subcommittee on Mineral Deposits is therefore planning to compile a list of problems which individual companies wish to have studied.

Copies of this list of research problems would be made available to faculties and students of earth science departments in Canadian universities and technical colleges. This would lead, we hope, to a matching of needs and interests. The Subcommittee would like you of the mineral industry to review your operation and submit to us a list of any field or laboratory problems in earth sciences which you would consider having a student undertake. We should also like you to indicate if you would be prepared to offer the student part-time or summer employment and/or financial assistance to the university to off-set secretarial technical or laboratory expenses incurred by the study of your problem.

Recent advances in technology and instrumentation have made generally available research tools unavailable even a decade ago. Today's students working with these tools and under the dual guidance of qualified professors and experienced exploration or mine geologists may be able to find answers which have long eluded us. The students would also benefit from the exposure to the men and problems of the mineral industry.

You would be contacted by the interested student(s) through his Earth Science Department head and the final decision on whether or not to accept any applicant would be yours.

With your assistance, lists could be compiled and distributed in time for the school year this fall. Your prompt but thoughtful attention to our requests will be greatly appreciated.

Also, any comments you may have upon this program would be welcomed.

Yours very truly,

SUBCOMMITTEE ON MINERAL DEPOSITS
OF THE NATIONAL ADVISORY COMMITTEE
ON RESEARCH IN THE GEOLOGICAL SCIENCES

University	Research Specialities	SPECIAL EQUIPMENT: Wet Chemistry	XRF	At. Absorption	Optical Spect.	Electron Probe	Y-ray Spectrometer	Neutron Activation	Mass Spectrometer	Electron Microscope	Scanning Electron Microscope	Reflectivity Equipment	X-ray Diffraction	Phase Equilibria Studies: 1 atm	0-2 Kb	2-10 Kb	Rock Deformation	Flume	Texture Goniometer	Other Equipment
Memorial[x]	Regional Geol. Petrology Structure Sedimentology	✓	✓	✓						*	*		✓					✓		
Dalhousie[x]	Oceanography Geophysics Petrology Geochemistry Regional Studies	✓	✓	✓	✓		✓	✓	✓	*	*		✓							Seismic, Gravimeter, Magnetometer, Resistivity, EM (shared)
Acadia	Petrology Paleontology Structure Applied Geochemistry	✓		✓	✓					*			✓						✓	Infrared and ultraviolet spectrometers
Mt. Allison	Economic Geol. Petrology Geochemistry Paleontology				*								*							

University	Research Specialities	SPECIAL EQUIPMENT																		Other Equipment
		Wet Chemistry	XRF	At. Absorption	Optical Spect.	Electron Probe	γ-ray Spectrometer	Neutron Activation	Mass Spectrometer	Electron Microscope	Scanning Electron Microscope	Reflectivity Equipment	X-ray Diffraction	Phase Equilibria Studies 1 atm	Phase Equilibria Studies 0-2 Kb	Phase Equilibria Studies 2-10 Kb	Rock Deformation	Flume	Texture Goniometer	
U.N.B. Fredericton	Petrology Economic Geology Structure	✓	✓	✓		*							✓						✓	Magnetometer Gravimeter, I.P.
U.N.B. St. John	Petroleum Geology Mining Geology																			
Laval	Mineral Expl. Metallogenesis Mineralogy Paleontology Structure	✓	✓	✓		*	✓			*		✓	✓							K-Ar Age dating
McGill[x]	Research in most fields is being undertaken	✓	✓	✓	✓	✓	✓		✓	*	*		✓	✓	✓	✓	✓			
Ecole Polytechnique	Mineral Expl. Metallogenesis Applied Geostatistics Engineering Geology	✓	✓	✓			✓	✓				✓	✓	✓	✓					

SPECIAL EQUIPMENT

University	Research Specialities	Wet Chemistry	XRF	At. Absorption	Optical Spect.	Electron Probe	Y-ray Spectrometer	Neutron Activation	Mass Spectrometer	Electron Microscope	Scanning Electron Microscope	Reflectivity Equipment	X-ray Diffraction	Phase Equilibria Studies 1 atm	Phase Equilibria Studies 0-2 Kb	Phase Equilibria Studies 2-10 Kb	Rock Deformation	Flume	Texture Goniometer	Other Equipment
Montreal	Geochemistry Sedimentology Paleontology Stratigraphy Precambrian Geology	✓	✓	✓					✓				✓							
Loyola	Petrology Regional Geology		✓										✓							Thermoluminescence Seismograph Magnetometer Resistivity
Ottawa	Petrology Mineralogy	✓	✓	✓	✓					*	*		✓					✓		
Carleton	Petrology Precambrian Geology Economic Geology Geochemistry	✓	✓	✓	✓	✓		*	✓	✓	*		✓	✓	✓					

University	Research Specialities	SPECIAL EQUIPMENT																	Other Equipment
		Wet Chemistry	XRF	At. Absorption	Optical Spect.	Electron Probe	γ-ray Spectrometer	Neutron Activation	Mass Spectrometer	Electron Microscope	Scanning Electron Microscope	Reflectivity Equipment	X-ray Diffraction	Phase Equilibria Studies 1 atm	Phase Equilibria Studies 0-2 Kb	Phase Equilibria Studies 2-10 Kb	Rock Deformation	Flume	Texture Goniometer	
Queen's	Petrology Structure Precambrian Geology Economic Geology Marine Geology	✓	✓	✓	✓	✓			✓	*	*	✓	✓	✓	✓					
Toronto[x]	Economic Geology Precambrian Geology Petrology Paleontology Structure	✓	✓	✓		✓			*	*	✓	✓	✓	✓	✓	✓	*	*	✓	Rocking furnaces for solubility studies Temperature gradient furnaces
McMaster	Paleontology Sedimentology Structure Geochemistry Crystallography	✓	✓	✓	✓	*	✓	✓	✓	*	*	✓	✓	✓	✓	✓	✓	✓		

SPECIAL EQUIPMENT

Second edition

University	Research Specialities	Wet Chemistry	XRF	At. Absorption	Optical Spect.	Electron Probe	γ-ray Spectrometer	Neutron Activation	Mass Spectrometer	Electron Microscope	Scanning Electron Microscope	Reflectivity Equipment	X-ray Diffraction	Phase Equilibria Studies 1 atm	Phase Equilibria Studies 0-2 Kb	Phase Equilibria Studies 2-10 Kb	Rock Deformation	Flume	Texture Goniometer	Other Equipment
Brock	Quaternary Geol. & Geochronology Environmental Geology Landscape Geochemistry Paleoecology	*	✓	✓				*	*			✓	✓							Radiocarbon dating Automated atomic absorption Shallow seismic Quantimet
Waterloo	Environmental Geology	*		✓		*			✓	*	*	✓	✓					✓		Drill-rig Earth resistivity E-logging, R/A logging
Western[x]	Applied Geology Geotectonics Mineralogy Petrology Stratigraphy	✓	✓	✓		✓			*		*	✓	✓	✓	✓	✓			✓	Automatic 4 circle goniometer Microdensitometer for X-ray 3 ft. diam. diamond saw

University	Research Specialities	Wet Chemistry	XRF	At. Absorption	Optical Spect.	Electron Probe	γ-ray Spectrometer	Neutron Activation	Mass Spectrometer	Electron Microscope	Scanning Electron Microscope	Reflectivity Equipment	X-ray Diffraction	Phase Equilibria Studies 1 atm	Phase Equilibria Studies 0-2 Kb	Phase Equilibria Studies 2-10 Kb	Rock Deformation	Flume	Texture Goniometer	Other Equipment
Windsor	Sedimentology Paleontology Petroleum Geology Hydrogeology	*	✓	*		*			✓	*			*				*	*		
Laurentian	Economic Geology Sudbury Geology Precambrian Geology Petrology	✓	✓	✓			*		*	*		✓	✓	✓	✓				✓	
Lakehead	Petrology Economic Geology Sedimentology	✓	*	✓					*	*			*					✓		
Manitoba[x]	Precambrian Geology Economic Geology X-ray crystallography Applied and Earth Geophys. Hydrogeology Biostratigraphy	✓	✓	✓	*	✓	*		✓	*			✓	✓	✓			✓		

University	Research Specialities	Wet Chemistry	XRF	At. Absorption	Optical Spect.	Electron Probe	γ-ray Spectrometer	Neutron Activation	Mass Spectrometer	Electron Microscope	Scanning Electron Microscope	Reflectivity Equipment	X-ray Diffraction	Phase Equilibria Studies 1 atm	Phase Equilibria Studies 0-2 Kb	Phase Equilibria Studies 2-10 Kb	Rock Deformation	Flume	Texture Goniometer	Other Equipment
Saskatchewan	Paleontology Quaternary Geology Mining Engineering Economic Geology Geophysics	✓	*	✓		✓							✓				✓			Seismic
Calgary	Economic Geology of Cordillera and central plains	✓	✓	✓			✓					✓		✓	✓					Geophysical exploration Automated single crystal goniometer
Alberta[x]	Isotope Geology Ore Mineralogy Petrology Analytical Geochemistry Petroleum Geology	✓	✓	✓		✓	*	*	✓	*	*	✓	✓		✓		*			

SPECIAL EQUIPMENT

Second edition

University	Researth Specialities	Wet Chemistry	XRF	At. Absorption	Optical Spect.	Electron Probe	γ-ray Spectrometer	Neutron Activation	Mass Spectrometer	Electron Microscope	Scanning Electron Microscope	Equipment Reflectivity	X-ray Diffraction	Phase Equilibria Studies 1 atm	Phase Equilibria Studies 0-2 Kb	Phase Equilibria Studies 2-10 Kb	Rock Deformation	Flume	Texture Goniometer	Other Equipment
U.B.C.[x]	Geomorphology Petrology Economic Geology Paleontology Marine geology and geochemistry	✓	✓	✓	✓	*			✓	*	*		✓	✓	✓	✓				Marine geological equipment including C.S.P. K-A dating facilities
Nova Scotia Technical College	Economic Geology Mining Geology and Exploration Mineral Beneficiation Mining Engineering Hydrometallurgy Pyrometallurgy	✓	✓	✓	✓	✓				✓	*		✓	✓	✓					Differential Thermal Analysis Thermo Gravimetric Analysis Mineral Dressing Pilot Plant of Capacity ~500 lbs/hr Autoclave ~5000 psi Rotary Kiln ~20 ft. x 2 ft. Diffractometer Induction Furnaces (Vacuum)

SPECIAL EQUIPMENT

Second edition

University	Research Specialities	Wet Chemistry	XRF	At. Absorption	Optical Spect.	Electron Probe	γ-ray Spectrometer	Neutron Activation	Mass Spectrometer	Electron Microscope	Scanning Electron Microscope	Reflectivity Equipment	X-ray Diffraction	Phase Equilibria Studies 1 atm	Phase Equilibria Studies 0-2 Kb	Phase Equilibria Studies 2-10 Kb	Rock Deformation	Flume	Texture Goniometer	Other Equipment
St. Francis Xavier University	Economic Geology Age Dating Petroleum Geology Salt Deposits Computer Applications	✓		✓					✓				✓							

Key:

x These universities either have separate departments of Geophysics or have geophysicists associated with other departments. These have not been included in the survey.

✓ Equipment within the department itself.

* Equipment shared with another department.

REPORT OF THE SUBCOMMITTEE ON GEOPHYSICAL METHODS APPLIED TO GEOLOGICAL PROBLEMS

Presented by R. D. Russell (March 11, 1972)

Members

R. D. Russell (Chairman)	University of British Columbia, Vancouver, British Columbia.
A. E. Beck	University of Western Ontario, London, Ontario.
B. Caner (Dr. Caner died suddenly on February 2nd, 1972).	Dominion Astrophysical Observatory, Vancouver, British Columbia.
H. J. Greenwood	University of British Columbia, Vancouver, British Columbia.
E. R. Kanasewich	University of Alberta, Edmonton, Alberta.
D. I. Ross	Bedford Institute, Dartmouth, Nova Scotia.
H. D. B. Wilson	University of Manitoba, Winnipeg, Manitoba.
J. T. Wilson	University of Toronto, Toronto, Ontario.

The committee has not met within the past years, and has generally been inactive. However, there has been some correspondence, and the following points have emerged.

There is general agreement that the activities of the Subcommittee are not sufficient to justify its existence. In terms of a bibliography and summary of current geophysical research, we cannot compete with the Canadian Geophysical Bulletin which fills this need in an admirable way. The symposium we organized three years ago was highly successful, in the opinion of most of us, but this could have been handled equally well by an ad hoc committee of the National Advisory Committee. In short, we believe that the committee should either be replaced by a reporter (probably with the power to co-opt an ad hoc committee when special need arises), or should be given more specific terms of reference so that his job is well defined. It is possible that the fault is that the present members of the committee have been too unimaginative.

Furthermore, there is a danger in having such a committee as ours. This is the possibility that other committees will leave geophysical problems to us, rather than give them proper consideration. In our view, the parts of geophysics which are of interest to the National Advisory Committee should blend smoothly and continuously with other geological studies, and not be singled out for special treatment.

A second point has been raised by Professor J.T. Wilson. Dr. Wilson points out that the training of geologists is usually so fully occupied with the classical geological subject material that little or no attention can be given to related sciences which could provide him with valuable assistance in his studies. In articles submitted to *Northern Miner* and to *Grolier's Encyclopedia*, of which he has sent the committee manuscript copies, he stresses that it is only through integration with these other fields, particularly with geophysics, that geologists will improve their abilities of prediction, which is the natural goal of all sciences.

It is very difficult to generalize, and clearly the training at different schools has quite different characteristics. Also, some geological engineers have a much stronger mathematical background than some geologists. However, the problem does seem to be reasonably widespread. At Tokyo, where the chairman of this committee has been lecturing to geologists during 1970/71, the negative attitude of students towards mathematics and physics was clearly evident. It is not surprising that these are difficult subjects for many geologists, and that few may become really expert in them. Probably this does not matter very much, provided that geology students keep a receptive mind to mathematical and physical arguments which affect their subjects. It is not clear that this is a matter that can be helped very much by our committee. Perhaps a more effective approach would be to try to make sure that there were mathematically-physically oriented scientists on most of the subcommittees.

APPENDIX D

GEOLOGICAL SURVEY OF CANADA
RESEARCH GRANTS TO CANADIAN UNIVERSITIES

General Grants, 1970-71

Name, Department & University	Project Title & Amount
Anderson, G.M. Geology Toronto	Geochemistry of the York River nepheline pegmatites and gneisses. ($1,365)
Assad, J.R. Géologie Laval	Les minérais nickelifères de Mattagami Lake Mines - leur gitologie et implications métallogéniques. ($1,365)
Azzaria, Louis M. Géologie et Minéralogie Laval	L'étude de la distribution de mercure dans les roches, sols, et l'air dans les environs des gîtes métallifères. ($1,365)
Baadsgaard, H. Geology Alberta	Geochemistry and isotopic exchange reactions between groundwater and the enclosing matrix. ($1,365)
Bachinski, D.J. Geology New Brunswick	Stratabound ore deposits. ($5,000)
Bachinski, S.L.W. (Mrs.) Geology New Brunswick	1. Preliminary investigation of the feldspars in "porphyries" associated with sulphide deposits, northern New Brunswick. 2. Preliminary investigation of possible occurrence of zeolite and/or prehnite-pumpellyte facies, N.B. ($3,000)
Barnes, C.R. Earth Sciences Waterloo	Ordovician Arctic Conodonts. ($1,365)
Bartlett, G.A. Geological Sciences Queen's	1. Biotas, paleoenvironments and tectonic history of the Arctic and Atlantic Continental Margins and the Gulf of St. Lawrence. 2. Identification, effect and control of pollution in marine environments of the Atlantic provinces. ($1,365)

Name, Department & University	Project Title & Amount
Bayliss, P., Levinson, A.A. Geology Calgary	Clay mineralogy and boron deduced paleo-salinity of shales in Northern Canada. ($1,365)
Beck, A.E. Geophysics Western Ontario	Disequilibrium studies of radioactive series in rocks. ($1,365)
Berry, L.G. Geological Sciences Queen's	Crystal structure studies of minerals. ($1,365)
Berard, Jean Génie géologique Ecole Polytechnique	Etude des facteurs de gélivité des roches. ($1,365)
Beswick, A.E. Geology Laurentian	Alkali metal distribution in granite melts and vapours. ($1,365)
Brown, R.L. Geology Carleton	Structural studies in Northern Appalachians. ($1,365)
Brueckner, W.D. Geology Memorial	1. Geomorphic problems in Newfoundland. 2. Avalon bedrock geology. ($1,000)
Bryan, R.B. Geography Alberta	The form of slopes in relation to variation in lithology and the erodibility of surficial materials. ($1,365)
Burke, K.B.S. Geology New Brunswick	Investigation of tectonic framework of south-eastern New Brunswick. ($1,365)
Burley, B.J. Geology McMaster	Investigations in the system $NaAlSiO_4$-$NaAlSi_3O_8$-H_2O. ($1,365)
Carmichael, C.M. Geophysics Western Ontario	K-Ar isochron studies. ($1, 365)
Carson, M.A. Geography McGill	Badland erosion in Queenston shales. ($1,365)

Name, Department & University	Project Title & Amount
Chao, G. Y. Geology Carleton	Crystal chemistry of apophyllite. ($1,365)
Cherry, J.A. Earth Sciences Manitoba	Comparison of surface manifestations of groundwater flow systems in representative areas of Western Canada. ($ 750)
Clark, A.H. Geological Sciences Queen's	Comparative study of the mineralogy, geochemistry and environment of formation of strata-bound lead-zinc-silver and pyritic copper deposits, southern Iberia. ($1,000)
Clark, G.S. Earth Sciences Manitoba	Rb-Sr isotopic age studies in northern Manitoba. ($1,000)
Clarke, W.B. Physics McMaster	Development of new dating methods. ($1,365)
Clifford, P.M. Geology McMaster	Deformation studies in Archean terrains, paleovolcanicity. ($1,365)
Cole, T.J.S. Physics Carleton	Application of Rb-Sr dating to geotectonic problems. ($1,365)
Copper, Paul Geology Laurentian	Morphology, ecology and evolution of the atrypoid spire-bearing brachiopod of eastern North America, especially Ontario. ($1,365)
Coy-Yll, Ramon Génie géologique Ecole Polytechnique	Propriétés optiques des sulfures par rapport à leur composition chimique et emplacement géologique. ($1,365)
Crocket, J.H. Geology McMaster	Trace element geochemistry of the Elliot Lake uranium ores using activation analysis. ($1,365)
Cronan, D.S. Geology Ottawa	Geochemistry and mineralogy of Canadian lacustrine ferromanganese deposits and associated sediments. ($1,365)

Name, Department & University	Project Title & Amount
Darling, R. G. Génie Géologique Ecole Polytechnique	Etude minéralogique et géochimique de Gisement de Louvem. ($1,365)
Dixon, O. A. Geology Ottawa	Ordovician-Silurian carbonates of Somerset and Prince of Wales Island, District of Franklin. ($1,365)
Doig, Ronald Geological Sciences McGill	Isotopic and petrologic studies of rocks of the Grenville province. ($1,365)
Donaldson, J. A. Geology Carleton	Study of heavy minerals in Proterozoic sandstones of the Western Canadian Shield. ($1,365)
Edgar, A. D. Geology Western Ontario	Geochemistry of the Montgary, Manitoba lithium-bearing pegmatites and other zoned pegmatites. ($1,365)
Elson, J. A. Geological Sciences McGill	Problems of Glacial Lake Agassiz. ($1,000)
Fahraeus, L. E. Geology Memorial	Studies of Lower Paleozoic conodonts from the Notre Dame Bay area. ($1,365)
Farquhar, R. M. Physics Toronto	Rubidium-strontium geochronology studies in the English River Gneiss Belt, northwestern Ontario. ($1,365)
Farrar, Edward Geological Sciences Queen's	Geochronology of metallogenic relationships in southern British Columbia and in Northern Chile. ($1,000)
Fawcett, J. J. Geology Toronto	Stability of the muscovite-chlorite-quartz assemblage. ($1,365)
Ferguson, R. B. Earth Sciences Manitoba	Crystal structure and chemistry of "abnormal" nickel minerals from Marbridge Mine, Malartic, Quebec. ($1,365)
Fortescue, J. A. C. Geological Sciences Brock	The experimental application of geochemical prospecting methods to the delineation of areas of pollution in the vicinity of St. Catharines, Ontario. ($1,365)

Name, Department & University	Project Title & Amount
Fox, R.C. Geology and Zoology Alberta	1. Tiffanian(?) (Late Paleocene) mammals from Cypress Hills, Alberta. 2. Facies differences, Campanian mammalian assemblages, Alberta. 3. Exploration survey for microvertebrates including mammals, Cenomanian rocks, Foothills, Alberta. ($1,365)
Fyson, W.K. Geology Ottawa	Relation of minor to major structures in the Maritime Provinces. Structural analysis of Lower Paleozoic rocks, Mt. Albert area, Gaspé Peninsula. ($1,365)
Gittins, John Geology Toronto	Ultramafic rocks of carbonatite complexes. ($1,365)
Goodwin, A.M. Geology Toronto	Geochemical study of English River Gneiss Belt Sioux Lookout – Lake St. Joseph area, Ontario. ($1,365)
Govett, G.J.S. Geology New Brunswick	Computer processing, interpretation and simulation of geochemical stream sediment and soil data. ($1,365)
Gower, J.A. (& White, W.H.) Geology British Columbia	Mineral deposits, Pacific Coast. ($1,000)
Greenwood, Brian Geography Toronto	Intertidal sedimentation. ($2,000)
Gregory, M.R. Geology Dalhousie	Benthonic foraminifera and sediments: Baffin Bay. ($2,655)
Greiner, H.R. Geology New Brunswick	Fossil fishes of the Maritime Provinces: their biologic and environmental implications. ($1,365)
Grice, R.H. Geological Sciences McGill	Field data collection and quantitative estimation of groundwater flows in multiaquifer systems. ($1,000)

Name, Department & University	Project Title & Amount
Grundy, H.D. Geology McMaster	Crystallography of the framework silicates. ($1,365)
Hall, D.H. Earth Sciences Manitoba	Regional magnetic anomalies in southeastern Manitoba. ($1,365)
Hillaire-Marcel, Claude Sciences de la Terre Québec	La Pléisotcène marin des Basses Terres de Saint-Laurent. ($1,960)
Hills, L.V. Geology Calgary	Paleobotany of the Beaufort Formation. ($1,365)
Hofmann, Hans Geology Montréal	Phanerozoic organosedimentary structures and problematica. ($1,365)
Hogarth, D.D. Geology Ottawa	1. Yttrium silicates. 2. Colour and paragenesis of lapis lazuli, etc. ($1,365)
Hutchinson, R.W. Geology Western Ontario	Genetic history of sulphide ores at Manitouwadge, Ontario. ($1,365)
James, R.S. Geology Toronto	Petrology of the cordierite-anthophyllite gneisses in the Manitouwadge area (N.W. Ontario). ($1,000)
Jamieson, E. Geology Memorial	Investigation of palaeoecological trends in Cambro-Ordovician reefs of western Newfoundland with special reference to the fossil algae. ($4,500)
Karrow, P.F., Dreimanis, A. Earth Sciences Waterloo	Study of Pleistocene fossil beetle of the Toronto and Port Talbot sections, south-western Ontario. ($1,365)
Keen, M.J. (and others) Geology Dalhousie	Petrological, mineralogical and metallurgical studies with an electron beam microprobe: a joint application on behalf of eight members of the Department. ($8,000)

Name, Department & University	Project Title & Amount
Kelly, R. Metallurgy and Materials Science McMaster	Studies on metamictization in minerals. ($1,365)
Kennedy, M.J. Geology Memorial	Structural relationships within the Appalachians of northwestern Newfoundland. ($1,365)
Knop, Osvald Chemistry Dalhousie	Structural studies of minerals. ($1,365)
Kretz, Ralph Geology Ottawa	Petrology and crystalline rocks near Yellowknife, N.W.T. ($1,365)
Krouse, H.R. Physics Alberta	Isotopic studies of western Canada evaporites. ($1,365)
Lajtai, E.Z. Geology New Brunswick	Dispersion of indicators by glacial transportation. ($1,365)
Lambert, R.S. Geology Alberta	Oxygen isotope studies of ores and plutonic complexes in the Slave Provinces, N.W.T. ($1,365)
Lawson, D.E. Earth Sciences Waterloo	The significance of small-scale sedimentary structures in the fluvial environment. ($2,700)
Leblanc, Gabriel Géologie Laval	Etude de la microséismicité: région de Québec. ($1,365)
Ledoux, R.L. Géologie Laval	Etude des phases de la décomposition de la muscovite, de la phlogopite et de la biotite. ($1,100)
Lerbekmo, J.F. Geology Alberta	Sedimentation and correlation studies in continental Upper Cretaceous and Paleocene deposits. ($1,365)

Name, Department & University	Project Title & Amount
Lesperance, P.J. Géologie Montréal	Biométrie de trilobites ordoviciens. ($1,365)
Liberty, B.A. Geological Sciences Brock	Paleozoic mapping in southern Ontario. ($1,365)
MacLean, W.H., Webber, G.R. Geological Sciences McGill	Inter-relationship of base-metal and gold ore deposition in the Porcupine district, N.W. Ontario. ($1,000)
Martignole, J.G. Géologie Montréal	Etude de la Province de Grenville au nord de Montréal. ($1,000)
Martin, R.F.C. Geological Sciences McGill	Petrology of contracted suites of Devonian felsic and basic igneous rocks in New Brunswick. ($1,365)
McAllister, A.L. Geology New Brunswick	Ore deposits and volcanism in the Northern Appalachians. ($1,365)
McCartney, W.D. Geological Sciences Queen's	Metallogenic studies, Grenville Province, Ont.-Que. ($1,365)
McDougall, D.J. Geology Loyola	Geothermometry based on radiation sensitivities of thermoluminescent minerals. ($1,365)
McGugan, Alan Geology Calgary	Permian stratigraphy and paleontology. ($1,365)
McNutt, R.H. Geology McMaster	1. A study of the rare earth elements in rocks and minerals. 2. A petrologic study of a contact aureole surrounding a Grenville anorthosite. ($1,365)
McTaggart, K.C. Geology British Columbia	Origin of the Coquihalla Serpentine Belt. ($ 900)

Name, Department & University	Project Title & Amount
Meagher, E.P. Geology British Columbia	High-temperature single-crystal X-ray analysis of minerals. ($1,365)
Mereu, R.F. Geophysics Western Ontario	Seismic studies of the upper crust from quarry blasts. ($1,365)
Middleton, G.V. Geology McMaster	Intertidal sediments. ($1,365)
Moore, J.M. Geology Carleton	1. Metamorphism of siliceous carbonate rocks near Marble Lake, Ontario. 2. Petrology of a Tertiary ring complex, B.C.-Yukon Territory. ($1,365)
Morton, R.D. Geology Alberta	Studies on the nature and origin of certain ore deposits from the Yukon, N.W.T., Saskatchewan and Norway. ($1,365)
Mountjoy, E.W. Geological Sciences McGill	Petrography and stratigraphy of Upper Devonian reef complexes, Alberta. ($1,000)
Mukherji, K.K. Geology Loyola	Thermoluminescence study of the Black River-Trenton Group in southern Ontario. ($ 670)
Naldrett, A.J. Geology Toronto	Field and experimental studies relating to nickel sulfide mineralization at Hope, B.C. and Duluth, Minnesota. ($1,365)
Neale, E.R.W. Geology Memorial	Early Paleozoic intrusion and volcanism in the Central Mobile Belt of Newfoundland with emphasis on rocks of the Burlington and Springdale Peninsulas. ($1,365)
Nelson, S.J. Geology Calgary	Historical geology, western Canada. ($1,365)
Newbury, R.W. Civil Engineering Manitoba	Evolution of the York Factory Peninsula. ($ 700)

Name, Department & University	Project Title & Amount
Noble, J.P.A. Geology New Brunswick	Silurian-Devonian stratigraphy of New Brunswick. ($1,000)
Norris, Geoffrey Geology Toronto	Palynology of the Mesozoic of western Canada. ($1,365)
Oldershaw, A.E. Geology Toronto	Diagenesis in carbonate sediments and sedimentary rocks. ($1,365)
Peach, P.A. Geological Sciences Brock	Compilation of data on fossil plants from the Gunflint Formation Ontario (from material assembled by the late Dr. Moorehouse). ($1,800)
Perrault, Guy Génie géologique Ecole Polytechnique	Minéralogie et pétrologie du Mont St-Hilaire. ($1,365)
Price, R.A. Geological Sciences Queen's	Structure and tectonic evolution of the south-eastern Canadian Cordillera. ($3,000)
Rankin, David Physics Alberta	Magnetotelluric studies of deep crustal structures in Alberta. ($1,365)
Read, P.B. Geology Carleton	Mineralogical studies in low grade metamorphic rocks. ($1,800)
Reynolds, P.H. Physics Dalhousie	I - Potassium-argon and fission tract chronology. II - Analysis of surface waves in the Canadian Shield. ($3,000)
Roeder, P.L. Geological Sciences Queen's	Gas equilibria in a closed system. ($1,365)
Ross, J.V. Geology British Columbia	Structural and mechanical properties of some common amphibole facies minerals. ($1,365)

Name, Department & University	Project Title & Amount
Rust, B.R. Geology Ottawa	Pleistocene stratigraphy of the Gatineau River Valley. ($1,365)
Rutherford, G.K. Geography Queen's	Nature and composition of sediments across a transect of Lake Ontario. ($1,638)
Schenk, P.E. Geology Dalhousie	A stratigraphic and sedimentological study of the Lower Devonian of Nova Scotia. ($1,365)
Scholoessin, H.H. Geophysics Western Ontario	Mechanism of polymorphic transitions in enstatite and effects on its thermal properties. ($1,365)
Schwarz, H.P. Geology McMaster	Radiometric dating of cave deposits by uranium-series disequilibrium. ($1,365)
Schwerdtner, W.M. Geology Toronto	Kinematic significance of hornblende and sillimanite lineations. ($1,365)
Scott, S.D. Geology Toronto	Stability relations and defect chemistry of iron sulphide minerals. ($1,365)
Seguin, M.K. Géologie Laval	Etude de magnétisme rémanent natural (MRN) des formations de fer de la partie sud de la fosse du Labrador. ($1,000)
Shaw, D.M. Geology McMaster	Geochemical studies on Grenville rocks and minerals. ($1,365)
Shaw, John Geography Alberta	Investigation of the mode and environment of origin of glacial flutes. ($ 730)
Simony, P.S. Geology Calgary	Geology of the Rocky Mountain Trench. ($4,157)
Smith, F.G. Geology Toronto	Grain growth in metamorphic rocks. ($1,365)

Name, Department & University	Project Title & Amount
Smith, T.E. Geology Windsor	Distribution of oxygen in the Nova Scotia granitic batholith. ($1,365)
Stearn, C.W. Geological Sciences McGill	Calcareous sponges of stromatoporoid affinities. ($1,475)
Steiner, Johann Geology Alberta	Sedimentological and environmental study of the Precambrian Wynd formation at Jasper, Alberta. ($ 750)
Stelck, C.R. Geology Alberta	Calibration of Phytoplankton of the Cretaceous, W. Canada. ($1,200)
Stevenson, J.S. Geological Sciences McGill	Strontium isotope abundance and chemical studies bearing on the petrogenesis of the granophyre ("micropegmatite") and of the Onaping tuff-breccia, Sudbury, Ontario. ($1,365)
Strong, D.F. Geology Memorial	Origin of sulphide deposits in the Snooks Arm Group, Betts Cove-Tilt Cove Region, Newfoundland. ($3,690)
Sutton, J.S. Geology Memorial	Geology of the area from Cape Bay to La Poile, southwestern Newfoundland. ($1,365)
Tanguay, Marc G. Génie géologique Ecole Polytechnique	Optical processing of aerial photo patterns by coherent light. ($1,365)
Terasmae, Jaan Geological Sciences Brock	1. Postglacial geochronology and paleoecology of the Kamloops area, British Columbia. 2. Late-Wisconsin geochronology in southern Ontario. ($2,500)
Thode, H.G. Chemistry McMaster	Sulphur isotope geochemistry. ($2,500)
Turnock, A.C. Earth Sciences Manitoba	Publication of G.A.C. Special Paper 9, Manitoba Geoscience Studies. ($6,500) Metamorphism and igneous intrusion in the Precambrian of Manitoba. ($1,365)

Name, Department & University	Project Title & Amount
Valiquette, Guy Génie géologique Ecole Polytechnique	Pétrologie des granites à molybdène. ($1,365)
VanLoon, J.C. Geology Toronto	An evaluation and development of methods for the determination of the constituent in natural waters. ($1,365)
Walker, R.G. Geology McMaster	Transport and deposition of resedimented conglomerates. ($1,365)
Wardlaw, N.C. Geology Saskatchewan	Cretaceous evaporite basins of Eastern Brazil and West Africa. ($1,500)
Warren, H.V. Geology British Columbia	Trace metal sampling in groundwater and streams. ($1,365)
Waterhouse, J.B. Geology Toronto	Climatic fluctuations and paleolatitudes recorded by Permian brachiopods of the Canadian Arctic Archipelago and Yukon. ($1,365)
Watkinson, D.H. Geology Toronto	Relationships between copper mineralization and alkalic rock complexes. ($1,365)
West, G.F. Physics Toronto	Crustal structure east of Lake Superior. ($1,365)
Westermann, G.E.G. Geology McMaster	Form and function of ammonoid shells. ($1,365)
Westgate, J.A. Geology Alberta	The glacial stratigraphy and boulder train (indicator fan) of the Pine Point area, Northwest Territories. ($1,365)
Williams, H. Geology Memorial	Stratigraphy of the Cinq Isle Formation and its relationships to nearby groups. ($1,365)
Wilson, H.D.B. Earth Sciences Manitoba	Metamorphism in the English River Gneiss Block. ($1,500)

Name, Department & University	Project Title & Amount
Wynne-Edwards, H.R. Geological Sciences Queen's	The geology of the Grenville Province – study of metamorphic assemblages. ($1,365)
Yole, R.W. Geology Carleton	1. Petrology and microfacies analysis, Paleozoic rocks of eastern Ontario and Mackenzie Valley. 2. Petrographic and paleomagnetic studies of diabases of Karmutsen Formation, Vancouver Island. ($1,365)
York, Derek Physics Toronto	Thermal history of the Canadian Shield from $^{40}Ar/^{39}Ar$ studies. ($1,365)

Special Grants for Research in Development of Computer-Processable Files, 1970-71

Name, Department & University	Project Title & Amount
Donaldson, J.A. Geology Carleton	Initiation of a computer-processable file of geological data for Precambrian strata of the western Canadian Shield. ($4,500)
Gower, J.A. Geology British Columbia	Techniques and applications of digitizing drill-core information. ($5,500)
Nichol, I. Geological Sciences Queen's	The interpretation of exploration oriented geochemical data in computer-processable data files. ($9,000)
Sutterlin, P.G. Geology Western Ontario	Development and application of an integrated data processing system for geological data and the development of a geochemical data file. ($14,000)
Williams, G.D. Geology Alberta	Characteristics of oil and gas pools relative to structure and stratigraphy of Alberta. ($7,000)
Wilson, H.D.B. Earth Sciences Manitoba	The geologic, geographic and temporal significance of the distribution of base metal and precious metal deposits of the world. ($4,000)
Wynne-Edwards, H.R. Geological Sciences Queen's	Electronic data processing of field data from the Grenville province in Québec. ($6,000)

General Grants, 1971-72

Name, Department & University	Project Title & Amount
Ade-Hall, J.M. Geology Dalhousie	The construction and use of a portable drilling system for the collection of oriented rock cores for paleomagnetic and rock magnetic studies. ($1,255)
Anderson, C.D. Earth Sciences Manitoba	Field tests of long-wire electromagnetic method. ($1,000)
Anderson, G.M. Geology Toronto	Geochemistry of the York River pegmatites and gneisses. ($1,255)
Assad, J.R. Géologie Laval	1. Fin - Les minérais nikelifères de Mattagami Lake Mines. 2. Etudes de minérais nikelifères de Dumont Nickel Ltd. - Abitibi. ($1,255)
Aumento, Fabrizio Geology Dalhousie	Detailed geological investigation of the oceanic crust. ($1,255)
Babcock, E.A. Geology Alberta	Investigation of faulting and jointing in the western Canadian Prairies. ($1,255)
Bachinski, D.J. Geology New Brunswick	Metamorphism of sulphides. ($3,000)
Bachinski, S.L.W. (Mrs.) Geology New Brunswick	1. Preliminary investigation of the feldspars in "Porphyries" associated with sulphide deposits, Northern New Brunswick. 2. Preliminary investigation of possible occurrence of zeolite and/or prehnite/pumpellyite facies rocks, New Brunswick. ($1,000)
Bancroft, G.M. Chemistry Western Ontario	Mössbauer spectra of silicates and lunar material. ($1,255)
Barnes, C.R. Earth Sciences Waterloo	Cambro-Ordovician conodonts from the Rocky Mountains. ($1,255)

Name, Department & University	Project Title & Amount
Bartlett, G.A. Geological Sciences Queen's	1. Biotas, paleoenvironments and tectonic history of the Arctic and Atlantic Continental margins and the Gulf of St. Lawrence. 2. Identification, effect and control of pollution in marine environments of the Atlantic Provinces. ($1,255)
Bayliss, Peter Geology Calgary	Clay mineralogy and boron deduced paleosalinity of shales in northern Canada. ($1,255)
Béland, Jacques Géologie Montréal	Etude de mouvements diapiriques de formations aux Iles-de-la-Madeleine, Québec. ($1,255)
Bell, Keith Geology Carleton	Chronology of igneous intrusions and the Grenville Front. ($1,255)
Berry, L.G. Geological Sciences Queen's	Crystal structure studies of minerals. ($1,255)
Beswick, A.E. Geology Laurentian	Alkali metal distributions in salic rocks. ($1,255)
Bousfield, E.L. Biology Carleton	Past and present factors controlling the distribution of the glacial lake relict community in eastern Canada. ($2,500)
Brisbin, W.C. Earth Sciences Manitoba	A study of deformational history and deformational environments within the Precambrian Shield. ($1,255)
Brooks, Christopher Geology Montréal	Sr and Pb isotopic compositions of relict primary minerals and their alteration products in Archean metavolcanics from Quebec. ($1,255)
Brown, A.C. Génie géologique Ecole Polytechnique	Etude de minéralisation cuprifère dans la série Cambro-Ordovicien de la région d'Acton, Cantons de l'Est, Québec. ($1,255)
Brueckner, W.D. Geology Memorial	Geomorphic problems in Newfoundland. ($1,000)

Name, Department & University	Project Title & Amount
Burke, K.B.S. Geology New Brunswick	Geophysics applied to geological problems in New Brunswick. ($1,255)
Burley, B.J. Geology McMaster	1. Investigations on the petrology of analcite-bearing rocks. 2. Investigation on the mineralogy of scapolites. ($1,255)
Carmichael, C.M. Geophysics Western Ontario	K-Ar isochron studies. ($1,255)
Cerny, Petr Earth Sciences Manitoba	Mineralogy and petrology of pegmatites. ($ 500)
Chao, G.Y. Geology Carleton	Crystal chemistry of apophyllite II crystal structure of apophyllite at 250°C. ($1,255)
Clark, A.H. Geological Sciences Queen's	Distribution of chlorine and fluorine in mineralized environments. ($1,255)
Clark, G.S. Earth Sciences Manitoba	Rb-Sr age investigation in the File Lake 10-69 area, northern Manitoba, and the Kasimere Lake area, extreme northern Manitoba. ($1,255)
Clarke, D.B. Geology Dalhousie	Electron microprobe investigations. ($5,000)
Clarke, W.B. Physics McMaster	Development of new dating methods. ($1,255)
Clifford, P.M. Geology McMaster	Stratigraphic and structural evolution in Archean "greenstone" belts. ($1,255)
Cole, T.J.S. Physics Carleton	Application of Rb-Sr dating to geotectonic problems. ($1,255)

Name, Department & University	Project Title & Amount
Coleman, M. L. Geology Alberta	Investigation of the relationship of composition and structure to oxygen isotope fractionation, for geothermometry. ($1,255)
Cooke, H. B. S. Geology Dalhousie	Quaternary studies in Nova Scotia and Prince Edward Island. ($1,255)
Copper, Paul Geology Laurentian	Morphology, evolution and ecology of Paleozoic spire-bearing brachiopods of eastern Canada. ($1,255)
Coy-Yll, Ramon Génie géologique Ecole Polytechnique	Propriétés optiques des sulfures par rapport à leur composition chimique et emplacement géologique. ($1,255)
Crocket, J.H. Geology McMaster	Noble metal abundances in stratiform pyritic base metal ores from the Bathurst-Newcastle district, New Brunswick. ($1,255)
Cronan, D.S. Geology Ottawa	Geochemistry and mineralogy of ferromanganese oxide deposits and associated sediments. ($1,255)
Currie, J.B. Geology Toronto	(Joint with S.O.O. Nwachukwu, Dept. of Geology, Nsukka, Nigeria) Paleomagnetic and susceptibility anisotropy studies in the Wabagoon volcanics of Lac des Milles Lacs areas of northwestern Ontario. ($1,700)
Darling, R.G. Génie géologique Ecole Polytechnique	La pétrologie et la géochimie du batholithe de Bourlamaque: Développement d'une méthode de prospection. ($1,255)
Davies, J.F. Geology Laurentian	Study of the McIntyre porphyry copper deposit. ($1,255)
Dixon, O.A. Geology Ottawa	Ordovician-Silurian faunas and carbonates, Somerset and Prince of Wales Islands, District of Franklin. ($1,255)
Doig, Ronald Geological Sciences McGill	Isotopic and petrologic studies of rocks of the Grenville Province. ($1,255)

Name, Department & University	Project Title & Amount
Donaldson, J.A. Geology Carleton	Study of heavy minerals in Proterozoic sandstones of the western Canadian Shield. ($1,255)
Duckworth, Kenneth Geology Calgary	Studies of the induced polarization response of the Hawk Creek orebody in British Columbia. ($1,255)
Dunlop, D.J. Physics Toronto (Erindale College)	Paleomagnetic and rock magnetic study of the Glamorgan gabbro. ($1,255)
Elson, J.A. Geological Sciences McGill	Problems of glacial Lake Agassiz. ($ 750)
Farquhar, R.M. Physics Toronto	Rb-Sr geochronology – Midwest Superior Geotraverse. ($2,000)
Farrar, Edward Geology Queen's	Geochronological studies. ($1,255)
Fawcett, J.J. Geology Toronto	Petrology of the English River gneiss belt. ($1,255)
Ferguson, R.B. Earth Sciences Manitoba	Crystal structure analyses of Canadian ore minerals. ($1,255)
Fletcher, W.K. Geology British Columbia	Application of flameless atomic absorption to determination of trace metals in geochemical samples. ($1,255)
Fortescue, J.A.C. Geological Sciences Brock	Applied landscape geochemistry in the area of St. Catharines, Ontario. ($1,255)
Fox, R.C. Geology and Zoology Alberta	Paleocene mammals from Alberta. ($1,255)
Fyson, W.K. Geology Ottawa	Relation of minor to major structures in the Maritime Provinces. Structural analysis of Lower Paleozoic rocks, Mt. Albert area, Gaspé Peninsula. ($1,255)

Name, Department & University	Project Title & Amount
Gees, R.A. Geology Dalhousie	Sedimentology and marine geology of the continental margin of eastern North America and other selected areas (special topic: grain surface textures). ($1,255)
Gélinas, Léopold Génie géologique Ecole Polytechnique	Géochimie des roches volcaniques des Appalaches. ($1,000)
Gittins, John Geology Toronto	Ultramafic rocks of carbonatite complexes. ($1,300)
Goodwin, A.M. Geology Toronto	Geochemical and petrographic study of English River gneiss belt, Sioux Lookout-Lake St. Joseph area, Ontario. ($2,000)
Govett, G.J.S. Geology New Brunswick	1. Computer processing, interpretation, and simultation of geochemical stream sediment and soil data. 2. Dispersion of Sb in stream sediments and soils, New Brunswick. ($1,255)
Gravenor, C.P. Geology Windsor	Study of wave-cut drumlins - Yarmouth, Nova Scotia. ($1,500)
Greenwood, Brian Geography Toronto	Coastal sedimentation. ($1,255)
Greggs, R.G. Geological Sciences Queen's	Franconian trilobite faunas of the Bison Creek Formation, southern Alberta. ($1,255)
Grundy, H.D. Geology McMaster	Crystallography of the framework silicates. ($1,255)
Gunn, B.M. Geology Montreal	Geochemistry of Archean sodic, potassic and pegmatitic batholiths of the Waswanipi-Chibougamau region. ($1,255)
Hall, D.H. Earth Sciences Manitoba	Crustal studies in Manitoba and northwestern Ontario. ($1,255)

Name, Department & University	Project Title & Amount
Hogarth, D.D. Geology Ottawa	1. Pegmatites of the Gatineau-Lièvre district. 2. Preparation for excursions of the 1972 International Geological Congress. ($1,255)
Hooper, Kenneth Geology Carleton	Elemental composition of fossils and shells. ($1,255)
Hudec, P.P. Geology Windsor	Physio-chemical weathering of rocks under different climatic environments. ($1,255)
James, R.S. Geology Laurentian	Petrology of the cordierite-anthophyllite gneisses in the Manitouwadge area, Ontario. ($1,255)
Karrow, P.F. Earth Sciences Waterloo	Quaternary paleontology, southwestern Ontario. ($1,255)
Keen, M.J. Geology Dalhousie	Seismic reflection studies on the mid-Atlantic Ridge at 45°N. ($1,500)
Kelly, Roger Metallurgy and Materials Science McMaster	Studies on metamictization in minerals. ($1,255)
Kennedy, M.J. Geology Memorial	Metamorphic rocks of the Grand Lake-Dear Lake region and their relationship to the Cambro-Ordovician shelf sequence. ($2,000)
Kesler, S.E. Geology Toronto	Distribution of ore metals in Island Arc igneous rocks associated with porphyry copper mineralization. ($1,255)
Knop, Osvald Chemistry Dalhousie	Studies on minerals. ($1,255)
Kramer, J.R. Geology McMaster	Air transport and sedimentation. ($1,255)

Name, Department & University	Project Title & Amount
Kretz, Ralph Geology Ottawa	Petrology of crystalline rocks near Yellowknife. ($1,255)
Krupicka, Jiri Geology Alberta	Petrology of the crystalline rocks of NE Devon Island (Arctic). ($ 900)
Kucera, R.E. Geology British Columbia	Time and space relations of geologic processes. ($ 500)
Lajtai, E.Z. Geology New Brunswick	The evolution of joints and faults. ($1,255)
Lambert, R.S. Geology Alberta	Oxygen isotope studies of ores and plutonic complexes in the Slave Province, N.W.T. and the W. Cordillera. ($1,255)
Lawson, D.E. Earth Sciences Waterloo	Point Bar sedimentation. ($1,255)
Ledoux, R.L. Géologie Laval	Etude des phases de la décomposition de la muscovite, de la phlogopite et de la biotite. ($ 800)
Leiper, W. Physics Dalhousie	(Joint with D.F. Coble, Dept. of Physics, Dalhousie Univ.) Application of Mössbauer spectrometry to the study of partially oxidized basalts. ($1,500)
Lenz, A.C. Geology Western Ontario	Graptolites and correlation of Silurian-Devonian strata of the Canadian Cordillera and Appalachians. ($1,255)
Lerbekmo, J.F. Geology Alberta	Sedimentation and correlation studies in continental Upper Cretaceous and Paleocene deposits in Alberta. ($1,255)
Lespérance, P.J. Géologie Montréal	Biométrie de trilobites Ordoviciens. ($1,255)

Name, Department & University	Project Title & Amount
Liberty, B.A. Geological Sciences Brock	Paleozoic mapping in southern Ontario. ($1,255)
Mamet, Bernard Géologie Montréal	Lames-minces servant à l'etude stratigraphique de carbonates Paléozoiques des Cordillères Américaines. ($1,255)
Martignole, J.G. Géologie Montréal	Genèse de localisation des dépôts d'Ilménite-Magnétite dans la région du massif d'Anorthosite de Morin. ($1,255)
Martin, R.F. Geological Sciences McGill	Petrology of gabbro-granophyre-granite associations in New Brunswick. ($1,255)
Mathews, W.H. Geology British Columbia	Urban geology – Greater Vancouver area. ($1,255)
McGugan, Alan Geology Calgary	Permian stratigraphy and palaeontology. ($1,255)
McNutt, R.H. Geology McMaster	Petrologic study of a corona-garnet amphibolite body. ($1,255)
McTaggart, K.C. Geology British Columbia	A study of the Nahlin ultramafic body of northern British Columbia. ($2,850)
Meagher, E.P. Geology British Columbia	High-temperature single-crystal X-ray analysis of minerals. ($1,255)
Middleton, G.V. Geology McMaster	Intertidal sediments. ($1,255)
Milligan, G.C. Geology Dalhousie	Investigations in George River Series, Cape Breton. ($2,000)
Moore, J.M. Geology Carleton	Metamorphism of siliceous carbonate rocks near Marble Lake, Ontario. ($1,255)

Name, Department & University	Project Title & Amount
Morton, R. D. Geology Alberta	Studies on the nature and origin of base-metal deposits in the Belt Series of S. W. Alberta and of uraniferous deposits in the East Arm of Great Slave Lake. ($1,255)
Naldrett, A. J. Geology Toronto	Study of the sulfur content of Archean volcanic rocks in northern and northwestern Ontario. ($1,255)
Neale, E. R. W. Geology Memorial	Urban geology, northern outskirts of St. John's, Newfoundland. ($1,255)
Nelson, S. J. Geology Calgary	Historical geology of western Canada. ($1,000)
Noble, J. P. A. Geology New Brunswick	Silurian-Devonian stratigraphy of New Brunswick. ($1,255)
Norris, Geoffrey Geology Toronto	Palynology of the Mesozoic of western Canada. ($1,255)
Ochietti, Serge Sciences de l'homme Section: Geographie Québec (Trois-Rivières)	Etude de dépôts et faits quaternaires du bas Saint-Maurice. ($3,000)
Oldershaw, A. E. Geology Toronto	Sedimentation and diagenesis of Cambro/ Ordovician carbonates, west Newfoundland. ($1,255)
Palmer, H. C. Geophysics Western Ontario	Paleomagnetism and geochronology of the Natkusiak Formation, Victoria Island. ($1,255)
Papezik, V. S. Geology Memorial	Late Precambrian ignimbrites of the Avalon Peninsula, Newfoundland. ($1,255)
Perrault, Guy Génie Géologique Ecole Polytechnique	Minéralogie et pétrologie du Mont St-Hilaire. ($1,255)

Name, Department & University	Project Title & Amount
Pouliot, Gaston Génie géologique Ecole Polytechnique	Etude minéralogique des minerais titanifères du Lac Allard, Québec. ($1,255)
Price, R.A. Geological Sciences Queen's	Structure and tectonic evolution of the south-eastern Canadian Cordillera. ($4,000)
Reynolds, P.H. Physics Dalhousie	Lead and strontium isotope studies on rocks from the oceanic crust and upper mantle. ($1,255)
Ross, J.V. Geology British Columbia	Structural and mechanical properties of some common amphibolite facies minerals. ($1,255)
Rust, B.R. Geology Ottawa	Pollution of sediments in the Ottawa River. ($1,255)
Schenk, P.E. Geology Dalhousie	Stratigraphic and sedimentologic study of the Torbrook Formation, Nova Scotia. ($1,255)
Schwarcz, H.P. Geology McMaster	Geochronology and paleotemperatures of cave deposits. ($1,255)
Schwerdtner, W.M. Geology Toronto	Kinematic significance of hornblende and sillimanite lineations. ($1,255)
Scott, S.D. Geology Toronto	Stability relations and defect chemistry of sulphide minerals. ($1,255)
Seguin, M.K. Géologie Laval	Etude des propriétés magnétiques des matériaux. ($1,255)
Shaw, D.M. Geology McMaster	Geochemical studies on Precambrian rocks and minerals. ($1,255)

Name, Department & University	Project Title & Amount
Simony, P.S. Geology Calgary	Geology of the Rocky Mountain Trench. ($5,570)
Sinclair, A.J. Geology British Columbia	Fission track dating of mineral deposits. ($1,255)
Slatt, R.M. Geology Memorial	Pleistocene geology of the Notre Dame Bay area. ($2,000)
Smith, D.L. Geological Sciences Queen's	Copper mineralization and North American Proterozoic clastic sediments. ($1,255)
Smith, F.G. Geology Toronto	Grain growth in metamorphic rocks. ($1,255)
Smith, T.E. Geology Windsor	Distribution of oxygen in the Nova Scotia granitic batholith. ($1,255)
Spang, J.H. Geology Calgary	Detailed structural analysis of a portion of the McConnell Thrust near Mount Yamnuska (Alberta). ($1,400)
Stearn, C.W. Geological Sciences McGill	Growth forms of stromatoporoids and hydrozoans. ($1,255)
Steiner, Johann Geology Alberta	Sedimentological and environmental study of the Precambrian Wynd Formation at Jasper, Alberta. ($ 800)
Stevens, R.K. Geology Memorial	Geology of the Bonne Bay area, west Newfoundland. ($3,305)
Stevenson, J.S. Geological Sciences McGill	Strontium isotope abundance and electron probe and chemical studies bearing on the petrogenesis of the granophyre (micropegmatite) and the Onaping Tuff Formation, Sudbury, Ontario. ($1,255)

Name, Department & University	Project Title & Amount
Stringer, Peter Geology New Brunswick	Analysis of polyphase deformation in selected areas of New Brunswick. ($1,255)
Strong, D.F. Geology Memorial	A geochemical study of the Lower Cambrian manganese deposits of the Conception Bay area, Newfoundland. ($1,255)
Sutton, J.S. Geology Memorial	Geology of the area from Cape Ray to La Poile, southwestern Newfoundland. ($1,255)
Tanguay, M.G. Génie géologique Ecole Polytechnique	Optical processing of aerial photo patterns by coherent light. ($1,255)
Teller, J.T. Earth Sciences Manitoba	Stratigraphy and petrology of glacial sediments in southern Manitoba. ($1,250)
Terasmae, Jaan Geological Sciences Brock	Late Quaternary history of Magdalen Island, Quebec. ($1,255)
Thode, H.G. Chemistry McMaster	Sulphur isotopes in lunar materials. ($1,255)
Trembath, L.T. Geology New Brunswick	A direct synthesis of sulphide and feldspar calibration standards. ($1,000)
Turnock, A.C. Earth Sciences Manitoba	Metamorphism and igneous intrusion in the Precambrian of Manitoba. ($1,255)
Udd, J.E. Mining Engineering and Applied Geophysics McGill	Model studies of folding in rocks. ($1,255)
Valiquette, Guy Génie géologique Ecole Polytechnique	Pétrologie des granites à molybdène. ($1,255)

Name, Department & University	Project Title & Amount
VanLoon, J.C. Geology Toronto	Evaluation and development of selective ion electrodes for use in geochemical field studies. ($1,255)
Vigrass, L.W. Geological Sciences Saskatchewan (Regina)	(Connected with Rummens) Occurrence of selenium and tellurium in rocks and soils of southern Saskatchewan. ($1,255)
Walker, R.G. Geology McMaster	Archean sedimentation: comparison with Phanerozoic geosynclinal sedimentation. ($1,255)
Warren, H.V. Geology British Columbia	Minor element concentrations in anomalous geochemical provinces. ($1,255)
Waterhouse, J.B. Geology Toronto	Permian brachiopod faunas of the Assistance and Troll Fiord Formations. ($1,255)
Watkinson, D.H. Geology Carleton	Electron microprobe study of rare-earth-bearing minerals from alkalic rock complexes. ($1,255)
West, G.F. Geophysics Toronto	Midwest Superior Geotraverse - gravity/magnetics/seismics. ($2,000)
Westermann, G.E.G. Geology McMaster	Structure and function of cephalopod shells. ($1,255)
Westgate, J.A. Geology Alberta	Delineation and characterization of glacial drift sheets in southern and central Alberta. ($1,255)
White, O.L. Civil Engineering Waterloo	Engineering geology of Kitchener-Waterloo area. ($1,000)
Williams, Harold Geology Memorial	Structural relationships and petrology of transported plutonic rocks, volcanic rocks and metamorphic rocks at Lark Harbour, Newfoundland. ($1,255)

Name, Department & University	Project Title & Amount
Williamson, D.H. Science Laurentian	"New developments in Sudbury geology" a symposium. ($6,500)
Wilson, H.D.B. Earth Sciences Manitoba	Metamorphism in the English River gneiss block. ($1,255)
Wolf, K.H. Geology Laurentian	Comparative sedimentological and petrologic study of uranium and other metal-bearing Precambrian sediments in Ontario. ($1,255)
Wynne-Edwards, H.R. Geological Sciences Queen's	Metamorphosed ore deposits in the Grenville Province. ($1,255)
York, Derek Physics Toronto	Thermal history of the Canadian Shield from $^{40}Ar/^{39}Ar$ studies – Midwest Superior Geotraverse. ($2,000)
Young, G.M. Geology Western Ontario	Stratigraphy and sedimentology of Hadrynian rocks of Banks and Victoria Islands. ($1,255)

Special Grants for Research in Development of Computer-Processable Files, 1971-72

Name, Department & University	Project Title & Amount
Coy-Yll, R. Génie géologique Ecole Polytechnique	Computer-processable file of ore mineralogy data. ($2,000)
Cruden, D.M. Geology Ottawa	Fabric analysis in the Ottawa graben. ($5,000)
Dreimanis, A., Sutterlin, P.G. Geology Western Ontario	Development of a file and analysis of Pleistocene till data from Ontario using the SAFRAS system. ($4,000)
Nichol, Ian Geological Sciences Queen's	The interpretation of exploration oriented geochemical data in computer-processable data files. ($11,000)
Williams, G.D. Geology Alberta	1. Characteristics of oil and gas pools relative to the structure and stratigraphy of Alberta. 2. Coal deposits of Alberta and adjacent areas. ($9,000)
Wilson, H.D.B. Earth Sciences Manitoba	The geologic, geographic and temporal significance of the distribution of base metal and precious metal deposits of the world. ($6,500)
Wynne-Edwards, H.R. Geological Sciences Queen's	Electronic processing of field data from the Grenville Province in Québec. ($9,000)
Zodrow, E.L. Geology and Mathematics St. Françis Xavier	Mineral target area selection by statistical methods, Cape Breton, Nova Scotia (in 3 parts). ($3,500)

EMR RESEARCH AGREEMENTS 1972-73

Name, Department & Organization	Project Title & Amount
Arsenault, H.H., Seguin, M. Physics, Geology and Mineralogy Laval	Filtrage optique des cartes aéromagnétiques. ($15,000)
Bell, R.T. Geological Sciences Brock	Survey of Archean sediments in the Midwest Superior Geotraverse. ($4,400)
Burwash, R.A. Geology Alberta	Radioactivity of Precambrian basement rocks. ($2,150)
Cerny, P. Earth Sciences Manitoba	Mineralogy, petrology and geochemistry of pegmatite deposits in southwestern Precambrian of Canada. ($5,600)
Clifford, P.M., McNutt, R.H., Walker, R.G. Geology McMaster	The evolution of an Archean "greenstone" belt. ($18,500)
Collins, D.H., von Bitter, P.H. Royal Ontario Museum	Development and testing of a computer-based system for the storage and retrieval of paleontological data. ($10,000)
Cronan, D.S. Geology Ottawa	Geochemistry of sediments from the Mid-Atlantic Ridge near 45°N. ($7,000)
Currie, J.B., Fawcett, J.J., Schwerdtner, W.M. Geology Toronto	Midwest Superior Geotraverse: Metamorphism, structural geometry and paleostrain analysis. ($10,000)
Dreimanis, A., Sutterlin, P.G. Geology Western Ontario	Development of a file and analysis of Pleistocene data from Ontario using the SAFRAS system. ($6,000)
Dunlop, D.J. Physics Toronto	Paleomagnetic and rock magnetic study of Grenville Province in Ontario. ($2,100)

Name, Department & Organization	Project Title & Amount
Farvolden, R.N., Frind, E.O. Earth Sciences Waterloo	Classification and mapping of surficial deposits in the Mid Grand River basin. ($3,000)
Fletcher, W.K. Geology British Columbia	Role of organic matter in the development of hydromorphic geochemical anomalies related to buried mineral deposits. ($16,000)
Franklin, J.M. Geology Lakehead	Metallogeny of the South Sturgess Lake volcanic belt: Midwest Superior Geotraverse. ($5,600)
Gittins, J. Geology Toronto	The petrology of agpaitic alkalic rock complexes in the Seal Lake-Red Wine Mountains area of Labrador. ($7,400)
Goodwin, A.M. Geology Toronto	Midwest Superior Geotraverse: Geochemical and petrographic studies of 1) English River gneiss belt, and 2) adjoining Sturgeon Lake volcanic assemblage. ($10,000)
Hills, L.V. Geology Calgary	The stratigraphy, mineralogy, paleogeography, macropaleobotany and palynology of the Beaufort Formation, Arctic Canada. ($7,000)
Kay, B.D. Land Resource Science Guelph	Instrumentation development for in situ measurement of unfrozen water and ice content of frozen soils. ($7,000)
Kelly, R. Metallurgy and Materials McMaster	Studies on metamictization in minerals. ($6,400)
MacRae, N.D. Geology Western Ontario	Petrology and geochemistry of the Great Lakes Nickel Intrusion. ($1,250)
Matyas, E.L., Lelievre, B., White, O.L. Civil Engineering Waterloo	Shoreline erosion on the Great Lakes. ($10,000)

Name, Department & Organization	Project Title & Amount
McTaggart, K.C. Greenwood, H.J., Read, P.B. Geology British Columbia	Comprehensive study of the ultramafic rocks of the Canadian Cordillera. ($6,400)
Moore, J.M., Bell, K. Geology Carleton	Proterozoic volcanism in Canada. ($10,000)
Naldrett, A.J., Goodwin, A.M. Geology Toronto	Study of the sulfur content of volcanic rocks from different tectonic environments. ($6,500)
Nichol, I. Geological Sciences Queen's	The interpretation of exploration oriented geochemical data in computer processable data files. ($15,000)
Norris, G. Geology Toronto	Cretaceous palynostratigraphy and floral provinces of western Canada. ($3,700)
Price, R.A. Geological Sciences Queen's	Tectonic analyses of the southwestern Cordillera in Canada. ($12,000)
Roberts, R.G. Earth Sciences Waterloo	The magnesium metasomatism of acid vitroclastic tuffs associated with zinc-copper massive sulphide deposits. ($3,150)
Shaw, D.M. Geology McMaster	Rare metal distribution in Canadian Precambrian rocks. ($5,000)
Silvester, P., Telford, W.M. Electrical and Mining Engineering Montréal	Multiple-frequency telluric and magnetotelluric response over various resistivity anomalies. ($9,000)
Sinclair, A.J. Geology British Columbia	Preparation of a manual on the use of cumulative probability plots in the interpretation of mineral exploration data. ($4,600)

Name, Department & Organization	Project Title & Amount
Strong, D.F. Geology Memorial	Metallogeny of central Newfoundland. ($14,000)
Waterhouse, J.B., Oldershaw, A.E. Geology Toronto	Permian brachiopods and paleoecology of Yukon Territory and Arctic Archipelago of Canada. ($7,500)
West, G.F. Physics Toronto	Midwest Superior Geotraverse: Gravity, magnetics, seismics. ($8,000)
Williams, G.D. Geology Alberta	Coal deposits of western Canada. ($6,500)
Williams, H. Geology Memorial	The Twillingate Granite: a pre-Ordovician remnant within the Ordovician proto-Atlantic Ocean. ($7,250)
Young, G.M. Geology Western Ontario	Publication "Huronian stratigraphy and sedimentation" symposium. ($5,000)