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**GEOLOGICAL SURVEY
PAPER 79-6**

**THE GEOSCIENCES IN CANADA, 1978
ANNUAL REPORT INCLUDING A STUDY CONCERNING
THE GEOLOGICAL SURVEY OF CANADA**

**Prepared by
THE CANADIAN GEOSCIENCE COUNCIL**

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SUMMARIES OF THE MAIN ACHIEVEMENTS

OF CGC MEMBER SOCIETIES IN 1978

CANADIAN GEOTECHNICAL SOCIETY

During 1978, the Canadian Geotechnical Society continued to grow in membership to a total of 914. Most of the members are associated with one of the ten regional sections established in the major centres across the country. 658 or 72% of the members are also members of the Engineering Geology Division, at present the only technical division of the Society. Four technical committees of the Society were established last year, and cover the topics of Foundations, Slope Stability, Tunnelling, and Dams and Embankments.

Water - A Geotechnical Consideration was the theme for the 31st Annual Canadian Geotechnical Conference held in October 1978, in Winnipeg. The Conference and the Society's Annual Business Meetings were attended by approximately 250 people. Many interesting papers were presented under the broad theme of the Conference. Keynote addresses by J.A. Cherry of Waterloo, on Hydrogeology and the nuclear fuel cycle and by F.D. Patton of Vancouver on The role of water in the analysis of the Downie slide added to the overall theme. D.G. Fredlund of Saskatoon presented the second annual Canadian Geotechnical Colloquium entitled Appropriate concepts and technology for unsaturated soils. The third colloquium, as selected and commissioned by the NRC Associate Committee on Geotechnical Research, will be presented by P.R. Kry at the 1979 Conference in Quebec City. The topic will be "Ice forces on wide structures".

Traditionally, the two awards of the Society are presented at the Annual Meetings. The 1978 recipient of the R.F. Legget award for outstanding contributions to geotechnique in Canada was D.H. MacDonald of Niagara Falls.

Dr. MacDonald is Vice-President of Acres Consulting Services Limited. The thrust of his geotechnical input has been in the field of hydroelectric development where he has contributed greatly to the Nelson River and Churchill River development schemes. The Society Prize for the best paper published in the Canadian Geotechnical Journal was awarded to R.A.L. Hodge and R.A. Freeze both of Vancouver. Their paper was entitled Groundwater flow systems and slope stability.

Under the editorship of D.J. Bazett of Vancouver, the Canadian Geotechnical Journal continues to serve its Society well and is increasingly becoming a geotechnical journal of international standing. The year 1978 saw the change in the format of the Society's bimonthly newsletter. Now offset printed, the newsletter is produced by W.J. Eden and P.S. Selvaduri both of Ottawa, J.W. Gadsby of Vancouver and B. Ladanyi of Montreal. A third publication of the Society was published early in 1978. The Canadian Manual on Foundation Engineering contains chapters on properties of soil and rock and their measurement, shallow and deep foundations and earth retaining structures for the support of the walls of foundation excavations.

The technical committees got off to a good start. The Foundations Committee chaired by L.S. Brzezinski of Montreal is monitoring the reaction to the recently published Manual on Foundation Engineering and will be keeping the manual up to date. Under the direction of D.G. Fredlund the Slope Stability Committee is planning a symposium on slope stability in urban areas to be held in Toronto in the spring of 1980. B. Ladanyi is the Chairman of the Tunnelling Committee. This committee is conducting a survey of tunnelling contractors in Canada and plans to hold a Tunnelling Symposium in Montreal in September 1979.

Each year the Society sponsors a cross-country lecture tour to add to the technical sessions of ten regional sections. This year's lecturer was Dr. W.H. Ward of the Building Research Establishment, England. The topics he spoke on included Ground motion and the development of shear bands in an excavated slope in Oxford clay and "The construction and instrumentation of the Kielder Experimental Tunnel".

This year, at the request of the NRC Associate Committee on Geotechnical Research, the Society is undertaking a survey of all geotechnical research and its funding in Canadian Universities. The survey is being conducted through the regional sections and should be completed by April 1979.

The Engineering Geology Division of the Society is the National Group of the International Association of Engineering Geologists. In this capacity 12 members of the Division attended the 3rd Congress of the IAEG in Madrid, Spain in September 1978. Canada is the largest national group of the 35 countries which comprise the International Society. The Division would like to express their gratitude to Dr. O.L. White of Toronto who recently stepped down as the founding Chairman of the Division.

GEOLOGICAL ASSOCIATION OF CANADA

Toronto was the site of the GAC's 31st annual meeting, held during October, 1978 in association with the Geological Society of America and the Mineralogical Association of Canada. Attendance was 4826; technical sessions and field trips attracted participants from all over North America and from abroad. Close to 1000 papers were presented orally or in poster sessions, and about half of the speakers/authors came from Canadian centres. Particular

thanks go to the Toronto '78 organizing committee, without whose dedication and at times total involvement, the meeting would not have reached such a pinnacle of success.

Professor Aleksis Dreimanis of the University of Western Ontario was the 1978 recipient of the Logan Medal, in recognition of his major contributions to the field of Quaternary geology in Canada and internationally. Dr. Christopher Brooks of the University of Montreal won the 1978 Past President's Medal for a single contribution on the importance of rubidium and strontium isotope ratios in determining the magmatic source level of volcanic rocks. The year 1978 marked the initial award, by GAC's Paleontology Division, of the Elkanah Billings medal for excellence in paleontology. The first recipient of the Billings Medal was Dr. George Jeletzky of the Geological Survey of Canada, for his fine biostratigraphic and paleontological studies of Mesozoic rocks in western and northern Canada.

Plans are well advanced for the 1979 GAC/MAC meeting, which will take place in Quebec City May 21-26, with the Laval University Geology Department and the Quebec Ministry of Natural Resources as hosts. Future annual meetings will be in Halifax, Banff, Winnipeg and Victoria.

GAC's major periodical publications are Geoscience Canada, Geolog and The Canadian Journal of Earth Sciences (published by the National Research Council). Geoscience Canada completed its first five years of publication under the editorship of G.V. Middleton of McMaster University: the new editor is R.H. McNutt, also of McMaster. G. Williams of the Atlantic Geoscience Centre continues to edit Geolog, and E.R.W. Neale of the GSC Calgary continues to edit CJES. Special Paper 17 Late Silurian and Early Devonian graptolite,

brachiopod and coral faunas from northwestern and Arctic Canada, was published during 1978. Several special papers are nearly complete or well advanced, including the P.S. Warren Memorial Volume on Biostratigraphy, and the Robinson Volume on Precambrian sulphide deposits. The first two guidebooks of GAC's guidebook series are Vancouver Geology, which has sold over 3500 copies and is in its third printing, and Garibaldi Geology, which has sold over 1300 copies. Both of these are projects of GAC's Cordilleran Section.

The Atlantic Geoscience Society, an affiliated society of GAC, held its third biennial symposium in January in Fredericton, with the general theme of provincialism, as exemplified by distributions of sediments, magmatic rocks, tectonic styles and paleontology. The Cordilleran Section held a workshop in 1978 on the Selwyn Basin. All GAC sections and a number of university geoscience departments were visited across Canada by C.R. Barnes, the 1977 GAC Past President's Medal winner. Dr. Barnes' talk was entitled Ordovician paleogeography and conodont biogeography of Canada.

In February a submission on the management of Canada's nuclear wastes was made to the House of Commons Standing Committee on National Resources and Public Works: the GAC president, vice-president and an expert witness in the field of hydrogeology appeared in Ottawa before this committee to answer questions. A presentation was made in September to the 35th annual Mines Ministers Conference on Technology development in the earth sciences, particularly in exploration for non-renewable resources. The brief is reproduced herein.

Sunday October 1st, 1978 marked the first annual celebration of Logan Day, an event suggested and organized by GAC members. High public interest and involvement in fossil hunts, field trips, picnics, barbecues, etc. led by

GAC members across Canada demonstrated that this is an enjoyable and useful means of marking the past history and current health and excitement of the earth sciences in Canada.

Precambrian Division (K. Card, GSC)

The Precambrian Division of the Geological Association of Canada held its annual business meeting on October 24th, 1978 in Toronto, in conjunction with the GAC/MAC/GSA convention. The following officers were elected: K.D. Card, president; P.C. Thurston, vice-president; R.A. Frith, secretary-treasurer; E.F. Pattison, central councillor; E.W. Mountjoy, eastern councillor; W.A. Gibbins, northern councillor. Division membership now exceeds 200.

The Division, under the direction of past-president F.H.A. Campbell plans to convene a symposium on Proterozoic Basins and Geosynclines of the Canadian Shield at the 1980 GAC/MAC meeting in Halifax. A symposium volume will be published by the Geological Survey of Canada in 1980.

The current president of the Precambrian Division has been designated an ex officio member of the Subcommittee on Precambrian Stratigraphy of the IUGS. The subcommittee will conduct a field trip for its members in Canada and the U.S.A. in September, 1979. Objectives of the excursion include review of proposals for Precambrian time classification and of candidate Precambrian reference sections.

The Division plans to make a contribution toward an international time classification scheme for the Precambrian. Contacts have been established with the Canadian and US working groups of the IUGS Subcommittee on Precambrian Stratigraphy. A questionnaire designed largely to assess the level of interest and willingness to participate has been circulated among the Division members.

Response to date indicates that there is a high level of interest and that the Division can make a contribution. Tentative plans for an informal workshop and discussion at the May, 1979 GAC/MAC meeting in Quebec are being formulated.

Volcanology Division (L. Ayres, Univ. of Manitoba)

Because of the intimate association between volcanism and many mineral deposits in Canada, volcanological research continued at the same high level as in previous years. This emphasis, however, is not obvious from the brief list of volcanology projects in Current Research 1977-78 (GSC Paper 78-5), because many workers classify their volcanology related projects under petrology or mineral deposits. A more complete compilation of volcanology research can be found in the Canadian Geophysical Bulletin.

Research is focused in 3 geographic areas: 1) the Superior Province, particularly in the Archean Abitibi greenstone belt of Ontario and Quebec and the Proterozoic circum-Superior volcanic zone that rims the Superior Province from Labrador to Manitoba, and may represent an ancient rift zone; 2) Late Proterozoic and Paleozoic units of the Appalachians; and 3) Mesozoic and Cenozoic volcanism in the Cordillera, including geothermal resources. Much of the research is on geochemical aspects but there is increasing emphasis on the morphologic and stratigraphic aspects of volcanism. Morphology will be highlighted in a symposium and related field trips at the Quebec City GAC meeting. Zircon isotopic dating in the Uchi Lake area of northwestern Ontario by Nunes and Thurston (Ontario Geological Survey) recorded the oldest known date (2959 Ma) on Archean volcanic sequences in Canada.

On the international scene, Canadian researchers are active in many areas including Mexico, South and Central America, and various oceanic islands. Work on ocean floor volcanism is continuing at several centres. In the neverending terminology conflict, international committees are currently attempting to resolve the conflicting komatiite (high magnesium basalt) nomenclature, and work on pyroclastic nomenclature is continuing.

Since the Division was formed in 1973, it has met annually in conjunction with the national GAC/MAC meetings; current membership is about 150. The Division newsletter, Ash Fall, is issued several times a year and is both a means of communication among members, and potentially a forum for airing problems particularly in contentious subjects such as nomenclature.

A major objective of the Division is to ensure that volcanology sessions, symposia, and field trips, organized either by the Division or interested individuals are a part of each national meeting. The first major field trip of this type will be in April, 1979 when a group of 20+ volcanologists head to the Canary Islands for a first-hand look at recent volcanoes.

Winnipeg Section (G. Gale, Manitoba Dep. Mines)

Financial conditions have dictated a low profile in the Winnipeg section during 1978; although a few frontiers have been pushed back, no ground was eroded. The monthly meetings were maintained during the autumn and winter months by the good graces of a combination of the GAC visiting lecturers, visitor's 'passing-through' and local geologists from university and government. The efforts of Chris Barnes, Dan Ziehlke, Rand Harrison, Erik Nielsen, Robert Pinsent, Calvert Bristol and Hank Williams were greatly appreciated in enlightening lectures ranging from conodonts to squirrels, carbonates to granites, as well as the disappearance of Appalachia in all directions but one.

The remains of a thirteen-lined ground squirrel discovered below 1 m of till and Lake Agassiz clay at Grand Beach by Erik Nielsen should shed new light on paleoecological and paleoclimatic conditions in southern Manitoba during the Late Wisconsin. It is hoped that recent advances in ^{14}C dating can clear up some of the uncertainties surrounding the age of the specimen. The squirrel is tentatively believed to have lived during the dry interval between Lake Agassiz I and Agassiz II (10 000 to 11 000 years ago). Confirmation of this age will make the dry interval in southern Manitoba longer and more extensive than previously thought.

Even though Winnipeg is central and a fair number of geologists pass through the city, it is often on too short notice for us to capitalize on these visitors as guest speakers. It would be greatly appreciated by the geological fraternity here if colleagues who will be in Winnipeg for an overnight stay would advise either the GAC executive or the Department of Earth Sciences if they have a prepared talk; new faces and new slants on old theses are well received in a geological community as small as ours.

Recent changes in provincial politics have resulted in the migration of a number of GAC members out of the province. This has been offset to some extent by a noticeable increase in visiting explorationists as the political climate becomes more tolerable for private industry. The provincial governments' policy of restraint has unfortunately affected GAC activities. A one-day annual meeting had to be cancelled at the last moment when the executive were informed by management that the government geologists would be far too busy to either make presentations or take time off from their duties to attend the deliberations. Hopefully, this type of restraint will give way to a more

enlightened attitude in the near future and the local section can get on with fostering and promoting a greater interest in both the geological sciences and Manitoban geology.

Structural Geology and Tectonics Division (W. Fyson, Univ. Ottawa)

Structural geology and tectonics encompass a wide range of activities. Most geological mapping programs undertaken by the federal or provincial surveys and universities include an element of structure. Practically all have tectonic implications. Thus well over 200 projects of current research listed for 1977-78 (GSC Paper 78-5) had a significant structural or tectonic component. These included studies of Archean, Proterozoic and Phanerozoic rocks in areas scattered across Canada's extensive outdoor laboratory; all provinces and territories, except Prince Edward Island, were represented. Stratigraphic studies are important for the large-scale tectonic or geotectonic picture, and perhaps the highlight in this field during the past year was the publication of a lithotectonic map of the Appalachians, from Newfoundland to Alabama.

Less than 100 of the projects listed (GSC Paper 78-5) were primarily concerned with structural interpretations. Publications arising from these projects were, as in previous years, mostly field oriented and concerned with understanding the nature and origin of megascopic and smaller structures. Mineral or shape fabrics in metamorphic rocks received considerable attention, and several papers, including a few that were wholly theoretical, described techniques of investigation, or micro and larger patterns, of fundamental interest. Experimental work was limited. It included refinements of model analogues developed elsewhere and an attempt to relate them to natural structures.

A successful symposium on analytical techniques in structural geology with accompanying field trips was organized by members of the Structural Geology and Tectonics Division at the joint GSA/GAC 1978 meeting in Toronto. We look forward to similar symposia and field trips in future years.

Paleontology Division (R. Ludvigsen, Univ. Toronto)

Founded in 1975, and currently with some 75 active members, the Division sponsored in 1978 a well-attended symposium on Zonal Boundaries and Speciation at the GAC/MAC/GSA annual meeting.

In 1978 the Division presented the Elkanah Billings Medal to Dr. J.A. Jeletzky of the GSC for his seminal work on Jurassic and Cretaceous macropaleontology of western and arctic Canada.

The Division cosponsored the Biostratigraphy Seminar held in September in western Newfoundland.

We are attempting to bring the Third North American Paleontological Convention to Canada in 1982.

Current plans include organization of two symposium at the GAC Meeting in Quebec City -- one of Ecostratigraphy and one on Anticosti Island paleontology as well as cosponsorship of the 1979 Biostratigraphy Seminar in Edmonton and Jasper.

The problem of publishing paleontological monographs in Canada has been a serious one, particularly with university paleontologists. The division is investigating the possibility of publishing such a monograph series under GAC auspices.

Executive elected at GAC/MAC/GSA meeting: Rolf Ludvigsen (Toronto) Chairman; Bernard Mamet (Montreal) Vice-Chairman; Alfred Lenz (Western Ontario) Secretary-Treasurer; Pierre-Andre Bourque (Laval) Councillor; Graham Williams (Bedford Inst.) Councillor.

Environmental Earth Sciences (J. Terasmae, Brock Univ.)

In the past year environmental earth sciences have become increasingly involved in urgent matters of national concern, and the problems of waste disposal, especially those substances that can be harmful to health, have attained prominence. Clearly it is the responsibility of environmental earth scientists to provide the necessary baseline data before effective solutions for these problems can be achieved. Recent symposia on environmental geochemistry of radionuclides, dispersion in groundwater flow systems, and toxic substances in the subsurface environment indicate some current fields of active research.

Research on the potential use of underground space is promoted by Dr. R.F. Legget as an innovative area of interest in environmental earth science. A two-day seminar on toxic substances in the subsurface was held at the University of Waterloo in November.

It must be emphasized, however, that the more 'traditional' areas of activity covering water resources, permafrost, soil mechanics, and geomorphology are of equal environmental importance.

One of the rather unique aspects of environmental earth science is that it frequently impinges on political decisions, as indicated by many recent public hearings on environmental problems, and the involvement in legal matters is a new development that should be considered in the training of our future generation of environmental earth scientists.

The funding of environmental earth science research has remained inadequate in comparison with the importance that it deserves in our national structure and scope of environmental problems.

Edmonton Geological Society (G. Mossop, Alberta Research Council)

The community of geologists in Edmonton remains relatively small but very diverse, encompassing earth scientists at the University of Alberta, the Alberta Research Council, and various private and commercial firms. During 1978, membership in the Edmonton Geological Society rose to 70, with good representation from all areas of geological endeavour. The luncheon meeting program, involving the presentation of technical papers by distinguished geologists, continued with great success. New initiatives in the area of field trips, presentation of short courses, and running earth science workshop for school science teachers have now either come to fruition or are scheduled for early 1979. The society continues to enjoy a beneficial affiliation with the Geological Association of Canada, as its Edmonton Section.

Cordilleran Section (R. Beavon, Vancouver)

The Cordilleran Section of GAC featured two innovations in 1978: the first, held on February 10th was the Penrose-style Selwyn Basin Workshop with specialist participation; the second held September 30th was the Logan Day celebration as reported in Geolog and the Western Miner.

Evening lectures on a wide range of geological subjects continue to be popular despite some reluctance to re-commute to downtown Vancouver.

Reprinting of Field Guides of the 1977 GAC, GSA, MAC, SEG Meeting was undertaken to satisfy continuing demand. These Guides include information on

Cordilleran geology that is not available or not published elsewhere. They are available at GSC, 6th Floor, 100 W. Pender St., Vancouver, B.C. V6B 1R3.

Other activities included preparations for the 1979 Symposium on The cratonic margin of the Cordillera and associated mineral deposits.

Newfoundland Section (R.J. Wardle, Newfoundland Dep. Mines and Energy)

The year's activities commenced with the annual fall meeting, held this year in Grand Falls. About 40 people attended and heard a variety of presentations on Newfoundland and Labrador geology.

The meeting was followed by a two-day field trip, led by Steve Colman-Sadd and Cyril O'Driscoll to examine the geology of the Avalon and Gander zones in the Baie d'Espoir region of Newfoundland's windswept south coast.

The year has also seen the publication of two further issues of the Melange, a lively quarterly newsletter which reports on geoscience and geological activities in the Province, and two issues of the Newfoundland Journal of Geological Education. The Journal is a rapidly expanding publication which aims to present semitechnical accounts of original research in the Province to senior high school and first year university students. The journal is currently distributed free of charge to all Newfoundland high schools, all Canadian geoscience departments, all national and provincial libraries and is also available on a subscription basis.

This year has also seen the revival of an old local section tradition, the monthly luncheon meeting. Two such meetings have been held to date.

The local section has also decided to award an annual \$300 scholarship to a student in his/her third year of geoscience at Memorial University.

Future plans for the year centre round the spring annual meeting which will be held around March, 1979. It is currently intended to run a one-day short course on age dating techniques at this meeting. Particular reference will be given to problems of Newfoundland and Labrador geology.

CANADIAN INSTITUTE OF MINING AND METALLURGY; GEOLOGY DIVISION

Activities of the Geology Division in 1978 continued to be widespread and varied in scope. At the CIM 1978 annual general meeting, held in Vancouver, the Geology Division organized five half-day technical sessions which included a total of 28 papers. In compliance with the general theme of the meeting - Minerals for Energy - two sessions centred on uranium deposits and one joint session organized in cooperation with the Canadian Geothermal Resources Association emphasized geothermal energy. The remaining sessions were dedicated to massive sulphides and general geological topics, a short course on exploration geochemistry attracted 60 participants.

The Barlow Memorial Medal, awarded annually to the best geological paper published in the CIM Bulletin during the previous year (1977), was awarded to G.D.J. (Julian) Boldy, Chief Geologist, Gulf Minerals Limited, for his paper (un) Certain Exploration Facts from Figures.

The Geology Division nominee, Dr. W.H. Gross, President of Lacana Mining Corporation Limited, was selected as one of five CIM distinguished lecturers for 1978/79. These honorary positions are selected on the basis of distinguished service and accomplishments related to the mineral industry.

Each year the Geology Division sponsors the university visiting lecturers program to provide liaison between industry and the universities. Thirty-one universities received visiting lecturers sponsored by this program in 1978/79.

First prize in the undergraduate student essay contest was awarded to T.M. Harrison of the university of British Columbia for his essay, Fission-track, potassium-argon and rubidium-strontium geochronology and thermal history of the Coast Plutonic Complex, near Prince Rupert, British Columbia.

The annual Geology Division field trip for 1978 centred on Yukon Territory mineral deposits. The excursion included three widely divergent types of deposits at the Anvil, Keno Hill and Whitehorse copper mines.

During 1978 the Geology Division initiated a special volume on Uranium Deposits in Canada which is being organized and edited by Dr. D.S. Robertson of Toronto.

1978 marked the beginning of the reorganization of the Geology Division, the initial step has been to revamp the publications committee and its duties to ensure the high-quality of all geological papers published in the CIM Bulletin. To achieve this goal, four associate editors, each responsible for specific subdisciplines, have been appointed to ensure each paper is closely scrutinized by two or more reviewers.

CANADIAN GEOPHYSICAL UNION

The Canadian Geophysical Union is a division of the Geological Association of Canada and of the Canadian Association of Physicists. In May, 1978, the Union had an independent meeting in London, Ont. A report of this

meeting has been published in EOS and by all accounts it was a success. The next meeting will be held June 4-6 in Fredericton, N.B. In 1980 the CGU jointly with the Division of Atmospheric and Space Physics of the CAP and the Canadian Meteorologic and Oceanographic Society will host the first annual meeting of the American Geophysical Union to be held outside the United States in Toronto. It should be noted that one of our founding members, J.T. Wilson is the incoming AGU president and will be installed at the Toronto meeting.

KEGS cosponsored a session on exploration geophysics in London and the CSEG and the CIS will cosponsor sessions in Fredericton on offshore exploration of the east coast and on Gravity Field and Positioning.

At the London meeting, the CGU awarded the first J. Tuzo Wilson medal to Prof. J. Tuzo Wilson. This medal is for "distinguished contributions to geophysics in Canada".

The CGU is also responsible for nominating 5 members of the Canadian National Committee of the International Union of Geodesy and Geophysics. These nominations will be made in 1979.

The following short reports describe highlights of the past year's activities. Details are contained in the Canadian Geophysical Bulletin edited by M.E. Evans and published through the courtesy of the Earth Physics Branch.

Geodesy (D. Wells, Environment Canada)

Geodetic activity in Canada in 1978 reflected an international trend (the application of geodesy to geodynamics) a continental trend (preparation for the redefinition of the North American geodetic networks) and a national trend (restructuring of the surveying profession).

Techniques for applying geodesy to geodynamics which were under study this year include microgeodetic networks across active faults, analysis of sea level records, precise gravimetry, analysis of earth tides, use of inertial surveying systems for vertical deflections, long baseline interferometry, and crustal tilts from geometric levelling.

As the 1983 redefinition of the North American horizontal geodetic networks approaches, increasing emphasis was placed on problems of geodetic data base management, compatibility between conventional, inertial and satellite data, testing of procedures for large adjustments, and maintenance of networks after redefinition. Problems associated with the 1985 redefinition of the North American vertical geodetic networks began to receive attention in 1978.

Canadian work formed an important contribution to the North American datum symposium in Washington in April. Announcement in August of the cancellation of federal support for the land registration and information service (LRIS) created serious problems for the maintenance of a geodetic data base in the Maritimes.

Network redefinition and new technologies such as satellite and inertial positioning are forcing a restructuring of the surveying profession in Canada. This year one of the major deficiencies in geodesy in Canada was addressed as Canadian geodesists took steps to upgrade the geodetic background of surveyors across Canada. Geodesists prepared a set of seminars on the impact of redefinition and new technologies on the surveying profession (sponsored by the geodesy and control surveys committee of the Canadian Institute of Surveying) these were presented in Edmonton in November and will be repeated regionally across Canada. LRIS sponsored preparation of a more

detailed set of seminars on geodesy, prepared at the University of New Brunswick.

The remaining major deficiency in geodesy in Canada continues to be the insufficiently accelerated application of geodetic techniques in the marine environment, particularly in arctic waters.

Geomagnetism (J.M. Hall and P.J.C. Ryall, Dalhousie University)

Activity. Work has continued in four main areas, study of the main field, the use of temporal variations in the study of crustal conductivity, paleomagnetism of continental and ocean rocks and mapping the history of the oceanic crust using linear magnetic anomaly patterns.

Highlights. Marine magnetic data continues to be recorded as part of ongoing multiparameter surveys concentrated in the Labrador Sea. The marine magnetic anomalies have been identified and used along with other geophysical data to determine the plate-tectonic evolution of the area. The results favour an interpretation in which Greenland moves north relative to North America from 75-60 Ma and moves past Ellesmere Island along Nares Strait from 60-40 Ma. Magnetics are being used along the Atlantic coast to extend Palaeozoic basement trends on the shelf to allow trans-Atlantic correlations with European trends.

Geomagnetic variation data from the northeastern United States has been analyzed to reveal the presence of a linear conductivity anomaly which runs parallel to a regional aeromagnetic lineament west of the New York - Vermont border which may be associated with a basement fracture zone.

A magnetometer array study of crustal ultramafic structures in the tip of South Africa during late 1977 by University of Alberta and South African National Research Laboratory has provided interesting new knowledge of plate interactions in the late Proterozoic.

Work is proceeding at several laboratories on the problem of the magnetization of ancient terranes. Investigators face two problems, first the clear separation of different components of magnetization generally requires very careful thermal demagnetization with many small temperature steps near to the blocking temperature. Secondly, criteria for the assignment of ages to the different components have to be developed. Several studies published during the last year show that it is beginning to be possible to unravel and date these complicated magnetizations.

Continuing study of the magnetism of the basalts of oceanic layer 2 has led to the use of the magnetic directions in mapping the tectonic state of the layer. The few observations presently available suggest, at least in the North Atlantic, that it is much more tectonically disturbed than had been supposed. Sampling of the 3 km thick crustal section in oceanic type rocks in Iceland by Canadian and other investigators is likely to aid in understanding the source of the linear magnetic anomaly patterns of the ocean lavas.

Knowledge of the geomagnetic history of the last 5 my is being refined by paleomagnetic study in Canada of two 1200 m drill cores from the Great Hungarian Basin.

Petroleum Geophysics (Dr. A. Easton Wren, Calgary)

The recovery which began in 1976, thrived in 1977 has seen a boom year in 1978. Geophysical exploration has reached record levels in Alberta and is increasing in British Columbia, Saskatchewan, Ontario, offshore Eastern Canada and the Arctic. Seismic crew counts reached 100 in January 1977 and will reach the same level by Christmas 1978. The overall activity level in crew months is double that for 1977.

The reason for this is primarily economic and reflects world oil prices as well as the drilling and geophysical incentive programs initiated by the Provincial Government of Alberta. However the economic momentum has been accompanied by an influx of new techniques and technology in the areas of acquisition, processing and interpretation. The larger more obvious hydrocarbon targets have long since been investigated and geophysics is being finely tuned to the more subtle stratigraphic traps.

The recent successes at Pembina (D.2 - Nisku reef) and Elsworth (Cretaceous Sandstone) are indicative of geophysical plays. There is no question that there is a growing appreciation and understanding of geophysics by management of most oil companies. The realization that geophysics can minimize the statistical odds in exploratory drilling is rapidly becoming accepted.

A highlight of the year was the Canadian Society of Exploration Geophysicists Annual Convention in the Calgary Inn. A fine technical program was well received by a large audience of 800 delegates.

Mining Geophysics (Norman R. Paterson, Paterson, Grant & Watson Limited)

Energy-related exploration geophysics continued to be very active in 1978, with a correspondingly high level of industry recruitment at both the graduate and postgraduate levels. Base metal exploration showed some signs of recovery, with more mining companies undertaking geophysical programs in the Yukon, British Columbia, Newfoundland and, to a lesser extent, in the central provinces.

The major event in exploration geophysics this year has been the application of a wide variety of complementary techniques to the search for uranium in the Athabasca Basin of northern Saskatchewan. The apparent relationship of the mineralization at Rabbit Lake, Key Lake and Midwest Lake to graphitic shears in the Archean basement has encouraged companies to carry out large-scale surveys combining EM and magnetics to locate favourable environments and structures. Airborne INPUT surveys, followed by wide-band, large separation ground EM, have been applied, with apparently increasing success, to depths of up to 800 feet. Quantitative magnetic analysis has been used effectively to determine basement topography. Large crystal gamma ray spectrometry has led to several discoveries both in the Athabasca Basin and in other Proterozoic areas of the Northwest Territories. There has been increasing acceptance of the multi-channel analyzer in both uranium exploration and radiometric mapping. The growing availability of high sensitivity spectrometer data has stimulated research into the problems of obtaining accurate estimates of elementary abundances in the ground. Research work is also underway in the area of pattern recognition and computer-zoning of spectrometer data.

The spectrometer had an unexpected stimulus in 1978 with the untimely demise of the Soviet COSMOS 914 nuclear satellite over Great Slave Lake, Northwest Territories. Using a combination of airborne and ground methods the Geological Survey and private contractors carried out an intensive and amazingly successful search for radioactive fission products. The pieces recovered varied from pin-head size to several 10's of cm. The generally low energy levels of the debris called for the measurement of bands and ratios not normally recorded in exploration geophysics - a good example of the ability of geophysicists to adapt techniques to the problems in hand.

In base-metal geophysics wide-band EM, drillhole methods (including VLF), and computer processing and analysis of data all received active research, and increasing field application. Studies continued at University of Toronto in the application and interpretation of wide-band EM for both layered and 3-dimensional structures. Some of this work was sponsored by the new Ontario Geoscience Research Grant Program. At the Mineral Exploration Research Institute in Montreal federally sponsored work was undertaken in drillhole VLF and telluric current measurements. Magneto-telluric research continued at the same Institute, with emphasis on applications to mineral exploration; experiments were conducted in the Abitibi greenstone belt. The University of Toronto conducted Ontario government supported research into the magnetic properties of well-studied volcanic rocks (Black River volcanics) in order to establish relationships of use in magnetic prospecting in such environments. The University of Windsor - also supported by the Ontario Government - started a program of detailed magnetic analysis of iron ore deposits, for the purpose of aiding quantitative interpretation of magnetic surveys as well as to study ore genesis.

There is an increasing interest in the application of geophysics to the location of sites suitable for nuclear power development and nuclear waste disposal. The CGC sponsored a symposium at the November GAC-GSA meeting in Toronto on this subject. Airborne magnetic gradiometer and wide-band EM surveys were carried out on both a research and production basis for this purpose in 1978. Seismic refraction and reflection, electrical resistivity/IP, VLF and audio frequency EM and micro-gravity were applied to site investigation problems for federal and provincial governments and utilities.

University enrollment appears to be about the same as in 1977 but at the graduate level there may be a shortage of students as more are being attracted into industry. We may be faced in 1979 with a problem of finding qualified M.Sc. and Ph.D. level students to carry out research program already started and for which funding is available.

Mathematical Geophysics (Chris Beaumont, Dalhousie University)

The continued strength of mathematical geophysics was in evidence during the whole day session on 'Mathematical Geophysics' at the first solo Canadian Geophysical Union Meeting at the University of Western Ontario in May. Michael Rochester is to be thanked for organizing that session. Strengths, if judged by activity and number of researchers in that field, continue in four main areas. Electromagnetic and Fluid Dynamics Properties of the Earth's Core, Michael Rochester, Memorial, and Doug Smylie, York, have extended their analytical work on core dynamics to include among others the effects of compressibility. Work has continued with John Linton, York, and Oliver Jensen, McGill, on the normal mode gravimeter. David Crossley, McGill, and Po Shen, Earth Physics, have also made contributions to the core oscillation problem.

Long Term Geodynamics (periods $>10^3$ years). Little is presently being done in Canada on the theoretical aspects of mantle convection apart from work by Howard Sharpe and Dick Peltier, Toronto, who have modelled the convective evolution of the Earth since accretion. They conclude, in the same vein as McKenzie and Weiss, that convection has been the dominant mode of energy transport throughout the Earth's history. Peltier and Patrick Wu have continued work on glacial isostasy. In this context Chris Beaumont and Garry Quinlan are applying Peltier's results to a detailed study of glacial rebound in Atlantic Canada. Other work at Dalhousie on geodynamics concerns the rheology of the lithosphere, a problem that is also of interest to Giorgio Ranalli, Carleton. Edo Nyland, Alberta, and his students have modelled shear heating at the base of the lithosphere and consolidation beneath recently impounded reservoirs.

Mathematical Seismology. Chris Chapman, Toronto, and F. Hron, Alberta, have continued to contribute to the theory of synthetic seismograms. In particular, Chris Chapman has developed a method employing the Radon transform that can be extended to earth models with lateral inhomogeneties. Techniques in Time Series Analysis. Tad Ulrych, UBC, and Oliver Jensen have continued independent studies of maximum entropy (auto-regressive) modelling of time series. Work on digital data processing also continues at the universities of Western Ontario and Alberta. Interpretation and Inverse Theory. An interesting new development is the theory for the joint inversion of magnetotelluric and direct current observations which was presented at the CGU meeting by Doug Oldenburg, UBC.

Geochronology and Stable Isotope Studies (P.H. Reynolds, Dalhousie Univ.)

The general level of productive activity in Canada has remained substantially constant over the past twelve months. Approximately 100 people are involved in one way or another with various geochron-stable isotope studies.

There are, however, only about 20 active 'group leaders'. On the geochronology front, the main emphasis continues to be the more or less routine isotopic age determination work using conventional K-Ar, Rb-Sr and U-Pb methods; the ages obtained form part of the basic data base of a wide spectrum of geologic projects. Workers in the stable isotope field are making significant contributions in a number of disciplines (for example, in aspects of oceanography, hydrology, environmental geology, climatology and in the study of extraterrestrial samples). Of the active laboratories in the country, probably only half could be considered fully 'state-of-the-art' operations. The remainder have fallen behind, the deficiencies being chiefly in the data processing area. There exists in the country as a whole five or six 'centres of excellence', laboratories which are distinguished because of high levels of productivity and/or by especially innovative research (for example, Derek York's argon dating lab at the University of Toronto, Brian Clarke's helium isotope work at McMaster). It is encouraging to see the involvement of Canadian scientists in the development of accelerator-based ^{14}C dating. It is, on the other hand, unfortunate that no one in Canada is doing Sm/Nd dating.

A noteworthy event which was not mentioned in last year's report was the visit of a delegation of isotope geologists from the People's Republic of China to a representative selection of Canadian isotope laboratories all the way from Halifax to Vancouver. The visit was repaid (late in 1977) by a Canadian delegation. To this reporter's knowledge, there has been little if any resulting collaboration or other follow-up to these visits.

Some university researchers continue to complain about the inadequacy of annual operating funds and/or the lack of stable long-term financing. At least a partial solution to these problems might be provided by an increase in the

amount of contracting out by government agencies. Any proposals to further expand the national 'physical plant' should be examined critically. (There are, for example, at least four relatively new stable isotope mass spectrometers in the Toronto-London region of south-western Ontario). Major new installations (for example, an ion microprobe) must be set up as a regional (or even a national) facility perhaps operated along the lines of the major astronomical observatories.

Seismology and Physics of the Earth's Interior (E. Kanasewich, Univ. Alberta)

The demands for geophysical graduates with expertise in exploration seismology continued to dominate this year's activities. In greatest demand are students with an M.Sc. degree in seismology. Graduates with a Ph.D. in seismology and also several years of practical industrial experience are also in great demand.

Much more research is being carried out on Canadian seismicity through environmental studies on the possibility of triggering by industrial activity in the forms of new dams and the extraction of hydrocarbons. These energy based studies are focussed on the Mica dam in British Columbia, the James Bay project and the areas of Rocky Mountain House, Cold Lake and Fort McMurray in Alberta. In parallel with increased crustal structure research by the COCORP group in the USA and by European seismologists, more crustal work is being done with particular emphasis in Newfoundland, the Manitoba-Saskatchewan border, British Columbia, and the high Arctic.

Mathematical modelling of elastic media by synthetic seismograms continues to occupy a large number of seismologists in universities. This is becoming an area in which Canadian expertise is recognized on a worldwide

basis. On a broader basis, several geophysicists are studying the free oscillations of the earth and undertones using mathematical modelling and experimental data. The possibility of detecting waves with periods greater than one hour is particularly exciting since it would provide direct information on the structure of the core of the earth.

The high rate of inflation continues to limit the amount of field observational data that is being collected. With the increasing power of computer centres, mathematical modelling is favored over the acquisition of new results.

Report on Gravity for the Canadian Geoscience Council (J. Tanner, Earth Physics Branch)

A major revision of the national gravity control network for Canada was made in 1978. This revision reduced the number of stations in this primary network from about 3500 to 1800 and was carried out with the view to completing a major readjustment of it in 1980 or 1981. Regional gravity mapping by the federal government and more detailed gravity mapping by the provinces continued at about the same level of activity as in previous years. The amount of coverage, however, was probably slightly reduced because of increasing costs and difficulties in operating in the remote and/or hostile areas remaining to be surveyed. Approximately 80% of Canada is covered by gravity stations at intervals of 15 km or less. Gravity surveys within the petroleum industry continued with perhaps a slightly increased emphasis on gravity surveys carried out in conjunction with seismic operations. Within the mining industry no survey of activity was carried out, but it is believed to be comparatively stable.

Significant steps were made towards improving our capability of carrying out highly precise gravity surveys (nanogravimetry). A limiting factor in the accuracy of such surveys is the lack of a sufficiently good calibration

standard to determine both scale and linearity of the gravimeters. While experiments are underway outside Canada with the aim of producing an absolute apparatus capable of measuring gravity accurately to 20 or 30 nm/sec² it is unlikely an operational apparatus will be available before five years.

It is also worthy to note the continued progress being made with research into the application of dynamic gravimeters (mounted on a 3-axis stabilized platform) toward the establishment of the horizontal and vertical positions of points on the Earth's surface. Experiments in 1978 demonstrated that it is possible to position points with sufficient accuracy for regional surveying. Future research will be directed towards establishing whether the approach is feasible economically and perfecting techniques.

Steady advances continued to be made in both our understanding of the cause of regional gravity anomalies within Canada and the methods used to interpret gravity anomalies. Principal among the former is the continuing study of gravity anomalies over the boundaries between structural provinces, where the emphasis is gradually shifting to the study of younger fold belts such as the Appalachians and eventually the Cordillera. The results of these investigations of younger fold belts may prove important to our understanding the evolution of the Precambrian crust. In any event this research appears to be providing a significant stimulus to geological and geophysical research in Canada. The major advances in interpretation techniques involved the increasing use of the so-called "inversion techniques". These methods offer the hope of being able to not only interpret analytically gravity data simultaneously with other geophysical data, but also to place limits on the possible range of gravity interpretations.

CANADIAN SOCIETY OF SOIL SCIENCE HOSTS A SUCCESSFUL
INTERNATIONAL SOILS CONGRESS

For four years or more the Canadian Society of Soil Science has been planning for the hosting of the Eleventh International Soils Congress which took place in Edmonton, June 19 to 27, 1978. More than eleven hundred soil scientists from 65 countries participated in the Congress whose theme was Optimum soil utilization systems under differing climatic restraints.

In part the success of the Congress resulted from the variety of types of scientific papers and diversity of exhibits. Over 10 percent of the 387 papers presented were by invited speakers either to the plenary sessions devoted to the Congress theme or to symposia on timely topics such as: Isotopes in Action, Soil deterioration and reclamation through man's activity. Of the remaining 321 volunteered papers 56 were in the form of poster presentations.

The Congress was preceded and followed by eleven multiple day tours which ranged from Halifax to Vancouver to Inuvik, and involved 344 participants. The variety of one day soils tours from Edmonton and Vancouver were highly popular, attracting 473.

For those who could not see Canada's soils directly, there was an outstanding display based on the Canadian System of Soil Classification. There were such exceedingly favourable reactions to this display that a publication from it is in preparation. Commercial exhibits and a variety of historical and educational displays operated throughout the Congress.

Organizing Committee Chairman, C.F. Bentley credits the success of the Congress to "the combination of generous supports of innumerable kinds, outstanding quality and amounts of volunteer help, and late surge of registrations."