CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

GEOLOGICAL SURVEY OF CANADA

ANNUAL REPORT

APRIL 1, 1972 TO MARCH 31, 1973

FOR DEPARTMENTAL USE ONLY

OTTAWA
1973

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ANNUAL REPORT APRIL 1, 1972 to MARCH 31, 1973

GEOLOGICAL SURVEY OF CANADA

INTRODUCTION

Y. O. Fortier, Director

This report, intended for departmental use but not for public distribution, gives a broad overview of all the scientific and technical support units of the Branch. At the beginning of the period covered by this report, the Atlantic Geoscience Centre, Dartmouth, N. S. became a division of the Survey thus truly extending our activities '*a mari usque ad mare*'.

Internal reporting procedures now provide readily available annual statements on the activities of each of the more than 400 approved scientific projects and these are not included in this report.

The Geological Survey of Canada surveys the materials and attributes of the landmass of Canada, its composition, forms and natural processes as potential resources and conditioners of terrain use and development. Its program, broadly inventory in character, is directed to: understanding of the natural resource base; identification of resources; appraisal of the natural resource endowment, and determination of the environment of the resources. The resources to be appraised are mainly non-renewable. They range from the extractive mineral and fossil fuel resources to the non-extractive materials and attributes of the terrain that condition landmass utilization and conservation (local, urban, regional).

The Geological Survey manages a system of information that provides an input to its program, comprises a national geoscience information base and conveys the results of its surveys and appraisals.

The major classes of G.S.C. activities are:

1. Geoscience survey of the Canadian landmass defined as the National Resource Base for energy, minerals and terrain attributes.

2. Geoscience Exploration Guidelines and Technology for Resource Identification.

3. Geoscience analysis, appraisal and measurement of Natural Endowment in Resources.

4. Data and information management system.

5. Supporting services.

During 1971-72, the authorized strength of the Geological Survey was 704 man-years (including 112 casuals) and the budget was about 17-million dollars. Although most studies were directed by staff members, some were led by scientists employed under personal service contracts in line with current government policy of contracting out wherever possible. Work such as aeromagnetic surveys, as in the past, was carried out under contract.

Substantial progress was achieved during the year in structuring the program of branch activities in accordance with departmental mission and objectives. Grouping of projects into activities and sub-activities and the display of these into a matrix together with program sub-objectives already permits a more efficient management and a more ready explanation of the Branch total program.

A new senior officer of the Geological Survey is Dr. B. D. Loncarevic, Director of the Atlantic Geoscience Centre. Many senior officers have left or have indicated their intention of leaving the Geological Survey for various reasons. These are Miss G. Derry, Scientific Program Secretary; Dr. S. Duffell, Assistant Chief of Regional and Economic Geology Division; Dr. S. C. Robinson, Acting Assistant Director for Planning, Dr. C. S. Lord, Chief Geologist, and Dr. Y. O. Fortier, Director.

During the report period, we published 48 new geological maps, 44 preliminary reports, 15 final reports and 379 aeromagnetic maps. In addition, continued public interest necessitated reprinting 21 reports, 12 geological maps and 99 aeromagnetic maps. Open file releases, an expeditious means of making new data available to the user public, continued to expand and 56 such releases were made. As well as these in-house publications, Survey officers published more than 180 papers in various scientific journals and took part in many scientific meetings and participated in university lectures and seminars.

Last August the culmination of several years of planning and hard work by many staff members was reached when the 24th International Geological Congress opened in Montreal. More than 3,900 attended the meetings. Fourteen Survey officers acted as convenors for the technical sessions, 22 chaired technical sessions and 56 staff members were among the 205 leaders and co-workers who organized the 64 major geological excursions. In addition, three permanent employees of the Survey served as Secretary-General, Assistant Secretary-General and Organizing Secretary of the Congress, and others served on the National Organizing Committee and the Executive Committee. Our contribution to this great meeting was indeed commensurate with our status as the major earth science agency of the federal government.

ATLANTIC GEOSCIENCE CENTRE

B. D. Loncarevic

Introduction

The Atlantic Geoscience Centre is responsible for the geoscientific description and inventory of that part of Canada which lies in the eastern offshore and adjacent onshore regions. To carry out these responsibilities the Centre has initiated programs of systematic geological mapping and subsurface investigations of sample cuttings and cores from wells drilled in exploration for petroleum and natural gas, mainly in the offshore regions. In addition, the study of modern present day sedimentary processes is carried out in order to more accurately reconstruct the geological processes that operated in the ancient past.

The data acquired as a result of detailed and reconnaissance studies is analyzed and synthesized to provide:

- an inventory of mineral resources;
- information to the Department for rational management of these resources;
- a scientific basis for a wide spectrum of decisions affecting the offshore regions;
- advice and information to Canadians in all sectors of economic and cultural life;
- a contribution to the world storehouse of knowledge.

A major objective of AGC is to provide Canadians with the geoscientific knowledge to assist in the exploration for and successful exploitation of the non-renewable resources of the frontier areas of eastern Canada. The strategy for this objective requires planning both on short-term and long-term basis.

The short-term program requires an immediate contribution to the Departmental need for mineral resource evaluation. In the eastern offshore, oil and gas are presently considered the more important potential resources. In view of the large Canadian continental shelf, and considering estimates that up to 40% of world hydrocarbon production will be from offshore regions by 1985, there is an urgent need to develop geological techniques and methodology to accurately determine the potential hydrocarbon reserves available to Canada. Exploitation of these resources, as well as other activities of man, impinge on the marine environment, and the Atlantic Geoscience Centre has a major role to play in evaluating probable consequences of such activities. The Centre is therefore concerned with immediate or short-term problems and the staff are frequently called upon to study and recommend a remedial action necessary to restore the already damaged environment. Typical problems are oil pollution of beaches, removal of shore materials by erosion and dredging, and the affect of industrial activity on benthonic faunas.

Within the long-term program there is a need for detailed and reconnaissance descriptions pertaining to the composition, thickness and structure of the sediments comprising the eastern Canada offshore regions. An important component of this work is subsea and subsurface geological mapping utilizing all facets of bottom sampling, dredging, coring, and geophysical profiling in conjunction with the study of sample cuttings, cores, mechanical well logs and other information from wells drilled in exploration for petroleum and natural gas. Because of the magnitude of the offshore area, much of the work for some time to come will be of a reconnaissance nature. A fundamental problem still is the nature of the boundary between the continental and oceanic crust at the continental margin. Very little is known with respect to the position and tectonic implications of this boundary, yet on a worldwide basis it constitutes a geological feature of first-order importance. There are indications also that this boundary has major economic significance with respect to the development of structures conducive to the accumulation of hydrocarbon resources.

Another component of the long-term program is research and development, both in the form of methodology and technology to facilitate the various scientific projects within the Centre. Modern marine research is dependent on sophisticated instrumentation which rapidly changes with technological advances in electronics. It would be unreasonable to expect significant contributions from marine surveys lacking the proper backup support of advanced instrumentation development.

Both short-term and long-term programs require competent administrative and technical support services. These have been inadequate in the past, but considerable advances are being made in the recruitment and organization of support staff which in future should greatly facilitate the research programs of the Atlantic Geoscience Centre.

Organizational Framework

The Atlantic Geoscience Centre was officially formed in December 1971 with the uniting of Marine Geology and Marine Geophysics Divisions of the Atlantic Oceanographic Laboratory (Marine Sciences Branch) and the Eastern Petroleum Geology Section of Crustal Geology Division (Geological Survey of Canada). Initially, the Atlantic Geoscience Centre reported directly to the Assistant Deputy Minister (Science and Technology), but on August 24, 1972, it became formally a Division of the Geological Survey of Canada (TB 714305). Internal organization of the Centre followed soon thereafter as a result of a two-day Organizational Development Workshop assisted by Mr. R. Lee. Four program Subdivisions were organized during these meetings and are as follows: (1) Regional Reconnaissance; (2) Eastern Petroleum Geology; (3) Environmental Marine Geology; and (4) Research Methods (not yetoperational). Support function for the Centre was organized within the Administration and Scientific and Technical Program Support Subdivision. The Director's office comprises a Scientific Program Coordinator and an Executive Assistant. This is the first annual report of the Centre for the period of fifteen months extending from January 1, 1972 to March 31, 1973.

Personnel Notes

Mr. T. S. Hillis joined the Centre on July 4, 1972, as an Executive Assistant to the Director on special assignment from the Career Assignment Program (CAP). Mrs. C. Beauvais became Personnel Services Clerk on November 21, 1972. As part of the new organization, Dr. B. R. Pelletier has assumed responsibility for Scientific Program Coordination, effective February 16, 1973.

Attendance at Meetings

B. D. Loncarevic

Canadian Science and Technology Mission to Japan, March 4-15, 1972

"Geological History and Structure of Continental Margins", Penrose Conference of the Geological Society of America, Washington, D.C., December 12-17, 1972

GSC Basin Analysis Review, Calgary, January 15-18, 1973

B. R. Pelletier

Ferromanganese Nodules of the Ocean - a conference workshop. Columbia University Harriman Campus, Harriman, New York, January 19-22, 1972

Workshop on Coastal Management, Department of the Environment, Bedford Institute of Oceanography, Dartmouth, March 21-23, 1972

Steering Committee on Offshore Geoscience Program for the West Coast, Ottawa, November 20, 1972

"Offshore Drilling in the Canadian Arctic", Department of Indian and Northern Development, Ottawa, December 4-5, 1972

GSC Basin Analysis Review, Calgary, January 15-18, 1973

Special Talks

B. D. Loncarevic

"Prospects for Deep-Sea Mining": First Canadian Science Writers' Symposium, Ottawa, January 15, 1972

"Oceanographers as Miners": Third Canadian Oceanography Symposium, CCIW, Burlington, May 2, 1972

"Ocean Mining": Nova Scotian Institute of Science, Halifax October 16, 1972

"Prospectors at Sea": Canadian Institute of Mining, Sudbury Branch, November 30, 1972

"Deep Sea Mineral Deposits": Logan Club, Ottawa, February 21, 1973

B. R. Pelletier

"Clastic Sediment Ratios and Environmental Models": Third Canadian Oceanographic Symposium, CCIW, Burlington, May 4, 1972

"Ice Scouring in the Beaufort Sea": 24th International Geological Congress, Montreal, August 21-30, 1972

"Occurrence of Submarine Pingos in the Beaufort Sea": 24th International Congress, Montreal, August 21-30, 1972

A set of four seminar-lectures at University of South Carolina, December, 1972

A graduate research seminar in "Topics in Sedimentation" at Acadia University, Wolfville, N.S., once a week throughout school year 1972-73

Membership on Committees

B. D. Loncarevic

Coordination of East Coast Offshore Program - Task Force

Bedford Institute of Oceanography Directors Coordination Committee

Atlantic Subcommittee on Oceanography - Canadian Committee on Oceanography

National Research Council Advisory Committee on Geodesy & Geophysics

Commission on Marine Geophysics, International Association for the Physical Sciences for the Ocean

Editorial Board - "Marine Geophysical Researches"

Editorial Board - "Science Forum"

B. R. Pelletier

Interdepartmental Committee on Remote Sensing

Interdepartmental Committee on Submersibles

Atlantic Subcommittee on Oceanography - Canadian Committee on Oceanography

National Advisory Committee for Research in Geological Science, National Research Council

Editor - "Maritime Sediments"

Convenor, Marine Geology and Geophysics Session, 24th International Geological Congress, Montreal

Manuscripts Approved for Publication

B. D. Loncarevic

"Book Review of THE SEA, Volume IV" for Journal
(#8, April 28, 1972)

"Promise of the Sea" for Northern Miner
(#23, October 26, 1972)

B. R. Pelletier

- and J. Shearer: "Sea Bottom Scouring in the Beaufort Sea"
for 24th International Geological Congress
(#1, February 5, 1972)

Visitors to AGC

During the report period there were over three hundred official visitors to the Centre including representatives from Academic Institutions, Industry, Government and other Agencies and eight group visits. The group visits were: U. S. Office of Naval Research (12 on January 18-19, 1972), Eastern Arctic Industry Workshop (18 on February 9-10-11, 1972), students from N. S. Institute of Technology (20 on March 30, 1972) and St. Francis Xavier University (15 on April 18, 1972), Council, NRC (18 on June 12, 1972), two IGC field excursions (on August 9 and August 31, 1972), and the Petroleum Mission from the People's Republic of China (22 on September 20-21, 1972).

The Government officials included: Hon. J. Davis (January 23, 1972) Drs. C. H. Smith, Y. O. Fortier, J. Hodgson and D. White (May 5-6, 1972), Hon. R. Stanbury (June 12, 1972), Hon. D. S. Macdonald (August 30, 1972), Hon. A. W. Schmidt, U. S. Ambassador to Canada (September 19, 1972), and Rear Admiral O. O. Chandabilov, Hydrographic Service, USSR (March 8, 1973).

Visitors from Industry: J. Favre & J. Rochet, IFP, Paris (January 21, 1972), Kenting Associates, Calgary (February 8-9, 1972), A. D. Baillie, Gulf Oil, Calgary (February 9-10-11, 1972), R. P. Stapleton, Texaco, Calgary (February 14 - March 3, 1972), D. H. Magnusson, Mobil, Calgary (March 1-2 and March 21-22, 1972), A. E. Pallister, Calgary (February 29, 1972), M. E. Smith, Mobil, Calgary (February 29, 1972), ACCESS representatives, Toronto (March 6 and April 14, 1972), D. E. Duff, Eastcan, Calgary (March 23-24 and April 26, 1973), G. de Lombares, Eastcan Calgary (March 23-24 and November 13-16, 1972), E. Lewitt, Mobil, Calgary (March 21-22, 1972), T. Fisher, B. P., Calgary (March 22, 1972), W. Toy, Mobil, Calgary (March 29 - April 3, 1972), G. Pye, Amoco, Calgary (April 5, 1972), B. Langhus, Gulf, Calgary (April 13, 1972), W. Elias, Caravel, Calgary (May 9, 1972), D. Lorenger, Paleo, Calgary (May - August, 1972), D. Niosi, Noranda, Toronto (May 26, 1972), J. Stevulak, Imperial, Calgary (June 6, 1972), H. Bourne, B. P., Calgary (June 6, 1972), G. Herb, Sun Oil, Calgary (June 7, 1972), L. Borgonovi, AGIP, Calgary (June 12-14 and

November 23, 1972), D. Byers, BP, Montreal (August 2, 1972), C. Pedroli and G. Peniguel, SOquip, Quebec (August 3, 1972), B. McKay, Foundation, Calgary (August 3, 1972), C. Cochard, Elf, Calgary (August 3, 1972), M. T. Wells, Ocean Science, Calgary (August 3, 1972), R. Slavin, Mobil, Calgary (August 10, 1972), E. H. Rainwater, Tenneco, Houston (August 28, 1972), I. H. MacKay, Bank of Montreal, Calgary (August 29, 1972), B. Byramjee and B. Bordenarie, IFP, Paris (August 31, 1972), B. Tillement, Aquitaine, Calgary (September 11, 1972), H. de la R. Winter, Southern Oil, Johannesburg (September 13-14, 1972), J. L. Alexander, Gulf, Calgary (September 27, 1972), D. Umpleby, Gulf, Calgary (October 4, 1972) E. K. Shaw, Imperial, Calgary (October 16, 1972), P. Graebner, Chevron, Calgary (October 17, 1972), N. J. McMillan, Aquitaine (October 30, 1972), S. Spinichi, AGIP, Milano (November 23, 1972), B. Dargie, Consumer Gas, Toronto (December 1, 1972), J. Angus, Mobil, Calgary (December 6, 1972), R. Tobhert, Arco, Dallas (December 12, 1972), A. Butler and C. Smith, Richfield, Dallas (December 13-14, 1972), R. Bray and V. Machacek, Texaco, Calgary (March 5-19, 1973), J. Glover, Consultants, San Francisco (March 20, 1973).

Visitors from Governmental and other organizations: A. W. Norris, ISPG, Calgary (May 1, 1972), R. Riddihough, EPB, Ottawa (May 8-12, 1972), G. L. Johnson, USNOO, Washington (May 25, 1972), B. A. MacGee, CCGD, Ottawa (May 24, 1972), R. Folinsbee, President 24th IGC, Montreal (June 9, 1972), D. Elvers, NOAA, Washington (September 4-8, 1972), M. F. Burrill, U. S. Board on Geographic Names (September 27, 1972), J. Ringis, Geological Survey of New South Wales (October 3-6, 1972), B. Letton, IGS, UK (October 27, 1972), G. Drilhon, OECD, Paris (November 3, 1972), A. E. Collin, MSD, Ottawa (November 10, 1972), W. Calkins, US Bureau of Land Management, Washington (December 1, 1972), T. J. G. Francis, UKAE (December 11-15, 1972), N. Kelland, Coastal Sedimentation Unit, UK (March 1, 1973) and P. C. Badgley, ONR, Washington (March 29-30, 1973).

Visitors from Academic institutions included: J. Ewing, Lamont, New York (February 3, 1972), R. Clowes, UBC (February 21-23, 1972), D. H. Matthews, Cambridge, UK (February 29, 1972), H. Reading, Oxford (March 17, 1972), C. Lister, Washington (Seattle) (April 24, 1972), J. H. Allen, Memorial, St. John's (April 26, 1972), J. M. Mabesoone, Sao Paulo, Brazil (May 1-5, 1972), D. Burrell, Alaska (May 23, 1972), G. Norris, Toronto (May 23-25, 1972), T. Lodore, New Hampshire (May 26, 1972), G. Pirie, Wisconsin (June 13 - July 10, 1972), R. Hesse, McGill (June 13, 1972), P. M. D. Duff, Edinburgh (July 18-20, 1972), R. Bojanowski, Academy of Sciences, Poland (July 25, 1972), G. V. Middleton, McMaster (July 26, 1972), Capt. P. Day, RMC (July 26, 1972), B. McCann, McMaster (August 3, 1972), D. Dinely, Bristol, UK (August 10, 1972), R. Carrol, McGill (August 10, 1972), J. Kubrisj, Academy of Mining and Metallurgy, Poland (September 5-7, 1972), S. Uyeda, Tokyo (September 29, 1972), D. S. Cronan, Ottawa (November 20-22, 1972), I. Lubinsky, Manitoba (November 29, 1972), N. Rast and G. Pajari, UNB (January 31, 1973), K. Hooper, Carleton, Ottawa (February 26-28, 1973), H. W. Edgerton, MIT (March 22-23, 1973), and A. Eddlestein, York, Toronto (March 23, 1973).

EASTERN PETROLEUM GEOLOGY SUBDIVISION

B. V. Sanford

Introduction

There are a number of sedimentary basins in eastern Canada that can be considered as potential petroleum provinces. These include the onshore-offshore Early Paleozoic basins that lie in the central Canadian Shield (Hudson Platform) and those that extend along its southeastern margin (St. Lawrence Platform), the Late Paleozoic (Carboniferous) basins of the Atlantic Provinces, Gulf of St. Lawrence and Bay of Fundy, and the Mesozoic-Tertiary basins that lie offshore along the eastern continental margin. Eastern Petroleum Geology Subdivision utilizes the disciplines of stratigraphy, sedimentology, geochemistry, geophysics and paleontology to reconstruct the detailed and regional three dimensional geological framework of the basins in order to assess the potential hydrocarbon resources in both the onshore and offshore regions of eastern Canada. A substantial portion of the scientific data is derived from the study of sample cuttings and cores and mechanical logs from wells drilled in exploration for oil and gas in eastern Canada, and deep reflection seismic profiles. Much of the offshore well data is obtained through the cooperation of Resource Management and Conservation Branch (Department of Energy, Mines and Resources).

The Eastern Petroleum Geology Subdivision was formed in January 1971 as a Section of Crustal Geology Division of the Geological Survey of Canada and later (August, 1971) transferred to Bedford Institute of Oceanography, Dartmouth, N. S. On January 1, 1972, the Section was united with Marine Geology and Marine Geophysics Sections of the Department of Energy, Mines and Resources to form the Atlantic Geoscience Centre. During the period from August 1971 to January 1972, much of the efforts of the Section were concentrated on the installation of instruments and equipment in the micropaleontology, palynology and sedimentology laboratories, and in training technicians to process the cores and sample residues. Near the end of January 1972, the laboratories were operational and from that date to March 31, 1973, 26 wells from the Scotian Shelf and Grand Banks were processed representing some 309,000 feet of drilling. This material is now providing the basic geological data for a number of ongoing projects. In addition, suites of microfossil, palynology, and nannofossil slides were prepared for Resource Management and Conservation Branch to be made available to industry and academic institutions for study after the wells have passed their period of confidentality. As a result of reorganization within AGC, Eastern Petroleum Geology Section was raised to the status of Subdivision.

Activities

Detailed and regional surface and subsurface geological investigations are being conducted in the Hudson Bay Basin. Prior to the period of the present report helicopter-supported field operations were carried out in the Hudson Bay Lowlands and on the islands (Mansel, Coats and Southampton) in northern Hudson Bay. In the summer of 1971, C. F. M. Lewis and B. V. Sanford carried out a survey on board MV HUDSON HANDLER. Equipment used included a two-man submersible (PISCES III), a small portable over-the-side core drill, side-scan sonar, and shallow seismic profiling equipment. This work has confirmed the presence of a major sedimentary basin beneath Hudson Bay consisting of Ordovician, Silurian, and Devonian rocks with a combined thickness of upwards to 8000 feet. The Silurian and Devonian systems of the Hudson Bay Basin contain a number of sedimentological similarities with rocks of comparable age which are productive of oil and gas in the Michigan Basin. These comparable conditions make the Hudson Bay Basin a potential petroleum province.

In June 1972, J. Wade initiated regional subsurface stratigraphical investigations of the Mesozoic and Tertiary rocks of the Atlantic Continental Margin Basins. Using sample cuttings, cores, mechanical logs, and well history reports, stratigraphic correlation was established in 36 wells drilled on the Scotian Shelf and Grand Banks. These data were integrated with some 8500 miles of marine reflection seismic data to prepare a suite of maps at scales of 1:1,000,000 and 1:2,000,000 illustrating basin fill, isopachous maps of Jurassic and Carboniferous salts, post-salt Jurassic, Cretaceous and Tertiary strata, and structure contours of the basement, Jurassic and Cretaceous. In addition, regional structure cross-sections have been constructed across the Scotian Shelf and Grand Banks which illustrate the stratigraphic and tectonic relationships between the two regions. The results of these studies indicate the presence of at least two major centres of deposition containing thick Jurassic, Cretaceous and Tertiary sedimentary sequences capable of generating and retaining large volumes of hydrocarbons.

In August 1971, L. F. Jansa initiated sedimentological and stratigraphical analysis, using data from wells drilled on the Scotian Shelf and Grand Banks. From the study of mechanical logs, cores and sample cuttings of 33 wells, a suite of maps and cross-sections, in which depositional environments are reconstructed, were prepared demonstrating the thickness, lithology, and sandshale ratios for the Mesozoic and Tertiary rocks on the Scotian Shelf and Grand Banks. Depositional systems vary from desert to alluvial, delta coastal plain, inner-outer shelf, and epibathyl environments. Areas of predominant carbonate, evaporite and sandstone accumulation were delineated. Several stages of clastic outbuilding by prograding coastal plain and deltas were also established.

Surface and subsurface stratigraphic studies of the Carboniferous and Permian rocks of the Atlantic provinces have been

carried out over a period of several years by R. D. Howie; this has recently been extended into the offshore regions of the Gulf of St. Lawrence and Bay of Fundy. The investigations to date provide an insight into the stratigraphic and tectonic framework of the Carboniferous basins which in some areas reach thicknesses of 30,000 feet. The presence of diapiric structures beneath the Gulf of St. Lawrence greatly enhance the economic potential of the region as a possible trapping mechanism for petroleum and natural gas. These structures would appear to occur in considerable numbers east of the Magdalen Islands as well as at various onshore localities of the Maritime provinces.

M. S. Barss has continued his palynological investigations in the Carboniferous basins of the Atlantic Provinces and recently extended these into the offshore regions of the Gulf of St. Lawrence and onto the Grand Banks. Preliminary biostratigraphic zonation of two wells in the Gulf of St. Lawrence and a third on Brion Island was completed which established a time-stratigraphic sequence ranging from Visean (Mississippian) to Stephanian (Pennsylvanian) in age.

I. A. Hardy is preparing a systematic index of subsurface data from wells drilled onshore and in the offshore regions of eastern Canada. For each well, this index will include formation tops, biostratigraphic zonation, petrographic data, fluid and hydrocarbon recovery, geochemistry and geophysics, etc. Once the material has been indexed it can be readily transposed to a computer system for rapid printout of isopachous, structure contour and facies maps. Although much of the subsurface data for eastern Canada wells can be examined in the offices of Provincial agencies and at the Resource Management and Conservation Branch of the Department of Energy, Mines and Resources at the Institute, this is the first attempt to combine all of the subsurface information of eastern Canada into a single filing system.

In August 1971, P. Ascoli initiated micropaleontological studies of the Mesozoic and Tertiary strata of the Atlantic Margin Basins. The studies are based on the identification and zonation of foraminifera and other microscopic organisms recovered from the sample residue of wells drilled for oil and gas on the Scotian Shelf and Grand Banks. The objective of the project is to establish local, regional and worldwide correlation and to reconstruct ecological environments of the Mesozoic and Cenozoic sediments of the Atlantic Margin Basins.

Also in August 1971, G. L. Williams initiated biostratigraphical zonation of the Mesozoic and Cenozoic rocks of the Atlantic Margin Basins based on palynology. The investigator has recently completed a joint study of the palynomorphs present in 104 samples from 8 shallow core holes drilled on the Grand Banks. This has permitted the recognition of 22 biostratigraphic zones in the Late Mesozoic-Cenozoic sediments of this region. Studies of other, conventional wells drilled on the Grand Banks

and the Scotian Shelf have also provided biostratigraphic control in the Jurassic and Early Cretaceous. Interpretations concerning paleoecology have been made based on the presence of distinctive dinoflagellate associations in some of the samples and from the dinoflagellate: spore and pollen ratio.

In the second half of 1972, D. F. Clark began studies of nannofossils from Mesozoic and Cenozoic sequences penetrated by offshore wells on the Scotian Shelf. Initial investigations were directed towards establishing a biostratigraphic zonation of the area based on nannofossils. Preliminary results suggest that these fossils will be useful as sensitive stratigraphic indicators for the Cretaceous and Early Tertiary. However, there has been observed a scarcity of the rosette-shaped Discoaster which, in other regions, normally has been a good stratigraphic tool for the Tertiary. This paucity can probably be attributed to a global cooling phenomenon experienced during the period, with the northernmost boundary of the Discoaster being south of the Scotian Shelf.

Personnel Notes

During the report year the following scientific and technical staff joined the Subdivision: Mrs. I. A. Hardy, physical scientist, May 15, 1972; Mr. J. A. Wade, research scientist, May 22, 1972; Mr. G. Grant, compiler-draftsman, May 24, 1972; Mr. W. MacMillan, palynology technician, July 4, 1972; Mr. D. F. Clark, physical scientist, October 1, 1972 and Mr. D. Clattenburg, sedimentology technician, February 14, 1973. These additions have brought the total staff to nine scientific, three technicians, one draftsman, one clerk-typist and five microfossil pickers on professional contract.

Attendance at Meetings

P. Ascoli

GSC Basin Analysis Review, Calgary, January 15-18, 1973

M. S. Barss

American Association of Stratigraphic Paleontologists, Newport, Rhode Island, October 25-28, 1972

GSC Basin Analysis Review, Calgary, January 15-18, 1973

D. F. Clark

American Association of Stratigraphic Paleontologists, Newport, Rhode Island, October 25-28, 1972

GSC Basin Analysis Review, Calgary, January 15-18, 1973

I. A. Hardy

Canstrat Sample Logging Course, Calgary, February 5-13, 1973

R. D. Howie

Seminar on the Canadian Petroleum Industry, Ottawa, May 2-3, 1972

24th International Geological Conference, Montreal, August 21-25, 1972

L. F. Jansa

24th International Geological Conference, Montreal, August 21-25, 1972

B. V. Sanford

Energy, Mines and Resources Management Seminar, Dartmouth, Nova Scotia, February 12-13, 1973

Energy, Mines and Resources, Managerial Grid, Cornwall, Ontario, October 29 - November 3, 1972

24th International Geological Conference, Montreal, August 21-25, 1972

Energy, Mines and Resources, Departmental Hydrocarbon Inventory, Ottawa, February 18-21, 1973

M. Trapnell

Energy, Mines and Resources, Secretarial Development Workshop, Dartmouth, Nova Scotia, January 16-18, 1973

G. L. Williams

American Association of Stratigraphic Paleontologists, Newport, Rhode Island, October 25-28, 1972

Laboratory Activities

The Micropaleontology-picking laboratory has completed picking of 26 wells from the Scotian Shelf and the Grand Banks. From these wells 3137 samples have been picked and 5918 slides have been prepared. Total footage with coverage is 309,169. Nineteen of these wells have been released from the confidential period and can be examined by the public.

The Palynology laboratory has completed processing for nannoplankton from 16 wells, comprising 1843 samples and 4000 slides. These wells are available for public examination.

Processing of palynology samples for 26 wells, 17 shallow core holes, and 200 reference samples has been completed. Twenty-three wells of the 26 wells are available for public examination. A total of 2000 samples and 9000 slides have been prepared.

Special Talks

L. F. Jansa

"Depositional History of the Continental Margin off Nova Scotia": GSC Basin Analysis Review, Calgary, January 16, 1973

"Recent Carbonate Deposition of Florida Keys": Dalhousie University, Geology Department, Halifax, February 13, 1973

B. V. Sanford

"Paleozoic Basins of Eastern Canada": GSC Basin Analysis Review, Calgary, January 16, 1973

"Paleozoic Geology and Petroleum Potential of the Hudson Bay Platform": 11th Annual Conference of the Ontario Petroleum Institute, Toronto, October 23, 1972

J. A. Wade

"Geology of Scotian Shelf and Grand Banks": GSC Basin Analysis Review, Calgary, January 16, 1973

"Hydrocarbon Potential of Sedimentary Basins of Eastern Canada": Department Hydrocarbon Inventory, Ottawa, February 19, 1973

"Hydrocarbon Inventory of Eastern Canada Basins": Comparison 1971-1972 data; Senior Departmental Staff, Ottawa, February 22, 1973

G. L. Williams

"Biostratigraphic Framework of Eastern Canada Basins": GSC Basin Analysis Review, Calgary, January 17, 1973

"Dinoflagellates in Time": Woods Hole Oceanographic Institute, Woods Hole, Mass., March 20, 1973

Membership on Committees

P. Ascoli

Member, International Paleontological Union, Working Group on Tethyan Ostracoda

M. S. Barss

Several Working Groups of the CIMP

Nominating Committee for AASP

R. D. Howie

Member, BIO Library Committee

B. V. Sanford

Member, Ontario Stratigraphic Committee

Member, American Commission on Stratigraphic Nomenclature

Geological Survey of Canada representative on Departmental Task Force to establish geoscientific objectives for the Atlantic Continental Shelf and Territorial Waters of Eastern Canada

Manuscripts Approved for Publication

D. F. Clark

"The Effects of Sonic Pressure on Calcareous Nannofossils" for Nature - in press (#32, February 9, 1973)

R. D. Howie

"Developments in Eastern Canada in 1971" for AAPG with J. V. Hill (#7, April 19, 1972)

L. F. Jansa

"Evolution of a Clastic Coastal Plain - Deltaic Complex and Overlying Carbonate Reefs and Banks, Sturgeon - Mitsue Area (Middle and Upper Devonian) Alberta, Canada" for GSC Paper - in press (#39, February 2, 1973)

"Tidal Deposits in the Monkman Quartzite, Lower Ordovician, Northeastern British Columbia, Canada", Proceedings of Tidal Flat Deposition Symposium, University of Miami - in press (#31, February 8, 1973)

B. V. Sanford

"Stratigraphy and Paleontology of the Paleozoic - Southern Ontario", Guide Book for IGC Field Trip (#9, April 28, 1972)

G. L. Williams

"A Glossary of the Terminology applied to Dinoflagellate Cysts and Acritarchs" for AASP Contribution Series - in press, with W. A. S. Sarjeant and E. J. Kidson (#28, January 26, 1973)

"Palynological Analyses of Upper Mesozoic and Cenozoic Rocks of the Grand Banks, Atlantic Continental Margin" for GSC Bulletin - in press, with W. W. Brideaux, (#35, March 14, 1973)

Active Projects during Report Year

50029 Identification and biostratigraphic interpretation of referred fossils - M. S. Barss

680109 Palynological zonation of the Carboniferous and Permian rocks of Atlantic Provinces, Gulf of St. Lawrence and Northern Canada - M. S. Barss

710059 Stratigraphy and sedimentology of the Mesozoic and Tertiary rocks of the Atlantic Shelf - L. F. Jansa

710061 Subsurface geology of the Paleozoic Basins of Eastern Canada - R. D. Howie

710062 Biostratigraphic zonation (Palynology) of the Mesozoic and Cenozoic rocks of the Atlantic Shelf - G. L. Williams

710065 Biostratigraphic zonation (foraminifera) of the Mesozoic and Cenozoic rocks of the Atlantic Shelf - P. Ascoli

710066 Paleozoic geology of the Hudson Bay Region - B. V. Sanford

710067 Eastern Canada sedimentary basin compilation project - B. V. Sanford

720103 Hydrocarbon Inventory of the sedimentary basins of Eastern Canada - J. A. Wade

720104 Regional subsurface geology of the Mesozoic and Cenozoic rocks of the Atlantic Continental Shelf - J. A. Wade

730082 Biostratigraphic zonation (nannofossils) of the Mesozoic and Cenozoic rocks of the Atlantic Shelf - D. F. Clark

730083 Structural and stratigraphic synthesis of the Phanerozoic rocks of Eastern Canada - I. M. Harris

730084 Depositional history and facies distribution of the Tertiary System on the Scotian Shelf - I. A. Hardy

730085 Classification of Dinocysts - G. L. Williams

ENVIRONMENTAL MARINE GEOLOGY SUBDIVISION

D. E. Buckley

Introduction

The need to use and exploit the environment often leads to conflict. The rational management requires a broad knowledge base to which the studies of modern geological processes contribute. In the near future it is likely that extensive development will be undertaken in the coastal zone and the offshore environments. The impact of such a development must be predicted, during the development the changes must be monitored and a capability must be developed to deal with contingencies such as oil spills, discharge of industrial effluents or collapse of man-made structures. The Environmental Marine Geology Subdivision is responsible for the development and application of geological understanding with the aid of which optimum use of the environment can be designed.

The study of modern geological processes increases our ability to interpret the geological past. The understanding and description of the past environmental conditions is important in assisting the economic exploration and exploitation of mineral and energy resources. The work of the subdivision includes geochemistry, paleoecology and sediment dynamics, the latter emphasizing beaches and the coastal zone.

Activities

Study of the significance of suspended particulates in effecting the chemical partition between sea water and the solid phase was continued by D. E. Buckley. The exceptionally high concentrations of suspended sediments in the Bay of Fundy and Minas Basin (up to 10 mg l^{-1}) are unique in the dynamic tidal regime of that area and afford an excellent opportunity to evaluate their geochemical and sedimentological significance. In continental shelf depressions such as the LaHave and Emerald Basins, Nova Scotia, an anomalous layer of suspended particulate matter 30 to 50 metres thick and occurring immediately above the bottom sediment interface was discovered using an optical attenuance meter (nephelometer). Sampling of these 'nepheloid' layers was carried out in a number of locations in 1972 in order to determine mineralogical and chemical composition and the mechanisms responsible for stability and distribution. Some evaluation of industrial outfall areas has been made by analyzing trace element levels in waters and sediments from a settling pond at Boat Harbour, Nova Scotia; from a settling pond and adjacent marine area at Belledune, New Brunswick; and from pulp and chemical plants in northern New Brunswick. Intensive geochemical studies of the LaHave River and estuary system (Nova Scotia) have continued with some cooperative phases being undertaken with personnel from the Coastal Oceanography Division of AOL.

R. Cranston has had principal responsibility for developing methods of silicate analyses of suspended and deposited sediments (Buckley, D.E., and Cranston, R.E. 1971. Chem. Geol., 7: 273-284; and 1972. Chem. Geol., 9: 311-314). In addition he has evaluated and adopted methods of cold-vapour mercury analyses for water and sediment samples (Cranston, R.E., and Buckley, D.E. 1972, Environ. Sci. & Technol., 6: 274-278). G. Winters has had principal responsibility for the development and testing of methods of trace element analyses in aqueous samples. In addition to development of chemical analytical methods there has been a continuing effort by the group to improve methods of statistical evaluation of all data and means of making these data available to a variety of uses (Cranston, R.E., and Buckley, D.E. AOL Data Series 1971-8-D; and Data Series/Bi-D-72-1 and 12).

Laboratory studies by M.A. Rashid indicate that humic compounds isolated from marine sediments are effective in dissolving significantly large quantities of Cu, Co, Ni, Zn and Mn (up to 338 mg g^{-1} of organic matter) from their insoluble carbonate or sulphide salts. The acid hydrolysate of humic acid, consisting of various amino acids, was twice as effective as the parent humic material, dissolving up to 682 mg of metal per gram of organic matter. Infrared analysis suggest that carboxyl, quinone, and amino groups participate in the organo-metallic reactions that are responsible for the solubility of the metals. The most likely mechanism of reaction appears to be that of chelation or complexing in which the metals are bonded firmly to organic molecules and are not released easily by exchange reactions.

Core cuttings from the offshore drilling for oil are analysed for their hydrocarbon content by J. Leonard. More than 1000 samples were analyzed for their methane, ethane, propane, butane, total carbon and organic carbon. The high molecular weight organic fractions of geochemical interest are being isolated from these samples for further detailed investigations and geological interpretations.

During 1971/72 D.A. Walker collected biweekly samples of algae from several tidal pools in the Halifax area. The purpose of this project was to observe and document morphogenesis and species succession in the tide-pool foraminiferal population. By means of scanning electron microscopy, test ultrastructure was investigated to determine changes in microstructure relative to growth and seasons. Energy dispersive spectrometry of these benthonic foraminifers was begun to determine the chemical composition of the tests of each species, and change in element concentration relative to growth and seasons.

Benthonic foraminifera from all of the HUDSON 70 stations have now been identified by F.J.E. Wagner. In general, arenaceous species are dominant at depths between about 500 and 1000 metres, with the exception of an area of abundance in the Beaufort Sea at about 50 metres depth north of Kugmallit Bay, Northwest Territories. Calcareous species are characteristic of the shelf area but several specimens were found at the

three deep stations beyond the limit of the arenaceous forms. Observations on the mollusc from the Beaufort Sea collected during the HUDSON 70 Expedition show that eighty percent of all stations at which living molluscs were found were in depths of 75 metres or less. Comparison of fossil molluscs from Herschel Island and Kay Point, Yukon Territory, with the recent faunas indicates that in pre-Wisconsinan time water temperatures were possibly slightly higher than at present.

During March and April of 1972 a field party under G. Vilks based at Tuktoyaktuk, Northwest Territories, sampled plankton from waters on the continental slope and shelf of the Beaufort Sea. Oceanographic observations indicate that seasonal changes in the water column take place only within the upper 30 metres, with colder and more saline surface water in the winter. The subsurface waters show basically similar density-depth relationships between the two sets of observations; a year-round upwelling of the subsurface water takes place along the continental slope. The population of planktonic foraminifera under the winter ice is reduced by a factor of 200, with a corresponding reduction of the total biomass by about a factor of 4. Paleoclimatic implications from these observations are that in the Arctic Ocean the relative amounts of planktonic foraminiferal tests in sediment cores can be used as sensitive indicators of changes in the past ice conditions.

G. Vilks has analysed planktonic foraminifera from plankton tows collected in the North Atlantic and along the ship's track during the HUDSON 70. Species diversity was found to be lower at stations in the polar and subpolar waters in comparison to waters at lower latitudes. The standing crops of planktonic foraminifera were highest in areas of water mass mixing and during seasons of weak surface thermoclines. A diurnal variation of planktonic foraminifera in the upper 200 metres was also found off Bermuda, where analysis of variance tests on specimen counts demonstrated a significant increase in numbers during daylight hours.

C.T. Schafer's studies of the foraminiferal fauna inhabiting the unpolluted areas of the Restigouche estuary, New Brunswick, describe a pattern which reflects the boundary between relatively stable and environmentally variable areas. The variable areas are represented by a hardy foraminiferal fauna dominated by species of Elphidium, Ammotium and Eggerella. A faunal change indicative of the persistent influence of Gulf of St. Lawrence water was noted. Specific faunal changes include an increase in the relative abundance of Reophax spp. and Saccammina atlantica. A considerable effort has been expended to develop instrumentation that will enable the marine geologist to make observations using techniques and methods that have been developed in the course of geological surveys on land. Prototypes of two tools have recently been tested. The first, a sophisticated turbidity meter, will enable sedimentologists, geochemists and marine ecologists to gather information on the spatial distribution of suspended materials in the water column. A second device consists of a portable submersible video

recorder which can be used by the scientist to describe accurately bottom phenomena. The operator records visual data using a video camera and simultaneously narrates the video tape (via an audio channel) using a specially modified diver air regulator containing a small microphone.

A Marine Science Atlas of the Beaufort Sea is being compiled by B.R. Pelletier from the results of past and existing projects on the marine aspects of the Beaufort Sea, including oceanography, biology, bathymetry, ice sediments, geology, and geophysics, access routes, and other cultural aspects. It is to contain maps, illustrative material (photos, sketches, graphs) and data on these aspects; all data will be plotted on a scale of 1:500,000 for reduction to atlas size of 15 x 12 inches.

A reconnaissance study of the coastal geomorphology of the southern Gulf of St. Lawrence was completed during 1972 by E.H. Owens. The region was divided into ten zones. Within each zone a series of site investigations was carried out to describe specific features which were characteristic of the coast. In addition, samples were collected from the littoral and backshore areas at a 10 km interval. Differences in sediment availability and exposure to wave processes vary considerable within the region. Zones 1 and 9 are characterized by resistant upland coasts with little or no littoral sediments. Zones 3, 6, and 8 have exposed coasts with low cliffs and narrow beaches or small barriers and spits. Zones 4 and 7 are sheltered areas with a variety of cliff and beach forms. Barrier spits and islands are common in zones 2, 5, and 10, which are the most dynamic areas in terms of beach and dune changes and inlet migration.

During the summers of 1971 and 1972, R.J. Knight and R. Dalrymple (McMaster University), with assistance from the Atlantic Geoscience Centre, mapped and sampled four sand bars near Noel, Nova Scotia. Tidal currents, suspended sediment concentrations, rates of bedform migration and sediment dispersion directions and rates were determined. It is planned to extend these types of observations to other sand bars and to continue to monitor the bars already studied for two further field seasons. The purpose of this project is chiefly threefold: (1) to determine the relation of sand movement to tidal and other currents in Minas Basin; (2) to relate the sedimentary structures, textures, and mineralogical composition of the sand to its movement within the Minas Basin; and (3) to determine the rates and patterns of movement of the dunes, bars, and other medium-to-large scale sedimentary bedforms in response to hydrodynamic factors.

Personnel Notes

As a result of the reorganization of Atlantic Geoscience Centre in the latter part of 1972 some staff which were part of the former Marine Geology Division were reassigned to new Subdivisions within AGC. B.R. Pelletier became senior Scientific Program Coordinator for AGC and D.E. Buckley became acting Head of Environmental Marine Geology. D. Clark joined the Eastern Petroleum Geology Subdivision to continue his work on nannofossils. C. Godden, M. Gorveatt and L. Brown joined the scientific

support staff of the Technical Services, Program Support Subdivision.

Georges Drapeau resigned from EMR to join the INRS of the Quebec Government at Ramouski, P.Q. in July, 1972.

Attendance at Meetings

D. E. Buckley

Ferromanganese Nodules of the Ocean - A conference workshop. Columbia University Harriman Campus, Harriman, New York, January 19-22, 1972

Bedford Institute Coastal Zone Seminar. Bedford Institute of Oceanography, Dartmouth, March 21-23, 1972

Managerial Grid Course, Cornwall, Ontario, April 9-14, 1972

Working Group of the Federal Provincial Consultative Committee on the Coastal Environment of P.E.I., Charlottetown, P.E.I., May 17-18, 1972

24th International Geological Congress, Montreal, P.Q., August 21-25, 1972

Planning and Coordination meeting for Ocean Research in the Gulf of St. Lawrence, Montreal, P.Q., December 13-15, 1972

R. E. Cranston

Bedford Institute Coastal Zone Seminar, Bedford Institute of Oceanography, Dartmouth, March 21-23, 1972

NAQUADAT Seminar, Moncton, N.B., June 13, 1972

Clay Minerals Conference, Woods Hole, Mass., U.S.A., September 11-14, 1972

G. Drapeau

Herring Spawning on Georges Bank, Saint John, N.B., February 20 - March 1, 1972

Bedford Institute Coastal Zone Seminar, Bedford Institute of Oceanography, Dartmouth, March 21-23, 1972

E. H. Owens

13th International Conference on Coastal Engineering, Vancouver, B.C., July 10-14, 1972

M. A. Rashid

24th International Geological Congress, Montreal, August 21-25, 1972

Advances in Petroleum Geochemistry, Symposium 85th Annual Meeting of the Geological Society of America, Minneapolis, Minn., U.S.A., November 13-15, 1972

C. T. Schafer

Geological Society of America, Tuscaloosa, Alabama, U.S.A., March 25-29, 1972

Bedford Institute Coastal Zone Seminar, Bedford Institute of Oceanography, Dartmouth, March 21-23, 1972

2nd Meeting of IEEE, Nova Scotia Technical College, Halifax, October 18, 1972

American Quaternary Association, 2nd National Conference, Miami, Florida, U.S.A., December 1-7, 1972

G. Vilks

Taxonomic Problems of Planktonic Foraminifera; Scripts Institute of Oceanography, LaJolla, and University of Southern California, Los Angeles, February 24-29, 1972

Leadership Skills Course, Bedford Institute of Oceanography, March 6-8, 1972

24th International Geological Congress, Montreal, P.Q., August 21-25, 1972

F. J. E. Wagner

24th International Geological Congress, Montreal, P.Q., August 21-25, 1972

D. A. Walker

Scanning Electron Microscope Symposium and Workshop, Chicago, Ill., U.S.A., March 25-27, 1972

Special Talks

D. E. Buckley

"Geochemical Interaction of Suspended Silicates with River and Marine Estuarine Water" 24th International Geological Congress, Montreal, P.Q., paper published in Section 10, August 24, 1972

E. H. Owens

"The Cleaning of Gravel Beaches polluted by Oil" 13th International Conference on Coastal Engineering, Vancouver, B.C., July 11, 1972

M. A. Rashid

"Amino Acids associated with Marine Sediments and Humic Compounds and their Role in Solubility and Complexing of Metals" 24th International Geological Congress, paper published in Section 10, Montreal, P.Q., August 24, 1972

C. T. Schafer

"Effects of Coastal-based Industry on the Local Distribution of Benthonic Foraminifera" Pacific Marine Station, Dillon Beach, California, May 10, 1972

G. Vilks

"Planktonic Foraminifera in the Water and Sediment of Beaufort Sea, Canadian Arctic, 24th International Geological Congress, Montreal, P.Q., August 23, 1972

F. J. E. Wagner

"Molluscan Fauna as Indicators of Late Pleistocene History, Southeastern Beaufort Sea" 24th International Geological Congress, Montreal, P.Q., August 23, 1972

Membership on Committees

D. E. Buckley

Member, Nova Scotia Research Foundation Advisory Committee on Dredging Operations

Advisor, Federal-Provincial (P.E.I.) Consultative Committee on the Coastal Environment

C. T. Schafer

IEEE Program Committee for "Ocean 74"

Production Statistics

Inorganic Geochemistry

Data Report, BI-D-72-12 Geochemical Data from the LaHave River Estuary; Manuscript Report BI-R-72-7

Organic Geochemistry

Hydrocarbon Analyses (October, 1972 - March, 1973):
Total number of samples - 1912, total carbon analyses - 705, organic carbon analyses - 1537, C_1 - C_4 hydrocarbon analyses - 1537, organic extractions - 40, organic compound fractionations - 23

Manuscripts Approved for Publication

D. E. Buckley

- and R. E. Cranston, "Atomic Absorption Analyses of 18 Elements from a Single Decomposition of Aluminosilicate - A Reply", Chemical Geology, vol. 9, p.311-314, (# 4, March 1, 1972)

D. F. Clark

"Improved Light Microscope Techniques for Viewing Nannofossils" Micropaleontology, (# 16, May 29, 1972)

G. Drapeau

"Pollution par le Mozout des Rives de la Baie Chedabouctou, Nouvelle Ecosse", TERRA, (# 3, March 21, 1972)

"Sedimentology of Herring Spawning Grounds on Georges Bank" ICNAF Bulletin,(# 10, April 29, 1972)

"Changes in Beach Profiles at Chedabucto Bay, Nova Scotia, following Large-Scale Removal of Sediments", Canadian Jour. of Earth Sciences, (# 11, May 18, 1972)

"Natural Cleaning of Oil Polluted Sea Shores", proceedings of the 13th International Conference on Coastal Engineering, July, 1972, (# 22, August 18, 1972)

"Factor Analysis: How it copes with Complex Geological Problems", (# 30, February 2, 1973)

- and L. H. King, "Surficial Geology of the Yarmouth - Browns Bank Map-Area", Marine Sciences Paper No. 2, Marine Sciences Directorate, DOE, GSC, Paper 72 - 24, (# 5, April 12, 1972)

E. H. Owens

"Zonal Studies of the Coast of the Maritime Region of Canada" in International Geography 1972, Adams, W.P. and Helleiner, F. editors: University of Toronto Press, p. 1017 - 1018, (# 19, August 10, 1972)

"The Cleaning of Gravel Beaches Polluted by Oil" proceedings of the 13th International Conference on Coastal Engineering, (# 20, August 15, 1972)

"The Investigation of Form and Processes in the Littoral Zone" in Coastal Geomorphology, Coates, D. R., editor: Publications in Geomorphology State University of New York, Binghamton, N.W., p. 11 - 41

"The Coastal Geomorphology of the Southern Gulf of St. Lawrence: A Reconnaissance" Maritime Sediments, vol. 8, no. 2, p. 61 - 64

M. A. Rashid

- and J. D. Leonard, "Modifications in the Solubility and Precipitation Behaviour of Various Metals as a Result of their Interaction with Sedimentary Humic Acid", Chemical Geology, vol. 11, p. 89 - 97, (# 21, August 18, 1972)

- with Jansen, A. and Rao, D. V. S., "Influence of Humic Substances on the Growth of Marine Phytoplankton: Diatoms", Limnology and Oceanography, (# 25, November 29, 1972)

- with Prakash, A. and Jansen, A., "Humic Substances and Aquatic Productivity" proceedings of the Symposium on Humic Compounds, Neuwersluis, The Netherlands, (# 26, December 11, 1972)

C. T. Schafer

"Distribution of Foraminifera near Pollution Sources in Chaleur Bay" Water,Air and Soil Pollution, (# 24, November 29, 1972)

D. A. Walker

- and G. Vilks, "Spinal Ultrastructure of the Planktonic Foraminifera Hastigerina Thompson and Globigerinella Cushman", Jour. of Faraminiferal Research, (# 13, May 18, 1972)

Active Projects

720114 Comparative ecology of recent planktonic foraminifera in surface waters of Arctic, Atlantic and Pacific Oceans - G. Vilks, D. A. Walker.

720115 Foraminiferal, molluscan and lithologic study of sediment cores from the Beaufort Sea and Northwest Passage - G. Vilks. F. J. E. Wagner, B. R. Pelletier.

720116 Recent benthonic foraminiferida and mollusca from the Continental Shelf, southeastern Beaufort Sea - F.J.E. Wagner.

730086 Hydrocarbon geochemical analyses of eastern offshore oil well samples - J. D. Leonard, M.A. Rashid.

730088 Regional coastal geomorphology of the southern Gulf of St. Lawrence - E. H. Owens.

730089 Geochemical interactions between natural water and particulate solids, and models for mechanisms of metal dispersion and accumulation in marine environments - D.E. Buckley, R. E. Cranston, R. Loucks, M. A. Rashid.

730090 Analytical methods for marine geochemical analyses of marine environments - R. E. Cranston.

730092 Marine geology of the nearshore and estuaries of Chaleur Bay, Gulf of St. Lawrence - C.T. Schafer.

730093 Test surface ultrastructure of benthonic foraminifera and applications by scanning electron microscopy - D.A. Walker.

-- Chemical characterization and diagenetic transformations of organic matter associated with marine sediments.

-- Role of humic and other organic compounds associated with marine sediments in solubility, mobility and accumulation of rare metals - M.A. Rashid.

-- Field and laboratory investigation of the life cycles, micro-ecology and species succession of tide pool foraminifera of Nova Scotia - D. A. Walker.

720101 Bottom studies of the Beaufort Sea - B.R. Pelletier.

720102 Marine Science Atlas, Beaufort Sea - B.R. Pelletier.

-- Sediment entropy studies in marine bodies of Eastern Canada - B.R. Pelletier.

REGIONAL RECONNAISSANCE SUBDIVISION

D. I. Ross

Introduction

The new concepts of global geology, which are rapidly evolving, are continuously changing the framework within which our data and observations are interpreted. The continental margins are now recognized as rifted structures formed by pulling apart of the continents. The adjoining oceanic crust might be coupled or not, thus creating two significantly different tectonic settings. The oceanic crust is created at the accretion edges of the lithospheric plates and has within it imprinted a record from which continental movements can be reconstructed.

The geological framework for the eastern continental shelf and margin of Canada is known only in a general outline. It is the responsibility of Regional Reconnaissance Subdivision to carry out field programs in key areas so that the new knowledge thus gained will advance our understanding most effectively. The work is centered around expeditions and consists of surficial and bedrock geological mapping, of broad reconnaissance of frontier areas and of systematic geophysical surveys. Projects are active in five regions: i) Nova Scotia Shelf, Bay of Fundy and Southern Grand Banks; ii) Gulf of St. Lawrence; iii) Northeast Newfoundland, Labrador Shelf and Sea; iv) Baffin Bay and adjoining Sounds; and v) Nova Scotia - Grand Banks Continental Margin and the adjoining deep ocean floor.

Activities

Investigations on the Grand Banks during the 1972 field season (L. H. King, B. MacLean, G. Fader, H. Josenhans and R. T. Haworth) consisted of one five-week cruise on CSS DAWSON. 1150 miles of seismic profiling and 8141 km of gravity and magnetic field data were collected primarily over the western part of Grand Banks: across the Laurentian Channel and St. Pierre, Green and Whale Banks. Preliminary results suggest that carboniferous strata are continuous from Cape Breton to within a few miles of the south coast of Newfoundland. The Mesozoic and Cenozoic coastal plain units onlap the carboniferous and older basement rocks which flank the Avalon and Burin Peninsulas. There is a prominent 1500-gamma positive magnetic anomaly coincident with a 70 milligal positive free air gravity anomaly in the centre of Whale Bank. There is an indication that the anomaly is elongated in a WNW-ESE direction with an abrupt termination in the vicinity of Whale Deep to the east.

An interpretation of gravity data from the Gulf of St. Lawrence east of the Magdalene Islands (Watts, A.B., 1972, Can. J. Earth Sci. 9: 1504-1528) suggests that the series of isolated negative gravity anomalies is caused by salt bodies. The area is described by Watts as one of the largest salt provinces in eastern Canada.

A reconnaissance bottom-sampling, seismic profiling and sonar side-scanning survey was carried out in an area northeast of Belle Isle, Newfoundland by I. M. Harris. Using a newly designed B.I.O. rock core drill a total of 25.4 metres of core was drilled at eight sites, and a total of 5.2 metres of core was recovered. Seismicly 'hard' rocks with lithologies comparable to Lower Paleozoic and Late Precambrian rocks on Belle Isle and nearby Newfoundland and Labrador extend at least 40 km northeast of Belle Isle. Gently folded rocks with good seismic penetration occur beneath a mantle of fill of variable thickness to the east of Belle Isle. The side-scan sonar records reveal numerous linear features on the sea floor, apparently caused by the grounding of icebergs.

A. C. Grant has completed a reconnaissance survey of the western margin of the Labrador Sea as far north as Davis Strait. Geophysical coverage of the Labrador Shelf is now adequate to define areas of interest for detailed surveys and sites for collection of vital stratigraphic data. Much of this information will be obtained through industrial exploration for petroleum, particularly the stratigraphy of the Mesozoic-Cenozoic coastal plain-type deposits. To complement these resource-oriented surveys it is necessary to define the regional setting of the coastal plain deposits in terms of the history of interaction between continental and oceanic basement. The central problem is that of tracing the evolution of the Labrador Sea by process of sea floor spreading.

Labrador Sea Project (led by W. J. M. van der Linden), as broadly defined at present, involves a five-year plan of integrated geological and geophysical activities to delineate the structural framework of the Labrador Sea, trace its geological history and evaluate its resource potential. Gravity and magnetic information was obtained on board CSS HUDSON along 5000 miles of 10 mile line-spacing track in an area off Hamilton Bank, between 52°N and 54°N. Seismic reflection profiling was carried out along every other line. Bottom gravimeter measurements were made in the same area by the Earth Physics Branch, EMR on board CNAV SACKVILLE. Bottom samples were collected by SACKVILLE and CSS DAWSON, latter off Saglek. The continental margin off Labrador is underlain by gently seaward-dipping Mesozoic-Cenozoic coastal plain deposits, similar to the coastal sequences along the Atlantic seaboard from Florida northward. Because of differential glacial erosion during the Pleistocene, these sediments are separated by a deep marginal trough from predominantly plutonic Precambrian Labrador rocks. A veneer of varying thickness of recent, predominantly glacial drift sediments and moraines, covers the shelf, obscuring the pre-glacial history of the Labrador continental margin. High frequency magnetic anomalies are

restricted to the inner shelf of Labrador and contrast sharply with the relatively smooth fields over the shelf off northeast Newfoundland, the Labrador Shelf Banks, and the deep basin anomalies. Towards the central part of the Labrador Basin these anomalies appear to align, parallel to the Basin Axis, providing control for the spreading history of the Labrador Sea.

During August, 1972, the Atlantic Geoscience Centre participated with industry in evaluating acoustic profiling techniques for resolving the character of overburden on the Labrador Shelf. Eastcan Exploration Limited conducted a three-week experimental cruise on Hamilton Bank with the 1,000 ton trawler "Newfoundland Hawk", which was equipped with TORAN navigation equipment, a side-scan sonar, a deep-tow sparker, and a surface-tow air-gun system. The latter was supplied by the Atlantic Geoscience Centre, with V. F. Coady and A. C. Grant as operators. The deep-tow sparker was a prototype system developed and operated by geophysicists from the Nova Scotia Research Foundation. Systematic surveys utilizing all profiling systems over common traverses were conducted at two selected sites on Hamilton Bank. All equipment functioned well, and concurrent operation of surface and deep-tow systems was routine. As anticipated, the combination of side-scan sonar and seismic profiles is a most effective survey procedure. The outstanding result of the cruise, however, was the success of the deep-tow sparker, which yielded impressively detailed profiles of the bottom and sub-bottom. Although it is a simple expedient in principle, the practical achievement of towing a seismic system at depth is not inconsiderable. Further exploitation of this technique will undoubtedly enhance the effectiveness of acoustic profiling as a sea-bottom survey tool.

Multidisciplinary surveys (R. Macnab and R. T. Haworth) utilized in 1972 a charter vessel, 2350-ton ice-strengthened freighter MINNA. The operation was East and Northeast of Newfoundland in the area between Flemish Cap and Orphan Knoll. A new generation of shipboard computers is being introduced by a phased replacement of PDP-8 machines with HP-2100 computers. The new systems have a larger memory, FORTRAN programming, disc operating systems, and are equipped with higher speed input/output devices.

In order to accelerate the release of previously collected gravity and magnetic data, a contract was issued to Computer Data Processors of Calgary to produce 72 maps at a Natural Resource Series scale of 1:250,000 from 128,000 gravity and 181,000 magnetic field data points. The contract was completed prior to March 31 deadline and all the maps are now in publication production.

During the year, assistance was rendered to the Canadian Hydrographic Service by a secondment of R. Macnab. In addition to further developing methodology of the East Coast surveys, he acted as the hydrographer in charge during the HUDSON multidisciplinary survey. He also assisted the West Coast program by consultation during several visits in order to establish standards and operational criteria for multidisciplinary surveys on board CSS PARIZEAU.

Analysis of geophysical data obtained by CSS HUDSON in the Baffin Bay area in 1971 continued. The seismic refraction data has provided good crustal structural control across the Bay from Baffin Island to Greenland (Keen, C. E. and Barrett, D. L., Geophys. J. Roy. Astr. Soc., 30 (5): 253-272). The central oceanic basin consists of 4 km of sediment with seismic velocities varying from 2.1 km per sec to 4.2 km per sec, underlain by 4 km of oceanic basement, giving a total depth of 10 km to the Mohorovicic discontinuity. Mantle velocities of 7.7 - 8.5 km per sec were observed. The sediment thickness across the Basin is uniform; towards the north it increases to 6 km. It is presumed that both layer 2 and layer 3 exist within the oceanic basement although two distinct velocities were not observed on all oceanic lines.

Through cooperative work with the Greenland Geological Survey the known onshore geology of central West Greenland has been extended offshore (Ross, D. I. and Henderson, G., Can. J. Earth Sci. 10, 485-497). The Melville Bay graben developed during the initial rifting of Canada and Greenland. Gravity data indicate that the maximum thickness of sediments (10 km) occurs at the southern end of the graben. A maximum sedimentary velocity of 4.6 km per sec was observed in the central region of the graben. Although the Tertiary basalt province of Disko Island - Nugssuaq Peninsula has been extended out into the offshore region, it is still not clear how it is connected with the basalt province of Cape Dyer and the thick pile of oceanic basalt forming the Davis Strait sill.

Detailed interpretation of the geophysical data collected off the west coast of Canada during the HUDSON 70 expedition (Srivastava, S.P. et al, 1971, Can. J. Earth Sci. 8: 1265-1281) show that the continental margin off Vancouver Island is severely faulted. The thickness of the sediments lying at the foot of the slope off Vancouver Island decreases to the north as a result of the postulated changes in direction of motion of various plates in this region (Tiffin, D. L. et al, 1972, Can. J. Earth Sci. 9: 280-296; Chase, R. L. and Tiffin, D. L., 24th IGC, Sect. 8. Mar. Geol. and Geophysics 17-27).

S. P. Srivastava continued participation on interpretation of geophysical data collected by the National Ocean Survey (U.S.A.) group of National Oceanic and Atmospheric Administration (NOAA) in the northeast Pacific. The decrease in the offset of the magnetic anomalies to the east along the Surveyor fracture zone and the presence of undisturbed north-south lineations east of it show strong evidence of differential sea-floor spreading. The extension of the Blanco fracture zone has been delineated northwestward to about 113°W. It is suggested that this fracture zone began about 15 million years ago.

Srivastava has continued to develop methods for the correction of diurnal magnetic variation on surveys at sea. Magnetic data from simultaneous recordings at several places along the Gulf of St. Lawrence (Srivastava, S. P., 1971, Earth and Planet. Sci. Letters, 10: 423-429) were used to estimate the error in the Gulf when using the base station at BIO. A method was developed to apply correction routinely. Field

trials of the equipment to monitor the magnetic variations at sea were carried out at 41.6°N, 60°W. A magnetometer buoy was moored in 4000 metres of water and obtained one and a half days' continuous recording. Using this record to estimate diurnal variation a cross over error on magnetic survey tracks in the vicinity of the buoy could be reduced to less than 10 gamma.

A PDP-11 computer was used by D.E. Heffler in the development of an on-line seismic data processing system. A core resident monitor system has been developed to provide keyboard control of seismic data processing. A very sharp 60Hz notch filter as well as a time variable filter are now used. Correlation and simple dereverberation programs have been written.

Personnel Notes

Dr. W. J. M. van der Linden joined the Subdivision January 1, 1972. Dr. R. A. Folingsbee took up a Post Doctoral Fellowship with the Subdivision in May. Mr. A. Jackson joined the staff on June 12.

Attendance at Meetings

I. Harris

G.A.C. (Nfd Section) Annual Meeting March 1-5, 1972.

AAPG - SEPM Denver, Colorado, April 13-17, 1972.

R. T. Haworth

G.S.C. Basin Analysis Review, Calgary, January 15-17, 1973.

C. E. Keen

Dynamics of Mid-Atlantic Ridge Workshop, Princeton, N.J., January 24-28, 1972.

53rd Annual Meeting, A.G.U., Washington, D.C., April 17-21, 1972.

Penrose Conference on Geological History and Structure of Continental Margins, Washington, December 11-18, 1972.

FAMOUS Mid-Atlantic Ridge Meeting, W.H.O.I., Wood's Hole, Mass., January 8-11, 1973.

L. H. King

Leadership Skills Course, Halifax, March 6-9, 1972.

Managerial Grid Course, October 29 - November 3, 1972.

24th International Geological Congress, Montreal, August 21-25, 1972.

D. I. Ross

Leadership Skills Course, Halifax, March 6-9, 1972.

Northern Canada Offshore Drilling Meeting, Ottawa, December 4-6, 1972.

S.P. Srivastava

Leadership Skills Course, Halifax, March 6-9, 1972.

Geomagnetic Induction Workshop, Ottawa, March 21, 1972.

W.J.M. van der Linden

G.S.C. Basin Analysis Review, Calgary, January 15-17, 1973.

Special Talks

D. L. Barrett

"Real Time Dereverberation and Signal Processing of Marine Seismic Reflection Profiles" I.E.E.E. "Ocean 72", Newport, R.I. September 15, 1972.

A. C. Grant

"Morphology and Geology of the Continental Margin off Labrador and Eastern Newfoundland." Lecture to Ottawa Geotechnical Group of NRC. February 8, 1972.

"Geophysical Investigations on the Continental Shelf Off Southern Baffin Island" 53rd Annual Meeting, A.G.U. April 19, 1972.

"Morphology and Geology of the Western Margin of the Labrador Sea" Talk to Alberta Society of Petroleum, Calgary, September 27, 1972.

Lectures to Department of Geology University of New Brunswick, January 30, 1973.

"Geology of the Labrador Shelf." G.S.C. Basin Analysis Review, Calgary, January 17, 1973.

I. Harris

"Geology of Meguma Group N.S." Memorial University, St. John's, Newfoundland, March 6, 1972.

R. T. Haworth

Lectures to Hydrography Step II Course, Ottawa, July 14-16, 1972.

Lectures to Hydrography Step II Course, Burlington, October 25, 1972.

"Computerized System for Storage and Retrieval of Geologic Data." 24th International Geological Congress, Montreal, August 24, 1972.

Presented paper by Shih and Heffler. "Bedford Institute Geographically Ordered Marine Geophysical Data Storage and Retrieval System." 24th International Geological Congress, August 22, 1972.

C. E. Keen

"A seismic Refraction Survey in Baffin Bay and Davis Strait", 53rd Annual Meeting, A.G.U., Washington, D.C., April 21, 1972.

"The Continental Margins of Eastern Canada." G.S.C. Basin Analysis Review, Calgary, January 16, 1973.

L. H. King

"Bedrock Geology of Scotia Shelf." G.S.C. Basin Analysis Review, Calgary, January 16, 1973.

B. MacLean

"The Scotian Shelf Submarine End-moraine Complex." 24th International Geological Congress, Montreal, August 26, 1972.

D. I. Ross

"Baffin Bay - Analysis of Gravity and Magnetic Data." 53rd Annual Meeting, A.G.U. April 19, 1972.

"Hudson 70", I.E.E.E. Ocean 72. Newport, R.I., September 14, 1972.

"Geophysical Interpretation of Baffin Bay." G.S.C. Basin Analysis Review, Calgary, January 17, 1973.

W.J.M. van der Linden

"Structure of the Seafloor West of New Zealand." 53rd Annual Meeting, A.G.U., April 20, 1972.

Membership on Committees

R. T. Haworth

Subcommittee on Gravity, Advisory Committee on Geodesy and Geophysics. National Research Council.

C. Keen

Subcommittee on Seismology and Physics of the Earth's Interior, Advisory Committee on Geodesy and Geophysics, National Research Council.

Commission on Geodynamics (Working Group 8), International Union of Geodesy and Geophysics.

L. H. King

Subcommittee on Quaternary Geology, National Advisory Committee on Research in Geological Science. National Research Council.

D. I. Ross

Subcommittee on Seismology and Physics of Earth's Interior, Advisory Committee on Geodesy and Geophysics, National Research Council.

JOIDES Planning Committee.

Manuscripts Approved for Publication

D. L. Barrett

"Real Time Dereverberation and Signal Processing of Marine Seismic Reflection Profiles." Proceedings I.E.E.E. "Ocean 72" Conference 1972. (#15 May 25, 1972)

A. C. Grant

"The Continental Margin Off Labrador and Eastern Newfoundland - Morphology and Geology." Can. J. Earth Sci. 9, 1972, pp 1394-1430. (#17 June 12, 1972)

I. M. Harris

"Anomalous Quartz and Calcite Bodies in the Goldenville Formation, Taylor Head, Nova Scotia." Maritime Sediments 7, 1971, pp 123-125. (#14 May 23, 1972).

C. E. Keen

"Some Geophysical Measurements on the Northern Shelf of Baffin Bay." Proceedings of Annual Meeting C.S.E.G. (#33 February 27, 1973)

"Seismic Refraction Studies in Baffin Bay: An example of a Developing Ocean Basin." Geophys. J. R. Astr. Soc. 30 1972, pp 253-271. (with D. L. Barrett) (#12 May 18, 1972)

"Structural Characteristics of Some Sedimentary Basins in Northern Baffin Bay." Can. J. Earth Sci. (in press) (with D. L. Barrett) (#34 March 9, 1973)

L. H. King

"Surficial Geology of the Yarmouth-Browns Bank Map Area." Marine Sciences Paper #2. (with G. Drapeau) (#5 March 1, 1972)

D. I. Ross

"Mid-Atlantic Ridge Near 45^{o}N: Computer Interpolation and Contouring of the Bathymetry and Magnetics." Marine Sciences Paper #11. (with P. J. Bhattacharyya) (#2 February 14, 1972)

"New Geophysical Data on the Continental Shelf of Central and Northern West Greenland." Can. J. Earth Sci. 10, 1973, pp. 485-497. (with G. Henderson) (#18 July 4, 1972)

S. P. Srivastava

"Differential Spreading of the Juan de Fuca and Gorda Rises as Obtained from a Detailed Magnetic Survey." Earth and Planet Sci. Lett. (in press). (with D. Elvers, K. Potter, T. Morley, and D. Seidel) (#37 March 16, 1973)

"Interpretation of Gravity and Magnetic Measurements Across the Continental Margin of British Columbia, Canada." Can. J. Earth Sci. (in press) (#36 March 16, 1973)

A. B. Watts

"Geophysical Investigations East of the Magdalen Islands, Southern Gulf of St. Lawrence." Can. J. Earth Sci. 9, 1972 pp. 1504-1528. (#6 April 17, 1972)

Active Projects

G.S.C. No.	
720105	Geophysical investigation of the Gulf of St. Lawrence - R. T. Haworth.
720106	Geophysical investigation of the Laurentian Channel and southern Grand Banks of Newfoundland - R. T. Haworth.
720108	An assessment of the methods used in applying diurnal correction to marine magnetic data - S. P. Srivastava.
720110	Underwater diamond-drill trial and support survey northeast of Belle Isle, Newfoundland - I. M. Harris.
720111	Geophysical studies of the continental slope and rise off the Canadian Eastern Seaboard - C. E. Keen.
720112	Marine Seismic data processing - D. E. Heffler.
730072	Regional Bedrock Geology, Grand Banks - L. H. King.
730073	Regional Bedrock Geology, Scotia Shelf and adjacent areas - L. H. King.
730074	Surficial Geology, Grand Banks - L. H. King.
730075	Surficial Geology, Scotia Shelf and adjacent areas - L. H. King.
730076	Surficial Geology of the Labrador Continental Shelf and Slope - W. J. M. van der Linden.
730077	Crustal study of the Labrador Continental Margin - W. J. M. van der Linden.
730078	Geological studies of Baffin Bay, Davis Strait and adjacent Continental Margins - D. I. Ross.
730080	Elastic and Physical Properties of Mafic rocks - D. L. Barrett.
730081	East Coast Offshore Surveys - R. F. Macnab.
--	Investigations on the Southeast Baffin Continental Shelf - A. C. Grant.

SCIENTIFIC AND TECHNICAL SUPPORT SUBDIVISION

K. S. Manchester

Introduction

Complexity of marine operations requires extensive and sophisticated support at all stages: i) While an operation is being planned, equipment has to be designed or modified, maintenance and calibration carried out, consumable supplies ordered and additional support services contracted. ii) In preparation for an expedition, equipment and supplies have to be assembled and loaded on board ship, ship fittings and modifications carried out as required, liaison with other agencies established and, when necessary, shore support parties dispatched. iii) During an operation equipment has to be maintained and watchkeepers provided, data has to be processed and samples classified. iv) Following an operation equipment has to be dismantled, refurbished and prepared for storage, maintenance and overhaul contracts raised, damage repaired or new equipment ordered, data and samples classified and dispatched. v) Finally, as a continuing responsibility, data files have to be maintained so that information is easily accessible, samples curated and stored and data indexes and sample inventories published.

Program Support Subdivision is responsible for a whole range of support services as illustrated above. The Head is actively engaged in planning all field projects. Subdivision personnel take part in carrying out operations under different project leaders. The close coordination between a project and support is required continuously in order to ensure that all the necessary resources are brought together when required.

Activities

A total of 23 field projects were supported by the Subdivision. Seven of these projects were expeditions on major ships: 1. DAWSON (King, April 17 - May 19); 2. MINNA (Macnab, May 30 - August 31, 1972); 3. HUDSON (Keen, July 4 - August 5, 1972); 4. HUDSON (Macnab - van der Linden, September 27 - November 2, 1972); 5. HUDSON (Loncarevic, November 3-8, 1972); 6. BAFFIN (Folinsbee, January 15-26, 1973), and 7. DAWSON (Fader, February 5-23, 1973). Other projects included nine field trips using small boats including a two-months study in the coastal zone around Minas Basin; five equipment testing and evaluation cruises; and two cooperative projects with industry (Grant, August 8 - September 1, 1972, EASTCAN, and MacLean, July 21 - August 12, 1972, MOBIL).

The Subdivision was also responsible for acquisition, initial testing and evaluation of a number of capital items including: i) Third complete sea gravimeter system (valued at $150,000 but purchased second-hand for $25,000); ii) A PDP-11 computer for on-line processing of seismic data

$40,000); and iii) A large RIX compressor for seismic profiling with the capacity of 150 CFM at 2000 lb. per sq. in. ($22,000).

During the year, new office accommodation was organized for the Division headquarters in the north end of the Laboratory wing of the BIO building. A new storage building providing 2400 sq. ft. was constructed at the north end of the property ($25,000). In order to relieve the acute space shortage, an area in the Institute depot building has been converted to provide 5000 sq. ft. for instrument maintenance and a record storage ($20,000).

The data storage and retrieval system GEOFILE is a computerized method of storing and accessing geophysical data. At present there are 500,000 km of gravity and magnetic data in the final processed files. The data are stored in the time order of accession. A new system, GEODATABASE, is being developed to store data in geographic order (K. G. Shih).

Personnel Notes

Mr. J. D. Hutchinson left the Subdivision on January 26, 1973. Mr. A. J. Boyce joined the Subdivision on March 5, 1973.

Attendance at Meetings

T. J. Corbett

Leadership Skills Training Course at AGC, March 1972

M. D. Hughes

"Oceanology International 72", March 19-24, 1972, Brighton, England

Askania G.M.B.H., Berlin, Germany, March 24-30, 1972, Training Course on Maintenance of Askania Seagravimeter

K. S. Manchester

Leadership Skills Training Course at AGC, March 1972

K. G. Shih

GSC Workshop on Automated Geophysical Data Reduction, Ottawa, April 24-27, 1972

Data Reports and Computer Notes

L. F. Barrett

- and R. T. Haworth. Bathymetry, Gravity and Magnetic Data over the Orpheus Gravity Anomaly, HUDSON 27-64. Data Report BI-D-72-15

- and R. T. Haworth, J. B. MacIntyre. Bathymetry, Gravity and Magnetic Data, DAWSON 72-009, Data Report BI-D-72-14

K. S. Manchester

- and K. G. Shih and B. L. Johnston. Magnetic and Bathymetric Profiles in the Davis Strait and Labrador Sea, BAFFIN 05-63. Data Report BI-D-72-2

- and K. G. Shih and B. L. Johnston. Magnetic and Bathymetric Profiles in the Eastern Canadian Arctic Areas, LABRADOR 12-63. Data Report BI-D-72-11

K. G. Shih

Marine Geophysical Data Presentation, Part 1, Methods and Instructions for Preparing Data Reports. BI Computer Note C-72-1

Marine Geophysical Data Presentation, Part 2, Displaying Data in Mercator Projection Scale. BI Computer Note BI-C-72-2

Computing Free Air Gravity and Magnetic Anomalies at Sea on the PDP-8 8K Computer. BI Computer Note BI-C-73-1

Geological Interpretation of Underwater Photographs Obtained on the Mid-Atlantic Ridge, HUDSON 19-66. Data Report BI-D-72-16

- and B. L. Johnston and S. P. Srivastava. Bathymetric and Magnetic Data Collected in the Northeastern Pacific Ocean and Bering Sea, PARIZEAU 1970. Data Report BI-D-72-13

- and J. B. MacIntyre and B. L. Johnston. Gravity and Magnetic Data Collected in the Northeastern Pacific Ocean and Bering Sea, BAFFIN 70-021. Data Report BI-D-72-7

- and K. S. Manchester. Geological Interpretation of Underwater Photographs Obtained on the Mid-Atlantic Ridge, HUDSON 22-68. Data Report BI-D-73-1

- and C. Williams and D. M. Porteous. Gravity and Magnetic Data Collected in the North Atlantic Ocean, HUDSON 06-65. Data Report BI-D-72-9

- and D. I. Ross and B. L. Johnston. Gravity and Magnetic Data of Baffin Bay Collected in 1970, HUDSON 69-050 and BAFFIN 70-021. Data Report BI-D-72-5

R. Sparkes

- and R. T. Haworth. Computerized System for Storage and Retrieval of Geologic Documents. 24th International Geological Congress. Montreal, Canada. Section 16 pp. 155-160

- and D. L. Barrett and B. L. Johnson. Bathymetry and Magnetic Data in Lancaster Sound Labrador 64-020. Data Report BI-D-73-3

- and R. T. Haworth and H. G. Cousins. Document Storage and Retrieval. BI Report BI-R-72-5

Active Projects

GSC No.

720113 Geographically Ordered Data Base - K. G. Shih

-- Development of Underwater Self-Contained T.V. Camera and Recording Unit - C. A. Godden

CENTRAL LABORATORIES AND TECHNICAL SERVICES DIVISION

J.A. MAXWELL, Chief

INTRODUCTION

The Central Laboratories and Technical Services Division comprises the following major units,

- Analytical Chemistry Section
- Mineralogy Section
- Electronic Services and Equipment Development
- Mechanical Services and Instrument Development Shop

and has three major objectives,

1. To provide the chemical, mineralogical, instrumental and technical services and advice required by Branch scientific projects and operations;

2. To provide mineralogical information to the Public;

3. To initiate and carry out the mineralogical, chemical and technical research and method development needed to meet previous objectives.

To achieve these objectives, the Division is engaged in the following activities:

1. The provision of chemical, mineralogical and instrumental analyses, information and advice;

2. The provision of electronic and mechanical services in the design, development, construction, modification, installation and maintenance of complex analytical and other instrumentation and equipment;

3. The modification and adaptation of existing methods, techniques and equipment, and the assessment, development, testing and application of new ones, required to carry out the work of the Division;

4. The development and maintenance of the National Systematic mineral collection, the Branch ore and meteorite collections;

5. Chemical and mineralogical research and method development including contributions to the development of international standards, as

required to carry out the work of the Division;

6. The preparation of representative sets of Canadian rocks and minerals for sale to the Public; the preparation and publication of guidebooks for Canadian mineral areas of interest to mineral collectors; the identification of mineralogical and related samples submitted by the Public.

The work of the Division requires the operation of a large suite of laboratories and workshops, and a very large part of the collective effort is directed towards providing the services requested by Branch staff in support of scientific projects.

In terms of the two major objectives of the Division, those of providing support services to Branch scientific projects and of carrying out the research and method development required to make these services possible, the Division has had a busy and successful year. Detailed statements of the activities and productivity of the Sections follow, but it is possible to highlight here a few of the major achievements:

- a program of secondment was introduced to provide opportunities for the broadening of the technical experience, and increasing the flexibility, of the Division staff. Temporary assignments were arranged in the chemical, emission spectrographic, mineralogy and sample preparation - mineral separation laboratories, as well as a part-time assignment to the office of the Administrative Officer. The scheme was satisfyingly successful and it is expected that further such secondments will be made.

- the demand for chemical and emission spectrographic services of the Analytical Chemistry Section rose sharply, with over twice as many samples (7,558) being submitted as in 1971-72; the number of samples completed (5,418) was 65% greater than the 1971-72 productivity. Of particular note is the fantastic jump in the total number of emission spectrographic determinations reported (70,838) compared to those (26,019) reported in 1971-72. This reflects the very successful and routine utilization of a direct-reading emission spectrometer.

- an energy dispersive spectrometer was added to one of the two electron microprobes in the Mineralogy Section and interfaced to a mini-computer; this has been used for the quantitative analysis of rock-forming silicate minerals and, by means of a computer program prepared in the Section, the raw data are treated to produce compositional values in weight % for up to 15 elements; an analysis takes about 10 minutes, and the procedure is being used routinely.

- the notable improvement in the productivity of the emission spectrographic laboratories has been mentioned. This can be attributed in part to the enthusiastic and venturesome attitude of the laboratory staff, to the upgrading and automating of ancillary equipment, such as the mechanical preparation of samples, bulk-loading of electrodes, the use of pre-weighed graphite buffer additions and, of course, the putting into routine operation of the direct-reading spectrometer. To the latter was added a teletype-writer and paper-tape recording system, the output of which is now converted to a final analytical report by the Computer Science Centre. A mini-computer

has also been added and it is anticipated that eventually the final computer-printed report will be produced in the laboratory itself.

- there have been many problems encountered in the effort to integrate the new system of microanalysis by emission spectroscopy using focused laser beam excitation ("laser microprobe") into mineralogy laboratory operations, but much of the ground work has now been laid, including the preparation of a computer program to control the automated reading of the spectrographic plate and the recording of the intensities of selected element lines.

- the automated multichannel X-ray fluorescence spectrometer of the chemical laboratories is showing its age and was out of action on several occasions. It has been completely overhauled and a new scheme developed in which unfused, finely-ground sample is pressed into a disc with powdered plastic. Both sides of the disc are read, and the analytical data are converted by computer to weight % by comparison with stored data on chemically-similar standard samples. The new method has many advantages, including better precision and accuracy, over the previous procedure.

- solid progress is reported in the curating of the National and Branch collections which are the responsibility of this Division. Among the 151 accessions added to the reference portion of the National Mineral Collection (now more than 1,660 species) was Canada's only authenticated diamonds, from Île Bizard, Quebec. The Ringsleben collection, from Toronto, was purchased as a major addition to the ore collection, and 35 specimens were added to the National Meteorite Collection which now represents 330 falls and finds.

- a new ("neo-classical") combined gravimetric-colorimetric-atomic absorption spectroscopic scheme of chemical analysis has been developed which, while yielding results comparable in precision and accuracy to the "classical" scheme, is much faster than the latter. It is an improvement on the lithium fluoborate scheme, and involves fusion of the sample with lithium metaborate, dissolution and gravimetric-colorimetric determination of Si, colorimetric determination of P, and the determination by atomic absorption spectroscopy of Al, total Fe, Mg, Ca, Na, K, Mn and Ti (and of Ba, Sr, Cr, and Ni if circumstances permit).

The preceding activities and others which are detailed in the Section reports, were carried out by essentially the same Division staff as in 1971-72 (one position, for our electron microprobe laboratory, was obtained on an over-strength basis) and the record of achievement reflects credit on all. Maximum use was made of allotted term, casual and "green student" time to buttress the efforts of the continuing staff, but the demands for services continue to exceed the resources of the Division and backlogs still remain. The Analytical Chemistry Section lost a position in 1967 when the writer moved into Division administration, and has been without it since then; the Instrument Development Shop needs a position to accommodate the many daily requests for minor and urgent services. Of most concern is the need to obtain a continuing position for an assistant to Mr. F. W. Jones (electronic services) who, as he points out in his report, is

unable any longer to cope single-handedly with Branch demands for his technical services and advice. The fact that Mr. Jones will retire in three years adds a sense of urgency to this obvious need. The laboratories of the Mineralogy Section are crowded with equipment and staff to the point of being hazardous, and it is hoped that some additional space will soon be made available to the Division to alleviate this.

As mentioned at the beginning, most of the effort of the staff of this Division is directed towards providing the scientific support services necessary to the operation of Branch scientific projects, and the record of productivity and related method development in this report emphasizes the present dedication of the staff in striving to fulfill this objective, a dedication which, for the most part, receives little recognition. It is hoped that a greater degree of support for their efforts will be forthcoming from our "client" Divisions.

DIVISION ADMINISTRATION

Personnel Notes

J. A. Maxwell : combined visits to the Institute of Sedimentary and Petroleum Geology, Calgary; Cordillera and Pacific Margin Subdivision (R.E.G. Division), Vancouver; and U.S. Geological Survey, Denver, Colorado, with attendance at Geological Society of America Annual Meeting, in November.

Analytical work was completed on lunar samples from the Apollo 14 and 15 missions, with the valued assistance of J.-L. Bouvier, and the analyses of four samples from the Apollo 16 mission have been started. Some samples from the Apollo 17 mission are also on hand for future study.

P. G. Belanger, of the Analytical Chemistry Section, assisted J.H. Lapp, Division Administrative Officer, for one day each week.

Miss Debbie Philips, from Rideau High School, and Bruce Watkinson, from Glebe Collegiate High School, spent their Spring holiday work experience program, in March, working with J.H. Lapp and J.M. Larose (Rock and Mineral Sets Preparation), respectively.

Attendance at meetings, conferences and courses

J. A. Maxwell: Attended the Grid Organizational Development Seminar, April 24-28, in Cornwall, Ontario.

Annual Meeting, Geological Society of America, Minneapolis, Minn., in November.

Miss A. H. Parke-Taylor: Attended a Secretarial Development Workshop in No. 8

Temporary Building, September 26-28, 1972.

Membership on Committees

J. A. Maxwell:

Chairman, Branch Classification Evaluation Committee, Technical Category

Member, Associate Committee on Meteorites, National Research Council

Member, Standards Committee, Geochemical Society

Branch Representative, Departmental Committee on Bilingualism and Biculturalism

Completed Manuscripts

Maxwell, J.A., Bouvier, J.L. and Wiik, H.B.

1972: Chemical composition of some Apollo 15 lunar samples. In "the Apollo 15 Lunar Samples", The Lunar Science Institute, pp. 233-238, ed. by J.W. Chamberlain and C. Watkins.

Wiik, H.B., Maxwell, J.A., and Bouvier, J.L.

1973: Chemical composition of some Apollo 14 lunar samples. Earth and Planetary Sci. Letters, V. 17, 365-368.

ANALYTICAL CHEMISTRY SECTION

Sydney Abbey

During 1972-73, the Section continued to provide compositional data on geological materials as a contribution to Branch projects; to collaborate in world-wide analytical studies on proposed international standard samples; to develop, adapt and publish methods for such analyses; and to provide consultation service on chemical and analytical matters for Branch officers, for other Government agencies and for geological groups in Canada and abroad.

Activities

A. General

Many changes occurred during the year, in the areas of production, methodology and personnel. Details are given below, but all can be summed up as an ever-increasing demand for our services, with no prospect of increasing our manpower resources beyond the opportunity to hire the occasional casual employee.

A number of visitors spent anywhere from a few hours to a few weeks in our laboratories, in order to observe and to study methods and equipment, or to exchange ideas. Included were representatives of the Institute of Sedimentary and Petroleum Geology, the Atlantic Geoscience Centre, the Canada Department of Agriculture, Provincial Governments (Ontario, Saskatchewan and British Columbia), universities (Laurentian, McGill and Dalhousie), three Canadian commercial enterprises, an exploration firm in Ireland, the British Museum, the New Zealand Geological Survey, a post-doctoral Fellow from Esthonia, a U.N. Fellow from Somalia and a number of delegates to the International Geological Congress. Inquiries were also received from Canadian industries and universities, Cambridge University and the Geological Survey of Israel.

In the course of personal travels, the writer discussed problems with an instrument manufacturer in Australia and visited laboratories of the New Zealand Department of Scientific and Industrial Research, the Saskatchewan Department of Mineral Resources and the Ontario Department of Natural Resources.

B. Chemical and X-Ray Fluorescence Laboratories

Production Analysis

There was a small increase in both the number of samples reported and the number of chemical determinations done. X-ray fluorescence determinations dropped to less than half of those done in the preceding year. The decrease was due in part to the increasing demand for analyses to which our relatively inflexible X-ray fluorescence analysis system is not adaptable, and also the result of repeated instrumental breakdowns.

Our X-ray fluorescence spectrometer is now over ten years old, and is not only showing the effects of age, but also the effects of limitations which have been overcome in more recently developed instruments. As replacement with a new instrument is not expected to be financially feasible for a year or two, a major overhaul of the instrument was undertaken. All of the spectrometer components were dismantled, cleaned, re-assembled and re-aligned. In the course of this work (and the method development work outlined below), operations were continually hampered by failures of components in nearly every part of the system. Matters were further complicated by difficulties in obtaining replacement parts for so old an instrument.

Meanwhile, the number of samples received was more than double that in the preceding year, resulting in a nearly four-fold increase in the backlog of work. In view of the increasing interest by several geologists in "complete" analyses of suites of rocks running in the thousands instead of the dozens or hundreds, and of the fact that the X-ray fluorescence system accounts for the bulk of the data reported from the "chemical" laboratories, the need for a new instrument and for an increase in staff becomes more urgent.

Some consideration has been given to the possibility (and the cost) of having complete rock analyses done by commercial laboratories. It was found that such laboratories tend to specialize either in rapid trace analyses for selected elements for exploration purposes or in analysis of commercial materials for conformance to specifications. Because of the limited demand for most of the types of analyses required by our Branch officers, few (if any) commercial laboratories can provide the kind of service done by our own laboratories, either in the area of precision work or in "rapid" analyses of large suites of samples.

International Reference Samples

Pressure of regular production work restricted our contribution to collaborative analyses of proposed international standard samples. The only analytical work done involved four rocks from the U.S. Geological Survey and four ores from the Geological Survey of India. Replicate portions of the former materials were analysed for lithium, rubidium, cesium, barium and strontium (along with regular production samples) as part of a homogeneity study. The Indian samples were analysed only for platinum.

A publication assigning "usable" values for most major and minor and some trace elements in eighteen international reference rocks appeared during the year, but the information in it became obsolete almost as soon as it appeared in print. As a result of the receipt of additional data, revisions and corrections, it is now possible to assign similar values to 29 such samples, and tentative values to four others. Samples of five additional proposed standards are on hand and possibly six more are expected. A revised publication will be prepared when time permits.

Analytical Method Development and Special Analyses

An entirely new scheme of X-ray fluorescence analysis was introduced. It involved the preparation of discs of unfused, finely ground rock samples, mixed with powdered plastic. The discs, which appear to be much more stable

than the boric acid-backed discs previously used, are analysed in the X-ray fluorescence spectrometer and the resulting readings compared with stored data on chemically similar "standards" by means of a mini-computer. This procedure required the use of international reference rocks and a number of previously analysed additional samples. All of the latter required re-analysis to confirm their earlier data.

Because of continuing difficulty in obtaining reliable silica values in the lithium-fluoborate scheme of analysis, a new scheme (tentatively labelled "neo-classical") was introduced for determination of most of the major and minor elements in rocks, and has been extensively applied in the re-analysis of samples used in calibration of the new X-ray fluorescence method. The scheme involves fusion of the sample with lithium metaborate in a graphite crucible and a single dehydration of the silica with hydrochloric acid, in the presence of methanol to eliminate boron. Following gravimetric determination of silica in the conventional manner, aliquots of the filtrate are analysed colorimetrically for unrecovered silica and for phosphorus, and by atomic absorption for aluminum, total iron, magnesium, calcium, sodium, potassium, manganese, titanium, and where they are present above the trace range, barium, strontium, chromium and nickel. Although the proposed scheme requires less analytical skill, results thus far indicate that it is comparable in precision and accuracy to the classical system for most elements, and is actually superior in the case of samples which contain unexpected concentrations of some unusual elements. The new scheme is, of course, much more rapid than classical analysis.

Other advances in method development included application of a selective-ion meter for fluorine determination in rocks, using a sample solution from which another aliquot can serve for the colorimetric determination of chlorine. Decomposition of tourmaline and other resistant minerals for a variety of analyses has been successfully carried out by digestion with acids under pressure in a Teflon-lined bomb. Apparatus for investigation of the use of a Karl Fischer titration method for water in rocks and a new all-quartz apparatus for the determination of ferrous iron by sulfur dioxide evolution were received, but pressure of other work prevented any applications before the end of the fiscal year.

Analytical work was completed on a number of samples in which individual noble metals were required, either where one or another noble metal was present as major constituents, or where the samples were meteorites. In the case of native silver, the matrix was removed by chloride precipitation; with native gold, separation of the matrix was found to be unnecessary.

C. Spectrographic Laboratories

General

The productivity of the laboratory in terms of both quality and quantity of analytical trace element determinations produced continued to improve. Efforts have been directed mainly towards upgrading of the laboratory equipment, introduction of alternate procedures for mechanized preparation of samples for analysis and preparation of buffers, etc., and use of computer programming to speed up the production of our working data and produce faster analytical results from our

direct reading spectrometer.

Analytical operations

Once again a very large increase in quantitative determinations on silicate rocks over the number in the preceding year was reported. This was due mainly to the more efficient use of the direct reader and the willing and enthusiastic co-operation of the whole staff of the laboratory during often difficult periods of changing conditions.

Determinations made by the photographically based methods, usually on the more complex and widely varying sample types, remained at about the same numerical level. However, as a result of continuing development work to improve our numerous working curves, significant progress was made in minimizing the inevitable analytical biases present.

Four samples from the Apollo 15 project and two from Apollo 16 were analyzed for traces, to complement the chemical analyses done by Dr. J. A. Maxwell.

We assisted in the Mines Branch program to produce standard ore samples by providing trace element data used in the certification of the reference samples of Mount Pleasant ore MP-1 and Highland Valley ore HV-1. We expect to continue to co-operate in this program as well as other similar international projects to provide certified analytical standard samples.

Trace element data were also supplied for a proposed rock standard, Mount Royal gabbro, MRG-1.

Certification of the four synthetic glass reference standards from the U.S. Geological Survey, on which we have previously submitted our trace analyses, has not yet been reported. Considerable work was carried out to resolve apparent analytical anomalies in some of the data for a few of the volatile elements.

Methods Development

The Jaco direct reading spectrometer was improved by addition of a teletypewriter and control system to produce a record of the analytical channel data on paper tape. A much more stable solid-state power supply to the photomultiplier tubes replaced the old one. All exit slits and associated optical components were re-aligned and re-calibrated, several changed to better wavelengths and used with more sensitive tubes, etc., to establish a new analytical program covering 22 elements with much better sensitivity for the critical trace elements than was available in the previous program.

The analytical method used on the direct reader is a variation of our current photographic procedure which is used for some 37 elements in silicate rocks. But to obtain more speed for routine direct reading analysis, we are now using alternative bulk loading of electrodes (rather than weighing the charges) and commercially obtained pre-weighed graphite for preparation of samples for analysis. The buffer mixture used is prepared in quantity in a high-speed commercial blender. The precision obtained, approximately ±15% of amount reported depending on the element, is very acceptable for this type

of analysis. The paper tape output from the teletypewriter is taken to the Department Data Centre and the analyses are then very quickly completed through a computer program on the main computer and reports printed and returned to us in final form.

A Nova model 1220 mini-computer was obtained by the laboratory at the end of March, 1973. This has now been installed and attached to the direct reader to be used to operate it in "dedicated" fashion. It is expected that further refinements to this analytical system will now be possible and that eventually the program for completing the analyses can be completed within the laboratory without recourse to the main computer.

Five new vibrator electrode loader units built in the laboratory are now in use. All our analytical balances have now been replaced by much more convenient to use current models. All these minor changes help to allow the operators to work more efficiently in preparing samples.

The Wadsworth spectrograph was fitted with a new support column for the arc stand and a new custom-built direct current power source at the end of March. Preliminary testing indicates an improvement in precision of several per cent can be expected in our fractional distillation method for volatile elements by use of the controlled current feature of this new source. Some improvement also may be made in precision of our other photographic methods with air-jet controlled excitation.

A comprehensive program to prepare a large number of series of synthetic standards has been put into operation on a continuing basis. To date, new series of standards have been prepared in silicate bases for Cu, Mo, Ge, Sb, Bi. Along with the continuing work on the analysis of the various international reference standards, and comparisons with those that are "certified", this has led to the upgrading and improvement in accuracy of a number of analytical working curves and the preparation of additional curves for Mo, Cu, Sn, Ni and Ge which further extend the range of our analytical services.

Personnel Notes

In an attempt at diversifying the skills of staff members, there was a major interchange of personnel between the various laboratories of this Section and the Mineralogy Section in the second half of the fiscal year. Details are given below.

Professional Staff

Serge Courville spent six months in the X-ray fluorescence laboratory of the Mineralogy Section.

Technical Staff

J.L. Bouvier was designated as supervisor of the analytical service function of the chemical and X-ray fluorescence laboratories, and K. A. Church as supervisor

of the spectrographic services laboratories.

Linda Seymour spent the latter half of the fiscal year in the spectrographic laboratories, while Gary Vickers worked in the sample preparation laboratories of the Mineralogy Section. At the same time, Jean Gravel and Richard Charbonneau of the Mineralogy Section, were temporarily seconded to our chemical and X-ray fluorescence laboratories.

Donna Irwin resigned her position in the spectrographic laboratories, and was replaced by Peter Bélanger, who is also assisting Divisional Administration on a part-time basis.

Three of the remaining winter casuals from 1971-72 Naomi Lee, John St. James and Lisa Saunderson, left at the end of May. A fourth, Scott Hawkins, continued as a summer student.

Casual employees and students who worked in the chemical and X-ray fluorescence laboratories for varying periods included J.R. Barry and Nancy Watson. Similarly employed in the spectrographic laboratories were, Rick Bowen, Cathy Carmody, Linda Kearns, Nelson Lacharity and Carol Smith.

At the end of the fiscal year, Clare Meeds was still employed as a casual in the spectrographic laboratories and René Guillas in the chemical and X-ray fluorescence laboratories.

Attendance at Meetings

Symposium on Standard Samples
(At International Geological Congress, Montreal, August 23)

Sydney Abbey

Analytical Workshop, Chemical Institute of Canada
(At Algonquin College, Ottawa, September 11-13)

Serge Courville
J. G. Sen Gupta
Sydney Abbey

Canadian Spectroscopy Symposium
(Montreal, October 24-25)

G. P. Bender
K. A. Church
W. H. Champ
Sydney Abbey

Membership on Committees, etc.

Serge Courville: Safety Officer, Central Laboratories and Technical Services Division

Executive Chemists' Group
Professional Institute of the Public Service.

Sydney Abbey: Organizing Committee, Analytical Workshop, Chemical Institute of Canada. (Also served as Chairman, session on Standardization and Standard Samples).

Chairman, session on Atomic Absorption, Canadian Spectroscopy Symposium.

D. Statistics

Note: In previous years, because of the need to prepare this report well before the actual end of the fiscal year, it was necessary to base numerical statistics on a 12-month period ending with the month of February. This year, however, the statistics cover the actual fiscal year, ending with the month of March. The "carried over" figures for 1972-73 are therefore not compatible with the "carried forward" figures for 1971-72.

1. Samples Processed

	Chemical and XRF	Spectro-graphic
Carried from 1971-72	727	1,360
Received, 1972-73	4,026	3,129
	4,753	4,489
Completed, 1972-73	1,895	3,532
	2,858	957
Withdrawn	62	7
Carried to 1973-74	2,796	950

Divisional Breakdown of Backlog

A.G.C.	1	0
C.L. & T.S.	0	5
R. & E.G.	2,582	283
R.G. & G.	213	651
Others	0	11
	2,796	950

2. Comparison with Preceding Year

	1971-72	1972-73
Samples Received		
Chem. and XRF	1,866	4,026
Spectrographic	1,762	3,532
Samples Completed		
Chem. and XRF	1,768	1,895
Spectrographic	1,595	3,523
Individual Spectrographic Analyses		
Qualitative	12	12
Semi-quantitative	26	26
Quantitative	1,908	3,933
Determinations		
Chemical	15,156	16,497
X-ray fluorescence	9,872	4,848
Spectrographic (semi-quantitative)	540	1,153
(quantitative)	25,479	69,685
Spectrographic Exposures		
Photographic	4,843	4,372
Direct Reader	0	2,818

Completed Manuscripts

J.L. Bouvier, J.G. Sen Gupta and Sydney Abbey
1972: Use of an "automatic sulphur titrator" in rock and mineral analysis: Determination of sulphur, total carbon, carbonate and ferrous iron. G.S.C. Paper 72-31.

J.G. Sen Gupta: The determination of gold, platinum group metals and some common metals in native silver by atomic absorption spectrometry. Anal. Chim. Acta, Vol. 63, pp. 19-28.

_____ in press: A review of the methods for the determination of the platinum-group metals, silver and gold by atomic-absorption spectroscopy. Minerals Sci. Engng., in press.

Sydney Abbey
1972a: "Standard samples" of silicate rocks and minerals - A review and compilation. G.S.C. Paper 72-30.

_____ 1972b: "Methods in Geochemistry and Geophysics, 5. Analytical Geochemistry" (a book review). Earth Sci. Reviews, Vol. 8, p. 325.

1972c: "Atomic absorption analyses of eighteen elements from a single decomposition of aluminosilicate" - Discussion. Chem. Geol., Vol. 9, pp. 305-309.

ELECTRONIC SERVICES AND EQUIPMENT

DEVELOPMENT SECTION

F.W. Jones

The functions of the unit are to maintain and service scientific laboratory equipment, as required, to redevelop and up-date laboratory instrumentation, to provide computer interface services and advice on new on-line laboratory systems and to advise on electrical and electronic specifications for new equipment as required.

Personnel Notes

E. McIntosh assisted in the general service work during the summer months.

Attendance at meetings, conferences and courses

In connection with work being done, the following visits were made:

- to Jarrel-Ash, Southbridge, Mass. (F. Breck, C. Allemande) regarding the laser microprobe;
- to American Optical Corp., Southbridge, Mass., regarding the laser microprobe;
- to Datagen, Southbridge, Mass. (R.J. Arsenault) regarding the computer system purchased by R.K. Wanless;
- to Institute of Sedimentary and Petroleum Geology, for discussion with G. Wanless.

Activities

The electronics laboratory and workshop was moved to larger quarters in Room 661, which was remodelled and equipped for this purpose.

This is the third fiscal year period in which electronic services have been directed towards computerization of laboratory data-gathering instrumentation, i.e. multi-channel, semi-automated systems. The first mini-computer, for control of the A.R.L. emission spectrometer, was put into use in April, 1970, and to date, the fifth of these mini-computers has recently been installed on the Jarrell-Ash

direct-reading spectrometer. Two other mini-computers are in the process of being installed by the Resource Geophysics and Geochemistry Division, and another at the Institute of Sedimentary and Petroleum Geology in Calgary.

The extent to which advice or technical assistance is required for this work varies. However, in the case of all the 8 computers referred to above, there was involvement from preliminary discussions on specifications and demonstrations of use, to situations like those of the Geochronology Laboratory (R.K. Wanless) and the Spectrographic Analysis Laboratories (K.A. Church) where 100 per cent technical aid was given to plan and set up the first phases of the systems. It is no overstatement to say that two thirds of the total time available was spent on the last two systems during the fiscal year.

It is very doubtful whether it will be possible for one person to continue to provide electronic service to this extent and, until such time as additional continuing assistance is available, technical work outside the Division will be discontinued in favour of technical advice.

Equipment in general has been serviced as needed but not maintained in the proper sense of the word. The following major items are listed to show the types of service rendered in excess of normal service:

A.R.L. Vacuum X-ray Quantometer, Anal. Chem. Section, C.L.T.S. Division; completely overhauled, new X-ray source voltage supply and H.V. counter tube supply added, alteration made to read-out to permit auto-determination, electronic and electro-mechanical sections checked, cleaned and serviced.

Jarrell-Ash Laser Microprobe, Mineralogy Section, C.L.T.S. Division; much time and effort was spent on this system which was completely out of use for two months. The whole laser assembly was taken to the American Optical Corporation plant in the U.S.A. for complete overhaul and replacement of circuit boards, etc. In addition, many hours were spent on additional trouble shooting, and in building up reference data from schematic diagrams.

Mass spectrometer, Institute of Sedimentary and Petroleum Geology, Calgary; One week was spent here with G. Wanless in discussion and examination of technical data to do with a new controlled-data acquisition system for an Atlaswerke CH4 mass spectrometer and H.P. 2100 computer. Additional time was spent subsequently in Ottawa, making up special connections and leads and in obtaining and sending small hardware items not easily purchased in Calgary. Numerous telephone conversations relative to new system were also made.

MECHANICAL SERVICES AND INSTRUMENT

DEVELOPMENT SHOP

G.A. Meilleur

The efforts of the Section are chiefly oriented toward support of Branch laboratories and field projects, through the provision of technical

services such as engineering drafting, fabrication and maintenance of scientific instruments or equipment. It also provides the liaison between commercial firms and scientific staff when similar work is to be contracted to commercial enterprises.

Personnel Notes

In addition to the continuing staff of A.Y. Cregheur, J.P. Fournier and B.A. Walker, G.A. Harrington continued as a term employee and T.E. Skene was employed for the summer months.

Attendance at meetings, conferences and courses

G. A. Meilleur : visits were made to a number of manufacturing enterprises and materials suppliers. These visits are mainly to arrange for the contracting out of work, to provide a follow-up on the progress of the work, and to enable periodic inspection to be made, to ensure that all specifications are being respected and applied.

Membership on Committees

G. A. Meilleur : Branch Parking Committee

Activities

Among the large number and variety of jobs submitted to the Section are those for the support of scientific projects which are unique to the Branch and which require developmental work and, on occasion, the fabrication of specific tools to carry it out; examples of this type of job are the development of oil and gas samplers, sampling of whale vertebra, the development of high pressure vessels, and of a sun compass. Projects of this nature present an interesting challenge to the Section and reflect the growing Branch interest in the development of new instruments and equipment.

A summary of the work done for the Branch is given under Production Statistics. In support of this work the Section originated 82 purchase orders for raw material, hardware, special components and specialized services. Several requests for materials and services were also submitted to other government organizations, such as the Mines Branch and National Research Council.

The purchase of a R-14 Nikon profile projector has greatly improved the inspection facilities of the Section. The instrument is presently equipped to provide up to 100x magnification and plans are being made to increase its power to 1000x if future Branch requirements are sufficient to warrant it.

The Section wishes to acknowledge and thank those who have contributed to our support and also those who patiently struggled with time and priority commit-

ments. We have good reason to believe that conditions will continue to improve and facilities will become more available, especially during the first half of the calendar year when the backlog is at its peak.

Production Statistics

During 1972-73, the Section received 171 requisitions for general work, including development, fabrication and other related services. This indicates a minor decrease compared to previous years, but is matched, and perhaps caused by, a substantial increase in daily services which do not require a formal requisition.

The following is a brief summary of the work distribution by Division:

Regional and Economic Geology	57.3%
Resource Geophysics and Geochemistry	22.5%
Central Laboratories and Technical Services	17.8%
Others	2.4%

In addition, a total of 18 requisitions have been contracted to outside industries or other Government enterprises for services such as machining, welding, sheet metal work, calibrating, anodizing, etc. This does not include requisitions sent directly from Division to commercial enterprises for similar services.

Acknowledgment for services and co-operation:

National Research of Canada

Atomic Energy of Canada

Mines Branch, Energy, Mines and Resources

MINERALOGY SECTION

R. J. Traill

The scientists and support staff of the Mineralogy Section produce data and provide scientific services in support of Branch objectives, by developing and applying analytical techniques of X-ray diffraction, X-ray fluorescence, electron and laser beam excitation, and by operating sample preparation and mineral-separating laboratories. Section staff are responsible for cataloguing, extending, and studying the Systematic Reference Series of Canada's National Mineral Collection, the National Meteorite Collection, and reference collections of the minerals of Canadian ore deposits; and for the dissemination of mineralogical information to the public by sale of sets of minerals and rocks, by identification of specimens, and by answering requests for information.

Activities

A.G. Plant, G.R. Lachance, Elvira Gasparrini and R.N. Delabio completed requests for electron microprobe analyses in support of 18 different Branch projects. Problems ranged from the analysis of isolated mineral grains to the analysis of complex assemblages requiring many hundreds of element analyses. As a result of a discussion with the staff of the Petrology Section, two scientists from that section were permitted to make their own microprobe analyses under supervision. An energy dispersive spectrometer was installed on one electron microprobe and a method was developed for the quantitative analysis of rock-forming silicates (pyroxenes, garnets, micas, feldspars, amphiboles, olivines). The energy dispersive system has been interfaced to a Hewlett-Packard computer and a program written by Mr. Lachance convolutes the raw data, carries out curve stripping and integration of peak areas as a function of energy to correct for background and non-resolution of peaks, and enables the conversion of on-line measured intensities to weight per cent for up to 15 elements in about 10 minutes. The output is then subjected to the normal matrix correction programs. The method is fully-operative and is being used routinely on normal requisition work. Outside service analytical work was restricted to 52 hours of microprobe time spent on analyses for the Earth Physics Branch of the Department of Energy, Mines and Resources.

M. Bonardi, R.N. Delabio and G. Pringle provided the following X-ray diffraction and mineralogical studies in direct support of 41 Branch projects: 2,122 mineral identifications, 265 analyses of minerals and rocks by diffractometer, 99 clay mineral analyses by X-ray diffractometer and 15 Guinier patterns. Examinations were made of 154 samples submitted for age determination (these included 34 rocks, 58 hornblendes, 49 biotites, 8 muscovites, 3 feldspars and 2 phlogopites) and reports were forwarded to the Geochronology Section. Review of data available in our reference file of X-ray powder patterns was completed and the data made ready for preparation of a manuscript revising Paper 60-4, Catalogue of X-ray Diffraction Patterns and Specimen Mounts on file at the Geological Survey of Canada. Work was started on the preparation of a reference file of standard

powder patterns of minerals, of better than normal quality, for measurement using the computer-controlled microdensitometer. Fifty-four of these were prepared and measured and a new reference file was established. Mr. Bonardi devoted several months to the problems of microanalysis by emission spectrography using focused laser beam excitation. Although hampered by breakdowns of the instrumentation, he succeeded in preparing standard plates for 65 elements and compiling an accurate list of the wavelengths and positions of the strongest and most interference-free lines. A computer program to read the plates and record as output the positions and intensities of selected elements has been written and proved to be effective. A mineralogical-petrographic study of a suite of broken ceramics recovered from the sunken vessel Machault was made at the request of the Archaeological Section of the National and Historic Parks Branch, Department of Indian and Northern Affairs.

R.J. Gravel and S. Courville completed 2,511 quantitative and 1,276 qualitative X-ray fluorescence analysis of rocks and minerals in direct support of 10 Branch (and 1 Mines Branch) projects, and indirectly in support of many others through provision of analyses of samples for age determination. Analyses were made for 26 different elements; those most often requested were Rb and Sr (517), Cu and S (151) and K (138). Mr. Courville replaced Mr. Gravel in the laboratory for a six-month period in order to gain additional experience with the X-ray fluorescence analysis method.

J.C. Paris, B. Machin, R. Charbonneau, A. Brown and M. Huot processed 2,328 samples in the sample preparation and mineral-separating laboratories and prepared 224 concentrates of minerals. This work required the following numbers of operations: crushed, ground and sized 2,336; heavy liquid separations 1,772; Frantz magnetic separations 1,450; Carpco magnetic separations 1,079; Superpanner separations 756; and Wilfley Table separations 36. Mr. Machin spent the summer months assisting Mr. Larose in the field, collecting bulk samples of minerals and rocks for the preparation of mineral and rock collections. Mr. Charbonneau was seconded to the Analytical Chemistry Section for six months to learn the methods of analyses used in that Section. He was replaced by Mr. Vickers. The services provided by this unit were used directly by 16 Branch projects and indirectly by all projects serviced by the Analytical Chemistry and Geochronology Sections.

H.R. Steacy reports that accessions to the reference portion of the National Mineral Collection totalled 151 specimens. These included 15 species new to the collection, raising the total representation to about 1,660 species. Important accessions included Canada's only authenticated diamonds from Ile Bizard, Quebec; specimens of nuffieldite and posnjakite; and some 200 pounds of altaite-bearing rock containing the new minerals mattagamite and tellurantimony. A major acquisition of the ore collection was the purchase of the large personal collection of the late Mr. W. C. Ringsleben of Toronto. Office projects of the Geological Survey and applied programs of other government agencies and of universities and industry were assisted by the compliance with 23 individual requests for mineral and ore specimens. Mineralogical studies were made of two new uranium occurrences in Ontario and summary reports were issued. Work in connection with the International Geological Congress involved planning and conducting excursions to classic mineral localities in Ontario and Quebec, and responsibility for the economic portion of the National exhibit at Georama. Mr. Steacy also served as host to seven groups of visitors to the G.S.C. during the year, and addressed

each group on the exhibits in Logan Hall and on the Geological Survey.

H.G. Ansell joined the staff in October and assumed responsibility for the identifications and reports on samples submitted by the general public. Results of the examination of 315 samples were incorporated in 93 reports mailed to submitters. In addition, about 50 identifications were made and verbal reports given to people who brought samples to the Survey personally. Mr. Ansell began a general overhaul of the reference portion of the National Mineral Collection involving re-spacing of the specimens, filing of new accessions, and re-grouping of the silicate minerals.

Mrs. A.P. Stenson completed and submitted for publication a guidebook to mineral collecting localities along the Alaska Highway. During the summer, she visited localities in the Cobalt-Timmins-Val D'or areas and gathered information of interest to rockhounds which is being incorporated in another guidebook. Twenty-three requests for information from the general public were answered during the year.

J.M. Larose, J. Turpin, T.H. Racine and D. Robertson prepared and shipped 7,450 Prospector's Sets of Rocks and Minerals. The distribution of these throughout Canada was as follows:

Alberta	1,016
British Columbia	1,298
Manitoba	122
New Brunswick	179
Newfoundland	211
Nova Scotia	215
Northwest Territories	282
Ontario	1,375
Prince Edward Island	1
Quebec	438
Saskatchewan	701
Yukon	803
Ottawa Office	655
Minister's Office	22
Others	132

Sales of the 120-specimen collection of minerals, rocks and ores representing the raw materials of the Canadian mining industry amounted to 329. At the request of the National Film Board, 100 special collections were supplied to accompany Earth Science film-strip kits. Revenue from the sale of all collections was approximately $24,000. During the summer, Mr. Larose, with the able assistance of B. Machin, collected more than 28 tons of rocks, minerals and fossils used in the various collections, from 85 localities in Alberta, British

Columbia, Manitoba, Northwest Territories, Ontario, Quebec and Saskatchewan. The distance travelled exceeded 18,000 miles.

R.J. Traill and A.G. Plant continued a study of the mineralogy and petrology of lunar rocks and regolith samples from the Apollo 15, 16 and 17 missions, in collaboration with M.R. Dence and R. Grieve of the Earth Physics Branch. The study forms part of a Branch project which also includes studies of meteorites and curatorship of the National Meteorite Collection. H.R. Steacy reports the addition of 35 specimens representing 17 meteorite falls to the collection. The number of different falls represented in the collection reached 330. Six meteorite specimens were loaned to Dr. I.R. Cameron, University of New Brunswick for cosmogenic nuclide studies. Six specimens were provided on an exchange basis to McMaster University for sulphur isotope studies. Five meteorites and nine tektites were loaned to the City of Montreal for display at Man and His World. Several suspected meteorites were examined but all proved to be of terrestrial origin.

Personnel Notes

H. Gary Ansell, formerly associated with the New Brunswick Research and Productivity Council joined our staff in October, 1972. Mr. Ansell is assisting H.R. Steacy with duties connected with the National Mineral Collection and G.S.C. collections of minerals and ores. He has also assumed responsibility for identification of specimens as a public service.

Miss Elvira Gasparrini joined the staff of the electron microprobe laboratory in January, 1973. She is an experienced electron microprobe operator, having spent six years at the University of Toronto.

Inter-sectional exchanges were arranged with the Analytical Chemistry Section enabling J. Gravel and R. Charbonneau to spend a period of six months as part of the analytical services team learning the methods and techniques used in the chemical laboratories.

Attendance at Meetings

G. R. Lachance	: Canadian Electron Probe Users Group, Kingston, June 5, 1972.
J. M. Larose	: Prospectors and Developers Association, Toronto, March, 1973.
A. G. Plant	: Canadian Electron Probe Users Group, Kingston, June 5, 1972.
	International Geological Congress, Montreal, August, 1972.
	Lunar Science Conference, Houston, March, 1973.

Ann P. Stenson	: Mineralogical Association of Canada Montreal, August, 1972.
R. J. Traill	: International Geological Congress Montreal, August, 1972.

Special Talks or Lectures

A. G. Plant gave an invited talk on electron microprobe analysis at the seminar on analytical techniques organised by the Chemical Institute of Canada in Ottawa, September, 1972.

H. R. Steacy addressed the November meeting of the Ottawa Valley Mineral Association.

Membership on Committees

A. G. Plant	: Mineralogical Association of Canada representative on the International Mineralogical Association Committee for Cosmic Mineralogy.
G. R. Lachance	: Branch Computer Services Committee
H. R. Steacy	: Vice-President, Mineral Museums Advisory Council G.A.C. representative on Youth Science Foundation Branch Exhibits Committee
Ann P. Stenson	: Treasurer, Mineralogical Association of Canada
R. J. Traill	: Branch Classification Evaluation Committee, Operational Category Associate Committee on Meteorites, National Research Council

Completed Manuscripts

The following manuscripts were accepted and approved by the Division:

Boyle, R.W. and Steacy, H.R.
1973: An auriferous radioactive hydrocarbon from the Richardson Mine, Eldorado, Ontario; Geol. Surv. Can., Paper 73-1, Part A, pp. 282-285.

Dence, M.R. and Plant, A.G.
1972: Analyses of Fra Mauro samples and the origin of the Imbrium Basin; Proc. Third Lunar Science Conf., Geochim. Cosmochim. Acta, Suppl. 3., Vol. 1, pp. 378-398, M.I.T. Press.

Grasty, R.L., Charbonneau, B.W. and Steacy, H.R.
1973: A uranium occurrence in Paleozoic rocks west of Ottawa; Geol. Surv. Can., Paper 73-1, Part A, pp. 286-289.

Grieve, R.A. F. and Plant, A.G.
1973: 64455, an ellipsoidal glass coated highland basalt projectile; Lunar Science IV (editors J.W. Chamberlain and C. Watkins), pp. 317-319. Lunar Science Institute.

Hogarth, D.D., Moyd, L., Rose, E.R. and Steacy, H.R.
1972: Classic mineral collecting localities in Ontario and Quebec; Guidebook for Excursions A-47, C-47a and C-47b of the 24th International Geological Congress.

Hogarth, D.D., Steacy, H.R. Semenov, E.G., Proschchenko, M.E.
1973: New occurrences and data for spencite; Can. Mineralogist Vol. 12, Part 1.

Olsen, E., Huebner, J.S., Douglas, J.A.V., and Plant, A.G.
1973: Meteoritic amphiboles; American Mineralogist, 58.

Sabina, Ann P.
1973(?) Rocks and minerals for the collector: The Alaska Highway. Geol. Surv. Can., Paper

Singh, S.K. and Bonardi, M.
1973: X-ray diffraction, chemical and optical studies of Fe-Ti omphacite from Labrador, Canada; Chemical Geology

Traill, R.J.
1973(?) A catalogue of Canadian Minerals: Supplement I; Geol. Surv. Can., Paper

GEOLOGICAL INFORMATION PROCESSING DIVISION

Peter Harker

The principal objectives of the Division are the communication of the results of the scientific program of the Geological Survey to users and potential users; the maintenance of a scientific library and associated data systems as an earth science information base as an essential service to the scientific staff and also for the benefit of the geological community, and the provision of geoscientific information services to the public. In support of these objectives, the Division maintains capabilities and facilities in scientific editing and information, cartography, library services, technical photography and publication distribution. The publications distribution office also publicizes reports, maps and open file items by means of a notification card system.

In addition to the work carried on in the Division, the Chief Scientific Editor, R. G. Blackadar, has a functional responsibility for the scientific editing carried out by E.J.W. Irish in Calgary and by Miss Tamara De-Vreeze for the Terrain Sciences Division.

During the year, the first steps have been taken in the application of automated cartography in the Survey. Initially, much of the effort will be towards the development of computerized methods in handling field data; considerable progress has been made in Regional and Economic Geology Division under Dr. W. W. Hutchison. Mr. C. E. McNeil has been acting as coordinator for G.I.P. Division and a program of training a small group of GSC cartographers in digitizing has been set up with Surveys and Mapping Branch.

The staff of the Division were involved in various aspects of the 24th International Geological Congress. R. G. Blackadar was principal geological adviser on the large Departmental exhibit. P. Harker, assisted by E. Macaulay, ran an information booth which handled a large number of enquiries on the activities of the Geological Survey and on the geology of Canada. R. G. Blackadar organized tours of the GSC building for visiting geologists from overseas and organized a display in Logan Hall illustrating the development of the Geological Map of Canada from Logan to present day.

The Division arranged a number of visits to the GSC for schools and other groups with the able assistance of H. R. Steacy as guide-lecturer. More extended consultive visits to the Division were made by Mr. Colin Simpson of the New Zealand Geological Survey, Mr. J. Parvey of the Australian Bureau of Mineral Resources, and Dr. Carlos Fortin of the Argentina Department of Mines.

Consultation and background material were provided to Mr. R. Collins for an illustrated article on the Geological Survey which was published in Imperial Oil Review. The article was very well received and was reprinted in the Journal of the Royal Canadian Geographical Society and several syndicated outlets in the U. S. It was reprinted as well for general GSC distribution.

Personnel Notes

Mrs. W. Robertson joined the staff as Division secretary (April).

R. G. Blackadar formally designated as Assistant Division Chief (March).

Courses, Meetings, Conferences

P. Harker completed Third Level PSC French language instruction.

L. P. St. Pierre attended the following courses:

Position Analysis and Description Writing, 25-27 April, 1973
Passed the bilingual language test
Staff Relations Orientation Course, 19-23 June, 1972
Fundamentals of Budget Formulation and Control, 25-27 October, 1972

Talks or Lectures

P. Harker and Mrs. D. M. Sutherland conducted a well attended seminar on Division function and services for the staff of the Atlantic Geoscience Centre at Dartmouth in July.

Membership on Committees

P. Harker
- GSC History Committee
- Chairman, Departmental Committee on Scientific and Technical Information
- Departmental representative on NRC Committee on Scientific and Technical Information.

CHIEF SCIENTIFIC EDITOR

R. G. Blackadar

The accompanying table shows the volume of work processed during the report period. Although it would seem that there is a considerable backlog in cartographic and the production areas, this is actually not the case. The numbers merely reflect the increased volume being handled. Indeed, there has been a further improvement in the time that elapses between submission of a manuscript to this office and its release to the public. Areas in which delays are most likely to occur are in proof-reading and printing of maps, both of which are beyond the direct supervision of the Geological Survey.

In an attempt to reduce the time taken to produce bulletin-type reports and to lower their costs, greater use has been made of offset printing techniques using typescripts produced in-house. Several lengthy reports as well as shorter paleontological reports were produced in this way and the quality of both text and plate reproduction appears acceptable both to our professional staff and to our users.

During the report period, 'Geology and Economic Minerals of Canada', 5th edition, was reprinted with a press run of 5,000 copies, bringing the total number of copies printed since the first printing in late 1970 to 15,000. Steps were taken to reprint the 1971, 4th edition, of 'Prospecting in Canada', and delivery is expected later in the spring. In August, Part 1 of the French edition of 'Geology and Economic Minerals of Canada' was published. Final editing was continued of Part 2. 'Prospecting in Canada' is being translated under contract and as various parts are received, they are being edited by L.-E. Vincent.

Miss C. T. Wilson, editorial assistant, accepted an appointment with the Department of the Environment and was replaced by Miss M. J. McLean.

Mr. L.-E. Vincent, French Editor, who had occupied the position on a temporary basis since March 1971, was appointed a permanent employee shortly after the end of this report period.

Membership on Committees

R. G. Blackadar
- History Committee: Geological Survey of Canada
- Exhibits Committee: EMR Committee for 24th International Geological Congress
- Departmental Subcommittee on Users' Needs

STATUS OF GEOLOGICAL MANUSCRIPTS ON MARCH 31, 1973
WITH COMPARABLE FIGURES FOR 1970-71 AND 1971-72

Type of Report	In Process*						Published During Year		
	Scientific Editing			Cartography and EM&R Ed. Div. & Q.P.					
	72-73	71-72	70-71	72-73	71-72	70-71	72-73	71-72	70-71
Memoirs	0	3	0	13	11	14	2	6	1
Bulletins	1	4	3	20	11	30	8	22	7
Econ. Geol. Reports	0	0	0	2	2	1	1	1	3
Misc. Reports, etc.	1	0	0	0	0	0	4	0	0
Multicolour Maps	0	0	0	11	30	31	32	31	24
P. S. Papers	3	6	6	42	30	58	44	59	60
P. S. Maps	0	0	0	9	10	9	16	19	1
Catalogues	0	0	0	0	0	0	0	0	1
Open File Reports	0	0	0	0	0	0	56	31	30

* Includes I.S.P.G.

GEOLOGICAL CARTOGRAPHY SECTION

C. E. McNeil

The Cartography Section is responsible for producing the maps and illustrations required for Geological Survey Reports and preparing graphics for outside publications, open file items, slides for illustrating lectures and offering minor services to all Divisions of the Branch. The acquisition of a PDP 11 computer, and with a digitizing table on order, an automated cartography task force will be set up to study new techniques in geological mapping. It is regretable that part of our cartographic staff still remains isolated in the City Centre office building.

The Photomechanical Unit again increased its production and gradually removed the backlog of work by the addition of one casual employee and by using the automated film processor to better advantage. The addition of a model 870 Whiteprinter brought about an increase of over 600% in this area of production. Xerographic reproduction dropped slightly as a result of better control over demands for long runs and was therefore able to provide faster service for small jobs. The acquisition of several new pieces of equipment and the introduction of newer, faster products has reflected in a general production increase over the past two years.

PERSONNEL

The Section strength of 57 positions was maintained during the fiscal year with the following changes taking place. In the Photomechanical Unit M. Thibault resigned and his position was filled by W. G. Wylie who transferred from one of the Drafting Units. Mrs. M. de la Fontaine was also hired as a casual. Within the Drafting Units three resignations occurred, Mrs. Z. Mokry, K. G. Howe and W. G. Wylie. One of these positions was filled by Miss Y. F. St. Pierre, a graduate from Algonquin College cartography course, and the other two remained vacant at the end of the fiscal year.

P. Debain attended the 33rd Annual Meeting of the American Congress on Surveying and Mapping held in Washington, D. C. and while there also visited the United States Geological Survey to investigate their research in automated cartography.

MEMBERSHIP ON COMMITTEES

C. E. McNeil	- Member, Classification Evaluation Committee - Member, E. M. & R. Advisory Board on Draftsmen and Compilers
E. P. Nunn	- Board of Directors, Ontario Institute of Chartered Cartographers
J. G. E. Gagnon	- Member, Cartography Suggestions Award Sub Committee
B. Mainville	- Member, Cartography Suggestions Award Sub Committee

PRODUCTION DATA

Maps and illustrations completed by the Cartography Section:

	1971-72	1972-73
Multicoloured geological maps	27	29
Preliminary geological maps	10	37
Figure illustrations (pocket)	47	101
Figure illustrations (page)	618	233
Multicoloured maps reprinted	10	15
Preliminary maps reprinted	15	11
Aeromagnetic maps reprinted	156	145
Indexes to Publications revised	13	25

Miscellaneous drafting totalled 131 illustrations and 43 slides. Miscellaneous jobs such as plotting projections, assembling base maps, preparing open file items, preparing displays etc. along with the miscellaneous drafting accounted for approximately 22% of our total man years.

Maps and illustrations in Progress at end of fiscal year

	1971-72	1972-73
Multicoloured geological maps	36	26
Preliminary geological maps	14	9
Figure illustrations	120	213

Maps and illustrations received, 1972-73

Multicoloured geological maps	24	14
Preliminary geological maps	11	34
Figure illustrations	550	348

Work Completed in Photomechanical Unit

Mapping Camera	1971-72	1972-73
Film negatives and positives	6,559	8,729
Contact Processes		
Film negatives and positives	14,659	16,098
Colour keys on film	1,190	892
Peelcoats	249	389
Scribe-etch	23	41
Colour proofs	53	92
Whiteprints	1,936	13,790
Xerox prints	384,887	311,638

LIBRARY SERVICES

Mrs. D.M. Sutherland

Activities

1. Library

GEO/REF. This program progressed at a good rate with promotion at both the CIM conference in Ottawa and the IGC in Montreal. There are now over 100 subscribers with 21 from the Geological Survey.

EXCHANGES AND TRANSLATIONS. These programs continue to provide added information to the library's resources. Great interest in the translations is shown by the fact that 276 have been sold through a commercial firm.

The exchange program was extended somewhat to add periodicals which began to be reported in the GEO/REF printouts. Exchanges were reactivated at the request of two Chinese organizations and the library has established a pattern of interlibrary loan requests for photocopies of rare publications with two of the largest exchange libraries in Russia.

LIBRARY FINDING LIST. This computerized list, which had previously contained only some 1800 titles and cross references from the periodical records in the Kardex, was expanded to some 3,000 entries; the new titles comprising infrequently published serials. Additional titles are being added as part of a long-range program to produce a complete alphabetic list of serials. The work done during this year was made possible by employing a librarian on contract.

FEDERAL GOVERNMENT LIBRARY SURVEY. This survey was conducted through the National Library by a team of about 17 people. It consisted of questionnaires and interviews with the major libraries of the government and this library was visited several times and used as a sample to test the methodology. The report should be ready by Fall, 1973.

2. Central Technical Files and Open File Unit

Central Technical Files has had more files added to its collections than in other years and the open files are almost doubled in number. The commercial firm outlet in Ottawa reports 323 sales of open files for the year.

3. Data Processing Unit

A "debugging" room was made available to users of the batch terminal when space was added to the unit.

Personnel

Three of the clerical staff won competitions in the same month. Backlogs developed in critical service areas before new staff members were appointed. The Map Custodian was on sick leave for two and a half months. Mr. E. Macaulay (GEO/REF) resigned in February in order to travel.

New Staff:

Miss E. Smith Purchasing clerk.

Miss S. Nicol. Kardex clerk.

Mr. B. Butler. Workroom and stack clerk.

Mrs. J. Copeland. Cataloguing clerk/typist.

Membership and Committees

DMS - Member Federal Government Libraries Committee

Member Standing Committee of Chief Librarians of EMR

Alternate member Branch Computer Facilities Committee

Statistics

I Acquisitions (received by purchase, exchange or gift)

Periodicals and serials	17,329
Books	601
Maps	1,336
CTF Reports	396
Open Files	56

II Circulation

a. Loans

Books, periodicals, etc. to GSC staff	24,214
To individuals other than GSC staff	4,155
To other libraries	2,079
Articles xeroxed in lieu of loan	6,674
Maps	1,176
CTF reports - not recorded completely	
Books borrowed or xerox obtained from other libraries for use of GSC staff	537

b. Open files examined 170

c. Registration (GSC staff not registered but everyone else borrowing in person is required to do so).

Government officials	
- EMR	155
- other departments	126
Industry	113
University (professors and students)	
- Carleton	53
- Ottawa	53
- other	43
Total	543

III Cataloguing

Books, periodicals, serials	969
Analytics	1,311
Maps	435

IV Clerical

Letters	500
Catalogue cards printed	36,500
Pages xeroxed	145,695
Requisitions and purchase orders	857
Total subscriptions	620

V Reference and Interlibrary Loans

Library Enquiries (estimate)	7,250
CTF enquiries	154
Interlibrary loan requests received	
- by form	3,382
- by Telex or letter	1,260
- by telephone	1,242
Total	5,884

VI Translations

Prepared by Secretary of State	106
Photocopies sold	276

VII Data Processing Unit

Cards punched by DPU staff	264,293
Geodat retrievals	30
Cards punched by GSC users	91,783

PUBLICATIONS DISTRIBUTION

J.L.L. Touchette

The following publications were received and made available for distribution during the year:

Economic Geology Series	1
Economic Geology Series (reprinted)	1
Memoirs	2
Bulletins	8
Preliminary Papers	44
Preliminary Papers (reprinted)	15
Miscellaneous Geology	15
Departmental Annual Report	1
Miscellaneous Report Series	4
Miscellaneous Report Series (reprinted)	5
Index of Publications (reprinted)	1
Maps "A" Series	32
Maps "A" Series (reprinted)	5
Preliminary Maps	16
Preliminary Maps (reprinted)	7
Aeromagnetic Maps	379
Aeromagnetic Maps (reprinted)	99
Aeromagnetic Maps (foreign)	163
Indices to G.S.C. Maps (revised)	4
Indices to Aeromagnetic Maps (revised)	20

Distribution Data

Maps	134,063
Reports	74,779
Indices, listings, etc.	52,948
Total Distribution (free and paid):	261,790

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PUBLICATIONS DISTRIBUTION - Continued

Other Data

Requests for publications, information, rock and mineral sets	19,710
Visitors (Cash sales 1,606 Others 2,464)	4,070
Notification lists (including Open File lists)	65
Total publications advertised	523

Revenue

Cash received from sales of reports, maps, rock and mineral sets, photographs, etc.		$ 76,894.44
Sales charged to deposit accounts:	$ 11,203.42	
Publications supplied to Sales Offices		
Calgary	29,511.25	
Vancouver	13,031.85	
Quebec	2,679.85	
Yellowknife	4,336.25	
Whitehorse	2,742.25	63,504.87
		$140,399.31

PHOTOGRAPHIC SERVICES

J. W. Kempt,
Acting Head.

During the course of the year 1972/73, there again has been a shift of the work-load in the direction of black and white slides, colour slides and colour duplicates. This was necessitated by the insatiable demands of the Survey staff for work to be presented at symposiums and geological conferences.

Just after the end of this report period, Mr. F. J. Cooke retired completing twenty-five years of doing more than his share of the photographic work.

The establishment of the Photographic Section has now fallen to a new low; from a strength of nine photographers a few years ago, we have now been reduced to our present staff of four.

A look to the future

(1) It is hoped that at least some of the vacant positions will be filled.

(2) The versatility of our present staff must be increased with on the job training as well as by extension courses at local community colleges.

(3) With time, patience and money, perhaps we may be able to purchase a macro unit for Miss J. White to replace the various Rube Goldberg devices she now uses.

(4) A time period of three days in advance of "Deadlines" will be asked for all work coming into the Section. It is increasingly difficult to meet target dates due to sickness, annual leave and shortage of staff.

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PHOTOGRAPHIC SECTION PRODUCTION TOTALS

Section Work	Black & White Negatives	11,237	
	Colour Negatives	60	
	Colour Transparencies	2,914	
	Black & White Prints	41,110	
	Black & White Slides	1,151	
	Colour Slides	1,743	
	Colour Duplicates	1,067	59,282
Field Work	Black & White Negatives Processed	5,125	5,125
Photo-Finishing	Negatives Opaqued	1,328	
	Negatives Retouched	315	
	Slides Hand Coloured	Nil	
	Slides Mounted	4,311	
	Prints Mounted	25	
	Prints Spotted	300	
	Photographs to Outside Agencies	1,038	7,317
Production to Commercial Firms			
	Black & White Prints	7,225	
	Colour Prints	150	7,375
	Grand Total		79,099

INSTITUTE OF SEDIMENTARY AND PETROLEUM GEOLOGY

D. J. McLaren

INTRODUCTION

The Institute of Sedimentary and Petroleum Geology is responsible, through field and laboratory research, for describing the geology of the western and northern sedimentary basins, from the 49th parallel to the Arctic Islands and between the Canadian Shield and the Rocky Mountain Trench. The scientific program of the Institute is carried out by three subdivisions: Regional Geology, Paleontology, and Energy. These subdivisions are supported by laboratories and technicians under the control of the Subdivision Head. A fourth subdivision is responsible for the Photographic, Cartographic, and Publications and Air Photo Sections and for the Library of the Institute.

The scientific program of the Subdivisions is described below. The emphasis in research continues to stress collaborative programs designed to elucidate and describe the geological history and structure of sedimentary basins with a view to providing geological data and interpretation necessary to exploration and exploitation of mineral resources; and to allow an evaluation to be made of resource occurrence and distribution, specifically hydrocarbons, coal and minerals.

In addition to its research responsibilities, the Institute is responsible for the custody of drilling cores, samples, and other data resulting from both onshore and offshore exploration activities by industry in Yukon Territory, Northwest Territories and Arctic Islands and for drilling samples from all provinces and continental shelves of western Canada. Samples and cores from the northern territories are submitted as required to Federal administration in conformity with regulations. In addition to scientific, administrative, and support staff of the Institute, the building houses units from other divisions and branches of the Department of Energy, Mines and Resources. These include members of the Terrain Sciences Division, the Mining Research Centre of the Mines Branch, and the field office of the National Energy Board. In addition, the Western Research Section of the Groundwater Subdivision of the Hydrologic Sciences Division of the Department of Environment is housed in trailers attached to the Institute building.

During the year, scientists of the Institute published 1 Bulletin, 5 Papers, 8 "A series maps", and 16 publications in outside journals. Seventeen items (reports and/or maps), originating at the Institute, were placed on Open File.

Postdoctorate Fellows

Dr. Peter Bender from Marburg, Germany, continued his research on Upper Paleozoic conodont biostratigraphy in northern Canada, especially Yukon Territory and the Arctic Islands.

Institute Committees

Library Committee:	D. F. Stott (Chairman) E. W. Bamber R. Thorsteinsson N. W. Rutter M. Jones (Secretary) R. W. Macqueen
Exhibits Committee:	N. C. Ollerenshaw (Chairman) R. W. Klassen M. Jones L. MacLachlan E. J. W. Irish D. K. Norris
Nomenclature Committee:	R. W. Macqueen (Chairman) W. V. Sliter G. C. Taylor E. J. W. Irish
Safety Committee:	G. M. Peterkin (Chairman) B. G. Delay A. G. Heinrich
Committee on Clay Mineralogy and Chemistry:	D. F. Stott (Chairman) R. M. Procter A. E. Foscolos
Committee on Curation of Rocks and Fossils:	J. D. Aitken (Chairman) E. W. Bamber K. Roy G. C. Taylor R. M. Procter W. V. Sliter

Attendance at Meetings, Conferences and Courses

D. J. McLaren

Meeting on the International Geological Correlation Programme in North America, Washington, D. C., January, 1973.

International Geological Congress, Montreal, August, 1972. (Chairman of Section 6 and member of the organizing committee).

Seminar on Guidelines for Scientific Activity in Northern Canada, Mont Gabriel, Quebec, October, 1972.

Special Talks or Lectures

D. J. McLaren

"Science and Northern Development" to the Arctic Environmental Seminar for Petroleum Geologists, Calgary, November 15, 1972.

"Non-renewable Resources" presented at the Seminar on Guidelines for Scientific Activity in Northern Canada, Mont Gabriel, Quebec, October, 1972.

"Report of the Committee on the Silurian-Devonian Boundary" to the Commission on Stratigraphy of the IUGS, at the IGC, Montreal, Quebec, August, 1972.

Membership on Committees

D. J. McLaren

Past President, Alberta Society of Petroleum Geologists.

Chairman of the Commission on Stratigraphy of IUGS.

Chairman of Canadian National Committee of IGCP.

Member of the Executive of the Canadian Geoscience Council.

Member of IUGS International Committee on Geoscience and Man.

Session Chairman for Fuel Reserves and their dependence on cost of discovery and exploitation, market prices and other influences, Session 1 of the Royal Society of Canada Symposium on Energy Resources, to be held in October, 1973, in Ottawa.

Chairman of Section 6, and member of organizing committee, IGC.

Convenor of Working Group No. 4, Mont Gabriel Seminar on Guidelines for Scientific Activity in Northern Canada, October, 1972.

Completed Manuscripts

D. J. McLaren

"Report from the Committee on the Silurian-Devonian Boundary and Stratigraphy" to the President of the Commission on Stratigraphy, Montreal, August, 1972; in IUGS Geol. Newsletter, v. 1972, no. 4, p. 268-288, 1972.

"Non-renewable Resources" (in press); in Proceedings of the Seminar on Guidelines for Scientific Activity in Northern Canada, Mont Gabriel, Quebec, October, 1972.

ADMINISTRATIVE SERVICES SUBDIVISION

A. W. Brusso

The objective of the Administrative Services Subdivision is to provide the financial, personnel and administrative services and support that are required to expedite the research program of the Division.

To achieve this objective, 17 staff members are employed in Office Services and Building and Engineering Services Sections. This represents a staff increase of one over the previous year.

Personnel Notes

Mrs. R. Kraft was transferred from the typing pool to the Energy Subdivision in July, 1972, on appointment as secretary to the Subdivision Head.

In September, Miss V. L. Blunden transferred from switchboard duties to the typing pool.

Miss V. L. Haase, who had been employed in the typing pool for the past four years, left in August to accept a secretarial position with the oil industry.

Mrs. I. A. Rose joined the staff in June as an accounts clerk.

Mr. D. Watson joined the staff in September, 1972, as a machinist, replacing E. A. Baiocchi who resigned.

In September, 1972, Mrs. E. Lagler and Mrs. I. J. Garner were taken on strength for employment as switchboard receptionist and pool typist.

Attendance at Meetings, Conventions and Courses

A. Jamieson, Mrs. I. A. Rose and Mrs. M. Ajram attended short courses of instruction on the D.S.S. Pay Forms and Pay Input Procedures which were organized by the Pay Services Division of D.S.S.

GEOLOGICAL INFORMATION SUBDIVISION

E. J. W. Irish

The Subdivision is responsible for the activities of the Photographic, Cartographic, Publications and Air Photo Sections, and for the Library of the Institute. One of its chief activities is the processing for publication of all manuscripts in order to promote and maintain high quality scientific standards for reports and maps produced by staff members. Also, the Subdivision maintains an Open File system, administered through the Library, as a means of releasing data and information to the public with the least possible delay.

During the year, the Air Photo and Publications Distribution units were combined to form the Distribution and Air Photo Section with a staff of four clerks, and this has resulted in increased efficiency of the service provided to the public.

All Sections recorded a steady increase over the previous year in the volume of work processed. Two of these, Photography and the Cartographic photomechanical unit are having difficulty keeping up with the demand.

During the fiscal year ending the 31st of March, 1973, the following manuscripts were accepted and approved by the Division for publication by the Geological Survey: 2 Memoirs, 5 Bulletins, 8 Papers, 3 maps (A series) and 3 Internal Reports. Twenty-five papers were approved for publication in outside scientific journals and 17 I.S.P.G. manuscripts were placed on Open File.

Personnel Notes

During the year F. Maiden transferred from the Core and Sample Repository to the Distribution and Air Photo Section. W. Rhoades transferred from the original Air Photo Library to the new Distribution and Air Photo Section.

Miss Tina Matiison resigned her position as Reference Librarian at the Institute to accept a position as Reference Librarian with the National Museum of Canada in Ottawa.

Miss Marcia Redman, a prospective student at the University of Alberta's Library School in Edmonton, and Miss Patricia Atherton, a student at University of British Columbia's Library School in Vancouver, each spent a week doing field work in the Library. Miss Wanda Fischer, a student from the Library Technicians Course at the Southern Alberta Institute of Technology, worked in the Library during the summer months. Mrs. Louise Beck and later Miss Judy Norton worked in the library under the Winter Works Project.

Mrs. Rozvita Vaska served as a part-time Russian translator.

Attendance at Meetings, Conventions and Courses

E. J. W. Irish

Geological Society of America, Annual Meeting; Minneapolis, Minn., November, 1972.

L. MacLachlan

American Congress of Surveying and Mapping, 33rd Annual Meeting; Washington, D. C., March 12-15, 1973.

Visited headquarters of the United States Geological Survey.

M. Jones

Second Colloquy on Northern Library Services, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, May, 1972.

T. Matiisen

Various meetings in Edmonton and Calgary in connection with her work as a member of the committee of Canadian Association of Special Libraries and Information Services, of the Canadian Library Association.

Membership on Committees

E. J. W. Irish

Commissioner, American Commission on Stratigraphic Nomenclature.

T. Matiisen

Member, Canadian Association of Special Libraries and Information Services, Canadian Library Association.

Geological Cartography Section

L. MacLachlan

Activities

The Section is responsible for producing all maps and illustrations required by the Institute staff for publication by the Geological Survey or in "outside" scientific journals and guide books. In addition, it handles a large amount of miscellaneous drafting for such things as slides, displays and manuscripts to be placed on Open File.

Current renovations to the building will soon give the Section much needed additional space.

Two draftsmen have been employed since January under the Winter Works Program.

Production Data

Maps and figure illustrations prepared by the Cartographic Section and sent to Ottawa for printing during the period April 1, 1972 to March 31, 1973.

	1971-1972	1972-1973
Multicoloured geological maps.....	12	8
Preliminary geological maps.....	1	0
Figure illustrations (page).....	57	345
Figure illustrations (pocket).....	7	40

Miscellaneous drafting totalled 607 separate items and included 146 illustrations for outside publications and 71 slides. This accounted for approximately 54 per cent of the total man years.

Manuscripts received	1971-1972	1972-1973
Multicoloured geological maps	8	4
Preliminary geological maps	0	0
Figure illustrations (page)	271	368
Figure illustrations (pocket)	30	15
Maps and illustrations in progress at March 31, 1973		
Multicoloured geological maps	6	3
Preliminary geological maps	0	0
Figure illustrations (page)	80	187
Figure illustrations (pocket)	21	13
Backlog of maps and illustrations in the Section		
Multicoloured geological maps	2	1
Preliminary geological maps	0	0
Figure illustrations (page)	120	66
Figure illustrations (pocket)	6	5
Reproduction services		
Diazo prints	3,169	5,950
Photostat prints	533	1,116
Photomechanical services		
Film (sheets, negative and positive)	1,450	1,820
Vandyke prints	620	200
Drafting keys on scribe	65	56
Blueline on Cronaflex	93	155
Colour proofs	35	51
Peel coats	217	127
C1 prints	0	243
KC5 prints	0	294

Seventy-seven orders were placed with commercial firms for line camera work; a total of 358 separate items. Much of the camera work of this type requiring a negative less than 8" x 10" is now being done by the Photographic Section of the Institute (174 line negatives in 1972-1973).

Photographic Section

D. G. Lawrence

Production Data

Negatives made and processed

	1971-1972	1972-1973
Black and white		
4" x 5" sheets	836	1,382
35 millimetre rolls	203*	479
Line drawings	0	174
Contact sheets	607*	479
Colour transparencies		
4" x 5" sheets	9	502
35 millimetre rolls	10	81
Total prints made		
All sizes	3,886	4,668
Number of slides mounted	0	726
Total number of work orders processed	194	343

The figures marked with an * in the 1971-1972 column refer to single units whereas in 1972-1973 the figure denotes sheets or rolls.

Publications and Air Photo Section

Mrs. M. H. Brooks

All publications of the Geological Survey, publications of Surveys and Mapping Branch west of the Shield, gravity maps of the Earth Physics Branch, and some miscellaneous Departmental publications continue to be distributed.

The Section now includes the western unit of the National Air Photo Library and aerial photographs may be viewed and ordered through this office.

Distribution Data

Office Statistics

	1970-1971	1971-1972	1972-1973
Visitors to office:	3,700 (approx.)	4,000 (approx.)	4,100 (approx.)
Letters received:	3,415	3,500	3,600
Telephone calls:	8,640	8,500	8,700

Distribution

Year	Items Received	Items Sold	Value
1970-1971	123,554	No count	$47,156.80
1971-1972	90,500	No count	52,400.74
1972-1973	88,381	45,463	36,055.55

Breakdown of Deposits (To Chief Treasury Officer, Ottawa)

	1970-1971	1971-1972	1972-1973
Surveys and Mapping:	$9,082.00	$9,283.90	$9,910.13
Mineral Resources:	454.13	464.20	363.10
Rock Sets:	454.13	464.20	497.84
GSC Publications:	22,705.03	23,209.75	16,304.09
GSC Maps	12,714.72	12,997.46	9,223.79
Gravity Maps	No count	No count	55.09
Total Receipts:	$45,410.01	$46,419.51	$36,354.04

Sales (Cash and Charge Accounts)

	1970-1971	1971-1972	1972-1973
Credit sales:	$26,731.95	$25,404.44	$18,382.70
Cash sales:	20,424.85	19,423.20	16,969.61
Received on Account:	24,985.16	26,996.31	19,384.43

The number of charge accounts increased from 270 in 1971-1972 to 282 in 1972-1973.

I.S.P.G. Library

M. Jones

With the continued growth of the collection and the increase in the number of scientific staff, the demand for library services continued to grow. The statistics also reflect the increased demand for services from the public, chiefly oil company personnel and the students and the staff of the University of Calgary, as they become aware of the excellence of the collection. Enquiries not only increased in number but in complexity and very heavy demands were placed upon the staff.

Emphasis was placed on the acquisition of older and out-of-print items, but much backlog work still remains to be done.

Statistics for the year are:

Acquisitions

Books, etc. acquired by purchase (excluding periodicals)....1,355
Books, etc. acquired by gift or exchange..... 3,000 (approx.)

Circulation

Books and periodicals (to staff only).....13,106
Interlibrary loans
- Borrowed from GSC Ottawa Library..... 301
- Borrowed from other libraries..... 350
- Loaned..... 88
- Xerox copies provided (through Riley's DataShare)..... 241

Reference

Books, periodicals, etc. consulted in library (other than staff)	1,594
Inquiries (less than five minutes)	5,434
Information searches (more than five minutes)	2,066
Visitors (excluding I.G.C. participants)	1,528

Serials

Serial publications received (titles)	688

PALEONTOLOGY SUBDIVISION

B. S. Norford

The Subdivision is responsible for research in paleontology and biostratigraphy in western and northern Canada. The research program is closely coordinated with those of the other Subdivisions of the Institute, with similar programs of the Atlantic Geoscience Centre and the Regional and Economic Geology Division and with those of a number of universities in Canada, the United States, France and the United Kingdom. Part of the program of the Subdivision is conducted by university scientists and by consulting companies.

The Subdivision presently consists of a permanent staff of fourteen scientists and six technicians, a postdoctoral fellow, a number of temporary assistants (involving a total manpower of 3 man-years in 1972-1973), diverse paleontological laboratories and extensive reference collections of fossils. Three scientists are stationed in Ottawa where Dr. Frebold (retired) continues his productive association with the Survey.

In 1972, members of the Subdivision carried out field studies in the Districts of Franklin and Mackenzie, the Yukon Territory, Alberta, British Columbia, Manitoba and Ontario; comparative material was collected from England. Several scientists led field excursions of the International Geological Congress.

A few years ago a program of sampling and study of fossils in cores from wells drilled in the Northwest Territories and the Yukon was initiated, the program was further expanded during the year. Open File Report 107 was issued, listing suites of macrofossils, microfossils and palynological slides from nonconfidential wells and announcing their availability for study. GSC Paper 72-38 was issued and is the third of a series publishing results of studies of such material.

Personnel Notes

M. F. McLaughlin joined the Survey in February; M. J. Rice resigned in September and no appointment was made to his position during the year. W. V. Sliter was appointed Head of the Micropaleontology Section in March.

D. Haden completed Geology 201 (Physical Geology) at the University of Calgary; H. M. McDonald, Botany 205 (Introductory Botany) and Geology 205 (Historical Geology); L. L. Ruddy, Geology 201 and Geology 205.

E. W. Bamber's joint paper with J. B. Waterhouse, "Carboniferous and Permian stratigraphy and paleontology, northern Yukon Territory, Canada", received honourable mention in association with the 1972 Medal of Merit Award of the Alberta Society of Petroleum Geologists.

Attendance at Meetings, Conventions and Courses

B. S. Norford

24th International Geological Congress, Montreal, August 21-30, 1972.

Special Talks or Lectures

B. S. Norford

"Institute of Sedimentary and Petroleum Geology"; University of Calgary Sigma Xi Club: October 12, 1972.

"Silurian reef trends in northwestern Greenland and adjacent Canada"; Department of Earth Sciences, University of Waterloo, February 1, 1973.

Membership on Committees

B. S. Norford

Leader, 24th International Geological Congress, Field Excursion A19.

Co-leader, 24th International Geological Congress, Field Excursion C18.

Overseas Representative (Canada), Palaeontological Association.

Manuscripts Completed

B. S. Norford

"The palatal structure of some Canadian Hadrosauridae (Reptilia: Ornithischia): discussion; Can. J. Earth Sci., v. 10, p. 109.

"Biostratigraphic determinations of fossils from the subsurface of the Yukon Territory and the Districts of Franklin, Keewatin and Mackenzie"; Geol. Surv. Can., Paper 72-38 (co-authored with W. W. Brideaux, T. P. Chamney, M. J. Copeland, Hans Frebold, W. S. Hopkins, J. A. Jeletzky, D. C. McGregor, A. W. Norris, A. E. H. Pedder, E. T. Tozer and T. T. Uyeno).

Macropaleontology Laboratory and Curating Facilities

S. Carbone
R. D. Michie

Curating Facilities

The functions of the curating office include the recording of all geological and geographical data relating to individual fossil collections, the proper storage and retrieval of these samples and the maintenance of routine office procedures. Approximately 10,000 new collections were recorded and stored in the past year. Some two hundred parcels of fossils were shipped and received. Two casual employees were trained and supervised during the year.

The office also is responsible for curating surface and subsurface palynological and micropaleontological samples processed both within and outside the I.S.P.G. Macrofossils extracted from well cores together with the previously mentioned material are made available to outside concerns, notably the oil exploration companies. A complete list of all subsurface paleontological material is periodically compiled and made available to the public. In the past year over 30 requests from private interests who wished to examine several thousand prepared microfossil slides were attended to by this office.

Laboratory

Macrofossils collected in the field are not in many cases immediately identifiable due to the nature and condition of their preservation. The macropaleontology laboratory provides services that prepare these fossils for study. One of the main functions of the laboratory is to produce precisely oriented thin-sections showing the internal structures of fossils. Over 2500 sections of corals,

fusulinids and smaller foraminifers were prepared in the past year. Other services include chemical and mechinal extraction techniques, casting and molding, grinding, sawing, and polishing of rocks and fossils.

The program of sampling well cores for macrofossils also was continued by laboratory staff. During the year approximately 140 macrofossil collections were made from the 20 wells that were examined.

Micropaleontology Laboratory

D. F. Haden

During the year laboratory personnel processed and curated the following samples:

Surface (outcrop)	889
Subsurface (well cuttings, core)	1,069
Total	1,958

1,809 samples were picked for microfossils by outside contract. Services performed as direct scientific support included photomicrography, drafting, log plotting, microfossil lists and distribution chart compilation. Other duties included fossil and sample curation and cataloguing, equipment purchasing and maintenance, and investigation and development of new laboratory procedures and techniques.

D. F. Haden also assisted Dr. Norford in the field during IGC field excursion A19 and in compilation of a fossil chart for the International Arctic Symposium in Saskatoon.

One student and one casual assistant were instructed and supervised for approximately 6 months during the year.

Palynology Laboratory

H. M. McDonald

The laboratory processed a total of 742 samples for palynomorph study this year; 522 for projects led by Drs. Brideaux, Hopkins, and Sweet; and 220 for other GSC projects. These preparations were made from clastic and coal samples obtained from the Arctic Islands, District of Mackenzie and eastern and western Canada. In addition, 30 samples were processed for megaspore study.

Duties of the technician include processing and mounting of samples, development of new laboratory techniques and procedures, photomicrographic services, and general maintenance of the laboratory and darkroom (Rm. 219).

Two temporary assistants were trained and supervised during the year.

Conodont Laboratory

L. L. Ruddy

During the year 614 lots of samples (approximately 1,270 kilograms of rock material) were processed and picked as follows:

176 - Research Projects - Dr. Uyeno
277 - Research Projects - Dr. Bender
161 - Projects led by other scientists
20+ - (Residues) heavy liquid separation for Dr. Thorsteinsson's research projects.

Operations of the laboratory include processing and picking of all samples, record keeping, requisitioning necessary laboratory equipment and general upkeep of the laboratory. Additional assistance in the laboratory was provided by temporary employees Linda Anderson and Gunther Jadatz. P. K. Bender and T. T. Uyeno also prepared some samples.

Reports

The Subdivision produced a total of 154 reports for direct quotation in publications, identifying and dating 2074 lots of fossils as follows.

Bamber	8 reports	on 36 lots
Brideaux	10 reports	on 111 lots
Chamney	18 reports	on 215 lots
Frebold (retired)	14 reports	on 205 lots
Hopkins	24 reports	on 155 lots
Jeletzky	8 reports	on 109 lots
Nassichuk	2 reports	on 5 lots
Norford	13 reports	on 276 lots
Norris	7 reports	on 66 lots
Pedder	10 reports	on 88 lots
Sliter	3 reports	on 441 lots
Sweet	2 reports	on 5 lots
Tozer	7 reports	on 40 lots
Uyeno	10 reports	on 89 lots

Scientists in universities.....	16 reports on	157 lots
Scientists in industry.....	1 report on	75 lots
Scientists with other governments.....	1 report on	1 lot

Macropaleontology Section

A. W. Norris

Scientists of the Section carried out stratigraphic and biostratigraphic studies on the Lower and Middle Devonian rocks in the northern Yukon Territory, District of Mackenzie, Ellesmere Island, and southeastern Manitoba; Upper Devonian rocks in northeastern Alberta; Carboniferous and Permian rocks in northeastern Alberta; Carboniferous and Permian rocks in northern Yukon Territory and northwestern District of Mackenzie; and on upper Paleozoic rocks in the Canadian Arctic Archipelago.

Attendance at Meetings, Conferences and Courses

W. W. Nassichuk

24th International Geological Congress, Montreal, August 21-30, 1972.

A. W. Norris

24th International Geological Congress, Montreal, August 21-30, 1972.

Field Trip, Athabasca Oil Sands area, September 9-12, 1972, in preparation for Canadian Society of Petroleum Geologists Oil Sands Symposium (September, 1973).

A. E. H. Pedder

24th International Geological Congress, Montreal, August 21-30, 1972.

Special Talks or Lectures

A. W. Norris

"Geology of the Hudson Platform"; Atlantic Geoscience Centre, Dartmouth, Nova Scotia, May, 1972 (co-authored with B. V. Sanford).

Membership on Committees

E. W. Bamber

Leader, 24th International Geological Congress, Field Excursion C17.

W. W. Nassichuk

Secretary-General, International Commission on Stratigraphy.

A. W. Norris

Canadian Society of Petroleum Geologists, Committee on Field Excursion, Athabasca Oil Sands Symposium, September, 1973.

Member, Subcommission on Devonian Stratigraphy, International Union of Geological Sciences.

A. E. H. Pedder

Member, Organizing Committee, Second International Symposium on Corals, Paris, 1974.

Completed Manuscripts

E. W. Bamber

"Description of Carboniferous and Permian stratigraphic sections, northern Yukon Territory and northwestern District of Mackenzie"; Geol. Surv. Can., Paper 72-19.

W. W. Nassichuk

"Upper Paleozoic evaporites in the Sverdrup Basin, Arctic Canada" (abst.); Bull. Am. Assoc. Petrol. Geol., v. 56, p. 612 (co-authored with G. R. Davies).

"The hydrozoan? Palaeoaplysina from the Upper Paleozoic of Ellesmere Island, Arctic Canada"; J. Paleontology, v. 47, p. 251-265 (co-authored with G. R. Davies).

"Upper Paleozoic carbonate mounds of the Sverdrup Basin"; Can. Soc. Petrol. Geol., Arctic Symposium, Saskatoon, May 24-26, 1973 (in press) (co-authored with G. R. Davies).

"The Sverdrup Basin" in The Canadian Arctic Islands and the Mackenzie Region; International Geological Congress, Field Excursion A66.

B. S. Norford, W. W. Brideaux, T. P. Chamney, M. J. Copeland, H. Frebold, W. S. Hopkins, Jr., J. A. Jeletzky, B. Johnson, D. C. McGregor, A. W. Norris, A. E. H. Pedder, E. T. Tozer, and T. T. Uyeno

"Biostratigraphic determinations of fossils from the subsurface of the Yukon Territory and the Districts of Franklin, Keewatin and Mackenzie"; Geol. Surv. Can., Paper 72-38.

A. W. Norris

"Summary of the Paleozoic (Devonian) Geology of the Athabasca-Clearwater Rivers outcrop belt, northeastern Alberta and northwestern Saskatchewan"; Can. Soc. Petrol. Geol. Guidebook, Athabasca Oil Sands Symposium, September, 1973 (in press).

"Devonian stratigraphy of the Hudson Platform"; Geol. Surv. Can., Memoir (in press).

Micropaleontology Section

Scientists of the Section conducted field studies during 1972 on Triassic, Jurassic, Cretaceous and Tertiary rocks on Amund Ringnes and Cornwall Islands, Devonian and Cretaceous rocks on the west flank of the Mackenzie Delta; Triassic, Jurassic, Cretaceous and Tertiary rocks of the Arctic Coastal Plain and Richardson Mountains; Jurassic and Cretaceous rocks of southern Alberta; Devonian rocks of southwestern Ontario; and Silurian and Devonian rocks of Prince of Wales Island, Comparative material for foraminiferal studies was collected from Cretaceous rocks in England.

Attendance at Meetings, Conferences and Courses

W. W. Brideaux

American Association of Stratigraphic Palynologists, Annual Meeting, Providence, October 25-28, 1972.

American Association of Stratigraphic Palynologists, Executive Meeting, Denver, March, 1972.

24th International Geological Congress, Field Excursion A20.

Stanford University, short course on dinoflagellates, June 15-30, 1972.

Geological Survey of Canada Palynology Workshop, Providence, October 24, 1972.

W. S. Hopkins, Jr.

American Association of Stratigraphic Palynologists, Annual Meeting, Providence, October 25-28, 1972.

Louisiana State University, short course on Mesozoic palynology, January 17-20, 1973.

Geological Survey of Canada Palynology Workshop, Providence, October 24, 1972.

A. R. Sweet

American Association of Stratigraphic Palynologists, Annual Meeting, Providence, October 25-28, 1972.

Geological Survey of Canada Palynology Workshop, Providence, October 24, 1972.

Consultations and Study of Comparative Material

T. P. Chamney

University of York, England.

University of London, England.

W. V. Sliter

National Museum of Natural History and U.S. Geological Survey, Washington, D.C.

University of Colorado, Boulder, Colorado.

Special Talks or Lectures

T. P. Chamney

"Problems in Foraminifera for biostratigraphic correlation - Boreal Lower Cretaceous"; Paleontological Section of the Canadian Society of Petroleum Geologists, April 4, 1972.

"Canadian Boreal Lower Cretaceous Biostratigraphy (Micropaleontology)"; First International Symposium on the Boreal Lower Cretaceous, London, England, September 19, 1972.

Membership on Committees

W. W. Brideaux

Chairman of balloting committee, American Association of Stratigraphic Palynologists.

Co-chairman and Councillor of planning committee, American Association of Stratigraphic Palynologists.

W. V. Sliter

Editor, Journal, Foraminiferal Research

A. R. Sweet

Member of balloting committee, American Association of Stratigraphic Palynologists.

Completed Manuscripts

K. P. Bender

"Pennsylvanian and Permian conodonts from Arctic Canada"; Geol. Surv. Can., Paper 73-1, part A, p. 251.

W. W. Brideaux

"Taxonomy, biostratigraphy and paleoecology of Mesozoic miospore and microplankton assemblages from District of Mackenzie"; Geol. Surv. Can., Paper 73-1, part A, p. 252.

"Lunatadinium dissolutum, gen. et sp. nov., a dinoflagellate cyst from Lower Cretaceous rocks, Yukon Territory and northern District of Mackenzie"; Bull. Can. Petrol. Geol. (in press) (co-authored with D. J. McIntyre).

"Palynological analysis of late Mesozoic-Cenozoic rocks of the Grand Banks, Atlantic Continental Margin"; Geol. Surv. Can., Bull. (in press) (co-authored with G. L. Williams).

T. P. Chamney

"Tertiary and Mesozoic micropaleontology sampling, west flank of the Mackenzie River Delta"; Geol. Surv. Can., Paper 73-1, part A, p. 253.

"Canadian boreal Lower Cretaceous biostratigraphy (Micropaleontology)"; First International Symposium on the Boreal Lower Cretaceous; Geol. Jour., Special vol., The Liverpool Geol. Soc. and The Manchester Geol. Assoc., Liverpool (in press).

W. S. Hopkins, Jr.

"An Albian spore-pollen flora from the Sverdrup Basin, Northwest Territories"; Am. Assoc. Strat. Palynol., Geoscience and Man (abst.), v. 4, p. 131-132.

"Description, palynology and paleoecology of the Hassel Formation (Cretaceous) on eastern Ellef Ringnes Island, District of Franklin"; Geol. Surv. Can., Paper 72-37.

"Upper Cretaceous marine strata on Somerset Island, N.W.T."; Can. J. Earth Sci. (in press) (co-authored with J. Dixon and O. A. Dixon).

B. S. Norford, W. W. Brideaux, T. P. Chamney, M. J. Copeland, H. Frebold, W. S. Hopkins, Jr., J. A. Jeletzky, B. Johnson, D. C. McGregor, A. W. Norris, A. E. H. Pedder, E. T. Tozer and T. T. Uyeno

"Biostratigraphic determinations of fossils from the subsurface of the Yukon Territory and the Districts of Franklin, Keewatin and Mackenzie"; Geol. Surv. Can., Paper 72-38.

W. V. Sliter

"Upper Cretaceous planktonic foraminiferal zoogeography and ecology - eastern Pacific margin"; Palaeogeography, Palaeoclimatology, Palaeoecology, v. 12, p. 15-31.

"Cretaceous foraminifers - depth habitats and their origin"; Nature, v. 239, p. 514-515.

"Cretaceous bathymetric distribution of benthic foraminifers"; J. Foram. Res., v. 2, p. 167-184.

"Test ultrastructure of some living benthic foraminifers"; Lethaia (in press).

A. R. Sweet

"The use of 'Quaternary O' in megaspore palynological preparations"; Rev. Palaeobot. Palynol. (Abs.)., v. 13, p. 229-231 (co-authored with L. V. Hills).

"Palynologic study of coals, and associated clastics of the Kootenay Formation, Crowsnest area"; Geol. Surv. Can., Paper 72-1, part B, p. 23.

"Palynology of some Kootenay coals in the Crowsnest area of southern British Columbia"; Am. Assoc. Strat. Palynol., Geoscience and Man (in press).

"Vegetative remains of Azolla schopfii Dijkstra from Genesee, Alberta"; Can. J. Bot. (in press) (co-authored with A. Chandrasekharam).

T. T. Uyeno

"Conodont biostratigraphy of Silurian and Devonian rocks of Canada"; Geol. Surv. Can., Paper 73-1, part A, p. 277.

Ottawa Paleontology Section

E. T. Tozer

J. A. Jeletzky conducted stratigraphic and biostratigraphic studies on Mesozoic rocks in Vancouver Island and mainland British Columbia and in England, Denmark, Italy, West Germany and Sweden and visited various museums and institutions in these countries.

Attendance at Meetings, Conferences and Courses

J. A. Jeletzky

International Geological Congress, Montreal, August 21-30, 1972.

International Symposium on the Stratigraphy of the Boreal Lower Cretaceous, London, September, 1972.

E. T. Tozer

International Geological Congress, Montreal, August 21-30, 1972.

Special Talks or Lectures

J. A. Jeletzky

"Biochronology of marine uppermost Jurassic, Berriasian and Valanginian in Canada"; Int. Symp. Strat. Boreal Lower Cret., London.

"Present status of morphology, phylogeny and taxomony of fossil Coleoidea"; Geology Department, University of Copenhagen.

Membership on Committees

J. A. Jeletzky

Royal Society of Canada, Miller Medal Committee.

Co-leader, 24th International Geological Congress, Field Excursion AO3 and CO3.

E. T. Tozer

Vice-President, Organizing Committee, Subcommission for Trassic Stratigraphy, Commission on Stratigraphy, International Union of Geological Sciences.

Completed Manuscripts

J. A. Jeletzky

"Mesozoic rocks of Manning Park area" in Geology of the Southern Canadian Cordillera; 24th International Geological Congress, Field Excursion AO3-CO3.

"Cretaceous and Jurassic stratigraphy of Northern Vancouver Island (102I) and Manning Park area (92H, E/2 and W/2), British Columbia"; Geol. Surv. Can., Paper 73-1, part A, p. 259-262.

"Age and depositional environments of Tertiary rocks of Nootka Island, British Columbia (92E): mollusks versus foraminifers"; Can. J. Earth Sci., v. 10(3), p. 331-365.

"Biochronology of marine boreal uppermost Jurassic, Berriasian and Valanginian in Canada"; J. Geol., London, England (special issue devoted to Proceedings of the International Symposium on the Stratigraphy of Boreal Lower Cretaceous, London, England, 1972) (in press).

E. T. Tozer

"Triassic ammonoids and Daonella from the Nakhlak Group, Anarak Region, Central Iran"; Geol. Surv. Iran, Rept. 28, p. 29-69.

"The Permian-Triassic boundary in the Canadian Arctic Archipelago"; Bull. Canadian Petrol. Geol., v. 20, p. 651-658 (with W. W. Nassichuk and R. Thorsteinsson).

REGIONAL GEOLOGY SUBDIVISION

D. F. Stott

The Regional Geology Subdivision is responsible for a program of research in the field and laboratory into the regional geology of the sedimentary basins of western and northern Canada, leading to an appraisal of their potentialities as reservoirs and sources of oil and gas, and also of other minerals including coal, potash, lead, zinc, and copper.

Some of the more important projects currently active within the Subdivision are related to the Basin Analysis Program and include co-ordinated mapping of northern Arctic Islands and Sverdrup Basin, as well as detailed structural and stratigraphic studies in northeastern British Columbia, District of Mackenzie, and Yukon. New projects being developed include special studies

related to the occurrence of lead and zinc mineralization in carbonate rocks, to the occurrence and distribution of coal, and also geological and geophysical studies of Arctic offshore areas.

The Subdivision includes 20 research scientists, 4 physical scientists, 3 technicians, and a number of casual employees.

Four Ph.D. students, G. Mossop, I. A. MacIlreath, L. D. Dyke, and D. W. Morrow, were supported in various ways by the Subdivision.

Personnel Notes

R. W. Macqueen completed his teaching duties for the academic year 1971-1972 at Erindale College, University of Toronto, June 30, 1972.

J. D. Aitken rejoined the GSC on June 23, 1972, having resigned previously from the GSC in August, 1969.

R. L. Christie relinquished his position as Section Head, Arctic Islands Section, in September after having carried out his duties for several years in a most effective manner. R. Thorsteinsson assumed the responsibilities as Section Head, having held that position some years previously.

C. J. Yorath was relieved of his duties as Acting Head, Northern Mainland Section, owing to increased responsibilities in the field of marine geology, and was named Co-ordinator of Marine Geology for I.S.P.G. The duties of Head, Northern Mainland Section, were assigned to D. G. Cook.

Three new scientists were added to the Subdivision during the year. G. K. Williams reported for duty in April, and was assigned to the Southern Mainland Section. D. W. Myhr joined in June, 1972, and was assigned to the Northern Mainland Section. A. D. Miall joined the Institute in October and was assigned to the Arctic Islands Section.

J. C. Beauvilain, a French student, is serving his military option at I.S.P.G., carrying on a French Retention Course and also pursuing a research project concerning coal stratigraphy.

Miss Arlene Renn resigned as Sedimentological Technician in September. She was replaced by J. L. Rees, who joined the staff in late December.

D. F. Stott was Acting Director of the Division for several periods, the most protracted ones being from August 21 to September 1, and from December 18 to 29.

Attendance at Meetings, Conferences, and Courses

D. F. Stott

Management Development Course No. 2, Bureau of Staff Development and Training, Public Service Commission, May 1-19, 1972, Carleton Place.

French Language Training, Language Bureau, Public Service Commission, Banff, Alberta, November 6-24, 1972 and February 12 - March 2, 1973.

Co-leader, Field Excursion A1O, International Geological Congress, August 9-19, 1972, Stratigraphy and Structure, Rocky Mountains and Foothills, central Alberta and northeastern British Columbia.

Membership on Committees

D. F. Stott

Member, Editorial Committee, Colloquium on the Cretaceous System, Geological Association of Canada, Annual Meeting, Saskatoon, 1973.

Completed Manuscripts

D. F. Stott

"Cretaceous stratigraphy, northeastern British Columbia"; First Geological Conference on western Canadian Coal, Edmonton, Alberta; Research Council of Alberta, Information Series, No. 60, p. 137-150.

"The Cretaceous Gething delta, northeastern British Columbia"; First Geological Conference on western Canadian Coal, Edmonton, Alberta; Research Council of Alberta, Information Series, No. 60, p. 151-163.

"Stratigraphy and structure, Rocky Mountains and Foothills of west-central Alberta and northeastern British Columbia"; Guidebook, Field Excursion A1O, International Geological Congress (co-authored with G. C. Taylor).

Tuchodi Lakes, British Columbia; Geol. Surv. Can., Memoir 373 (co-authored with G. C. Taylor).

Northern Mainland Section

D. G. Cook

Activities

Research interests of those in the Northern Mainland Section pertain to stratigraphic and structural studies in the Interior Plains, the Mackenzie Delta, and the thrust and fold belt of the Cordillera, between 64 degrees north latitude and the Arctic Ocean. Research included both surface and subsurface studies, aimed at energy and mineral resource evaluation in conjunction with the establishment of a sound geoscience data base.

Surface studies included field work carried out in northern Yukon Territory, compilation of stratigraphic reports on Proterozoic and Paleozoic stratigraphy, and compilation of geological maps and reports of northern Yukon Territory, northern Mackenzie Mountains, and Franklin Mountains. Subsurface studies dealt primarily with Mesozoic and Cenozoic strata in Mackenzie Delta, and Paleozoic and Mesozoic strata in the northern Interior Plains including Porcupine Plateau.

A number of personnel contributed to field guidebooks, and as guides for International Geological Congress field trips.

Attendance at Meetings, Conferences and Courses

D. G. Cook

IGC field excursions A15 and C15, August 8-19 and September 1-11, 1972 (guide).

24th Canadian Conference on Coal, Edmonton, Alberta, September 19-22, 1972.

Cordilleran Section, G.A.C., Annual Meeting, Vancouver, B.C., February 8-10, 1973.

J. D. Aitken

Attended, at his own expense, the 24th International Geological Congress, and an attendant field excursion on the Geology of the Environs of Quebec City.

Served as co-chairman of Section 6(a) of the 24th International Geological Congress, and edited, or arranged to be edited, the manuscripts pertaining to that subsection.

With B. S. Norford and W. H. Fritz, organized and led Congress field excursion A19, "Cambrian and Ordovician biostratigraphy of the southern Rocky Mountains".

H. R. Belyea

Leader, International Geological Congress field excursion C18.

D. W. Myhr

Two courses in sedimentology of graduate and post-graduate academic levels were completed at the University of Calgary, 1972-1973 calendar year.

D. K. Norris

International Geological Congress field excursions A25 and C25, August 10-19 and September 1-10, 1972 (co-leader).

F. G. Young

Attended the International Geological Congress, Montreal, August, 1972.

Attended the Conference on "Modern and Ancient Geosynclinal Sedimentation", University of Wisconsin, Madison, November 10-11, 1972.

Attended the Geological Association of Canada, Cordilleran Section, Symposium on "Sedimentary Geology and Mineral Deposits of the Canadian Cordillera", Vancouver, February 9-10, 1973.

Special Talks or Lectures

D. G. Cook

"Tectonic framework of the Mackenzie Arc and related plains"; Basin Analysis Review, I.S.P.G., January 15, 1973 (co-authored with G. C. Taylor).

J. D. Aitken

"The concept of the Kicking Horse Rim - an example of useful output from curiosity-oriented research"; P. S. Warren Geological Society, March 6, 1973, and Department of Geology, University of British Columbia, March 9, 1973 (the latter on behalf of the Public Service Commission).

D. K. Norris

"Structural geometry and depositional history of northern Yukon Territory and northwestern District of Mackenzie"; Basin Analysis Review, I.S.P.G., January 15, 1973.

"Structural geometry of the northern Canadian Cordillera"; Structural Geology Seminar, University of Calgary, March 19, 1973.

F. G. Young

"Miogeoclinal Early Cambrian and older clastics of the Columbia and Rocky Mountains"; Geological Association of Canada, Cordilleran Section, Symposium on Sedimentary Geology and Mineral Deposits of the Canadian Cordillera, Vancouver, February, 1973.

Membership on Committees

D. G. Cook

Member, Canadian Society of Petroleum Geologists, Research and Graduate Students Awards Committee.

J. D. Aitken

Councillor, Geological Association of Canada (ending May, 1973).

Chairman and Editor, Symposium on the Geology of the Canadian Arctic, Saskatoon, May, 1973.

F. G. Young

Member, Canadian Society of Petroleum Geologists, Research and Graduate Students Awards Committee.

Completed Manuscripts

D. G. Cook

"Tectonics of Northern Franklin Mountains, Colville Hills of Canada"; The Oil and Gas Jour., v. 70, p. 150-160 (co-authored with J. D. Aitken).

"Main Ranges and Western Ranges - Kicking Horse Pass and Roger's Pass Section" in The Canadian Rockies and Tectonic Evolution of the Southeastern Cordillera; I.G.C. Field Excursion A15-C15 (co-authored with H. R. Balkwill and R. A. Price).

"Mackenzie Valley and Northernmost Interior Plains" in The Canadian Arctic Islands and the Mackenzie Region; I.G.C. Field Excursion A66 (co-authored with C. J. Yorath).

J. D. Aitken

"Tectonics of Northern Franklin Mountains, Colville Hills of Canada"; The Oil and Gas Jour., v. 70, p. 150-160 (co-authored with D. G. Cook).

"Reconnaissance studies of Proterozoic and Cambrian stratigraphy, Lower Mackenzie River area (Operation Norman), District of Mackenzie"; Geol. Surv. Can., Paper 73-9 (co-authored with R. W. Macqueen and J. L. Usher).

"Cambrian and Orodvician Biostratigraphy of the Southern Canadian Rocky Mountains"; I.G.C. Field Excursion A19 (co-authored with B. S. Norford and W. H. Fritz).

H. R. Belyea

"Devonian stratigraphy and facies of the southern Rocky Mountains of Canada, and the adjacent Plains"; I.G.C. Field Excursion C18 (co-authored with J. E. Labrecque).

"Devonian of Western Canada", an introduction to a joint paper with A. Fediaevsky of CFP and M. Elloy of Aquitaine, concerned with a description of thin sections of the Devonian of Western Canada, to be published in the Bulletin de recherches de Pau.

W. S. MacKenzie

"Upper Devonian Echinoderm Debris Beds with Graded Texture, District of Mackenzie, Northwest Territories"; Can. J. Earth Sci., v. 10, no. 4, p. 519-528.

"Lower Paleozoic and Proterozoic stratigraphy, Mobil Colville Hills E-15 well and environs, Interior Platform, District of Mackenzie" (in press); Geol. Surv. Can., Paper 73-1B, Report of Activities, Nov. 1, 1972 to March 31, 1973 (co-authored with R. W. Macqueen).

"Stratigraphy of the southern part of the Devonian Ancient Wall carbonate complex, Jasper National Park, Alberta"; Geol. Surv. Can., Bull. (in press) (co-authored with E. W. Mountjoy).

D. K. Norris

"Structural and stratigraphic studies in the tectonic complex of northern Yukon Territory, north of Purcupine River"; Geol. Surv. Can., Paper 72-1, pt. B, p. 91-99.

"A method for the determination of geographic position"; Geol. Surv. Can., Paper 72-1, pt. B, p. 124-125.

"En echelon folding in the northern Canadian Cordillera"; Bull. Can. Petrol. Geol., v. 20, no. 3, p. 634-642, 5 figs.

F. G. Young

"Mesozoic Epicontinental, Flyschoid and Molassoid Depositional Phases of Yukon's North Slope"; Proc. Geol. Assoc. Can. - Can. Soc. Petrol. Geol. Symposium on Canadian Arctic Geology.

Southern Mainland Section

G. C. Taylor

Activities

This Section is responsible for stratigraphic, sedimentological, and structural studies in the Southern Interior Platform and the Canadian Cordillera south of the sixty-fourth parallel of latitude.

Members of the Section were deeply involved in the synthesis of both surface and subsurface data into the Basin Analysis Program. Specific stratigraphic studies were completed on the Triassic surface successions of the Rocky Mountains and Foothills and the subsurface Cambrian successions of the Interior Plains of Alberta. A special study of the natural gas potential of the Milk River sands of eastern Alberta also was completed. Data garnered from the detailed studies of the Potash shafts of Saskatchewan is nearing a final synthesis. Compilation and interpretation of field data on the structural styles and carbonate to shale facies fronts were carried forward, in particular the relationships of the latter to base metal mineralization was being investigated.

Several members of the Section participated as leaders or guides for field trips of the International Geological Congress, involving presentation, not

only of their own information, but of their colleagues and the geological community at large.

Attendance at Meetings, Conferences and Courses

G. C. Taylor

Geological Association of Canada, Cordilleran Section Symposium on sedimentary geology and mineral deposits in the Canadian Cordillera, Vancouver, British Columbia, February 9, 10, 1973.

Carbonate Facies Seminar, Miami, Florida, September 8-16, 1972.

D. W. Gibson

Carbonate Facies Seminar, Miami, Florida, September 8-16, 1972.

R. W. Macqueen

Geological Society of America, Annual Meeting, Minneapolis, Minn., November 13-15, 1972.

American Commission on Stratigraphic Nomenclature, Annual Meeting, Minneapolis, Minn., November 15, 1972.

"Friends of the Microscope" Seminar, Duluth, Minn., November 16, 17, 1972.

Geological Association of Canada, Cordilleran Section, Vancouver, B.C., Symposium on sedimentary geology and mineral deposits in the Canadian Cordillera, February 9, 10, 1973.

N. C. Meijer-Drees

Carbonate Facies Seminar, Miami, Florida, September 8-16, 1972.

N. C. Ollerenshaw

Group d'Etude pour le Jurassique, September 29 - October 1, 1972.

Field trip in southern Jura, France; Excursion de l'Association des Géologues du Sud-Est et du Groupe Français du Cretace, October 11, 12, 1972, France.

L. L. Price

10th Annual National Conference on Earth Science, Banff, May, 1972.

Special Talks or Lectures

G. C. Taylor

"Carbonate facies fronts of northeastern B.C.", Symposium on Sedimentary Geology and Mineral Deposits in Canadian Cordillera, Geological Association of Canada, Cordilleran Section, Vancouver, B.C., February, 1973.

R. W. Macqueen

"Carbonate facies and metallic mineral exploration", Symposium on Sedimentary Geology and Mineral Deposits in Canadian Cordillera, Geological Association of Canada, Cordilleran Section, Vancouver, B.C., February 10, 1973. Talk in part repeated to McConnell Club, I.S.P.G., Calgary.

N. C. Ollerenshaw

"Les Contreforts des Montagnes Rocheuses au Sud de l'Alberta"; presented in French to the Laboratoire de Géologie Alpine, Institut Dolomieu, Université de Grenoble, France, December 6, 1972.

Membership on Committees

D. W. Gibson

Member, International Union of Geological Sciences Subcommission on Triassic Stratigraphy.

R. W. Macqueen

Director, Canadian Society of Petroleum Geologists, 1973.

Commissioner, American Commission on Stratigraphic Nomenclature, representing I.S.P.G., 1973-1975.

Completed Manuscripts

G. C. Taylor

"Theory of carbonate to shale facies fronts as indicators of base metal mineralization put to test in northern Rocky Mountains" in The Northern Miner, p. 58, November 30, 1972.

"Devonian facies and relationships to lead-zinc mineralization in northeastern British Columbia"; Geol. Assoc. Can., Cordilleran Section, Programme and Abstracts, p. 18-19.

"Tuchodi Lake, Northeast British Columbia"; Geol. Surv. Can., Memoir 373 (in press) (co-authored with D. F. Stott).

"Stratigraphy and structure, Rocky Mountains and Foothills of west-central Alberta and northeast British Columbia"; IGC Field Excursion A10 (co-authored with D. F. Stott).

D. W. Gibson

"Triassic rocks of the southern Canadian Rocky Mountains"; Geol. Surv. Can., Bull. (in press).

R. W. Macqueen

"Reconnaissance studies studies of Proterozoic and Cambrian stratigraphy, lower Mackenzie River area (Operation Norman), District of Mackenzie"; Geol. Surv. Can., Paper 73-9 (in press); Open File 143; (co-authored with J. D. Aitken, and J. L. Usher).

"A Proterozoic sedimentary succession with traces of copper mineralization Cap Mountain, southern Franklin Mountains, District of Mackenzie"; in Report of Activities, Part A, April to October, 1972, Geol. Surv. Can., Paper 73-1, pt. A, p. 243-246 (co-authored with J. D. Aitken and A. E. Foscolos).

"Lower Paleozoic and Proterozoic stratigraphy, Mobil Colville Hills E-15 well and environs, Interior Platform, District of Mackenzie" in Report of Activities, Part B, November, 1972 to March, 1973, Geol. Surv. Can., Paper 73-1, pt. B (in press) (co-authored with W. S. MacKenzie).

"Carbonate facies and metallic mineral exploration" in Geol. Assoc. Can., Cordilleran Section Meeting, Sedimentary Geology and Mineral Deposits of the Canadian Cordillera; Programme and Abstracts, p. 13-16.

"Lower Carboniferous stratigraphy and sedimentology of the southern Canadian Rocky Mountains"; IGC Field Excursion C17 (co-authored with E. W. Bamber and B. L. Mamet).

N. C. Meijer-Drees

"The Milk River Formation in the Suffield and Medicine Hat areas"; Internal Report, April, 1972.

D. C. Pugh

"Subsurface Paleozoic stratigraphy in northern and central Alberta"; Geol. Surv. Can., Paper 72-12 (in press).

Awards, Prizes, etc.

N. C. Ollerenshaw

Dr. Ollerenshaw was awarded a place under the Canada-France Scientist Exchange Program, and visited the University of Grenoble, France, for the period June - December, 1972.

Arctic Islands Section

R. Thorsteinsson

Activities

Field work by members of the Section included two major, air-supported projects: H. R. Balkwill, in collaboration with K. J. Roy, continued studies of the regional stratigraphy and structure of the Mesozoic rocks on Amund Ringnes, Ellef Ringnes and Cornwall Islands; J. Wm. Kerr, in collaboration with D. W. Morrow (Graduate Student), concluded his second and final year of regional geological studies on the Paleozoic rocks of the Grinnell Peninsula.

Several smaller field parties carried out field research projects in various parts of the Arctic Islands. G. R. Davies continued sedimentological and stratigraphic studies of Carboniferous and Permian rocks on Ellesmere Island. R. Thorsteinsson continued stratigraphic and structural studies on Cornwallis Island, and neighbouring smaller islands. H. P. Trettin completed a second field season devoted to a sedimentological and stratigraphical study of Lower Devonian rocks in central Ellesmere Island. G. Mossop, a Graduate Student, completed his second and final season in studies of Ordovician evaporites in central Ellesmere Island.

G. R. Davies, A. D. Miall, and K. J. Roy prepared extensive studies for the January meetings of the Northern Basin Analysis Review Program, held at the Institute in January, 1973.

Attendance at Meetings, Conferences, and Courses

R. L. Christie

International Geological Congress, Montreal, August, 1972.

Canadian Centre for Remote Sensing course, Ottawa, September, 1972.

Student at Language Bureau School for French, Banff, January and March-April, 1973.

G. R. Davies

American Association of Petroleum Geologists, Annual Meeting, Denver, Colorado, April, 1972.

Comparative sedimentology course, University of Miami, Florida, September, 1972.

J. Wm. Kerr

Permafrost course, University of Calgary, February, 1973.

K. J. Roy

Earth Sciences Symposium, Banff, May, 1972.

R. Thorsteinsson

Mont Gabriel Seminar on Guidelines for Scientific Activities in Northern Canada, Working Group No. 4, Non-Renewable Resources, Mont Gabriel, Quebec, August, 1972.

H. P. Trettin

International Geological Congress, Montreal, August, 1972.

Membership on Committees

H. R. Balkwill

Member, Advisory Committee for National Conference on Earth Sciences (University of Alberta/Canadian Society of Petroleum Geologists).

Chairman, Helicopter Safety Committee (Canadian Society of Petroleum Geologists).

R. L. Christie

Member, Working Group for Geoscience, Canadian Advisory Committee on Remote Sensing.

G. R. Davies

Chairman, Link Award Committee, Canadian Society of Petroleum Geologists.

Member, Medal of Merit Committee, Canadian Society of Petroleum Geologists.

President, McConnell Club, I.S.P.G.

J. Wm. Kerr

Member of doctoral thesis committee, as outside examiner, University of Texas, March, 1973.

A. D. Miall

Member, Link Award Committee, Canadian Society of Petroleum Geologists.

Exhibits Chairman, 1974 Canadian Society of Petroleum Geologists International Symposium.

K. J. Roy

Member, Borehole Subcommittee on Metrication, Canadian Petroleum Association.

H. P. Trettin

Member, Geodynamics Subcommittee, National Advisory Committee on

Research in the Geological Sciences.

Member, Organizing Committee, Arctic Symposium of Geological Association of Canada and Canadian Society of Petroleum Geologists, to be held in Saskatoon, May, 1973.

Special Talks or Lectures

H. R. Balkwill

Field Guide, International Geological Congress, Field Excursion C15.

R. L. Christie

Field Guide, International Geological Congress, Field Excursion A66.

"Remote Sensing", delivered at I.S.P.G. in November, and Vancouver GSC office in December, 1972.

G. R. Davies

"Upper Paleozoic evaporites in the Sverdrup Basin", American Association of Petroleum Geologists, Annual Meeting, Denver, Colorado, April, 1972.

"Paleozoic stratigraphy, Canadian Arctic Archipelago", Basin Analysis Review, I.S.P.G., January, 1973.

A. D. Miall

"Banks Island", Basin Analysis Review, I.S.P.G., January, 1973.

K. J. Roy

"Mesozoic of Sverdrup Basin", Basin Analysis Review, I.S.P.G., January, 1973.

R. Thorsteinsson

"Carboniferous and Permian rocks of the Canadian Arctic Archipelago", Edmonton Geological Society, June, 1972.

H. P. Trettin

"The Innuitian Province", International Geological Congress, Montreal August, 1972.

"Sedimentology and facies relationships of lower Paleozoic flysch in the Hazen Trough, Ellesmere Island", International Geological Congress, Montreal, August, 1972.

"Tectonic and depositional framework of Arctic Islands", Basin Analysis Review, I.S.P.G., January, 1973.

Completed Manuscripts

H. R. Balkwill

"Structural geology, lower Kicking Horse River region, Rocky Mountains, British Columbia"; Bull. Can. Petrol. Geol., v. 20, p. 608-633.

"Main Ranges and Western Ranges - Kicking Horse Pass and Roger's Pass Section" in The Canadian Rockies and Tectonic Evolution of the Southeastern Cordillera; IGC Field Excursion A15-C15 (co-authored with D. G. Cook).

R. L. Christie

"Regional geology of northern Canada"; contributed to paper by D. J. McLaren et al., for 5th International Congress on "Arctic Oil and Gas: Problems and Possibilities", Le Havre, France, May, 1973.

"Three new lower Paleozoic formations of the Boothia Peninsula region, Canadian Arctic Archipelago"; Geol. Surv. Can., Paper (in press).

Contribution to "The Canadian Arctic Islands and the Mackenzie Region", International Geological Congress, Field Excursion A66 (co-authored with D. G. Cook, W. W. Nassichuk, H. P. Trettin, and C. J. Yorath).

G. R. Davies

"Devonian stratigraphy and facies of the southern Canadian Rocky Mountains and the adjacent plains - introduction"; International Geological Congress, Field Excursion C18 (co-authored with W. R. Maiklem and J. Craig).

"The hydrozoan? Palaeoaplysina from the upper Paleozoic of Ellesmere Island, Arctic Canada"; J. Paleontology (co-authored with W. W. Nassichuk).

"Origin of laminated and graded sediments, Middle Devonian of western Canada"; Bull. Geol. Assoc. Am. (co-authored with S. D. Ludlam).

"A scale with indexing system and micro-scale for field photography"; Geotimes.

"Upper Paleozoic carbonate mounds of the Sverdrup Basin", Can. Soc. Petrol. Geol./ Geol. Assoc. Can., Arctic Symposium, Saskatoon (co-authored with W. W. Nassichuk).

"Paleozoic evaporites of the Arctic Islands", (abst.) 4th International Salt Symposium, Abstracts, Houston, 1973.

J. Wm. Kerr

"Geology of outstanding Arctic aerial photographs, 2. Schei Summit Area, Central Ellesmere Island"; Bull. Can. Petrol. Geol., v. 20, no. 1, p. 175-183, March, 1972.

A. D. Miall (completed in 1972 prior to joining Survey)

"Regional geology of northern Yukon"; Bull. Can. Petrol. Geol., v. 21, p. 81-116, 1973.

"Markov chain analysis applied to an ancient alluvial plain succession"; Sedimentology, v. 20, 1973.

K. J. Roy

"Isachsen Formation, Amund Ringnes Island, District of Franklin"; Geol. Surv. Can., Paper 73-1, Part A, p. 264-273.

"The geological background and petroleum potential of Arctic North America"; contribution to paper presented by D. J. McLaren et al., for 5th International Congress on "Arctic Oil and Gas: Problems and Possibilities", Le Havre, France, May, 1973.

Co-ordinator - Marine Geology

C. J. Yorath

Activities

Marine geological activities in the Arctic as they relate to the I.S.P.G. Division are the responsibility of the Co-ordinator for Marine Geology-I.S.P.G. These responsibilities include providing management with advice pertaining to marine bedrock geological and geophysical activities in the Arctic, planning and conducting such studies in conjunction with the Northern Mainland and Arctic Islands Sections of I.S.P.G. and co-ordinating these programs with other Divisions of the Geological Survey.

Marine geological activities by members of this Division will be undertaken in several ways. Owing to the very high costs of operating in the Arctic, participation surveys with industry are planned. Government vessels, when available, will be used and these will include oceanographic research vessels and ice breakers. It is hoped that future additions to the staff will permit operations to be carried out from ice stations.

Attendance at Meetings, Conferences and Courses

C. J. Yorath

National Conference on Earth Science, Banff, Alberta, May, 1972.

Pacific Offshore Planning Meeting, Ottawa, November, 1972.

Potential Petroleum Evaluation Meeting, Ottawa, February, 1973.

Northern Offshore Drilling Seminar, Ottawa, December, 1972.

Basin Analysis Review Seminar, I.S.P.G., Calgary, January, 1973.

Special Talks or Lectures

C. J. Yorath

"Geology of the Beaufort-Mackenzie Basin"; Basin Analysis Review, I.S.P.G., January, 1973.

"Petroleum energy and the Canadian Earth Scientist"; Canadian Youth

science Congress, Calgary, April, 1972.

Membership on Committees

C. J. Yorath

Chairman, Education and Applications of Geology Committee, Canadian Society of Petroleum Geologists.

Member, Technical Program Committee, National Conference, Canadian Society of Exploration Geophysicists.

President, McConnell Club, I.S.P.G.

Completed Manuscripts

C. J. Yorath

"Arctic Offshore"; in Report of Working Group No. 4, Non-renewable Resources, Seminar on Guidelines for Scientific Activities in Northern Canada, Mont Gabriel, Quebec, August, 1972.

"Beaufort-Mackenzie Basin"; in Geological background and petroleum potential of Arctic North America, 5th International Conference on "Arctic Oil and Gas: Problems and Possibilities", Le Havre, France, May, 1973.

"Mackenzie Valley and Northernmost Interior Plains"; in The Canadian Arctic Islands and the Mackenzie Region; International Geological Congress, Field Excursion A66 (co-authored with D. G. Cook).

Sedimentological Laboratories

Production Data

These laboratories provide lapidary services for the geological staff. Heavy mineral separations, mineral staining and insoluble carbonate residues are also done on a routine basis. The laboratories have a staff of two: Mr. W. O. McEwan and Mr. J. L. Rees.

Production figures from this unit are:

Thin sections, standard..... 2,035

Thin sections, large	105
Thin sections, stained	128
Thin sections, stained and covered only	470
Thin sections, unconsolidated material and well cutting	455
Polished and slabbed specimens	648
Acetate peels, stained and unstained	4
Acid insoluble residue determinations	61
Heavy mineral separations	11

ENERGY SUBDIVISION

R. G. McCrossan

The Energy Subdivision is responsible for the Institute's programs of energy resource evaluation for the sedimentary basins of western and northern Canada. Sections within the Subdivision conduct research in the fields of organic and inorganic geochemistry, clay mineralogy, coal petrology and petroleum geology, and are responsible for co-ordination of the Basin Analysis program, petroleum resource evaluation program and coal resource evaluation program. The Subdivision provides analytical support for research programs of other Subdivisions in the Institute, and administers the storage of confidential and non-confidential cores, samples and logs of northern wells. A library of confidential and non-confidential company reports covering geological and geophysical work in the Territories is also maintained.

Some of the more important currently active projects within the Subdivision are related to the resource evaluation programs with input from staff members of the other two Subdivisions through the Basin Analysis Program. The second annual evaluation of the petroleum and coal resources of Canada took place in February, 1973. Another important project was the "Future Petroleum Provinces of Canada" volume under the editorship of R. G. McCrossan, consisting of papers by 27 authors from industry, universities and government, describing the petroleum potential of Canada's sedimentary basins, and published by the Canadian Society of Petroleum Geologists.

The sampling segment of the joint Federal-Provincial program to evaluate the coal resources of Saskatchewan was begun during the summer of 1972, resulting in the delineation of areas of significant coal seam development.

The staff of the Subdivision includes two research managers, four research scientists, seven physical scientists, one chemist, six technicians, two clerks, plus a number of casual employees.

Personnel Notes

J. A. Irvine joined the staff in June to undertake field operations of the Saskatchewan Coal Evaluation Program.

B. R. Cormier joined the staff in May to assist in the Saskatchewan Coal Evaluation Program.

K. F. Der joined the staff of the Geology of Petroleum Section as a geologist, replacing Mrs. C. Havard who resigned from the GSC to continue her post-graduate education.

C. Gusa joined the staff of the Geology of Petroleum Section as a technician in charge of northern well data and information systems.

Attendance at Meetings, Conferences and Courses

R. G. McCrossan

Trip to France to meet with Institut Français du Petrole to discuss results of a joint geochemical study in Alberta. Also visited CFP and Elf Oil while in France.

Visit to the Geological Survey of Britain to study the seismic methods used in the North Sea, and other work related to marine geology.

Special Talks or Lectures

R. G. McCrossan

"The Geology and Petroleum Potential of the Canadian Sedimentary Basins"; Can. Soc. Petrol. Geologists, Calgary, Alberta, March 5 and 18, 1973. Also presented at 13th Annual Institute of Petroleum Exploration and Economics, Dallas, Texas, March, 1973.

Membership on Committees

R. G. McCrossan

Member, Academic Advisory Committee, American Association of Petroleum Geologists.

Member, Committee on Professional Status of Geologists, Canadian Society of Petroleum Geologists.

Completed Manuscripts

R. G. McCrossan

Introduction to Future Petroleum Provinces of Canada; CSPG Memoir 1 (co-authored with J. W. Porter).

"The Geology and Petroleum Potential of the Canadian Sedimentary Basins - a Synthesis"; in Future Petroleum Provinces of Canada, CSPG Memoir 1 (co-authored with J. W. Porter).

"Identification of Petroleum Source Rocks using Hydrocarbon Gas and Organic Carbon Content"; GSC Paper (in press) (co-authored with L. R. Snowdon).

"The Geological Background and Petroleum Potential of Arctic North America"; Conference on Arctic Oil and Gas; Problems and Possibilities - Le Havre, France, May 2-3, 1973 (paper presented by D. J. McLaren) (co-authored with K. J. Roy, R. L. Christie and C. J. Yorath).

Geochemistry Section

Inorganic Geochemistry, Mineralogy and Clay Mineralogy

The program in inorganic geochemistry, mineralogy and clay mineralogy continues to develop with the growing awareness of the scientific staff of the value of the analyses provided.

A. E. Foscolos produced a total of 46 reports for the Institute staff as follows:

(i) 22 reports in mineralogy and clay mineralogy involving 13,079 analyses.

(ii) 24 reports in geochemistry containing 5,021 analyses.

Mineralogy and Clay Mineralogy Laboratory

A. G. Heinrich

The mineralogy and clay mineralogy laboratory determines qualitatively and semiquantitatively minerals and clay minerals in sedimentary rocks as well as performing X-ray fluorescence analyses. During the report year, 1,332 rock samples were processed yielding 12,502 mineral identifications and 577 elemental determinations.

Inorganic Geochemistry and Clay Chemistry Laboratory

R. R. Barefoot

The laboratory determines the elemental composition of sedimentary rocks and quantizes minerals and clay minerals in sedimentary rocks by differential dissolution, differential fusion, wet chemical analyses and a combination of instrumental analytical methods such as thermal, thermogravimetric, differential thermogravimetric, etc.

The production is summarized as follows;

1. Wet chemical analyses by atomic absorption spectroscopy.....	2,112*
2. Determination of carbon and organic matter.....	1,204
3. Sulphur determination.....	64
4. Differential thermal, thermogravimetric and differential thermogravimetric analyses.....	162
5. Mineral analyses.....	607
6. Other analyses (phosphates by colorimetry, loss or ignition, water conductivity pH of rocks, etc.	961
Total analyses.....	5,021

*Elements determined are: silica, alumina, iron, magnesium, calcium, sodium, potassium, lithium, manganese, titanium, strontium, zinc, copper, nickel, vanadium, chromium and cobalt.

Attendance at Meetings, Conferences and Courses

A. E. Foscolos

X-ray fluorescence spectroscopy seminar given by Philips Electronics, Vancouver, August 13-18, 1972.

Visit with Dr. H. Kodama of the Soil Research Institute, Department of Agriculture in Ottawa to prepare two joint publications and one oral presentation for the forthcoming 1973 National Clay Conference. The subject concerned the use of interstratified clay minerals as markers for source rocks.

A. G. Heinrich

Advance Fortran Programming at Southern Alberta Institute of Technology, September, 1972 to January, 1973.

R. R. Barefoot

Advance Fortran Programming at Southern Alberta Institute of Technology, September, 1972 to January, 1973.

Organic Geochemistry

The main activity of this unit is concerned with the determination of potential petroleum source rocks and level of thermal alteration of sediments in the Arctic Islands and District of Mackenzie, N.W.T. Geochemical models were developed for the Eagle Plains Basin and refined for the Sverdrup Basin, and preliminary interpretations were made for the Arctic Islands Fold Complex.

Attendance at Meetings, Conferences and Courses

L. R. Snowdon

Gordon Research Conference on Geochemistry, Plymouth, New Hampshire, August 14-18, 1972.

Introductory Geology Course, University of Calgary, September, 1972 - December, 1972.

Historical Geology Course, University of Calgary, January, 1973 - April, 1973.

Canadian Stratigraphic Services well-logging course, Calgary, February 19-27, 1973.

Completed Manuscripts

R. G. McCrossan, N. L. Ball, and L. R. Snowdon

"An Evaluation of Surface Geochemical Prospecting for Petroleum, Olds-Caroline Area, Alberta"; GSC Paper 71-31.

L. R. Snowdon and R. G. McCrossan

"Identification of Petroleum Source Rocks using Hydrocarbon Gas and Organic Carbon Content"; GSC Paper (in press).

N. L. Ball and L. R. Snowdon

"A Preliminary Evaluation of the Applicability of the Helium Survey Technique to Prospecting for Petroleum"; GSC Paper 73-1B.

Special Talks or Lectures

L. R. Snowdon

"Organic Geochemistry of the Sverdrup Basin"; Basin Analysis Review, I.S.P.G., Calgary, January, 1973.

Organic Geochemistry Laboratory

Saturated hydrocarbon gas analyses and organic and total carbon analyses were run on samples of drill cuttings from about 38 wells in the Northwest Territories, Arctic Islands, and East Coast Offshore. Approximately 8,000 gas analyses were run and 16,000 carbon determinations were made. Downhole loop of all wells were plotted and levels of thermal diagenesis estimated. About 25 solvent extractions were completed on samples in which there was an appreciable amount of extractable hydrocarbon gas.

Two summer students were employed during the summer of 1972 and two casuals were employed during the winter of 1973.

Coal Section

Coal Petrology

P. A. Hacquebard

This unit is responsible for petrological investigations of Canadian coals and dispersed coaly matter in clastic sediments. The petrological studies, which include determinations of coal rank by reflected and transmitted light, are carried out to obtain information on coal geology, coal mining and coal utilization (particularly the evaluation of coking coals), as well as on changes in regional and organic metamorphism of clastic rocks (with application towards the search for oil, gas and possibly mineral deposits).

Activities

During the report year, the coal petrology studies on coals in the Rocky Mountain Foothills Belt have been continued. The results have been reported in 5 technical reports which give information on rank (by reflectance), petrographic composition and predicted coke properties of the seams examined, as well as on seam correlation. The reports describe coals from the following areas: Carmacks, Carbon Creek, Smoky River, Coalspur and Line Creek.

As part of a joint Federal-Provincial program, coal petrological studies of Saskatchewan lignites are in progress. Results to date indicate that, on the "whole-seam" basis, there is great uniformity in maceral composition and that, on this basis, the individual seams cannot be separated.

A microscopic study of coal samples from different types of drilling also was undertaken. It showed that reverse circulation drilling provides better samples with less rock contamination than standard rotary drilling.

Studies of organic metamorphism by means of rank determinations (by reflectance) on in-situ coals in offshore wells in Eastern Canada have been carried out. The results were incorporated in a paper presented at the IGC in Montreal in 1972.

Umpire (ring) analyses were carried out on two sets of samples that were circulated by the International Committee on Coal Petrology and by the A.S.T.M. subcommittee DO5-28. These analyses were carried out to obtain standardization of procedures and techniques in order to arrive at comparable and repro-

ducible results.

The regional study of "tonstein" bands (clay-stone partings) in the coal seams of the Crowsnest field has been completed. A report on this study is in preparation.

Attendance at Meetings, Conferences and Courses

T. F. Birmingham

Co-ordinating Committee for Joint Federal-Provincial Project on Saskatchewan Lignites; Calgary, February 1973.

A. R. Cameron

Canadian Institute of Mining and Metallurgy; Ottawa, April, 1972.

Canadian Advisory Committee on Coal Research; Ottawa, April, 1972.

North American Coal Petrologist; Penn State University, June, 1972.

North American Coal Petrologist; Bethlehem, Pa., March, 1973.

International Committee on Coal Petrology; Belgrade, Yugoslavia, September, 1972, and visits to coal petrology laboratories in France and West Germany.

Co-ordinating Committee for Joint Federal-Provincial Project on Saskatchewan Lignites; Regina, December, 1972.

Geological Society of America, N.E. Section; Allentown, Pa., March, 1973.

J. R. Donaldson

North American Coal Petrologist; Penn State University, June, 1972.

P. A. Hacquebard

Canadian Institute of Mining and Metallurgy; Ottawa, April, 1972.

Canadian Advisory Committee on Coal Research; Ottawa, April, 1972.

North American Coal Petrologist; Penn State University, June, 1972.

North American Coal Petrologist; Bethlehem, Pa., March, 1973.

International Geological Congress; Montreal, August, 1972.

24th Canadian Conference on Coal; Edmonton, September, 1972.

Basin Analysis Review; Institute of Sedimentary and Petroleum Geology, Calgary, January, 1973.

Geological Society of America, N.E. Section; Allentown, Pa., March, 1973.

Special Talks or Lectures

A. R. Cameron

"Petrography of Kootenay coals"; North American Coal Petrologists, Penn State University, June, 1972.

A. R. Cameron

"Report on activities of the Industrial Applications Subcommittee of I.C.C.P."; North American Coal Petrologists, Bethlehem, Pa., March, 1973.

P. A. Hacquebard

"Coal research carried out at GSC"; C.I.M.M., Ottawa, April, 1972.

"The Carboniferous of Eastern Canada"; McConnell Club, Calgary, May, 1972.

"Geology and coalification of Kootenay coals"; North American Coal Petrologists, Penn State University, June, 1972.

"Pre- and postdeformational coalification and its significance for oil and gas exploration"; I.G.C., Montreal, August, 1972.

Membership on Committees

A. R. Cameron

Member, Industrial Applications Subcommittee of International Committee for Coal Petrology.

Member, Coal Petrology Committee, Coal Geology Division of G.S.A.

Member, Subcommittee D5-18 of A.S.T.M. (for revision of Standard D 2796-69).

Member, Canadian Advisory Committee on Coal Research.

P. A. Hacquebard

Member, Nomenclature Subcommittee of International Committee for Coal Petrology.

Member, Subcommittee for Petrography of Organic Matter in Sediments and Application to Geology of I.C.C.P.

Member, 1970 Symposium Committee of Coal Geology Division of G.S.A.

Member, Pennsylvanian Stratigraphy Committee of Coal Geology Division of G.S.A.

Member, Canadian Advisory Committee on Coal Research.

Completed Manuscripts

T. F. Birmingham and A. R. Cameron

"Petrography and coking potential of the No. 4 seam, No. 5 Mine area, Smoky River coalfield, Alberta"; Geol. Surv. Can., Tech. Rept. 83 E/14-2.

A. R. Cameron

"Petrography and coking potential of the Nos. 9, 10A and 10B seams, Line Creek, British Columbia"; Geol. Surv. Can., Tech. Rept. 82 G/15-4.

P. A. Hacquebard

"Petrographic correlation of the Tantalus and Tantalus Butte coal seams at Carmacks, Yukon Territory"; Geol. Surv. Can., Tech. Rept. 115 I/1-3.

P. A. Hacquebard and T. F. Birmingham

"Petrography of Val D'Or and Mynheer seams, Coalspur coal area, Alberta"; Geol. Surv. Can., Tech. Rept. 83 F/2-1

P. A. Hacquebard and J. R. Donaldson

"Petrography of eight coal seams from upper part of Gething Formation in Carbon Creek area, British Columbia"; Geol. Surv. Can., Tech. Rept. 93 O/15-1.

Outside Publications

A. R. Cameron

"Petrography of Kootenay coals in the Upper Elk River and Crowsnest areas, British Columbia and Alberta"; Proc. First Geol. Conf. Western Can. Coal, Res. Council Alta., Inf. Series No. 60, p. 31-46.

P. A. Hacquebard

"The Carboniferous of Eastern Canada"; 7th Carboniferous Congress, Krefeld, 1971, v. 1, p. 69-90.

Coal Evaluation

B. A. Latour

The activities of this unit were directed primarily toward its involvement in the joint Federal-Provincial program to evaluate the coal resources of Saskatchewan. The unit was responsible for planning and co-ordinating the activities of the Department within the program and for providing a team composed of a geologist and a technician which, together with two similar teams from Saskatchewan, participated in the extensive drilling operations. Two hundred holes, for a total of 102,995 feet, were drilled on a 6-8 mile spacing across all that part of southern Saskatchewan underlain by the coal-bearing Ravenscrag Formation. The results of this drilling have enabled delineation to be made of those areas of significant seam development within the Ravenscrag Formation. These areas will be drilled in more detail in 1973 in order to establish coal reserve estimation.

Attendance at Meetings, Conferences and Courses

J. A. Irvine

Geological Society of America, Coal Field Trip, Bismarck, North Dakota, November 10-11, 1972.

B. A. Latour

24th Canadian Conference on Coal, Edmonton, Alberta, September 19-21, 1972.

Canadian Institute of Mining and Metallurgy, Annual Western Meeting, Saskatoon, Saskatchewan, October 24-25, 1972.

Special Talks or Lectures

B. A. Latour

"Coal in Western Canada", geology class, Southern Alberta Institute of Technology, Calgary, Alberta, May 5, 1972.

Membership on Committees

B. A. Latour

Member, Departmental Advisory Committee on Coal.

Completed Manuscripts

B. A. Latour

"Coal Deposits of Western and Northern Canada"; Proc. First Geological Conference on Western Canadian Coal, Res. Council Alta., Inf. Series No. 60, p. 1-8.

"Coal"; Report of Working Group No. 4, Non-renewable Resources, Seminar on Guidelines for Scientific Activities in Northern Canada, Mont Gabriel, Quebec, August, 1972 (in press).

Geology of Petroleum Section

R. M. Procter

The main activities of this Section were devoted to the annual evaluation of Canada's petroleum resources, which took place in January and February, 1973 in Calgary and Ottawa. Much of the geological input for this exercise came from the northern Basin Analysis group, co-ordinated by this Section.

A joint project with Dr. L. A. Pogorski of Chemical Projects Limited, Toronto, to study the use of helium as an indicator of reservoired hydrocarbons was carried out, with the results reported in GSC Paper 73-1B.

Attendance at Meetings, Conferences and Courses

N. L. Ball

CSEG Course Practical Formation Evaluation, Calgary, February, 1973.

Geology of Canada's Sedimentary Basins, I.S.P.G., Calgary, February, 1973.

Petroleum Evaluation Meeting, GSC, Ottawa, February, 1973.

Meeting in Toronto with Chemical Projects Limited to discuss results of the joint project, March, 1973.

F. K. Der

CSEG Course Practical Formation Evaluation, Calgary, February, 1973.

R. M. Procter

Seminar on Guidelines for Scientific Activities in Northern Canada, Mont Gabriel, Quebec, October 1-18, 1972.

Geology of Canada's Sedimentary Basins, I.S.P.G., Calgary, February, 1973.

Petroleum Evaluation Meeting, GSC, Ottawa, February, 1973.

Completed Manuscripts

N. L. Ball and L. R. Snowdon

"A preliminary evaluation of the applicability of the Helium Survey Technique to prospecting for petroleum"; Geol. Surv. Can., Paper 73-1B.

L. L. Price and N. L. Ball

"Stratigraphy of Cominco Potash Shaft No. 1, Vanscoy, Saskatchewan"; Geol. Surv. Can., Paper 72-11.

R. M. Procter

"Petroleum potential of Northern Canada"; Seminar on Guidelines for Scientific Activities in Northern Canada, Mont Gabriel, Quebec, August, 1972.

Core, Sample and Log Examination Facilities

Samples and logs are available for all provincial wells drilled in western Canada, and cores, samples and logs are available for all territorial and Arctic Island wells.

Samples and logs received in 1972-1973 were:

	Samples	Logs
N.W.T.	53,765	322
British Columbia	60,766	540
Alberta	248,277	5,782
Saskatchewan	30,219	1,224
Manitoba	3,786	
Offshore	1,638	
	398,451	7,568

Cores received from N.W.T.: 1,115 boxes.

Total number of visitors to facilities: 2,700.

Samples were examined from 960 wells, and 26,931 boxes of cores were examined. Use of the facilities showed a considerable increase from the previous year.

DIVISION OF REGIONAL AND ECONOMIC GEOLOGY

J.O. Wheeler, Chief

S. Duffell, Assistant Chief

INTRODUCTION

The Regional and Economic Geology Division surveys, describes and interprets the bedrock geology of Canada, exluding the Western Canada and Arctic Sedimentary Basins, but including the Pacific Continental Shelf. The Division also identifies the geological characteristics of occurrences of mineral commodities and relates these to the geology of Canada for the purpose of estimating the mineral potential of the nation.

The objectives of the division are:

1. To provide a systematic geological framework to consistent standards as the basis for estimating the potential for minerals and fuels in Canada.

2. To establish the geological settings favourable to the occurrence of various types of deposits of minerals and fuels.

3. To establish the potential abundance and probable distribution of mineral and fuel resources in Canada.

4. To provide standards, controls, and reference material to ensure consistent terminology, description, and correlation for the systematic and uniform presentation of the geology of Canada.

The geological framework is portrayed mainly by various kinds of geological maps showing three-dimensional spatial data and interpretations combined with a fourth dimension - time. It comprises information on the composition, physical properties, distribution, thickness, age, mutual relations and architecture of the crustal rocks of Canada. This information leads to an understanding of the sequence of geological events and processes giving rise to the formation and subsequent alteration of the crustal rocks and of the related minerals and fuel deposits that they contain.

The geological framework is identified by:

The National Bedrock Geological Reconnaissance at a minimum scale of 1 inch to 8 miles which will be completed by about 1976. Three areas in the Precambrian Shield (two to be mapped in 1973), two small areas in Newfoundland, and several areas in the Cordillera remain to be mapped.

The quality of information resulting from the reconnaissance is satisfactory for the present over most of Canada except in the Precambrian Shield where the 8-mile reconnaissance is not detailed enough to properly depict its complex geology and pre-1945 mapping is obsolescent. Consequently about 260 out of 921 four-mile map-

areas require upgrading to suitable standards. Most of these are in the Precambrian Shield, mainly in the Northwest Territories. On the basis of present resources the upgrading will be completed by about 2000 A.D.

The upgrading surveys are being done partly by remapping areas of poor outcrop at 1 inch to 4 miles and partly by regional multi-disciplinary surveys of geological sub-provinces from which are produced high quality geological maps at 1:250,000 to consistent standards. Integrated teams of specialists are concentrating on regional parameters of the geological framework that transcend map-boundaries. For example, in Bear-Slave Province individual scientists are investigating respectively Archean sediments, Archean basement, granites, Proterozoic volcanics, and mineral deposits. Similar integrated studies are being carried out in Northern and Southern Churchill Province.

By means of this team approach the Division is trying to develop, scientifically and logistically, the most effective way of obtaining a perceptive identification of the geological framework of a region, its evolution, and its potential for mineral resources.

Already several types of results have emerged:

(1) A study of the regional units in the Bear Province by P. Hoffman has revealed that they comprise tectonic elements and a structural style similar to those of the Phanerozoic fold belts - particularly the Cordilleran region. The East Arm fold belt also investigated by Hoffman is apparently an "aulacogen" - a short sediments and volcanic-filled rift zone that developed in association with the sedimentation along the western edge of the Slave Province. Both these broad features suggest that the Earth's surface was composed of several large plates and that fold belts and large rifts resulted respectively from the interaction and splitting of these plates as far back as 2 billion years ago.

(2) The identification by R.H. Ridler in the Archean of the Ennadai-Rankin Inlet Belt of several volcanic cycles and associated exhalite facies, similar to those of the mineral-rich Abitibi greenstone belt, has permitted the delineation of several areas favourable for the exploration of massive sulphide and gold deposits.

(3) Stratigraphic studies and regional mapping in the Cariboo Mountains and adjacent Rocky Mountains under R.B. Campbell provide a classic example of the contrast in the kinds of structures developed at the deeper and hotter levels of the earth's crusts wih those near the surface. In addition his studies indicate that Precambrian Shield basement was probably involved in deformation of the Main Ranges of the Rocky Mountains implying that the amount of "telescoping" thrust sheets there is probably much less than the current estimates.

The Marine Geology unit of the Cordilleran and Pacific Margin Subdivision in Vancouver, British Columbia is carrying out submarine geological and geophysical surveys along traverses normal to the coast on the Pacific Continental Shelf for basin analyses, fuel and mineral potential, delineation of the continental margin for the purposes of establishing Canadian sovereignty, and engineering and environmental considerations for sea bed development on the shelf and slope.

The Division is also engaged in studies of regional parameters other than those in integrated studies. These are needed for regional understanding and to knit together knowledge of the geological framework. For example, studies of the upper Paleozoic rocks of the Cordillera have revealed that around 300 million years the central part of the region was underlain by crust similar to that found beneath the oceans today and that it was flanked by chains of volcanoes. Investigations by G.H. Eisbacher of some of the Late Cretaceous-Early Tertiary sedimentary basins in Northern British Columbia have yielded results in several fields. An analyses of the sedimentary history has provided the link between the development of the eastern and western Cordillera, identified the environment in which coal deposits occur, suggested other areas where they may be found, and delineated regions for possible paleoplacer deposits.

Other regional parameter studies are major rocks that contain important mineral commodities, for example, ultramafic and alkaline rocks and anorthosites.

The second and third objectives are largely the responsibility of the Economic Geology Subdivision, established in May, and are concerned with Mineral Resource Geology and Estimates of Mineral Potential respectively. Mineral Resource Geology embraces field and laboratory study to determine the "habitat" of various mineral commodities and the geological characteristics that define them derived from concepts of their origin and associations empirically observed in Canada and abroad. Settings in the geological framework of Canada favourable for the occurrence of various types of deposits of mineral commodities are then identified thus providing a conceptual or metallogenic analysis for a qualitative estimate of the potential abundance and probable distribution of mineral resources both regionally and nationally.

Commodity portfolios being studied are: Pb-Zn, Cu-Mo, Au-Ag, Li-Be-Sn-W, Co and Ta, Cr, Ni, Rare earths, Ti, Fe, U, Ba, Sr, and F.

Estimates of Mineral Potential in the past have been largely qualitative. Methodology has been undergoing research and development in the Geomathematics Section over several years and has culminated in mineral potential maps for copper and zinc in the Abitibi Belt. During the past year quantitative estimates within an order of magnitude of Pb,Zn,Cu,Mo,Ni,Fe, and U on a national basis within 5 months were provided by a Departmental task force in which the leadership and major input was provided by five members of the Economic Geology Subdivision under G.B. Leech. These

estimates, except for Fe and U, were pioneer ones. The project was a decided additional burden to the program of the Subdivision but thanks to the effort and dedication of the participants it was completed on schedule.

Finally special studies are being undertaken in geochronology, paleomagnetism, paleontology, and petrology to provide standards, controls, correlation and reference materials to back up systematic studies. Most of these studies concern correlation of geological events and measurement of geological time. These activities are the responsibility of the Correlation and Standards Subdivision, although some of the staff of this Subdivision also contribute to activities identifying the geological framework.

The Division mounted 40 field projects ranging from local topical investigations, though national commodity surveys, to complex aircraft-supported multi-disciplinary surveys. The Division is heavily involved in preparing regional compilations to be published at a scale of 1:1 million. Several officers were engaged in leading and guiding field trips in many parts of Canada for the 24th International Geological Congress. In addition the expertise of several officers of the divison in the regional geology of Canada contributed to the successful oral presentation at the Congress and subsequent publication of the "Variations in Tectonic Styles in Canada" by the Geological Association of Canada.

The Division through its own staff and by contract undertook the National Parks Branch, Department of Indian and Northern Affairs, geological inventories of Pacific Rim, Waterton Lakes, Gros Morne, and Kejimkujik National Parks.

The Staff of the Division continues to be involved in foreign assignments. A. Davidson is a project leader from the CIDA Omo River Project in Ethiopia for which K.E. Eade is Canadian Monitor. D.C. McGregor, since January, has been establishing a palynological laboratory and program for the Government of Bolivia under a U.N. Technical Assistance Programme. G.B. Leech was a member of a three-man Geological Survey team asked to advise on technical and other aspects of a proposed agreement for the investigation of the Goias Region in Brazil. This required two weeks' study following participation in a seminar on mineral exploration in Rio de Janeiro.

A special project under W.W. Hutchison, computer assistance to geological field mapping, continued with several officers in the Division engaged on pilot projects. Considerable progress was made in testing existing methods of storage and retrieval of geological field data, experimenting with various ways of manipulating data, and taking firm steps toward the establishment of an automated system of data reduction and cartography (ASDRAC) integrated with the system in Surveys and Mapping Branch and its P.D.P.10 computer.

By the end of the year the Division had been formed into several subunits: Precambrian Shield Subdivision under W.F. Fahrig, Cordilleran and Pacific Margin Subdivision under H. Gabrielse housed in Vancouver, B.C., Economic Geology Subdivision under G.B. Leech, and Correlation and Standards Subdivision under J.E. Reesor, and the Appalachian Section under W.H. Poole.

The Division at present has a staff of 119,including 93 professionals and 26 support staff.

During the year, members of the Division submitted to Division for publication 56 internal and 81 external manuscripts. They also gave a total of 93 talks to various meetings and institutions.

PERSONNEL NOTES

MEMBERSHIP ON COMMITTEES

J.O. Wheeler
- Councillor, Geological Society of Canada
- Director, Canadian Geological Foundation
- Member, Working Group on Geoscience, Canada Centre for Remote Sensing
- Member, Nominations Committee, Earth Sciences Section, Royal Society of Canada
- Member, Visiting Committee, Dept. of Geology, Memorial Univ., St. John's, Nfld.

S. Duffell
- Member, Treasury Board Bargaining Unit, Research Scientists Group
- Interdepartmental Committee on Field Bonus, Member
- Member, Departmental Committee on Land Use Regulations.

ATTENDANCE AT MEETINGS

Canadian Institute of Mining and Metallurgy, Annual Meeting, Ottawa, April 1972

- S. Duffell

Fourth Northern Resources Conference, Whitehorse, April 1972

- J.O. Wheeler

24th International Geological Congress, Montreal, August 1972

- J.O. Wheeler
- S. Duffell

Geological Society of America, Annual Meeting, Minneapolis, November 1972

- J.O. Wheeler

Mining Exploration Group, Symposium on "Government Geological Activity in the Cordillera", Vancouver, February, 1973

- J.O. Wheeler

Prospectors and Developers Association, Annual Meeting, Toronto, March, 1973

- S. Duffell

Guide for IGC field excursion AXO, AO1 - Calgary to Vancouver, July-August, 1972

- J.O. Wheeler

SPECIAL TALKS

Wheeler, J.O. - "Role of EMR in the North" at Fourth Northern Resources Conference, Whitehorse.

- The Cordilleran Structural Province" in Variations in Tectonic Styles in Canada Symposium, Montreal, August 1972; McGill University, March 1973.

- "The Cordillera - a composite orogen"; Queen's University, November, 1972; University of Western Ontario, January, 1973; Earth Physics Branch, February, 1973.

- "Mesozoic Tectonics of Whitehorse Trough", University of Western Ontario, January 1973.

- "The Role of the G.S.C. in mineral resource studies", MEG Symposium on Government Geological Activity in the Cordillera; Vancouver, February 1973.

OUTSIDE PUBLICATIONS

Wheeler, J.O.
1972: Role of EMR in the North; 4th Northern Resources Conference, Proceedings, pp. 116-118.

Wheeler, J.O. and Gabrielse H. et al.
1972: "The Cordilleran Structural Province", in Variations in Tectonic Styles in Canada, R.A. Price and R.J.W. Douglas, Editors, Geol. Assoc. Canada, Special Paper No. 11, pp. 1-81.

COMPUTERIZED GEOLOGIC FIELD MAPPING PROJECT

Project 710098

By

W.W. Hutchison

INTRODUCTION

Activity and progressduring the year has been substantial and encouraging. The number of people actively involved is still small, but until we have our system operational (with appropriate hardware, software and manpower), I wish only those who are keen and strongly motivated to become involved.

HIGHLIGHTS OF THE YEAR'S ACTIVITIES

Activity was concentrated in two main areas:

1) Auto-cartography
2) Field data collection, data reduction and cartographic analysis.

Auto-cartography

In this category, substantial impetus to our progress was provided through the acquisition of a mini-computer (PDP 11-45), and a digitizer. The imminent arrival of hardware (in late March) led to discussions with Surveys and Mapping (22nd February, 1973) on precise details (in manner and timing) of the hook-up of G.S.C. as a fully operational sub-station of Surveys and Mapping, and also anticipation of strain this would impose on Surveys and Mapping. In G.S.C., Harker, Hutchison and McNeil discussed plans for training of digitizing teams, housing of computer and digitizer, and how this could be co-ordinated with other in-house computer activities.

It is emphasized that many useful, informal discussions have been held with Brig. L.J. Harris and other members of staff of Surveys and Mapping, to whom we express our gratitude. Without their experience and organization, we could not have progressed so quickly on this project.

Field Data Collection, Data Reduction and Cartographic Analysis

During the year this work was really carried by the pilot projects. (Critical support to these have been provided by T.M. Gordon and by G. Freeman (G.S.C.) at two computer courses for geologists).

No further development work was done on plotting, in anticipation of our own in-house flat-bed plotter (EAl 430).

The work of the pilot projects indicated that basically two approaches were being taken, namely fixed-format + free text or SAFRAS. Because SAFRAS is not yet fully operational, it does not yet get our gold seal of approval.

T.M. Gordon investigated and appraised our own in-house general information management system (MARS). In late March, 1973, this appeared to be the most promising system for handling the wide variety of field data formats.

In Vancouver, Roddick and Hutchison developed (through Ted Powell of Entropy Systems) a Sub-Area Retrieval System (SARS) which allows instant retrieval of the complete data-base of a sub-area on one command. At the user's wish, various selective retrievals can be run to bring out the main characters of each sub-area for comparative purposes. This system is used on a terminal in the geologist's office. (The computer is the IBM 360/67 on campus at U.B.C.). The generalized information system used here is the Michigan Terminal System (MTS) which is well suited for geological text. The use of this interactive system at Vancouver is one of the major breakthroughs that could be used more widely in G.S.C.

PERSONNEL

It is obvious that with all the varied computer activities (whether part of our project or otherwise) related to recording, reduction and/or analysis of field data and map compilation, the convergence of some pilot projects towards operational status and the need to orient our activities more towards production, someone must start co-ordinating these efforts and guide future development of the system. For this purpose, Malcolm McKellar has been retained to work as systems development consultant. A geologist who has also worked in a management capacity within a geological-geophysical computer company in Calgary, he is well grounded on the problems facing us ahead.

I would like to emphasize that this project has had absolutely vital assistance from T.M. Gordon -- without this, the project could well have foundered.

ECONOMIC GEOLOGY SUBDIVISION

G.B. Leech

INTRODUCTION

The Economic Geology Subdivision became functional in May 1972. It embraces the Mineral Deposits Geology Section, the Geomathematics Section, the Mineral Data Bank Unit and a Special Projects group. Its establishment coincided with the disbandment of the Task Force of Special Projects, all but two of whose members it includes. Fourteen of the Subdivision's members are in research classifications, eight in physical science, one in computer science and five in other classifications.

The objectives of the Subdivision are: to determine the character and distribution of mineral commodities in Canada and the ways in which they become concentrated during the evolution of their geological environments; to determine the local and regional geological features conducive to the occurrence of specific types of mineral deposits; to develop and apply methods of using the above information to provide qualitative and quantitative determinations of Canada's mineral resources.

The Subdivision integrates four main types of activities towards these objectives. The first is the comprehensive study of all aspects of the geology of specific mineral commodities and groups of naturally related commodities. The purposes are: to identify, describe and classify for each commodity or group the characteristic modes of occurrence (deposit-types); to determine how the formation of each deposit-type is related to its environment; and to identify the combinations of subtle diagnostic features that provide clues to the presence of mineral deposits of specific types in specific environments.

The second activity, whose actuality is severely limited by lack of manpower, is the comprehensive metallogenic study of large regions (e.g. geological provinces, subprovinces) to try to relate the known mineral resources to the evolution of the geological features in ways that indicate the likely character, distribution and abundance of undiscovered resources. This activity is heavily dependent upon the mineral commodity studies and is linked to the third activity.

The third activity is the development of mathematical methods for the quantification, analysis and integration of geoscience data. There are two principal geomathematical tasks. One is the development and use of methods of digitizing, for quantification, the geological information in maps and texts. The other is the development and application of methods for multivariate analyses of these data on mineral deposits and their environments. The first priority is for methods applicable regionally, to complement the more "traditional" types of geological input to regional metallogeny in estimating mineral resources.

The fourth activity, the development and operation of data banks and computer-based data management systems, is fundamental to the progress of each of the preceding three. The Mineral Data Bank unit is central to this activity. Part of the development proceeds through the Geomathematics Section, e.g. special data banks of digitized areal geological data and the development of an improved SAFRAS-type of data management system, and part proceeds in the Mineral Deposits Section, which provides major input to the parts of the Mineral Data Bank that concern the commodities the section is studying.

The demand for quantitative estimates of Canada's mineral resources brings a new dimension and a new urgency to the Survey's work. The definition of Canada's mineral resources has been a G.S.C. purpose continuously from the days of Logan's statement that:

> "The object of the Survey is to ascertain the mineral resources of the country, and this is kept steadily in view. Whatever new scientific facts have resulted from it, have come in the course of what I conceive to be economic researches carried on in a scientific way."

The Survey's assessments of mineral resources other than energy minerals and iron have been chiefly qualitative, but the geomathematics program was established in anticipation of demands of regional quantitative estimates.

It is imperative that the impact of the demand for quantitative estimates upon the Mineral Deposits Geology Section, in particular, be clearly understood. This is an additional task. It is not an alternative one that can be accommodated by realigning priorities and dropping current programs in this Section. The current commodity programs and their continuation into regional metallogeny are core activities essential to the intelligent estimation of undiscovered resources. These programs, and the experience of the individual commodity specialists, made it possible to carry out a crash project like Operation September but a continuing responsibility should not be met through intermittent crash programs. The additional activities required to fulfill a continuing responsibility for estimates should not come through curtailment of the basic commodity and regional metallogenic work. That should be strengthened.

Combining the activities of this Subdivision with those of regional geology and petrology in a single Division, just before this report-year, has been thoroughly advantageous. It has stimulated the cross-flow of information and concepts, for which there is plenty of scope. Mineral resource estimation, in particular, integrates a remarkably broad spectrum of the Survey's activities. This work exposes the direct economic significance that apparently unrelated and "purely scientific" information, ranging from the paleoecology of trilobites to the crystal chemistry of pyroxenes, has when fitted into a well-considered metallogenic synthesis.

PERSONNEL CHANGES

F.D. Anderson joined the Subdivision as staff geologist in October, 1972 after long experience in the areal geology of mineral-bearing regions in the Canadian Appalachians.

ATTENDANCE AT MEETINGS

G.B. Leech
- Canadian Institute of Mining & Metallurgy; Annual Meeting, Ottawa, April 1972
- 24th International Geological Congress, Montreal, August 1972
- 2nd Seminario de actualizacao em exploracao mineral; Rio de Janeiro, Brazil, November 1972
- Prospectors & Developers Association; Annual Meeting, Toronto, March 1973

LECTURES

G.B. Leech
- "Metallogenic maps and the Metallogenic Map of Canada" - Canadian Institute of Mining and Metallurgy; Annual Meeting, April 1972
- "Geology of western Rocky Mountains and Rocky Mountain Trench" - 6 talks during each of the 24th International Geological Congress Excursions A03 and C03, August - September, 1972
- "Geology and mineral deposits of the Canadian Shield" - presentations totalling about 5 hours of talks and question periods at seminar on mineral exploration, Rio de Janeiro, Brazil, November 1972

MEMBERSHIP ON COMMITTEES

G.B. Leech
- Committee for the Metallogenic Map of North America
- Commission for the Tectonics of Ore Deposits, International Association, on Genesis of Ore Deposits
- Publications Committee, Society of Economic Geologists
- Committee on History of the Geological Survey (chairman)

COMPLETED MANUSCRIPTS

(i) Internal

1972: Report on Canada's resources of nickel, copper, molybdenum, lead, zinc, uranium and iron; EMR Internal Report, containing (anonymous) contributions by O.R. Eckstrand, G.A. Gross, R.V. Kirkham, G.B. Leech, H.W. Little and D.F. Sangster.

OPERATION SEPTEMBER

G.B. Leech

Operation September was a crash project to provide order of magnitude estimates of Canada's resources of copper, nickel, molybdenum, lead, zinc, uranium and iron. It was a tri-branch project (Geological Survey, Mineral Resources Branch and Mines Branch), co-ordinated and heavily contributed to by the Geological Survey of Canada.

The Department's demand for these estimates followed upon its achievement of estimates for oil and gas and it was somewhat a case of "Go and do likewise". But the tasks were vastly different. In contrast to fossil fuels, deposits of which usually have large dimensions and lie within relatively well-ordered beds, the metals occur mostly in smaller deposits that have diverse origins and consequently varied characteristics, are commonly polymetallic and occur typically in complex geological environments where extrapolation of measurements is infeasible. Furthermore, the estimates for copper, nickel, molybdenum, lead and zinc were truly pioneer ones.

Operation September estimates were expressed in 4 classes of assurance of existence and 3 levels of probability of exploitability by 2000 A.D., for each report region. Estimates for uranium and iron were further classified by deposit-type. Though the estimates were demanded on only an individual commodity basis, our ability to quantify the linkages between interdependent commodities provided important additional information. For example, besides indicating the total copper resources in a given area, the figures in each existence-exploitability category could be subdivided to indicate the amounts of copper attributable to deposits containing zinc, molybdenum and nickel respectively.

Operation September proceeded in three stages. Stage one was the assembly of data on the locations and the sizes of known mineral deposits, including depleted and unexploited ones. Mineral Resources Branch provided the main "production and reserves" data, which were augmented with Geological Survey information. These data were among the factors used in estimating undiscovered resources.

Stage two, the estimation of undiscovered resources, was the Geological Survey's prime responsibility. Five commodity specialists, namely O.R. Eckstrand (nickel), G.A. Gross (iron), R.V. Kirkham (copper and molybdenum), H.W. Little (uranium) and D.F. Sangster (lead and zinc) carried the direct responsibilities. D. Cranstone of Mineral Resources Branch determined certain nickel estimates. The work was not strictly compartmentalized, contrary to what the above list might suggest, and those responsible for nickel, copper, molybdenum, lead and zinc in particular worked closely together, because of the polymetallic nature of many types of mineral deposits. These men's ability to attack the problem on the basis of deposit-types was fundamental to the success of the operation. It yielded tonnage estimates that were accompanied by estimates of the characteristics of the deposits in which the metals would be contained and which would affect their exploitability.

Stage three was assessment of the probability that the metals estimated to exist would be exploitable (as distinct from exploited) by 2000 A.D. Exploitability was rated by teams of Mines Branch, Mineral Resources Branch and Geological Survey staffs.

Operation September entailed $3\frac{1}{4}$ man-years of G.S.C. work, plus additional costs not measureable in years and dollars. It reached its goal on schedule. It demonstrated the value of our program of commodity studies but it was also a reminder of the dangerous fragility of one-man staffing for major mineral commodities. Operation September disclosed the considerable ability in mineral economics that resides within the G.S.C. The Operation aided program planning by pointing out specific improvements required in the data base and to the range of G.S.C. activities than can contribute to mineral resource estimation.

SPECIAL PROJECTS

The Special Projects group conduct the Uranium Program (H.W. Little) and the Iron and Manganese project (G.A. Gross).

URANIUM PROGRAM

Activity in the uranium program was devoted to uranium resource estimates required for Operation September during more than a third of the year. Preparation of these uranium estimates involved consultations with the United States Geological Survey at Denver, the United States Atomic Energy Commission at Grand Junction and the Vancouver and Calgary staffs of the Geological Survey of Canada. Prior to finalizing arrangements for 24th International Geological Congress Excursion C67 in September, H.W. Little prepared a summary of recent research on the origin of conglomeratic uranium ores. After guiding the International Geological Congress excursion, Dr. Little was a member of a group of 22 foreign geologists invited to tour American uranium deposits. Field work in New Brunswick followed. The program in the balance of the year involved laboratory research and compilation of data on uranium and thorium deposits of Canada and preparation of related manuscripts.

IRON AND MANGANESE PROJECT

More than a third of the year was devoted to preparation of resource estimates for Operation September. The national estimate for iron that had already been produced in this project was the foundation for the new operation. On the departure of Dr. Gross (see Personnel Changes) the normal progress of the project became curtailed. C.R. McLeod, who worked previously with Dr. Gross, continues the collection and compilation of data on iron and manganese deposits, with particular reference to the composition of iron-formations. The manganese part of the project includes reference to mineral resources of the ocean floor.

PERSONNEL CHANGES

G.A. Gross was appointed to head the Commonwealth Geological Liaison Office, London, England, for a two year term that commenced on 1 October, 1972.

ATTENDANCE AT MEETINGS

24th International Geological Congress, Montreal, August 1972
H.W. Little, G.A. Gross, A. Boyer, C.R. McLeod

International Atomic Energy Agency (Working Group Meetings) Montreal, August 1972
H.W. Little

Third Underwater Mining Institute, Milwaukee, April 1972
G.A. Gross

Canadian Institute of Mining and Metallurgy, Ottawa, April 1972
G.A. Gross

MEMBERSHIP ON COMMITTEES

H.W. Little - International Atomic Energy Agency (Working Group No. 2)

G.A. Gross
- Canadian collaborator, Journal of Mines, Metals and Fuels, India
- International Association on the Genesis of Ore Deposits, Committee for Correlation of Iron-Manganese stratabound ore deposits
- Publications Committee, Society of Economic Geologists
- Commonwealth Committee on Mineral Resources and Geology

COMPLETED MANUSCRIPTS

(ii) External

Gross, G.A. 1972: Primary features in cherty iron-formation; Sed. Geol., vol. 7, p. 241-261.

Little, H.W in press: Canada; in, Uranium Resources, Production and Demand; Joint Rept. Nuclear Energy Assoc. and Internat. Atomic Energy Agency, Paris and Vienna.

GEOMATHEMATICS SECTION

F.P. Agterberg

OBJECTIVES

The objective of the Section is to carry out a program of research on the development of mathematical methods for the quantification, statistical analysis and integration of geoscience data of various types. Existing or newly developed methodology is applied to provide probabilistic estimates of mineral resource potential in various regions of Canada.

ACTIVITIES

Two contour maps at scale 1:500,000 were published in May, 1972. These indicate the copper and zinc potential of an area of approximately 33,000 square miles (86,200 square kilometers) in western Quebec (near Noranda and Val-d'Or) and east-central Ontario (near Timmins and Kirkland Lake). Methods for estimating the probability that large copper and zinc deposits occur within specific relatively small "cells" (10 x 10 km) were presented in the accompanying report. The following three areas were specifically indicated as having relatively high potential for copper (and zinc): (a) approximately 5000 km^2 north and west of Timmins, Ontario; (b) approximately 2000 km^2 south of Lake Abitibi on both sides of the Ontario-Quebec provincial boundary; and (c) approximately 2000 km^2 east of Amos, Quebec.

Large copper and zinc deposits were not known to exist in area (b) but in 1972 several promising discoveries were made there. By February, 1973, drilling on the new Magusi River deposit (Quebec) in area (b) had resulted in a preliminary estimate of 3,740,000 tons of ore averaging 1.2 per cent Cu and 3.2 per cent Zn. This rather rapid confirmation of one of the multivariate statistical predictions suggests that the use of this technique may extend beyond the estimation of long-term regional mineral potential. The contour maps for potential may also assist industry to outline target areas for consideration in mineral exploration programs.

Although areas where undiscovered deposits are likely to occur can be selected mathematically for some mineral deposit types, efforts to forecast the number, sizes and grades of deposits within given small "cells" (e.g. 10 x 10 km) have not yet been successful. However, these parameters of mineralization may be regarded as numbers originating from probability distributions which are approximately constant for larger regions.

Most of our techniques have been developed in relation to Precambrian deposits. Phanerozoic base metal deposits are now being studied as part of Project Appalachia. It is hoped that this new project will result in improved methods of quantitative prediction because of closer collaboration with other Survey personnel and the fact that the younger rocks in the Maritime Provinces are known in more detail than the Precambrian of the Canadian Shield.

F.P. Agterberg and C.F. Chung continued work on developing probabilistic models for evaluating regional mineral potential, mainly using data for Archean environments in the Superior Province, which were recently collected and coded under the supervision of A.G. Fabbri. F.P. Agterberg completed a 4-year project

to prepare the manuscript of a book entitled Geomathematics (Mathematical background and geoscience applications) to be published by the Elsevier Publishing Company.

A.G. Fabbri completed a computer-based data file for geomathematical use. It contains mainly coded lithological data for about 8,500 cells measuring 10 km on a side in the Superior and Southern Provinces of the Canadian Shield, and data on sizes and grades for about 500 base and precious metal deposits in the Superior Province. In June, 1972, he also completed an internal report on data acquisition activities for the Bulkley-Nechako area in Central British Columbia, carried out in collaboration with the B.C. Department of Mines and Petroleum Resources during the Winter Works Program, 1972. Since the summer of 1972, A.G. Fabbri has supervised data acquisition activities by casual personnel for Project Appalachia.

A.M. Kelly, with R.M. Laramee, continued work on a SAFRAS-oriented mineral deposit file. At the beginning of the year, he visited provincial departments of mines in Quebec, New Brunswick and Newfoundland to discuss the acquisition of mineral deposit data. He co-chaired a meeting at the Geological Data Storage and Retrieval Session of the 24th International Geological Congress in Montreal. A.M. Kelly also participated in writing a report by the Mineral Deposits Working Committee originated by the National Advisory Committee on Research in the Geological Sciences Subcommittee on Computer Applications. A preliminary version of this report entitled "Guide to building computer-based files for mineral and fuel deposits data" will be issued in May, 1973.

In December, 1972, F.P. Agterberg and C.F. Chung completed a report entitled "Geomathematical prediction of variations in sulphur content, New Lingan Mine, Sydney coalfield, Nova Scotia", which was accepted by Department of Energy, Mines and Resources as an input to further planning for the Lingan mine. The Cape Breton Development Company will continue to use geomathematical methods to forecast sulphur content in blocks of coal before mining them.

J.S. Springer, Thornhill, Ontario continued acting as a consultant to the section by collecting and coding geological data for a three-dimensional study of gold and copper mineralization in the Coniaurum, McIntyre and Hollinger deposits near Timmins, Ontario.

PERSONNEL CHANGES

The former Geomathematics Unit was renamed Geomathematics Section with F.P. Agterberg, head, after the reorganization of the division.

A.S. Wong has been on staff during the report year as a casual employee. A.C. Bartlett-Page joined the section in October, 1972 as a casual employee to assist in the development of a new Geological Data Management System (Project 720099). V.A. Newell, casual employee, left the Survey in March, 1973, and was replaced by C. McCann, Winter Works employee. A.A. Carrara and R.R.S. Divi were on contract during part of the year and assisted in the supervision of four summer students (1972) and five Winter Works personnel (February-March, 1973).

ATTENDANCE AT MEETINGS

10th International Symposium on Application of Computer methods in the Mineral Industry, Johannesburg, South Africa, April 1972

F.P. Agterberg

Job Control Language course at Systems Dimensions Ltd., Ottawa, July 1972
R.M. Laramee

24th International Geological Congress, Montreal, August 1972
F.P. Agterberg, C.F. Chung, A.G. Fabbri, A.M. Kelly

Geostatistics Course, Mathematical Morphology Centre, Fontainebleau, France, September 1972
C.F. Chung

Quantitative Geology Symposium and dedication of Heroy Geological Laboratory, University of Syracuse, N.Y., October 1972
F.P. Agterberg

Symposium on Probability theory and its Applications, Carleton University, Ottawa, March 1973
C.F. Chung

MEMBERSHIP ON COMMITTEES

F.P. Agterberg
- Member of Council, International Association for Mathematical Geology (until August 1972)
- Associate Editor, Canadian Journal of Earth Sciences
- Computer Applications and Process Control Committee of the Canadian Institute of Mining and Metallurgy (Representative of CIM Geology Division, since December 1972)

A.M. Kelly
- Branch Computer Facilities Committee
- Mineral Deposits Working Committee; Sub-committee on Computer Applications of the National Advisory Committee on Research in the Geological Sciences

SPECIAL TALKS OR LECTURES

F.P. Agterberg
- Lectures as co-leader of Computer Workshop, University of Western Ontario, London, September, 1972 (IGC-Excursion C-50)
- "Statistics in Geology" - Course GEO 4110, Geology Department, University of Ottawa, January-April, 1973

F.P. Agterberg and A.G. Fabbri - "Harmonic analysis of copper and gold occurrences in the Abitibi area of the Canadian Shield" - Computer Application Symposium, Johannesburg, April, 1972

A.G. Fabbri - "Geomathematical evaluation of mineral potential" - seminar at the Institute of Mineral Raw Materials, Kutna-Hora, Czechoslovakia, September, 1972.

COMPLETED MANUSCRIPTS

(ii) External

Agterberg, F.P.
in press: Geomathematics, Mathematical Background and Geo-science Applications; Elsevier, Amsterdam.

1972: Statistical evaluation methods (review of book by L. Sachs); Earth-Science Reviews, vol. 7, p. 65.

Agterberg, F.P., and Robinson, S.C.
1972: Mathematical problems in geology; Bull. Internat. Statistical Inst., vol. 44, p. 567-595 (Discussion, p. 596).

MINERAL DEPOSITS GEOLOGY SECTION

D.F. Sangster

OBJECTIVES

The Mineral Deposits Geology Section comprises 9 Research Scientists, 3 Physical Scientists, 1 Precision Worker and 1 casual support staff. This group is responsible for investigating the geology of selected mineral commodities, areas favourable for the occurrence of economic mineral deposits and those geological features necessary for estimation of Canadian mineral potential.

The Section program can be broadly divided into three activities:

1) comprehensive geological studies of all aspects of selected elements and the ways in which these are concentrated in the Earth's crust. This involves field examination of selected deposits as well as the systematic collection, recording, compilation and presentation of geological information on mineral deposits;

2) metallogenic studies of large geological segments of Canada with the object of relating the distribution and nature of mineral deposits within the geological framework of these segments;

3) a geologically-oriented merging of the previously mentioned activities as the basis for estimations of the mineral potential of selected regions or the nation as a whole.

HIGHLIGHTS

The year under review was notable for the following reasons:

(a) Reorganization of the Section within the new Economic Geology Subdivision involved the transfer of the Mineral Data Bank (the main repository of geological data on mineral deposits) to form a separate unit headed by D.R.E. Whitmore and the appointment of D.F. Sangster to succeed E.R. Rose as acting section head.

(c) This was the Section's first full year of operation within the Regional and Economic Geology Division. This transfer into the same Division as the regional geologists proved sound and the increased communication and association between economic and regional geologists is being exploited to good advantage.

(c) The normal program of the Section was disrupted early in the fiscal year by the requirements of Operation September. The Section was responsible for 5 of the 7 commodities for which estimates were needed and for all five (Ni, Cu, Mo, Pb and Zn) there were no previous estimates to build upon. The Operation involved the full-time effort of three commodity officers during most of the field season, and of support staff. This resulted in severe curtailment of the field examination of deposits of major commodities by experienced scientists, an activity that is the foundation of the commodity program. More importantly, however, the nationwide assessment of mineral resources resulted in what appears to be a permanent shift in emphasis of the main objective of the Section. Whereas previously our prime objective was the geological study of Canadian mineral deposits, emphasis in the future will be on more application of these studies to assessment of mineral resources.

(d) The on-going program of the Section was continued by completion of studies on niobium and tantalum deposits of Canada.

PERSONNEL CHANGES

Professor F.M. Vokes, Trondheim University, assisted the Section, as consultant, classifying molybdenum deposits of Canada. G.A. Gross transferred to Special Projects and D.R.E. Whitmore transferred to the Mineral Data Bank Unit. R. Lancaster joined the Section as a casual employee.

ATTENDANCE AT MEETINGS

24th International Geological Congress, Montreal, August 1972
R.V. Kirkham, R.W. Mulligan, R.I. Thorpe, D.F. Sangster, J.Y.H. Rimsaite, O.R. Eckstrand, J.L. Jambor

Canadian Institute of Mining and Metallurgy, Annual Meeting, Ottawa, April 1972
R.V. Kirkham, R.W. Mulligan, R.I. Thorpe, D.F. Sangster, J.L. Jambor

Prospectors' and Developer's Association, Annual Meeting, Toronto, March 1973
R.V. Kirkham, O.R. Eckstrand, R.W. Mulligan, D.F. Sangster

American Institute of Mining Engineers, Chicago, Illinois, February 1973
D.F. Sangster

Geological Association of Canada, Cordilleran Section, Vancouver
D.F. Sangster, R.V. Kirkham

Society of Economic Geologists, Minneapolis, Minnesota, November 1972
D.F. Sangster

Western University Geological Conference, Vancouver, October 1972
D.F. Sangster

International Clay Conference, Madrid, Spain, June 1972
J.Y.H. Rimsaite

Geostatistics Course, Mathematical Morphology Centre, Fontainebleau, France, September 1972
O.R. Eckstrand

MEMBERSHIP ON COMMITTEES

J.L. Jambor
- Executive Committee, Mineralogical Association of Canada

D.F. Sangster
- Age dating committee, Geological Survey of Canada
- Chief Treasurer, International Association on the Genesis of Ore Deposits
- Editorial Board, Economic Geology

SPECIAL TALKS

Eckstrand, O.R. - "Redox control of the formation of nickeliferous opaque mineral assemblages in a serpentinite" - 24th International Geological Congress, Montreal.

Jambor, J.L. - "Hydrothermal alteration at the porphyry copper deposits of the Babine Lake area, British Columbia" - Canadian Institute of Mining and Metallurgy, Annual Meeting, Ottawa (with D.J. Carson).

Kirkham, R.V. - "Relationship between red bed copper deposits and paleolatitude" - Geological Association of Canada, Cordilleran Section, Vancouver, February 1973.

- "Copper deposits at Boleo, Mexico and Creta, Oklahoma" - Dawson Geology Club, University of British Columbia, Vancouver, February 1973.

Rimsaite, J.Y.H. - "Distribution of major and minor constituents between mica and host ultrabasic rocks and between mica and zoned spinel" - 24th International Geological Congress, Montreal.

- "Genesis of chlorite, vermiculite, serpentine, talc and secondary oxides in ultrabasic rocks" - International Clay Conference, Madrid, Spain.

Sangster, D.F. - "The role of the Geological Survey of Canada in exploration geology" - Western University Geological Conference, Vancouver.

- "Isotope geology of massive sulphide deposits" - American Institute of Mining Engineers, Chicago, Illinois, February 1973.

- "Lower Cambrian carbonate facies and lead-zinc mineralization in the Canadian Cordillera" - Geological Association of Canada, Cordilleran Section, Vancouver, February 1973.

- "Genealogy of the lead-zinc family tree" - Mineral Exploration Group, Vancouver, February 1973.

PRODUCTION STATISTICS

Mineral Deposits Laboratory

Preparation of polished sections:
Regional and Economic Geology Division
Mineral Deposits Section..... 253

Precambrian Section	107
Petrology Section	16
Resource Geophysics and Geochemistry Division	5
Central Laboratories and Technical Services Division	10
Total	391
Large specimens slabbed	516
Large slabs polished	148

COMPLETED MANUSCRIPTS

(i) Internal

Dawson, K.R.
in press: Niobium and Tantalum Deposits of Canada; Geol. Surv. Can., Paper.

Sangster, D.F.
1972: Precambrian volcanogenic massive sulphide deposits in Canada: a review; Geol. Surv. Can., Paper 72-22.

(ii) External

Mulligan, R.
1973: Lithium distribution in Canadian granitoid rocks; Can. J. Earth Sci., vol. 10, p. 316-323.

Rimsaite, J.Y.H.
in press: Genesis of chlorite, vermiculite, serpentine, talc and secondary oxides in ultrabasic rocks; Internat. Clay. J.

MINERAL DATA BANK

D.R.E. Whitmore

ACTIVITIES

The Mineral Data Bank is a repository for and secondary source of mineral deposit data in the Geological Survey of Canada. The data comprise geological descriptions, maps, plans and sections of deposits as well as ore reserves, ore potential evaluations, chemical, mineralogical and other analytical data dealing either with entire deposits or significant portions of them.

Primary responsibility for the collection of mineral deposit data rests with the Mineral Deposits Section. For the principal commodities in Canada's mineral industry, those that have been assigned as portfolios to commodity geologists, the role of the Data Bank is to assist in data collection wherever it may become necessary or more efficient to do so. Specifically this takes the form of reviewing and keeping abreast of current exploration literature.

In a sense the individual files of the various commodity geologists may be considered "de facto" extensions of the Data Bank which will return to it physically if the geologist should terminate or interrupt his work or be otherwise assigned. Consequently it is obvious that wherever standardization of such individual files is possible it should be encouraged. The Data Bank plays a role in promoting this objective - a subject that will be dealt with later under computerization.

For those commodities assigned to specified geologists, data come in large part from direct observation in field and laboratory, as well as from publications and other sources. For the unassigned commodities, which may be considered the direct responsibility of the Data Bank, the data are all secondhand, either from publications or by contact with field officers in the Survey or elsewhere. The spectrum of unassigned commodities is very broad. It becomes necessary to assign priorities among them and to concentrate attention on the more important; - a choice which can be made only in consultation with others (Mineral Deposits Section, Economic Geology Subdivision, Mineral Resources Branch etc., etc.). Among those worked on during 1972-73 are kyanite, asbestos, barite-fluorite (turned over to Dr. Dawson) and gold.

Reviews of current exploration activity together with location and geological background material are circulated via the internal report UPDATE, begun last August-September and continued monthly. This publication whose elements, property-news items, have a repetitive additive character, appears to lend itself to computer-assisted preparation and this will be attempted in the coming year. Items of general interest are also included, to highlight GSC (EMR) scientific achievements of apparent economic significance as well as to comment on trends in exploration techniques and concepts.

Computerization of files speeds selective retrieval of data particularly as the files become very large. Already in some applications, e.g. retrieval and plotting of specific classes of deposits from a large mineral deposit file, the use of a computer is almost essential. However for many other uses while computerizing would be a convenience it can hardly be justified in terms of costs. In some, e.g. map files, computers have only a marginal contribution

to make. Thus while the area of computer and computer-assisted files is expanding and that of conventional files shrinking the need for the latter will be with us for a long time to come.

Several years ago an experimental computer file, the M-file, was initiated. Active generation of this file ceased in 1969 before any serious attempt to develop it could begin. Computer technology has overtaken the M-file. Further development of a computer file involves working in co-operation with A.M. Kelly (project 710030) and this is being actively pursued. The Data Bank takes responsibility for the geological as against the house-keeping aspects of the file.

PERSONNEL CHANGES

D.G. Rose, support geologist, was added to the staff of the Data Bank in September, 1972, bringing the total staff exclusive of temporary casual summer help to three. Mr. Rose has provided invaluable help in producing UPDATE regularly and promptly. Miss E.M. Burns continued as data compiler of the Mineral Data Files.

PRECAMBRIAN SUBDIVISION

W.F. Fahrig

INTRODUCTION

The objective of the Precambrian Subdivision is to describe the rocks of the Precambrian Shield and to determine the history of the development of these rocks. The main objective has been approached in two ways - first by a program of reconnaissance mapping that will encompass all of the Shield, and secondly by improving the mapping of areas most likely to provide data for elucidating the historical development of the Shield. These areas are chiefly ones in which supracrustal rocks have been preserved, and in general these same areas are of greatest economic interest so that knowledge of their geology is most important in accurately assessing the mineral potential of the Shield. In meeting this goal, large areas are being mapped or remapped on a scale suitable for publication at 1:250,000. Within each of these areas certain aspects of the geology is being examined by specialists. Work of this type has started in the Bear - Slave Provinces with J.B. Henderson and M.B. Lambert completing the study of sedimentary and volcanic rocks of the Yellowknife and Hearne Lake areas, and R.A. Frith commencing the updating of 1:250,000 mapping of the Indin Lake area. This program will be expanded, particularly in the Bear Province.

A similar approach is being taken in the study of supracrustal rocks of the Prince Albert and Penrhyn Groups in the Committee Bay area. Three new staff members (T. Frisch, F.H.A. Campbell, M. Schau) carried out familiarization trips in this area in preparation for the updating of geological mapping. Similarly, updating of the Ennadai Belt, started several years ago, is continuing.

Several members of the subdivision were involved with the 24th International Geological Congress that was held in Montreal in August, 1972. The following members prepared guide books and acted as leaders or co-leaders of International Congress Field Trips, W.R.A. Baragar, J.B. Henderson, P.F. Hoffman, M.J. Frarey, J.A. Fraser, M.B. Lambert, J.C. McGlynn, R.H. Ridler. Congress Field trip to Bear - Slave Province (guide book A27 by J.C. McGlynn and J.A. Fraser) was cancelled due to lack of participants. In addition to above work relating to field trips, L.P. Tremblay chaired two Congress meetings and M.J. Frarey one session.

T.O. Frisch, M.J. Frarey, A. Davidson, F.C. Taylor, J.A. Fraser, P.F. Hoffman, J.C. McGlynn, J.B. Henderson, I.M. Ermanovics, W.F. Fahrig, and R.H. Ridler contributed to a special symposium, "Variations in tectonic styles in Canada", sponsored by the Geological Association of Canada and held in conjunction with the International Geological Congress.

PERSONNEL NOTES

There was an addition of six new Research Scientists to the subdivision during the report year. These are M.B. Lambert, T. Frisch, R.A. Frith, F.H.A. Campbell, F.W. Chandler and M. Schau. Mrs. D. Adams has continued to provide invaluable drafting services to the subdivision during a period when commitments such as the International Congress and the Tectonic Styles symposium

brought great pressure on the regular drafting facilities. Technical support on a continuing basis will be supplied with the addition of a new Physical Scientist, D.N. Proudfoot to the subdivision. L.P. Tremblay completed the technical editing of the French edition of Economic Geology Report No. 1. A Davidson began a leave of absence which will last for a period of two years during which time he will be Project Leader of the Canadian International Development Agency (CIDA) Omo River Project in Ethiopia. K.E. Eade is Canadian monitor of this project which involves a geological and geochemical survey of 85,000 sq. km.

Three staff members, R. Baragar, M. Lambert and M. Schau, spent some time observing the eruption of a volcano on Heimaey Island, near Iceland. Their visit provided material for numerous illustrated talks on the behavior of this volcano. I. Ermanovics organized an intramural seminar series of 17 lectures on the topic, volcanology and volcanic rocks, and spent several weeks at the Geophysical Laboratory, Washington, determining the ages of zircons from gneissic terrain in eastern Manitoba.

R.H. Ridler was awarded the Barlow Medal for the best geological paper submitted to the Canadian Institute of Mining and Metallurgy.

C.K. Bell, Research Geologist with the Geological Survey for 19 years, died suddenly on January 11, 1973. His greatest contributions were to the understanding of the Precambrian geology of northern Saskatchewan and the Thompson mineral belt of central Manitoba.

ATTENDANCE AT MEETINGS

International Geological Congress, Montreal, August 1972
F.C. Taylor, K.E. Eade, M.J. Frarey, L.P. Tremblay, J.A. Fraser, R.H. Ridler, M.M. Lambert, J.C. McGlynn

National Meeting of the Canadian Institute of Mining, Ottawa, April 1972
W.W. Heywood, G.D. Jackson, L.P. Tremblay

Manitoba and Saskatchewan Summary of Field Work - Fall, 1972 - Regina and Winnipeg
K.E. Eade, G.D. Jackson, F.W. Chandler

Annual Meeting and Field Trip of Sub-Committee on volcanology of National Research Council Associate Committee on Geology and Geophysics - Nova Scotia
W.R.A. Baragar

American Geophysical Union, Washington, D.C., April 1972
I.F. Ermanovics, R.A. Frith

MEMBERSHIP ON COMMITTEES

Baragar, W.R.A.	- Member of Sub-Committee on Volcanology of the National Research Council - Associate Committee on Geodesy and Geophysics
Frarey, M.J.	- Member of Federal Provincial Committee on Huronian Stratigraphy - Chairman, GSC Committee on Precambrian Nomenclature

Heywood, W.W. - Local executive, Canadian Institute of Mining
- Chairman, Sub-Committee of the Departmental Field Equipment Committee
- GSC Committee on air charter operations

Reinhardt, W.W. - Member, Age Determination Committee

Taylor, F.C. - Chairman, GSC Age Determination Committee
- Chairman, Departmental Field Equipment Committee

Tremblay, L.P. - GSC Committee on Precambrian Nomenclature

SPECIAL TALKS

Ermanovics, I. - "Geological studies in Archean of Manitoba"- Manitoba Mines Branch summary of field work.

Frarey, M.J. - "Geology of the Southern Province" - University of Ottawa, graduate student seminar.

Henderson, J.B. - "Archean Turbidites" - University of Ottawa, graduate student seminar.

Hoffman, P.F. - Talks, some or all of (1) "Coronation geosyncline"
(2) "Aulocogens"
(3) "Proterozoic reef complex"

at University of British Columbia, University of Alberta, University of Manitoba, Yale, University of Connecticut, Memorial University, Dalhousie University, University of Toronto, McMaster University, Queen's University, Cordilleran Section Geological Association of Canada, Symposium on modern and ancient geosynclinal sedimentation - Madison Wisconsin, State University of New York, Binghamton, Laurentian University.

Reinhardt, E.W. - One hour talk, Mineral Exploration Classes, Ontario Department Mines.

Ridler, R.H. - "Nature and uses of Archean exhalites" - University of Ottawa, graduate student seminar

- "Archean exhalites" at the Prospectors and Developers Meeting, Toronto, and at Ohio State University.

Taylor, F.C. - "Nain Province" - University of Ottawa, graduate student seminar.

Regional and Economic Geology Division - 16 talks in the series "Vulcanism, Volcanism and Volcanic rocks" sponsored by the Precambrian Subdivision (Baragar, Ridler, Lambert, Schau, Johnson and Vokes, Frisch, Tremblay, Sangster, Eckstrand, Campbell, Froese, Frith, Brown, Currie).

COMPLETED MANUSCRIPTS

(i) Internal

Baragar, W.R.A.

1972: Age of Coppermine River basalts; in R.K. Wanless and Loveridge, Geol. Surv. Can., Paper 72-73, Rubidium-strontium isochron age studies Rept. 1, p. 21-24.

1973: Coppermine and Dismal Lakes Map-Areas; Geol. Surv. Can., Paper 71-39 and maps 1337A and 1338A (with J.A. Donaldson).

Bostock, H.H.

1973: Belle Isle, Newfoundland (2M/14 West); Geol. Surv. Can., Paper 73-1A, p. 2-4

in press: Radiometric Dating in the Long Range Grenville Inlier; (in Age Determinations and Geological Studies, K/AR Isotopic Age Report II, by Wanless, et al.), Geol. Surv. Can., Paper.

Eade, K.E.

in press: Geology of Nueltin Lake and Edehon Lake (W 1/2) area, District of Keewatin; Geol. Surv. Can., Paper 72-21.

in press: Regional, lithological, and temporal variations in the abundance of some trace elements in rocks of the Canadian Shield; K.E. Eade and W.F. Fahrig; Geol. Surv. Can., Memoir.

Ermanovics, I.F.

in press: Precambrian Geology of the Berens River map-area, west Manitoba; Geol. Surv. Can., Paper.

Frisch, T.

in press: Metamorphic and plutonic rocks, northernmost Ellesmere Island, Canadian Arctic Archipelago; Geol. Surv. Can., Bulletin.

Henderson, J.B., Lambert, M.B. and Peeling, G.R.

1973: Yellowknife and Hearne Lake Map-areas,District of Mackenzie; Geol. Surv. Can., Paper 73-1A, p. 148-151.

Heywood, W.W.

in press: The geology of Southampton, Coats and Walrus Islands, Northwest Territories; Geol. Surv. Can., Memoir (with B.V. Sanford).

in press: The Geology of the Tavani map-area, District of Keewatin, Northwest Territories; Geol. Surv. Can., Paper and map.

Hoffman, P.F.

1973: Aphebian supracrustal rocks of the Athapuscow aulacogen, east arm of Great Slave Lake; Geol. Surv. Can., Paper 73-1A, p. 151-156.

Lambert, M.B.
1973: Yellowknife and Hearne Lake Map-areas, District of Mackenzie; Geol. Surv. Can., Paper 73-1A (with Henderson, J.B. and Peeling, G.R.).

Morgan, W.C.
1973: Ramah Group and the contact between Archean and Proterozoic in north Labrador; Geol. Surv. Can., Paper 73-1A, p. 162.

Reinhardt, E.W.
in press: Geology of the Carleton Place area, Ontario, 31F/1; Geol. Surv. Can., "A" series final multi-coloured map with marginal notes, scale 1:50,000.

Reinhardt, E.W. and Chandler, F.W.
1973: Gibson-McQuoid Lakes map-area, District of Keewatin; Geol. Surv. Can., Paper 73-1A, p. 162-165.

Ridler, R.H.
1973: Volcanic Stratigraphy and Metallogeny, Rankin Inlet-Ennadai Belt, District of Keewatin; Geol. Surv. Can., Paper 73-1A, p. 165-174.

Schau, M.P.
1973: Volcanic Rocks of the Prince Albert Group; Geol. Surv. Can., Paper 73-1A, p. 175-177.

Taylor, F.C.
1972: Reconnaissance geology of a part of the Precambrian Shield, N.E. Quebec and N. Labrador, Part III; Geol. Surv. Can., Paper 71-48.

Tremblay, L.
1972: Géologie et ressources minérales du Canada, Série de la géologie économique No. 1, cinquième édition, éditeur scientifique de l'édition française - Partie A, Chap. 1 à VII.

1973: Ibid., Partie B, Chap. VIII à XIII.

1973: Ibid., Partie C, tableaux et cartes.

1972: Geology of the Beaverlodge Mining Area, Saskatchewan; Geol. Surv. Can., Memoir 367, 265 p. Final edition, with coloured map and figures. In part revised from the advanced edition published in 1968.

(ii) External

Baragar, W.R.A.
1972: Report on Volcanology; (editor) Can. Geophys. Bull., vol. 24, p. 392-421.

Bell, C.K.
1972: Geology and Mineral Deposits of the Flin Flon, Lynn Lake and Thompson Areas, Manitoba, and the Churchill-Superior front of the western Precambrian Shield; 24th Internat. Geol. Cong. (with C.J.A. Coats, T.T. Quirke, D.A. Cranstone and F.H.A. Campbell).

Campbell, F.H.A.
1972: Geology and Mineral Deposits of the Flin Flon, Lynn Lake and Thompson Areas, Manitoba, and the Churchill-Superior front of the western Precambrian Shield; 24th Internat. Geol. Cong., Guidebook, Excursions A31, C31 (with C.J.A. Coats, T.T. Quirke, D.A. Cranstone and C.K. Bell).

in press: Geology of the Turnbull Lake Area; Manitoba Mines Branch, Publ. 71-2D.

in press: Sickle-Wasekwan contact relationships; Manitoba Mines Branch, Publ. 71-1A

in press: Primary sedimentary structures in the Precambrian rocks of Manitoba, Manitoba Mines Branch, Geological Paper.

Frarey, M.J.
1972: The Southern Province; in Variations in Tectonic Styles in Canada; Geol. Assoc. Can., Special Paper No. 11 (co-author with K.D. Card, W.R. Church, J.M. Franklin, J.A. Robertson, G.F. West, and G.M. Young).

1972: Guidebook for Excursions A35, C35; 24th Internat. Geol. Cong., Montreal (co-author with A.J. Baer, L.D. Ayres).

1972: Discussion: A.C.S.N. Note 40 - Subdivision of the Precambrian: an interim scheme to be used by the U.S. Geological Survey; Bull. Am. Assoc. Petrol. Geol., vol. 56, no. 10, p. 2083, 2084 (with W.F. Fahrig).

Frisch, T.
1972: Minor intrusions of the rapakivi suite in southwest Greenland; Geol. Soc. Amer. Abstr. with Programs 4, p. 513 (with D. Bridgwater).

in press: Clinopyroxenes from Shefford Mountain, a Monteregian intrusion in southern Quebec; Bull. Geol. Soc. Amer.

Hoffman, P.F.
1972: Archean and Proterozoic sedimentary and volcanic rocks of the Yellowknife-Great Slave Lake area; Guidebook, 24th Internat. Geol. Cong., 35 p. (with J.B. Henderson).

1972: The Bear Province; "Variations in Tectonic Styles in Canada"; Geol. Assoc. Can., Spec. Paper No. 11, p. 453-504 (with J.A. Fraser, T.N. Irvine and G. Mursky).

1973: Evolution of an early Proterozoic continental margin; the Coronation Geosyncline and associated aulacogens, northwest Canadian Shield; in "Evolution of the Precambrian Crust" (eds. J. Sutton and J.F. Windley), Phil. Trans. Roy. Soc. (London), A. 273, p. 547-581.

1973: Shoaling-upward shale-to-dolomite cycles in the Rocknest Formation, Northwest Territories; in "Tidal Deposits: A Compilation of Examples" (eds. R.N. Ginsburg and G. de V. Klein), Comparative Sedimentology Lab. Preprint, Univ. of Miami, p. 1-6.

in press: Proterozoic carbonate platform-to-basin facies zonation, Pethei Group, Great Slave Lake; Am. Assoc. Petrol. Geol., Bulletin.

in press: Aulacogens and the evolution of continental margins; in "Modern and Ancient Geosynclinal Sedimentation" (ed. R.H. Dott, Jr.), Soc. Econ. Paleont. Mineral., Spec. Publ. (with J.F. Dewey and K. Burke).

in press: Algal mats, cryptalgal fabrics and structures, Hemelin Pool, Western Australia; in "Carbonate Sedimentation, Shark Bay, Western Australia" (ed. B.W. Logan), Am. Assoc. Petrol. Geol., Memoir (with B.W. Logan and C.D. Gebelein).

Jackson, G.D.
1972: Correlation of Major Aphebian Rock Units in the Northeastern Canadian Shield; Can. J. Earth Sci., vol. 9, No. 12, p. 1650-1669 (with F.C. Taylor).

in press: A test of the nature and extent of continental drift as provided by the study of the Proterozoic dike swarms of the Canadian Shield; Symposium volume, Second International Symposium on Arctic Geology (by W.F. Fahrig, E. Irving, G.D. Jackson).

Lambert, M.B.
1972: Evolution of the Bennett Lake cauldron subsidence complex, southwestern Yukon Territory, Canada; Proc. 24th Internat. Geol. Cong., 1972, Section 2, p. 191-197.

1972: Volcanic rocks of the northern Canadian Cordillera; Guidebook to field excursion A12, 24th Internat. Geol. Cong., 54 p. (with J.G. Souther).

McGlynn, J.C.
in press: Drift of Canadian Shield; in "Continental Drift, Sea Floor spreading, and plate tectonics - Implications to the Earth Sciences', Ed. Jarling, D.H., Runcorn, S.K., Academic Press, London (with J.A. Donaldson, E. Irving and J.R. Park).

in press: Non Energy mineral potential in the north; In contribution on Non-renewable resources for Mount Gabriel Conference 1972, Dept. of Indian Affairs and Northern Development (by D.G. McLaren).

in press: Remanent magnetism and age of Nonacho group sandstones and associated Sparron dykes; Can. J. Earth Sci. (with E. Irving and G. Hansen).

Morgan, W.C.
1972: Granulite facies metamorphosed basic dykes of the Torngat Mountains, Labrador; Min. Mag., Vol. 38, p. 666–669 (with F.C. Taylor)

Ridler, R.H.
1972: Ultramafic and Gabbroic Bodies, in the Superior Province; Geol. Assoc. Can., Special Paper No. 11, p. 553–571 (with T.N. Irvine).

Taylor, F.C.
1972: Precambrian Basic Dikes Metamorphosed to Granulite Facies in the Vicinity of Four Peaks, Torngat Mountains, Labrador, Newfoundland; Min. Mag., Vol. 38, p. 666–669 (with W.C. Morgan).

in press: Correlation of major Aphebian rock units in northeastern Canadian Shield; Can. J. Earth Sci. (with G.D. Jackson).

1972: A revision of Precambrian structural provinces in northeastern Quebec and northern Labrador: Reply; Can. J. Earth Sci., vol. 9, p. 930–932.

PALEOMAGNETISM SECTION

E.J. Schwarz

INTRODUCTION

The objective of the Section is the study of magnetic properties of rocks and minerals and the interpretation of the results in terms of solution of geologic problems. These include tectonic, chronologic (also correlation) and economic problems encountered in understanding the geological framework.

ACTIVITIES

The work of the Section was concentrated on Precambrian Geology with the exception of the magnetic stratigraphy project.

(a) Paleomagnetism. A large project was started on the Lac St. Jean, Sept Isles, and Allard Lake anorthosites (with R. Frith); projects on the Otish Mountain gabbro (with E. Chown, Loyola University), Mealy Mountain anorthosite, and Michael gabbro (with A. Larochelle) were essentially completed. Diabase dikes were sampled in Labrador and on the west coast of Greenland, and material was collected from the 3.7×10^9 yrs. old basement in Greenland. A study of the diabase dikes near Kaminak Lake (with A. Davidson) is nearly completed. The Seal-Croteau Group study with J. Roy (Earth Physics Branch) was completed.

Paleomagnetic measurements were carried out as a service to L. Kornik and P. McGrath (800 samples for magnetic anomaly studies), J. Henderson and I. Ermanovics of the Geological Survey and Chevron Oil Company and J. Seguin (Université de Laval). D.T.A. Symons (University of Windsor) worked in the office during the summer months preparing reports on some of the projects he initiated while a member of the Section.

(b) Magnetic stratigraphy. The magnetic reversal stratigraphy study on Paleozoic sediments in southern Ontario and Quebec has been continued. The collection and measurement systems have been perfected and preliminary results which will allow an evaluation of the feasibility of this study should be available within the next year. The facilities were used for about six months by several members of the Terrain Sciences Division in a study on the magnetics of recent sediments.

(c) Rock Magnetism. Two aspects of the Rock Magnetism program were emphasized: (1) assistance in paleomagnetism studies where the magnetization was complex and (2) possibility of selecting magnetic anomalies in exploring for sulphide ore deposits (with Falconbridge Nickel Mines and International Nickel Company). Furthermore, fabric studies based on magnetic anisotropy were initiated in some Sudbury ore deposits and in granite bodies in an attempt to distinguish between different types (R. Frith).

(d) Laboratories. The existing instrumentation was updated and improved and an instrument was designed for the rapid determination of magnetite impurity contents in the quality control of asbestos (at the request of A. Winder, Mines Branch). The laboratory at Blackburn, Ontario is almost fully operational.

PERSONNEL NOTES

W.F. Fahrig left the Section late in the year to become Chief of the Precambrian Geology Subdivision. K. Clark became a permanent member of the Section.

ATTENDANCE AT MEETINGS

American Geophysical Union; Annual Meeting, Washington, D.C.
J.H. Foster

24th International Geological Congress, Montreal
E.J. Schwarz

TALKS

E.J. Schwarz
- "Magnetic properties of pyrrhotites and their contribution to magnetic anomalies" - 24th International Geological Congress, Montreal, 1972
- "Magnetic properties of pyrrhotite and their use in applied geology and geophysics" - University of Michigan, Ann Arbor, U.S.A.

MEMBERSHIP ON COMMITTEES

E.J. Schwarz
- Canadian representative working group III_5, International Association of Geomagnetism and Aeronomy.
- Member of Geomagnetism Subcommittee of the Associate Committee on Geodesy and Geophysics, National Research Council.

PRODUCTION STATISTICS

Remanent Magnetization Measurements	12,000
Alternating Field washings	8,000
Thermal washing	60
Susceptibility determinations	3,300
Curie temperatures	140
Anisotropy of susceptibility	200

COMPLETED MANUSCRIPTS

(i) Internal

Eade, K.E., and Fahrig, W.F.
in press: Regional, lithological and temporal variation in the abundances of some trace elements in the Canadiian Shield; Geol. Surv. Can., Paper.

Mott, R.J., and Foster, J.H.
1973: Preliminary paleomagnetic studies in freshwater lake sediment cores of late Pleistocene age; Geol. Surv. Can., Paper 73-1B.

Schwarz, E.J., and Whillans, T.
in press: A ballistic magnetometer for the measurement of rock magnetic properties; Geol. Surv. Can., Paper.

Symons, D.T.A.
in press: Paleomagnetic results from the Tertiary Mt. Barr and Hope plutonic complexes, British Columbia; Geol. Surv. Can., Paper.

in press: Unit correlations and tectonic rotation from paleomagnetism of the Triassic Copper Mountain intrusions, B.C.; Geol. Surv. Can., Paper.

(ii) External

Fahrig, W.F., and Schwarz, E.J.
1973: Additional paleomagnetic data on the Baffin Diabase dikes and a revised Franklin pole; Can. J. Earth Sci., vol. 10, no. 4, p. 576-581.

Fahrig, W.F., and Larochelle, A.
in press: Paleomagnetism of the Michael gabbro and possible evidence of the rotation of Makkovik sub-province; Can. J. Earth Sci.

Fahrig, W.F., and Roy, J.
in press: The paleomagnetism of Seal and Croteau rocks from the Grenville Front, Labrador-polar wandering and tectonic implications; Can. J. Earth Sci.

Schwarz, E.J.
1972: Magnetic properties of pyrrhotite and their contribution to magnetic anomalies; 24th Internat. Geol. Congress, Proc. Section IX, p. 84-88.

Schwarz, E.J., and Vaughan, D.J.
1972: Magnetic phase relations of pyrrhotite; J. Geomag. Geolec., vol. 24, 18 p.

Symons, D.T.A.
1972: Paleomagnetism of the Triassic Guichon batholith and rotation in the Interior Plateau, British Columbia: Reply; Can. J. Earth Sci., vol. 9, p. 1343-1347.

1973: Concordant Cretaceous paleolatitudes from Coast Range felsic plutons in the Canadian Cordillera; Nature, No. 241, p. 59-61.

in press: Paleomagnetic zones in the Oligocene East Sooke gabbro, Vancouver Island, B.C.; J. Geophys. Res.

in press: Paleomagnetic results from the Jurassic Topley intrusions near Endako, B.C.; Can. J. Earth Sci.

CORDILLERAN AND PACIFIC MARGIN SECTION

H. Gabrielse

The Cordilleran and Pacific Margin Section comprises a Geological Research Unit and an Information Service Unit.

GEOLOGICAL RESEARCH UNIT

This unit, comprising 14 officers and 1 clerk, is based in Vancouver, British Columbia and conducts geological research in the Cordilleran Orogen. It publishes maps, reports and scientific papers that describe the general composition, structure, origin and geological development of the Cordillera and relates these to the mineral deposits of the region to help in assessing the mineral potential of the region, to guide mineral exploration and to provide aid for planning of the orderly development of land utilization in the region. The Marine Geology Group is conducting a long range program of geological and geophysical studies of the Pacific Continental Shelf to provide information on hydrocarbon and other resource potential. The investigations are supplemented by, or supplement, related cooperative activities by other sections and divisions of the Geological Survey of Canada and the Mineralogical Branch of the British Columbia Department of Mines and Petroleum Resources. Current activities of the Section are directed towards two interrelated objectives: the completion of the reconnaissance phase of regional investigations to provide a broad geological and tectonic framework for the Cordilleran region, and detailed studies of specific problems to further the understanding of the nature and sequence of geological processes, with particular reference to the formation and localization of mineral deposits. Reconnaissance studies were carried out in northwestern Yukon, eastern Yukon and western District of Mackenzie, north-central British Columbia, central Vancouver Island, and the southern Coast Range. More detailed investigations were concerned with volcanic rocks in northwestern British Columbia, Mesozoic and Tertiary sedimentary rocks of north-central British Columbia, Upper Paleozoic strata in north-central British Columbia, Upper Cretaceous and Lower Tertiary rocks of the west Coast of Vancouver Island, a local area of plutonic rocks in the Coast Mountains, and an Upper Paleozoic-Lower Mesozoic assemblage in south-central British Columbia. The Marine Geology Group carried out investigations in the Strait of Juan de Fuca.

Thirteen members of the Section undertook field work in 1972. D.L. Tiffin took part in a co-operative marine geophysical program in the Strait of Juan de Fuca with the United States Geological Survey in which gravity, magnetic, seismic and bathymetric data were obtained. B.E.B. Cameron continued study of the Tertiary stratigraphy and microfaunas in the Nootka Sound and Kyoquot Sound-Esperanza Inlet Area. S.L. Blusson, completed field work for Operation Stewart, a geological reconnaissance of northeastern Selwyn Basin and adjacent Mackenzie fold belt in eastern Yukon Territory and western District of Mackenzie. D.J. Tempelman-Kluit completed the reconnaissance mapping for Operaion Snag-Yukon in western Yukon Territory. R.B. Campbell began a study of the stratigraphy and structure of the Mount Ida Group in south-central British Columbia with the object of revising parts of Vernon map-area. The project on Tectonic Framework of Sustut and Sifton Basins in north-central British Columbia was completed by G.H. Eisbacher. J.W.H. Monger began studies of Upper Paleozoic rocks in Omineca Mountains. J.E. Muller carried out investigations of the geology of Pacific Rim

National Park for the Parks Branch, Department of Indian and Northern Affairs. T.A. Richards and C.J. Dodds continued mapping in the Hazelton (east-half) map-area dealing particularly with facies changes and stratigraphy of mid-Mesozoic volcanic and sedimentary rocks. J.A. Roddick and W.W. Hutchison completed the shoreline geology of the Coast Mountains project with work mainly between Knight Inlet and Howe Sound. They supervised a doctoral thesis by G.J. Woodsworth on metamorphism and plutonism in the Mount Raleigh area of the southern Coast Mountains. J.G. Souther extended his detailed mapping of the Mt. Edziza Volcanic Complex into the Spectrum Range in northwestern British Columbia. This followed completion of his studies of volcanic rocks for the previous year in Japan.

The remainder of the staff was engaged in office and laboratory studies. Compilation of 1:1,000,000 maps for the western Cordilleran region, in co-operation with members of the United States Geological Survey, was essentially completed with the assistance of A.V. Okulitch, employed under contract.

Seven members of the Section took part as leaders of 24th International Geological Congress field excursions. In addition the staff of the Vancouver Office played a major role in orientation day activities and logistics for excursions that began and ended in Vancouver.

The Section played a large role in the Geological Association of Canada's symposium on Sedimentary Geology and Mineral Deposits of the Canadian Cordillera and several members contributed to a Mineral Exploration Group symposium involving governmental work in the Cordillera. An unusually heavy load of consultation with industry resulted from great exploration activity in Selwyn Basin and north-central British Columbia. Numerous talks were given to educational institutions and Natural History groups.

J.A. Roddick and W.W. Hutchison continued to develop techniques for computer processing of geological data and W.W. Hutchison spent much time concerned with Branch activities in this field.

PERSONNEL CHANGES

During the year three members of the Marine Sciences Group were appointed to continuing staff: R. Currie, I. Fridecky and D. Seeman. Miss L. Harvie was appointed to continuing staff with the Information Services Unit replacing Miss P. Lane who was transferred to the Surveys and Mapping Branch.

ATTENDANCE AT MEETINGS

Geological Society of America, Cordilleran Section Meeting, Hawaii, April 1972
W.W. Hutchison

Geological Society of Japan, General Meeting, Kyushu University, Hakata, Japan, April 1972
J.G. Souther

National Conference on Earth Science (Arenaceous Deposits), Banff, Alberta, April 1972
G.H. Eisbacher

Volcanological Society of Japan, Tokyo University, Tokyo, Japan, May 1972
J.G. Souther

International Geological Congress, Montreal, Quebec, August 1972
W.W. Hutchison, J.A. Roddick

Circum-Pacific Plutonism Project, Santa Cruz, California, September 1972
W.W. Hutchison, J.A. Roddick

Penrose Ophiolite Field Conference, Portland, Oregon, September 1972
J.W.H. Monger

American Geophysical Union, Pacific Northwest Region, Vancouver, British Columbia, October 1972
D.L. Tiffin

Field Conference Purcell Anticlinorium and Kootenay Arc, October 1972
H. Gabrielse, S.L. Blusson, D.J. Tempelman-Kluit

Geological Society of America, Annual Meeting, Minneapolis, Minnesota, November 1972
G.H. Eisbacher

Geosynclinal Sedimentation, Madison, Wisconsin, November 1972
G.H. Eisbacher

Canadian Hydrographic Conference, Victoria, British Columbia, February 1973
D.L. Tiffin

Geological Association of Canada, Cordilleran Section Meeting, Vancouver, British Columbia, February 1973
S.L. Blusson, R.B. Campbell, G.H. Eisbacher, H. Gabrielse, J.W.H. Monger, J.E. Muller, T. Richards, J.G. Souther, D.J. Tempelman-Kluit, H.W. Tipper

Intermediate Fortran Course, University of British Columbia, Vancouver, February 1973
J.A. Roddick

Mining Engineering Group, Government Geological Research Symposium, Vancouver, February 1973
S.L. Blusson, R.B. Campbell, T. Richards, H.W. Tipper, H. Gabrielse

Geological Society of America, Cordilleran Section Meeting, Portland, Oregon, March 1973
S.L. Blusson, J.W.H. Monger, T. Richards, J.A. Roddick, D.L. Tiffin

Prospectors and Developers Association, Toronto, Ontario, March 1973
D.J. Tempelman-Kluit

MEMBERSHIP ON COMMITTEES

B.E.B. Cameron – Part time lecturer, Geology Department, University of British Columbia.

R.B. Campbell	- Technical Program Committee, Vice-Chairman, Annual General Meeting, Canadian Institute of Mining and Metallurgy, 1973.
	- General Convention Committee, British Columbia Section, Canadian Institute of Mining and Metallurgy.
G.H. Eisbacher	- Program Committee, Cordilleran Section, Geological Association of Canada.
H. Gabrielse	- Co-editor, Pacific Geology.
	- Member, Committee on Penrose Conferences, Geological Society of America.
	- Member, Technical Program Committee, Circum-Pacific Energy Minerals Resources Conference, Honolulu, Hawaii, 1974.
	- Member, Working Group 2, Inter-Union Commission on Geodynamics.
	- Departmental Representative, Federal Interdepartmental Co-ordinating Committee for Yukon Territory.
W.W. Hutchison	- Vice-President, and editor, Geolog, Geological Association of Canada.
	- Chairman, National Advisory Committee, Sub-Committee on Storage and Retrieval of Geologic Data.
	- Member of Executive, Circum-Pacific Plutonism Project.
	- Member, National Advisory Committee, Committee on Computor Applications.
	- Chairman, International Union of Geological Sciences Committee - CODEODATA (effective February, 1973).
J.W.H. Monger	- Member, National Research Council Subcommittee on Geodynamics.
	- Member, Ad Hoc Committee on Scientific Direction of Geological Society of America.
D.J. Tempelman-Kluit	- Secretary-Treasurer, Geological Association of Canada, Cordilleran Section.
D.L. Tiffin	- Member, Pacific Sub-Committee on Oceanography.
	- Member, Organizing Committee, Workshop on Estuaries, Pacific Sub-Committee on Oceanography.

SPECIAL TALKS

Blusson, S.L.

- "Regional setting of bedded base metal deposits in Selwyn-Mackenzie Mountains" - Geological Association of Canada, Cordilleran Section Meeting, February 1973.

- "Operation Stewart" - Mining Engineering Group, Geological Research Symposium, Vancouver, B.C. February 1973.

Eisbacher, G.

- "Flysch and Molasse equivalents in the Canadian Cordillera" - Banff, Arenaceous Deposits Symposium, April 4, 1973.

- "The possibility of paleoplacer deposits in the Sustut group, north-central B.C." - Canadian Institute of Mining and Metallurgy Meeting, Prince George, September 9, 1972.

- "Evolution of successor basins in the Canadian Cordillera" - Geosynclinal Sedimentation, Madison, Wisconsin, November 10, 1972.

- "Facies changes in Cordilleran successor basins" - Geological Association of Canada, Cordilleran Section Meeting, February 9, 1972.

- "Zeolite Diagenesis of the Sustut Group, B.C." - Geological Association of Canada, Cordilleran Section Meeting, February 9, 1972 (with P. Read).

Gabrielse, H.

- "Geological Investigations in Mackenzie and Logan Mountains, Yukon Territory and District of Mackenzie" - Natural History Society, Vancouver, B.C.

- "Geosynclinal Nomenclature in the Cordillera" - Geology Department, University of British Columbia, November 1972.

- "Proterozoic of the Cordillera" - Geology Department, University of British Columbia, February 1973.

- "Environments of Cordilleran Depositional Basins" - Geological Association of Canada, Cordilleran Section Meeting, February 1973.

- "Logan Mountains and the Ragged Range" - Canadian Alpine Club, Vancouver Section, March 1973.

Hutchison, W.W. - "Chemical Variations in major parautochthonous plutons of the Canadian Coast Plutonic Complex, B.C. between 58-55°N. - Geological Society of America, Cordilleran Section, April 1972.

- "Evolution of Plutons in Central Coast Mountains" - Circum-Pacific Plutonism Conference, Santa Cruz, September 1972.

- "Evolution of Coast Mountains, B.C." - 4th Year Students, University of British Columbia, November 1972.

Leaming, S. - During the past year gave talks to Delta Rock Club of 40 members and New Westminster Lapidary Club of 35 members, on the work of the Geological Survey illustrated by display of publications, slides, and photographs.

Monger, J.W.H. - "Correlation of pre-Tertiary geology between Canadian and United States' segments of the Cordillera" - Geological Society of America Meeting, Cordilleran Section.

- "Evolution of the Canadian Cordillera" - Department of Geology, University of Washington, November, 1972; Department of Geology, University of British Columbia, April 1973.

Muller, J. - "Fault and Fracture tectonics of Insular Belt" - Geological Associati n of Canada, Cordillera Section Meeting.

- Informal talks on geology of Vancouver Island and Pacific Cordillera during the International Geological Congress tours A03, A06, and C03.

Richards, T. - "Mesozoic Stratigraphy and Copper Mineralization in the Hazelton-Smithers map areas" - At Mineral Engineering Group Symposium.

Roddick, J. - "A Computer-based system for geological field data on the Coast Mountains Project, B.C." - 24th International Geological Congress, Montreal, August 1972.

- "Plutonic and Associated Rocks of the Coast Mountains of B.C." - Circum-Pacific Plutonism Project, Santa Cruz, California, September 1972.

Souther, J.G. - "Geology of Canada" - Lecture series Hokkaido University, Sapporo, Japan, April 1972.

- "Physical evolution of Mt. Edziza Volcanic complex, B.C., Canada" - Tokyo University, Tokyo, Japan, May 1972.

- "Geology of Japan" - Geological Association of Canada, Lecture, Vancouver, B.C., December 1972.

- "Mount Edziza, British Columbia's new Volcanic Park" - Heritage Court Series, B.C. Provincial Museum, Victoria, B.C., March 1973.

- "Volcanic Stratigraphy of Western Canada" - University of British Columbia, Vancouver, B.C.

- "Volcanism in British Columbia" and "The process of volcanism" - Cariboo College, Kamloops, B.C.

Tempelman-Kluit, D.J. - "The geologic setting of the Anvil Range Base Metal Deposits" - graduate course in economic geology, University of British Columbia, November 1972.

Tiffin, D.L. - "Tectonics and Sedimentary Basin Studies off North Vancouver Island, B.C." - American Geophysical Union, Meeting Vancouver, October 1972.

- "Geology and Tectonics of the Pacific Margin" - Seminar Atlantic Geoscience Centre, Dartmouth, Nova Scotia, November 1972.

- "Geological Framework of the Pacific Margin" - Seminar Marine Sciences Directorate, Pacific, Victoria, November 1972.

- "Geology and Resource Potential of West Coast Basins" - Workshop, Calgary, Institute of Sedimentary and Petroleum Geology, January 1973.

Tipper, H.W. - "Mesozoic Stratigraphy and Mineralization in Hazelton-Smithers area" - Mineral Engineering Group Symposium Vancouver (with T. Richards).

COMPLETED MANUSCRIPTS

(i) Internal

Cameron, B.E.B.
1973: Tertiary stratigraphy and microfaunas from the Pacific Margin, west coast Vancouver Island; Geol. Surv. Can., Paper 73-1A, p. 19, 20.

Campbell, R.B.
1972: Stratigraphy and structure of the Mount Ida Group, Vernon (82L), Adams Lake (82M W½), and Bonaparte (92P) map-areas; Geol. Surv. Can., Paper 73-1A, p. 21-23 (with A.V. Okulitch).

1972: McBride map-area, British Columbia; Geol. Surv. Can., open file (with E.W. Mountjoy and F.G. Young).

Eisbacher, G.
1973: Tectonic framework of Sustut and Sifton Basins, British Columbia; Geol. Surv. Can., Paper 73-1A, p. 24-26.

in press: Sedimentary history and tectonic evolution of the Sustut Group, northern British Columbia; Geol. Surv. Can., Paper.

Hutchison, W.W.
1973: Coast Mountains Project - Examination of shoreline between Knight Inlet and Howe Sound; Geol. Surv. Can., Paper 73-1A, p. 42, 43 (with J.A. Roddick).

in press: Geology of Pemberton E/2; Geol. Surv. Can., Paper (with J.A. Roddick).

Leaming, S.
in press: Rock and mineral collecting in British Columbia; Geol. Surv. Can., Paper 72-53.

Muller, J.E.
1972: Nootka Sound area, British Columbia (92E); Geol. Surv. Can., Paper 72-1A, p. 33-36.

Richards, T.
1973: Hazelton East-Half map-area, British Columbia (93M); Geol. Surv. Can., Paper 73-1A (with C.J. Dodds).

in press: Geology of Manning Park; by J.A. Coates (compiled by T. Richards) Geol. Surv. Can., Paper.

Roddick, J.A.
in press: Geology of Pemberton E/2; Geol. Surv. Can., Paper and preliminary map.

1973: Coast Mountains Project - Examination of shoreline between Knight Inlet and Howe Sound; Geol. Surv. Can., Paper 73-1A, p. 42, 43 (with W.W. Hutchison).

Souther, J.G.
in press: Stratigraphy and Paleomagnetism of Mount Edziza Volcanic Complex, northwestern British Columbia; Geol. Surv. Can., Paper (with D.T.A. Symons).

Tempelman-Kluit, D.J.
1973: Operation Snag-Yukon 115H, 115J, 115K (E½), 115N (E½); Geol. Surv. Can., Paper 73-1A, p. 48, 49.

(ii) External

Campbell, R.B.
in press: Structural cross-section and tectonic model of the Southeastern Canadian Cordillera; Can. J. Earth Sci.

Eisbacher, G.
1972: In-Situa Gesteinsspannungen und Mechanismen der Kluftoeffnung; Geol. Rundsch., vol. 61, p. 29-53.

in press: Evolution of successor basins in the Canadian Cordillera; Soc. Econ. Pal. Min., Spec. Publ.

Hutchison, W.W.
1972: Chemical Variation in major parautochthonous plutons of the Canadian Coast Plutonic Complex, B.C., between 53-55° N; Geol. Soc. Amer., Abstracts with Program, vol. 4, No. 3, p. 175, 176.

1972: A computer-based system for geological field data on the Coast Mountains Project, British Columbia, Canada; 24th Internat. Geol. Congr., Section 16, p. 36-46 (with J.A. Roddick).

Monger, J.W.
1973: Correlation of pre-Tertiary geology between Canadian and United States' segment of the Cordillera; Geol. Soc. Amer., Abstracts with Program, vol. 5, No. 1, p. 82.

Roddick, J.A.
1972: A computer-based system for geological field data on the Coast Mountains Project, British Columbia; 24th Internat. Geol. Congr., Section 16, p. 36-46 (with W.W. Hutchison).

in press: Plutonic and Associated rocks of the Coast Mountains of British Columbia, in I.G.C.P. report on the Circum-Pacific Plutonism Project.

Souther, J.G.
in press: Aenigmatite from Mount Edziza, British Columbia (with Kenaz Yagi).

1972: Physical Evolution of Mt. Edziza Volcanic complex, northwestern British Columbia, Volcanological Society of Japan, vol. 17, No. 2, p. 107-108.

Tipper, H.W.
in press: Upper Bajocian-Lower Bathonian Ammonite Fauna and Stratigraphy of Smithers Area, British Columbia; Can. J. Earth Sci. (with H. Frebold).

INFORMATION SERVICES UNIT

S. Leaming

Average monthly sales declined in fiscal year 1972-73 to $3389 from $3708 in 1971-72 reaching a low value of $748.60 in December. The number of visitors declined from 10,266 to 8,865.

The sale of topographic maps increased slightly in the year so that the decline in total sales resulted in decline in sales of G.S.C. and B.C. Department publications. This points to factors affecting the mineral industry. The upturn in sales in March 1973 indicates increased exploration activity in at least two regions of the Cordillera.

In December, the provincial sales tax was collected for the first time.

Activities

Mr. Leaming spent approximately six weeks in the field visiting properties with the objective of:

(1) keeping in touch with the jade industry
(2) collecting minerals for the office collection
(3) obtaining knowledge of rock and mineral collecting sites in the Cordillera
(4) collecting photographs of natural resources and geological phenomena as illustrative material to talks to various groups.

Two more jade areas were examined during the summer, one at Dease Lake and the other at the Cassiar Asbestos mine. In addition the placer jade deposits on Wheaton Creek were visited. Repeat visits were made to the Bridge River area where continuing exploration of jade deposits is revealing more about the occurrence of this material.

Mr. Leaming gave talks to the Rock Clubs in Delta and New Westminster on the work of the Geological Survey of Canada. His office time was divided between public information matters, some section and administrative duties, and the preparation of report on jade in the Cordillera.

MONTH	VISITORS	TOPOGRAPHIC MAPS NO.	TOPOGRAPHIC MAPS VALUE	G.S.C. PUBLICATIONS NO.	G.S.C. PUBLICATIONS VALUE	ROCKS $2 SETS	MINERALS	MINERAL SETS $25		B.C. GOV'T. PUBLICATIONS	MINES BRANCH	PHOTOCOPIES	
Apr. 72	994	4188	$1941.55	1050	$1240.05	12 $ 24	18 $ 36	1	$25	$180.00	$ 4.80	229	$34.35
May	944	5463	$3117.00	2071	$1913.65	12 $ 24	27 $ 52	1	$25	$173.00	$18.55	252	$37.90
June	842	5634	$2505.30	979	$ 893.15	13 $ 26	132 $264	1	$25	$121.50	$10.90	346	$51.95
July	878	5138	$2618.25	690	$ 707.90	21 $ 42	23 $ 46	1	$25	$188.00	0.00	219	$33.60
Aug.	870	5847	$2764.10	754	$ 827.75	15 $ 30	39 $ 78	1	$25	$179.50	$17.50	185	$27.90
Sept.	719	3939	$1803.25	590	$ 768.65	13 $ 26	13 $ 26	1	$25	$183.50	$39.90	93	$13.95
Oct.	653	2840	$1370.50	592	$ 660.95	42 $ 84	92 $184	5	$125	$103.00	$27.00	160	$24.00
Nov.	569	2799	$1333.25	1025	$1009.40	52 $104	70 $140	0		$185.00	$ 6.25	238	$35.70
Dec.	376	1638	$ 748.60	591	$ 701.60	52 $104	81 $162	2	$50	$122.00	$ 7.85	209	$31.35
Jan. 73	672	2763	$1250.70	1001	$1476.30	57 $114	112 $224	1	$25	$231.50	$ 1.75	399	$59.85
Feb. 73	635	3601	$1552.75	1004	$1019.65	16 $ 32	21 $ 42	2	$50	$197.50	$ 2.50	207	$31.05
Mar. 73	713	4103	$1971.33	1044	$1517.55	17 $ 34	13 $ 26	3	$75	$289.50	$12.20	336	$50.40
	8865	47,953	$22,976.58	10,391	$12,736.60	322 $748	641$1110	16	$475	$2,044.00	$149.20	2873	$432.00

PETROLOGY SECTION

J.E. Reesor

ACTIVITIES

The Petrology Section conducts field and laboratory research into the theories and problems of petrology by carrying out systematic studies of specific rock types as well as detailed field studies of critical map-areas. These studies are expected to provide a means of elucidating petrologic problems of economic or regional significance. In addition, the section provides consultation on petrologic problems to scientists of the Branch, other government agencies and the public. The Petrology Section maintains the lapidary facilities and a general petrology laboratory for the Branch.

Members of the Petrology Section continued to carry out field work ranging from the Arctic to Labrador to British Columbia. A number were leaders of the 24th International Congress field trips during part of July and August. T.N. Irvine is spending a year at the Geophysical Laboratory, Carnegie Institution, Washington, D.C. and T.M. Gordon has continued to help in developing computer oriented systems for collection and treatment of geological data as well as acting as consultant in the development of Mineral Deposits files.

ATTENDANCE AT MEETINGS

24th International Geological Congress, Montreal, August, 1973

K.L. Currie, R.F. Emslie, J.E. Reesor

24th International Geological Congress, Field Trip A01-AX01

J.E. Reesor - co-leader

Geological Society of America, 1972 Annual Meeting, Minneapolis

R.F. Emslie

Geological Association of Canada, Cordilleran Section, Spring, 1973

T.M. Gordon

MEMBERSHIP ON COMMITTEES

T.M. Gordon
- Branch Computer Users Committee
- Geol. Surv. Can. Age Determinations Committee
- Field Data Working Group, National Advisory Committee on Research in Geological Sciences

J.E. Reesor - Committee on committees, Geological Society of America
- Member of organizing Committees, 24th International Geological Congress
- Branch representative to Departmental Committee on Research Scientist appraisal

SPECIAL TALKS

J.E. Reesor - "Structural and metamorphic evolution in the Shuswap Metamorphic Complex, British Columbia" - University of Ottawa and 24th International Geological Congress

R.F. Emslie - "Chemical characteristics of anorthosite suites and their significance" - Geological Society of America, Annual Meeting
- "Characteristics of anorthosites suites" - Ottawa University and Lakehead University

T.M. Gordon - "Computerizing field data" - Regional and Economic Geology Division, Geological Survey of Canada

K.L. Currie - "Control of peralkaline magma compositions by liquid Immiscibility" - 24th International Geological Congress

COMPLETED MANUSCRIPTS

(i) Internal

Currie, K.L.
in press: Alkaline rocks of Canada; Geol. Surv. Can., Bull.

in press: The geology and petrology of the Ice River alkaline complex; Geol. Surv. Can., Bull.

Froese, E.
1972: Geological setting of the Snow Lake area; Geol. Surv. Can., Paper 72-1B, p. 78-81 (with J.M. Moore).

(ii) External

Currie, K.L.
1972: Silicate immiscibility in ancient 'basalts' of the Barberton Mountain Land, Transvaal; Nature, Physical Sciences, vol. 235, p. 66-88 (with J. Ferguson).

1972: A study of fenitization in mafic rocks with special reference to the Callendar Bay complex; Can. J. Earth Sci., vol. 9, p. 1254-1261 (with J. Ferguson).

1972: A criterion for predicting liquid immiscibility in silicate melts; Nature, Physical Sciences, vol. 240, p. 66-88.

1972: A note on the conditions of formation of melilite in the Oka alkaline carbonitite complex, Quebec; Can. J. Earth Sci., vol. 9, p. 1766-1771 (with L. Gelinas).

Emslie, R.F.
1972: Oceanic crust and the identification of ancient oceanic crust on the continents. A summary: in Symposium on Identification of Ancient Oceanic Crust, Earth Physics Branch, vol. 42, p. 153-156.

in press: Some chemical characteristics of anorthositic suites and their significance; Can. J. Earth Sci.

Froese, E.
1973: The oxidation of almandine and iron cordierite; Can. Mineralogist, vol. 11.

Gordon, T.M.
in press: Determination of internally consistent thermodynamic data from phase equilibrium experiments; J. Geol.

Irvine, T.N.
1972: In Fraser, J.A., et al. The Bear Province; Geol. Assoc. Can., Special Paper No. 11, p. 453-503.

PETROLOGY LABORATORY

M. Turay

The petrology laboratory provides equipment and help for petrographic determinations and certain mineral separations. Services carried out on request include determination of specific gravity and mineral compositions, mineral staining, special petrographic studies, determination of optical properties of minerals and development of new petrographic techniques. The laboratory also provides occasional help for classification of samples in the representative rock collection (Curator: W.U. Ter Haar Romeny).

The X-ray diffractometer unit can be used on request and under supervision for qualitative and quantitative determinations (powder mounts).

Work performed during the report year

Mineral composition and point counting of thin sections	12
Mineral composition and point counting of slabs	20
Mineral operation	2
Staining of carbonates	60
Staining of feldspars: thin sections	30
Staining of feldspars: slabs	300
U stage determinations	4
Specific gravity	100
Refractive index determination	5
X-ray traces of minerals and rocks	23

Determination of the mineral composition of two artifacts.

Also, two translations of guidebooks for the 24th International Geological Congress were edited; a basic course in Fortran language was attended.

LAPIDARY SERVICES

A.E. Whitehead

The lapidary has a three man staff consisting of A.E. Whitehead (Supervisor), Y. Demers and M. Beaulne.

Work Report for 1972-73

(1)	Standard thin sections with small, large and no cover slips ..	3357
(2)	Standard oriented thin section with small, large and no cover slips	259
(3)	Large thin sections, orientated with cover slips, and no cover slips	238
(4)	Polished thin sections	171
(5)	Oil thin sections with small and large cover slips	2
	Total	4027

Man hour jobs 1972-73

(1)	Large and small polished surfaces	515	= 298½ hrs.
(2)	Trim saw cuts	2076	= 83½ hrs.
(3)	Other duties	247	= 99¼ hrs.
	Total	2838	= 481¼ hrs.
Slab Saw Cuts		261	= 260½ hrs.

Special Jobs

(1) 17 ceramic discs were resurfaced for Mr. Lavergne. These discs could then be re-used which resulted in a considerable saving.

(2) Excess material was cut away from Dr. Kuc's fossil seeds for study. A section was made of the roots of the fossils in sandstone.

(3) Samples of jade were prepared for the Economic Geology, Embassy and National Film Board Collection.

(4) Twenty-four polished thin sections were prepared from old pottery that was underwater for years.

(5) Rough samples 5 millimetre thick, were prepared for Dr. Katsube for electrical rock properties studies.

(6) Mounted grains were polished for Dr. R. Emslie.

(7) Samples were prepared for auto-radiograph and photography.

(8) Numerous samples were stripped of weathered surfaces prior to chemical analysis and staining.

(9) Thin sections were made from small drill core chips provided by Dr. R.G. Skinner.

(10) Standard and large orientated thin sections were prepared from pieces of apoxied rectangular blocks and drill cores for Dr. B. MacDonald.

(11) Various cutting and grinding procedures were carried out on a ceramic tube and 5" alundum tube to assist Dr. Currie in repairing a furnace.

(12) 21 different sized cubes were made from rough samples, and one surface on each cube was polished, for Dr. Ermanovics.

(13) Slabs of uranium ore were cut and polished for presentation to visiting delegates from the 24th International Geological Congress.

(14) A damaged pistle was cut, rounded and polished for Mrs. Watson.

Plaques and Mementos

Pen Set

A double pen set with a calendar clock was made from the Bruce Mines Conglomerate for Dr. Duffell.

Plaques

(1) Plaques for 25 years service were made from Bruce Mines Conglomerate with the G.S.C. crest and name plates for 28 employees.

(2) K. Pollitt requested a Red Shield Trophy for the United Appeal to be awarded to the winning Division.

(3) Two slabs of Bruce Mines Conglomerate were polished; one for the Director's secretary, and one for Dr. Duffell for display.

(4) A plaque made from anorthosite was requested by E. Raymond for Mr. G. Donohoe of Geodetic Survey on his retirement.

Paper Weights were presented to G. Bowes, R.H. Chilton, N. Fortune, Cathy Thomas, Mr. Gadbois, Mr. De Leeuw and S. Cantin on their departures.

OTHER ACTIVITIES

Consultations (1) The operation of the lapidary was explained to Dr. Leech's visitors. (2) A summary of the cost of operation of the lapidary was prepared for the use of the Director of the Ontario Department of Mines. (3) The method of preparation of polished thin sections was explained to Mr. Cranston from Vancouver. (4) Mr. R. Writhlin was instructed on the proper use of his Carveth mini-polisher.

Experiments (1) Mounted polished samples were glued to a glass slide, ground down to 30 microns thickness, then apoxy glued on a circular slide which fitted the electron probe. The lakeside cemented glass was removed exposing the polished surface of the section ready for study on the circular slide. (2) Very good sections were prepared on a mini polisher from Carveth for Dr. Irvine in Washington, D.C.

Training and Visitors (1) Mr. Bates and his class (30) from Ottawa Technical High School toured the lapidary and other laboratories. (2) Mr. Steacy and ten students from Ashbury College visited the laboratory. (3) Training was provided to a student from Ottawa Technical High School and to M. Delabio, R. LaCroix and R. Bradley of Champlain High School. (4) D. Hardy, from Bedford Institute, Dartmouth, Nova Scotia, was given two weeks training in laboratory methods.

GEOCHRONOLOGY SECTION

R.K. Wanless

ACTIVITIES

The Geochronology Section undertakes isotopic analyses of geological material in support of age determination projects and stable isotope investigations. The geochronological results are based on the following isotopic parent-daughter pairs; ^{40}K- ^{40}Ar; ^{87}Rb- ^{87}Sr; $^{206}Pb/^{238}U$; $^{206}Pb/^{235}U$; and $^{208}Pb/^{232}Th$; whereas abundance data for the stable isotopes of sulphur and lead are provided for investigations designed to elucidate the origin and development of ore deposits. The section also designs and assembles a variety of high-vacuum extractive and analytical apparatus required to support this research program.

For several years $^{40}K - ^{40}Ar$ age measurements have been undertaken on a large variety of mineral and whole-rock samples spanning the whole of the geological column. While this technique will continue to be extensively used a more precise method based on the $^{87}Rb - ^{87}Sr$ isotopic ratios in suites of whole-rock samples has gained favour as a technique more likely to yield the original time of rock formation. During the report-year the latter technique has been successfully applied to twenty rock suites in the Precambrian Shield. The Rb-Sr method, however, is not universally applicable and one is forced to apply the much more technically difficult technique of Pb-U, Pb-Th dating based on the trace quantities of lead, uranium and thorium found in zircon, sphene and other uranium bearing minerals. The method holds much promise but, as noted above, is technically complicated. During the past year, laboratory techniques have been perfected whereby small quantities of zircon ($10-20 \times 10^{-3}$gm.) may be processed in an ultra-clean laboratory. In addition, by employing a silica-gel sample mounting technique, precise mass spectrometric isotopic analyses can be routinely carried out on less than 1×10^{-6}gm. of lead. Prior to the perfection of the methods noted above, large zircon concentrates were required and it was necessary to collect several hundred pounds or rock. However, measurements may now be successfully undertaken if 25-50 kilograms of rock are available for study. We now envisage the application of this technique to the precise dating of rock sequences found in remote areas of Canada. To further expedite this aspect of the dating program a method has been developed that permits the geologist concerned to verify the existence of zircon in the rock before collection is undertaken, thereby avoiding the high cost of shipment of questionable samples to Ottawa for processing.

Additional information has been obtained for samples selected in regions where anomalously old biotite K-Ar 'ages' have been obtained. Research has centered on establishing the geographical extent of the anomoly in the Chibougamau, Quebec area and identifying additional anomalous regions and the relation between the anomalies and the Grenville Front.

It has been established that the mineral hornblende may also yield excessively old 'ages' and an isochron technique analagous to that employed in Rb-Sr whole-rock dating may be used to determine the true age of mineral formation. Experience gained with samples from Precambrian terranes has

recently been applied to suspect hornblende results obtained in relatively young Cordilleran rocks where anomalously old 'ages' may not be readily recognized.

The isochron technique has also been applied to the dating of whole-rock samples of very young continental basalts and the chronology of the Mt. Edziza volcanic complex of northern British Columbia has been precisely established. This study has revealed that the major portion of the volcanic sequence was deposited 5.9 m.y. ago and that an extensive rhyolitic event occurred 1 m.y. ago.

A mini-computer has been procured to operate in a dedicated mode and is currently being interfaced with the six operating mass spectrometers. Eventually the unit will be programmed to accept data from all spectrometers simultaneously and to carry out all routine calculations. The final phase envisaged is the computer control of certain focusing and switching functions of the individual mass spectrometers.

The design of the vacuum systems of both argon mass spectrometers was extensively modified and new hi-vacuum isolation valves were installed. A second transistorized control unit was assembled and installed to replace the circuitry originally supplied with the first argon mass spectrometer. A new 100 l/sec vac-ion pump and associated hi-vacuum valves were installed on the smaller solid source mass spectrometer thus completing the up-grading of all solid source mass spectrometer vacuum systems.

Extensive vacuum system modifications and repairs were carried out on the Laval University mass spectrometer and Laval personnel visited the laboratory to observe the operational techniques employed.

PERSONNEL CHANGES

Mrs. Mary Neidy (casual technician) resigned on June 30th. Mr. Douglas Cochrane was employed as a chemical technician (casual) from June 19th to September 19th as a chemical technician (casual) in the Rb-Sr preparation laboratory.

Mr. W.N. Houston joined the section on October 10th as an isotopic analyst assigned to work in the K-Ar dating program. He transferred to another section on April 27th, 1973.

ATTENDANCE AT MEETINGS

24th International Geological Congress

R.K. Wanless

MEMBERSHIP ON COMMITTEES

R.K. Wanless
- Secretary, Subcommittee on Isotope Studies and Geochronology, National Research Council Associate Committee on Geodesy and Geophysics
- Member, Geological Survey of Canada Age Determination Committee

PRODUCTION STATISTICS

Argon extractions	204
Argon isotopic analyses	289
Potassium isotope dilution determinations	166
K-Ar ages reported	134
Rubidium isotope analyses	101
Strontium isotope analyses	254
Rb-Sr isochron projects	20
Lead isotope analyses	119
Uranium isotope analyses	23
Thorium isotope analyses	22
Zircon analyses completed	5
Uraninite samples dated	13
Common lead samples analysed	60
Sulphide samples converted to SO_2	232
Sulphate samlles converted to sulphide	22
SO_2 isotopic analyses	477
CO_2 isotopic analyses	104

EASTERN PALEONTOLOGY SECTION

W.T. Dean

ACTIVITIES

The staff of the section now includes four scientists whose researches are concerned for the most part with the study, description and biochronological evaluation of Paleozoic fossil faunas and floras in eastern Canada, though part of their work is carried out on related topics in western Canada and elsewhere. They are supported by a technical and laboratory staff of five whose duties include the extraction and preparation of fossils, particularly microfossils, as well as indexing the large collections of fossils obtained by GSC geologists each year in both eastern and western Canada. Forty-five scientific reports and three papers were written for and in collaboration with members of both GSC and outside organizations in North America and Europe.

W.T. Dean carried out field investigations on Cambrian rocks and fossils in eastern Newfoundland as well as on the Ordovician of Newfoundland, Alberta and related successions in northern California and the Virginia Appalachians.

W.H. Fritz measured, and collected fossils from, Cambrian sections in the Mackenzie Mountains, Yukon Territory while giving support to geologists in Operation Stewart, and obtained additional data on facies changes in the Sekwi Mountain area. He also consulted with GSC officers in the Calgary and Vancouver offices and spent a week studying Cambrian outcrops in Labrador and Sardinia for the purpose of assessing regional relationships.

In January 1973 D.C. McGregor was posted to Bolivia for one year as part of the United Nations Technical Assistance programme.

Type Collection

Thomas E. Bolton continued as Curator of the National Type Collection of Invertebrate and Plant fossils. A total of 2064 types described in both Survey and outside publications was added to the collection in 1972. Publications in which these types were reported are as follows:

GSC Bull.	188	- Ammonites, Lower Cretaceous, B.C.	125 types
	204	- Brachiopods, Devonian, Ontario	164
	209	- Trilobites, Cambrian, B.C.	23
	212	- Trilobites, Cambrian, Mackenzie Mtns.	263
GSC Paper	70-38	- Palynomorphs, Devonian, Arctic	209
	71-13	- Palynomorphs and Conodonts, Devonian, Arctic	71
	71-19	- Invertebrate faunas, Ordovician & Silurian, Quebec	196
	71-28	- Plants, Devonian, Arctic	10
	72-15	- Invertebrate faunas, Silurian, Ontario & Quebec	153
	72-43	- Brachiopods, Jurassic, B.C.	28
			1242

Types in Outside Publications:

Astrova, A.A. (Pal. Instit., USSR), Proc. Geol. Assoc. Can., 24:2	52
Bolton, T.E. and Copeland, M.J. (GSC), ODM, Geological Guidebook 4	56
Chiang, K.K. (Univ. Western Ontario), J. Pal., 46:1	66

Chiang, K.K. (Univ. Western Ontario), J. Pal., 46:3	14 types
Dean, W.T. (GSC), Can. J. Earth Sci., 9:3	6
Dean, W.T. (GSC), Can. J. Earth Sci., 9:4	1
Hopkins, W.S. et al. (GSC), Can. J. Earth Sci., 9:4	28
Jackson, D.E. (Open Univ.) and Lenz, A.C. (Univ. Western Ontario), Palaeontology, 15:4	54
Johnson, J.G. and Boucot, A.J. (Oregon State Univ.), J. Pal., 46:1...	6
Johnson, J.G. (Oregon State Univ.) and Ludvigsen, R. (Univ. Calgary), J. Pal., 46:1	1
Johnson, J.G. (Oregon State Univ.) and Norris, A.W. (GSC), J. Pal., 46:4	3
Kuc, M. (GSC), Can. J. Earth Sci., 9:5	1
Lenz, A.C. (Univ. Western Ontario), J. Pal., 46:1.....	17
Lenz, A.C. (Univ. Western Ontario), Can. J. Earth Sci., 9:9.....	38
Ludvigsen, R. (Univ. Western Ontario), Can. J. Earth Sci., 9:3	36
Norris, A.W. and Uyeno, T.T. (GSC), Geol. Assoc. Can., Sp. Paper 9...	17
Ormiston, A.R. (Amoco), J. Pal., 46:5	31
Pedder, A.E.H. (GSC), J. Pal., 46:5	30
Petryk, A.A. (Texaco Canada) and Mamet, B.L. (Univ. Montreal), Can. J. Earth Sci., 9:7	119
Pocock, S.A.J. (Imperial Oil), Palaeontographica B:130.....	217
Tozer, E.T. (GSC), Palaeontology, 15:4	17
Young, F.G. (GSC), Can. J. Earth Sci., 9:1	12
	822

Manuscript of Volume V of the "Catalogue of Type Invertebrate Fossils of the Geological Survey of Canada" was completed and submitted for publication.

PERSONNEL CHANGES

W.H. Fritz transferred to the section from ISPG, Calgary.

Mrs. M. Camfield resigned from full-time employment to carry out part-time duties, and Mrs. P. Higham joined the section as palynological technician.

ATTENDANCE AT CONFERENCES

M.J. Copeland spent two weeks conferring with members of the U.S. Geological Survey and U.S. National Museum in Washington, D.C.

W.H. Fritz acted as one of the guides during field Excursion A-19 of the 24th International Geological Congress, and attended meetings of the Cambrian Sub-commission on Stratigraphy in Montreal. Cambrian fossils and stratigraphic data were examined in visits to the State University of New York at Stony Brook, and City College and the American Museum of Natural History, New York.

D.C. McGregor acted as co-leader for field excursion A-59 of the 24th International Geological Congress and attended the annual meeting of the American Association of Stratigraphic Palynologists at Newport, Rhode Island, from October 24-28, 1972.

MEMBERSHIP ON COMMITTEES

M.J. Copeland – Geological Association of Canada, Councillor, Member of Executive Committee, Editor and Chairman of Editorial Committee (concurrent terms ending August 22, 1972)

W.T. Dean – Adviser, Treatise on Invertebrate Paleontology, Member, Subcommittee on Ordovician Stratigraphy, Geological Society of London

D.C. McGregor – American Assoc. Stratigraphic Palynologists, Councillor Member of Executive Committee and International Affairs Committee,
– North American Secretary for Stratigraphic Palynology, Commission Internationale de Microflore du Paleozoique

PRODUCTION STATISTICS

Paleontology Preparation Laboratory Services

Name	Saw Cuts	Thin Sections	Polished Sections	Rubber Moulds	Plaster Casts	Rubber Casts	Mech. Prep.
Bolton, T.E.	221	177	2	6	12		
Copeland, M.J.	15	1	5				
Dean, W.T.	223			15	31	9	
Frebold, H.	36		16	78	202	97	108
Jeletzky, J.A.	2	4		73	152		
Tozer, E.T.	2		2				
Divisional & Branch Services							
Benson, D.	1		1			1	
Duffell, S.	9						
Kuc, M.				1	2		
Patrequin, F.	55	55					
Petrovic, M.	25	33					
Prest, V.	4	3					
Rheinhardt, E.W.	98						
Taylor, F.C.	34						
Total	725	273	26	173	399	107	108

Parcels Received.....318
Parcels Shipped 501
Fossil Localities Recorded –
Invertebrates (GSC#89032 to 89779).....747
Plants (GSC #9090 to 9110) 20

The technical curator, B.J. Botte, attended the Industrial Accident Prevention Association's conference in Toronto and various other meetings concerned with industrial safety. He also taught a "Standard First Aid" course and spent two days demonstrating paleontology laboratory techniques to students at Ottawa Technical High School.

Micropaleontology Laboratory Services

Rock samples were examined for macrofossils and trilobites and brachiopods were removed for identification. The remainder of the samples were cut or crushed into 1 cm pieces. All samples were weighed. 400 gm lots were dissolved in a 10 per cent glacial acetic acid solution. Residues were washed, wet sieved and dried. The resulting fractions were catalogued and mailed to Dr. Tom Uyeno in Calgary for heavy liquid separation and identification.

The following samples were processed.

Age	Nfld.	N.B.	Yukon	U.S.A.	Turkey
Devonian			1		
Silurian	10	1			3 (no age)
Ordovician	53	1		4	
Cambrian			3		
Total	63	2	4	4	3

Identification and classification of the remaining ostracods from 400 feet of core (sampled at 1-foot intervals) from the Hamilton Formation of Stoney Point, Ipperwash Provincial Park, Southwestern Ontario, was carried out. Most samples contain at least 100 specimens.

Paleopalynology Laboratory Services

One hundred and eighty samples were processed for recovery of miospores, megaspores, acritarchs, chitinozoa and miscellaneous palynomorphs. Approximately 1200 slides were prepared.

COMPLETED MANUSCRIPTS

(i) Internal

Copeland, M.J.

1973: Ostracoda from the Ellis Bay Formation (Ordovician), Anticosti Island, Quebec; Geol. Surv. Can., Paper 72-43.

1973: Geology of the National Capital Region - Géologie de la Région de la Capitale Nationale; Geol. Surv. Can., pamphlet.

1973: In Norford, B.S., et al. Biostratigraphic determinations of fossils from the subsurface of the Yukon Territory and the Districts of Franklin, Keewatin and Mackenzie; Geol. Surv. Can., Paper 72-38.

Dean, W.T.
in press: Ordovician trilobites from the Ogilvie Mountains, northwestern Yukon; Geol. Surv. Can., Bull.

Fritz, W.H.
1973: Cambrian biostratigraphy Mackenzie Mountains and Labrador; Geol. Surv. Can., Paper 31-1, Pt. A, p. 254-259.

in press: Medial Lower Cambrian trilobites from the Mackenzie Mountains, northwestern Canada; Geol. Surv. Can., Paper 73-24.

(ii) External

Copeland, M.J.
1973: Memorial to John Fletcher Caley (1903-1971); Geol. Soc. Amer.

in press: In Berdan, J.M. and Copeland, M.J. Ostracodes from Lower Devonian formations in Alaska and Yukon Territory; U.S. Geol. Surv., Prof. Paper 825.

Dean, W.T.
1972: In Williams. A., et al. Ordovician correlation tables for the British Isles; Geol. Soc. Lond., Spec. Rept. No. 3, p. 1-74.

1973: In Boucot, A.J., et al. Pre-late Middle Devonian biostratigraphy of the Eastern Klamath Belt, northern California; Geol. Soc. Amer., Abstracts.

in press: In Özgül, N., et al. Lower Paleozoic stratigraphy of the eastern Taurus Mountains in the Tufanbeyli region, southern Turkey; Bull. Geol. Soc. Turkey.

in press: The Lower Palaeozoic stratigraphy and faunas of the Taurus Mountains near Beysehir, Turkey. III. Trilobites of the Sobova Fm. (Ordovician); Bull. Brit. Mus. (Nat. Hist.), Geol., 24 (8).

McGregor, D.C.
1972: In Carroll, R.L., et al. Vertebrate paleontology of eastern Canada; Field Excursion A-59, 24th Internat. Geol. Congr., Guide Book, p. 1-113.

in press: Lower and Middle Devonian spores of eastern Gaspé, Canada. 1. Systematics; Palaeontographica, Abt. B.

in press: Early Devonian spores from central Ellesmere Island, Canadian Arctic; Can. J. Earth Sci.

APPALACHIAN, EASTERN LOWLANDS AND ATLANTIC MARGIN SECTION

W.H. Poole

This Section (now formally designated the Appalachian Section) is responsible for geological investigations of geosynclinal rocks in the Appalachian area (insular Newfoundland, Maritime Provinces and southern Quebec). Objectives of the Section (reduced from five to three geologists near year's end) are to define the composition of the rocks, their stratigraphy and structure; to determine their mode of origin and evolution; to provide information for the evaluation and implication of these features on the potential of mineral resources; and to publish the results in maps, reports and scientific papers.

Geological studies were mainly of a stratigraphic and structural nature, and varied from reconnaissance to detailed. Reconnaissance maps at scales of 1:250,000 or 1:125,000 have been completed in the region with the exception of three small areas in insular Newfoundland. The report and map of one such area, Bay of Islands map-area (12G), was completed by Prof. H. Williams under contract with Memorial University of Newfoundland and is now in press. Field work was conducted during 1972 by Prof. Williams under contract in another such area, Hare Bay klippe on Great Northern Peninsula and will be completed in 1973. The last area to be studied under the reconnaissance program will be southern Avalon; work is expected to start in 1974. Also, manuscripts are presently being prepared by L.M. Cumming and H.H. Bostock on Precambrian and Paleozoic rocks lying west of the Hare Bay klippe and on both sides of Strait of Belle Isle.

Field studies of a more detailed nature were carried out in Newfoundland. Compilation of mining company data, supplemented by field examination, was conducted by F.D. Anderson during 1972 in the central mineral belt southwest of Buchans mine.

Preparation of terminal reports and maps kept two geologists of the Section in the office: R. Skinner on three map-areas in New Brunswick's central mineral belt and D.G. Benson on Cape Breton Island and northern mainland Nova Scotia projects. In addition, Benson was appointed leader "at the last minute" of an International Geological Congress field trip through Nova Scotia and New Brunswick when the trip organization was foundering; he contributed to the guidebook, completed planning the trip and led the excursion.

With Professor John Rodgers of Yale University and contributions from many local experts, Poole prepared a guidebook and led two 13-day excursions dealing with Canadian Appalachian stratigraphy and structure for the 24th International Geological Congress.

A special report on the geology and other associated aspects of the new Gros Morne National Park, Newfoundland, was prepared by L.M. Cumming at the request of the National and Historic Parks Branch, Indian and Northern Affairs Department.

Advice and project evaluation were provided by W.H. Poole to mineral development programs in four eastern provinces funded in part by the Departments of Regional Economic Expansion and Energy, Mines and Resources. In addition he designed and checked the geological input to Project Appalachia, a geomathematical analysis of geology and mineral deposits to determine the mineral potential of the Canadian Appalachian region.

Throughtout the year, geologists of the Section were consulted by many geologists from the mining and petroleum industries regarding potential resources in Eastern Canada.

On March 31, 1973, personnel of the Section consisted of three geologists (L.M. Cumming, W.H. Poole and R. Skinner).

PERSONNEL CHANGES

On March 28, 1973, F.D. Anderson and D.G. Benson were assigned the positions of Staff Geologists, Economic Geology Subdivision and Correlations and Standards Subdivision, respectively.

ATTENDANCE AT MEETINGS

Penrose Conference, Geological Society of America, "Geology and Geophysics of Northern Appalachians", Amherst, Massachusetts, May 28-June 2, 1972
L.M. Cumming, W.H. Poole

24th International Geological Congress, Montreal, Quebec, August 21-30, 1972
F.D. Anderson, D.G. Benson, L.M. Cumming, W.H. Poole, R. Skinner

"Fortran for Field Geologists", course, Geological Survey of Canada
D.G. Benson, L.M. Cumming, R. Skinner

"Computing Science", course, Carleton University, Ottawa, Ontario, part time, January - April, 1973
D.G. Benson

Managerial Grid Course, Dept. of Energy, Mines and Resources, Cornwall, Ontario, February 4-9, 1973
F.D. Anderson

Prospectors and Developers Association, Annual Meeting, Toronto, Ontario, March 12-14, 1973
L.M. Cumming

Geological Society of America, Northeastern Section, Allentown, Pennsylvania, March 22-24, 1973
F.D. Anderson, W.H. Poole

Atlantic Provinces, several meetings to discuss federal-supported mineral development programs being carried out by provincial departments of mines.
W.H. Poole

SPECIAL TALKS AND LECTURES

Benson, D.G. - "Geology of Nova Scotia" - 24th International Geological Congress, field excursion A-57, Sackville, New Brunswick, August 13, 1972.

Cumming, L.M. - "Geology of Gros Morne National Park" - National Parks headquarters staff, Ottawa, December 11, 1972.

Poole, W.H. - "Geophysics and geology of Miramichi anticlinorium" - Penrose Conference, Geological Society of America, Amherst, Massachusetts, May 31, 1972.

- "Structural elements of Canadian Appalachian region" - 24th International Geological Congress, field excursions A63 and C63, St. John's, Newfoundland, August 7 and August 31, 1972.

- "Geology of Canadian Appalachian region" - Department of Geology, University of North Carolina, Chapel Hill, North Carolina, March 19 and 20, 1973.

MEMBERSHIP ON COMMITTEES

F.D. Anderson - Member, Management Board, Northeastern Section, Geological Society of America

D.G. Benson - Field Trip Leader, 24th International Geological Congress, excursion A-57

L.M. Cumming - Member, Executive Committee, and Chairman, Tours Committee, Canadian Institute of Mining and Metallurgy, Ottawa Branch

W.H. Poole
- Member, Advisory Committee for Cape Breton mineral resources development program
- Member, Subcommittee, Project 6 of Canada-Newfoundland Mineral Exploration and Evaluation program
- Associate Member, 24th International Geological Congress, Field Excursion Committee
- Field Trip Leader, 24th International Geological Congress, excursions A63 and C63

R. Skinner - Branch Representative, Departmental Field Equipment Committee

COMPLETED MANUSCRIPTS

(i) Internal

Anderson, F.D.
1973: Central mineral belt of Newfoundland; Geol. Surv. Can., Paper 73-1A, p. 2.

Cumming, L.M.
1973: Geology of the proposed Gros Morne National Park, western Newfoundland; Geol. Surv. Can., Paper 73-1A, p. 5-7.

Williams, Harold, Smith, W.R., and Stevens, R.K.
1973: Hare Bay allochthon, northern Newfoundland; Geol. Surv. Can., Paper 73-1A, p. 8-14.

(ii) External

Benson, D.G.
1972: Stop descriptions; in, Excursions A57 and C57, "Appalachian stratigraphy and structure of the Maritime Provinces" by Potter, R.R., Bingley, J.M. and Smith, J.C.; 24th International Geological Congress, Montreal, Quebec.

Poole, W.H.
1972: Excursions A63 and C63, Appalachian geotectonic elements of the Atlantic Provinces and southern Quebec; 24th International Geological Congress, Montreal, Quebec (with John Rodgers and contributions from others).

1972: Late Precambrian rocks of eastern Avalon Peninsula, Newfoundland - a volcanic island complex: Discussion; Can. J. Earth Sci., vol. 9, p. 1058, 1059 (with R.A. Frith).

RESOURCE GEOPHYSICS AND GEOCHEMISTRY DIVISION

A. G. Darnley, Chief

INTRODUCTION

The objectives of the Geological Survey as a whole are stated elsewhere in this report. The Resource Geophysics and Geochemistry Division contributes to these objectives by the provision of discipline oriented special services, and prepares for the future by research and development aimed at expanding the usefulness of these disciplines.

During 1972/73 the RGG division has made some progress towards the better integration of its own projects, and has endeavoured to better match provision of specialized data to the immediate requirements of other mapping divisions and outside agencies. Thus changes have been made in the scheduling of aeromagnetic survey areas, in order to have completion prior to completion of reconnaissance mapping, and considerable attention has been focussed upon the problems of detecting the presence and distribution of permafrost. Shared cost surveys (which began with the Federal-Provincial Aeromagnetic Program in 1962) included in 1972 a refraction seismic survey across the Sverdrup Basin, for which 75 percent of the costs were paid by industry; two experimental high-sensitivity aeromagnetic surveys in the Kirkland Lake and Bathurst areas, shared with the Provinces of Ontario and New Brunswick respectively; and a series of airborne gamma spectrometer flights to measure snow-water depth, sponsored by DOE and sundry Ontario agencies.

The major in-house project during 1972 was the Bear-Slave regional geochemical reconnaissance by lake sediment sampling. This covered an area of 36,000 square miles. Completion of the project, including all analytical work and the publication of the principal maps within a period of 10 months proves that rapid results are not the prerogative of industry. Final appraisal of this project as to its ultimate cost-effectiveness will unfortunately not be possible for several years until the significance of the observed trace-element distribution patterns are investigated in detail. Fifty percent of the area of the geochemical survey (plus an extra 7000 square miles to the south) was covered by airborne gamma spectrometry in order to compare the data produced by two completely different methods of measurement. The results for uranium show good agreement at this reconnaissance level. At the sample spacings used costs for the two methods are approximately equal: the lake sediment sampling is manpower intensive, employing at every stage (field and laboratory) more than 3 times the number of personnal required by the equipment intensive airborne method. It may be noted that release of the airborne gamma spectrometry results on Open File in April 1973 resulted in the staking of 200 claims. Staking from the lake sediment surveys is expected to follow when industry has had an opportunity to look for the sources of the sediment.

Early in 1973 there was considerable staking in the Mont Laurier area of Quebec resulting from the release of the 1971 shared-cost airborne spectrometry survey. Interest was also aroused by two chance but possibly significant discoveries of uranium mineralization in Palaeozoic calcareous sandstone just west of Ottawa, and in specimen material from the old Richardson Mine, Eldorado, Ontario.

In the realm of research, the main achievements in 1972/73 have been in the growth of understanding of the complex parameters which control the electrical properties of rocks and minerals. For a long time EM field techniques have existed in the absence of any very satisfactory or comprehensive theories. There is still a very long way to go, but progress is now being made.

Slowly and painstakingly progress has also been made on the automated compilation of high sensitivity aeromagnetic maps. A bottle neck has existed in this technique for in excess of 2 years, but problems have now been overcome and at the end of the period under review the first batch of maps (relating to the Abitibi area surveyed in 1971) were at the printers, and the Timmins area maps (almost issued, and then withdrawn in 1971) were ready for the printers. As with any involved computer based techniques many seemingly trivial problems and inconsistencies in data, which can be readily recognized and adjusted or eliminated by a human compilar, require elaborate programming before they can be automatically digested. The final cost of automation is thus far beyond initial expectations, especially in programming and "debugging" time, but the ultimate reward is in greatly increased flexibility of data handling and mode of presentation. This background to automation was plainly apparent to the 32 participants at the Workshop on Geophysical Data Reduction organized by the Division in April 1972.

In the past geophysical and geochemical data have commonly been supplied to the geoscience community as separate and independent commodities. Their utilization has been left to the chance interests, knowledge (and prejudices) of geologists or exploration personnel. The extent, effectiveness and rapidity with which these specialized data have been used has therefore been largely fortuitous and uncontrolled by the suppliers of the data. In this situation each segment of population of geoscience specialists has tried to push its own methodology to the limit and has taken only a very limited interest in neighbouring developments. Although this has certainly advanced the frontiers of individual facets of science, it has weakened the effectiveness of overall effort in terms of specific applications. Looking to the future, it would appear inevitable that outside of universities, where fundamental basic research is being performed, organizations concerned with applied science will tend to become increasingly mission-oriented with multi-disciplinary teams of specialists organized around a particular problem or group of problems. However, it is important to recognize that a multi-disciplinary approach will only avoid mediocrity if mission-oriented teams are large enough to contain viable groups of specialists, with support staff, so that professional isolation is avoided. Since at

the present time individual specialists are commonly divided between several missions, and each mission really requires total involvement, an organization structure based on mission can only be fully effective when the numbers of specialists are sufficient to meet the demand.

It is always difficult (and risky) to forecast the technical developments of even the immediate future. As far as airborne surveys are concerned, the trend is likely to be towards saturation coverage with multi-sensor surveys. Undoubtedly sub-surface exploration will loom increasingly important; for this much hinges on the development of cheaper drilling technology. Sub-surface reconnaissance as distinct from logging is becoming a more urgent requirement. Electrical methods provide one obvious route, but as a complement possibly the major application of the trace gas geochemistry will be to subsurface rather than atmospheric air. It has been recognized for some time that real-time techniques of geochemical analysis will have considerable importance when the portability/sensitivity problem can be overcome. These would particularly relate to the problem of finding low grade disseminated deposits in the Shield environment. For the purpose of standardizing and comparing results, it is highly desirable that as much geoscience data as possible be expressed in suitable absolute units, with known limits of uncertainty. For some purposes relative measurements are useful and may be unavoidable, but even these should relate to specified standards.

As far as working in government is concerned, a major factor is going to be the "make or buy" policy. Basic and much applied research is, can, and will be done in universities and associated research institutions. Routine work can and will be done increasingly by industrial contractors. The work area where it seems essential that government retains control is in the experimental application and evaluation of geoscience techniques, in the establishing and maintenance of control standards and quality specifications, in the inspection of routine work, and in the supervision of overall correlation. As long as an organized technically based society wishes to develop its natural resources efficiently, it is impossible to consider these geoscience necessities not being directly undertaken by a central government agency.

Meetings attended by A. G. Darnley

Workshop on Uranium Exploration, I.A.E.A. Vienna, April 1972 (presented paper).

Exploration Geochemistry Symposium, London, U.K., April 1972.

International Geological Congress, Montreal, August 1972 (presented paper).

Seminar on Mineral Exploration, Rio de Janeiro, Brazil (presented paper).

GSC-CIDA Mission to Brazil (Goias Project) Nov. 1972.

Prospectors & Developers Convention, Toronto, March 1973.

Membership on Committees - A. G. Darnley

EMR-CIDA Liaison Sub-Committee

CCRS - Geoscience Working Group

Outside Talks

Dept. of Geology, Queen's University, March 22, 1973
Subject: Geophysics, Geochemistry & Quantitative Geology

CONTRACT SURVEYS SECTION

A. Larochelle

The activity of this section is focussed on the acquisition and diffusion of conventional aeromagnetic data. More specifically, this function includes supervision and monitoring of contracts let to private firms for the flying and compilation of the related aeromagnetic surveys. These responsibilities are extended to similar contracts funded by other Canadian Government agencies, at their request. The section is also responsible for storing and retrieving the original survey recordings and to provide base maps to the contractors. Finally the compilation of the magnetic anomaly map of Canada and other similar documents related to the aeromagnetic survey programs of the Geological Survey is carried out by the section.

Within the scope of the Federal-Provincial Aeromagnetic Surveys program two contracts (B.C.-Lockwood and Northern Baffin) were completed during the fiscal year and another one (Quebec, Ungava Peninsula) was initiated. Progress in the other component surveys of the program during the same period is summarized in the following table:

Survey Area	Miles Flown 1972-73	Map Sheets Published 1972-73	% State of Completion Flying	Maps
B.C. (Lockwood)	4,615	8	100	100
B.C. (Geoterrex)	17,400	21	100	23
Keewatin	71,114	139	63	41
Labrador-Melville	39,885	0	32	9
Northern Baffin	0	36	100	100
Northern Quebec	43,237	57	95	69
Quebec (Ungava Peninsula)	2,000	-	-	-

The supervision of aeromagnetic/radiometric airborne surveys in Niger, Cameroon, Upper Volta and Guyana continued during the fiscal year. Each of these contracts is scheduled for completion early in the 1973-74 fiscal year. Another contract for an airborne survey in Ivory Coast was scheduled to start in November 1972 but it had to be postponed one year on account of administrative delays. In-flight digitized data obtained during a conventional aeromagnetic survey in Upper Volta were successfully compiled entirely by computer methods. The acceptance of the first maps produced by this technique helped setting up standards for future surveys of this type.

The second edition of the anomaly map of Canada was published during the summer of 1972. Although this provides an impressive up-to-date synthesis of the G.S.C. aeromagnetic coverage, it has been realized that the credibility of this map could be improved by the flying of tie lines between individual surveys flown at different times and with different equipment over the years. Planning for this work has been initiated.

Attendance at Meetings

E. E. Ready - attended the Prospectors and Developers meeting in Toronto in March 1973.

ELECTRICAL METHODS SECTION

L. S. Collett

The activities of the section or any other component must fall within the stated Departmental and GSC Branch objectives of the Science and Technology Sector. For us the relevant objective is "To facilitate the discovery and identification of the mineral and energy resources of Canada" and the relevant activities are:

- Characterization of geological, geomorphological and geotechnical properties of surface and near-surface materials ..... and
- Provision of scientific standards and controls, experimental study of processes, development of instruments, methods and systems for identification, surveys, data recording, compilation, interpretation and transfer,

through the sub-activities of:

- studying the physical properties of surface and near-surface rock and earth materials ..... and
- the development and provision of new and improved methods and instruments in support of scientific activities.

Having noted this, the leadership of the section has rather a broad mandate to fulfil. Selection of mission-oriented projects then is left to the section to choose wisely based on the cumulative experience of the human resources available through repeated contacts with management, industry and universities. Through a judicial selection of projects, experience and know-how is maintained in the section and promulgated through publications.

The work of the section does not fall in the "Big Science" league where team work is stressed, yet team effort and integration between projects are paramount. Projects that have been selected fall in the prime area of electrical methods pertaining to mineral exploration, geological mapping and engineering problems. Innovation, or adaption of old methods to new problems, is an important component of each project which in some cases results in an invention. This section works closely with industry through experimental survey contracts and the development of new geophysical instrumentation. More basic research of the section is the project on the electrical characteristics of rocks and minerals. This information is very essential to the development of new geophysical techniques and already new instrumentation is being developed in the field of induced polarization as a result.

The present priorities of the section are:

- Assessment of airborne electromagnetic systems over a wide frequency range,
- ground checking using VLF and higher frequencies,
- electrical characteristics of rocks and minerals, and
- applied theoretical EM problems pertaining to projects in hand and guiding direction for future projects.

Research Highlights

INPUT Surveys (A. V. Dyck)

A theoretical interpretation has been completed for the homogeneous ground and two-layer case for a minimum-coupled coil system (vertical axis transmitter and receiver). For the homogeneous case, amplitude vs decay time curves have been calculated for conductivities varying from 0.01 to 5.0 mho/m. For the two-layer case, a similar set of curves have been calculated for quantitatively determining thickness and conductivity of a highly conducting overburden layer. A paper on "Surficial conductivity mapping with the airborne INPUT system" by Dyck, Becker and Collett has been submitted to CIM Bull.

VLF Method (W. J. Scott)

Airborne Radiophase and E-Phase surveys were conducted in co-operation with the province of New Brunswick in the Caledonian Mountain area. Ground follow-up work was carried out on selected sites in New Brunswick to check the airborne anomalies. Further ground work was extended in the Cobequid Complex region in Nova Scotia. Good agreement was obtained between integrated ground surveys (mag, resistivity and Radiohm) and known geology. A contract to Barringer Research Ltd. to construct ground E-Phase equipment was awarded during the year. Experimental surveys are being extended into the permafrost areas in the Mackenzie valley.

Airborne Resistivity Electromagnetic System (A. Becker and A. K. Sinha)

The feasibility of a variable frequency EM system has been further substantiated by extensive theoretical studies and computer modelling work. The undesirable effects of a limited conductivity aperture of fixed frequency conventional systems may be overcome with the introduction of this new concept of a device for automatically changing the transmitter frequency in concert with the ground conductivity. The phase of the secondary field appears to be a suitable criterion for operating the decision-making equipment. When this quantity is maintained constant, the operating frequency is directly proportional to the ground resistivity. Field testing of this method using a system with fixed multi-frequencies is in progress by contract with Scintrex Ltd. A paper entitled "A proposal for a new method of airborne electromagnetic mapping" was presented at the 42nd Annual International Meeting of the Society of Exploration Geophysicists, Anaheim, California, Novamber 28, 1972.

Natural Field Extremely Low Frequency System (R. H. Ahrens)

A 3-component orthogonal coil system has been constructed and field tested for detecting 8 Hz Schumann resonance ELF signals. The equipment has the capability of recording amplitude of the three magnetic components and phase of the two horizontal components with respect to the vertical component. With these five parameters, the spatial configuration of total wave can be constructed. A test profile was made over the fault running along the edge of the Gatineau Hills at Church Hilltop, near Luskville, Quebec. A pronounced increase in the vertical magnetic field component was experienced over the fault. Also the averaged phase readings between the vertical and the two horizontal components showed a remarkable change in traversing the fault. The tilt angle of the normal of the elliptically polarized magnetic field indicated a minimum in the region of the fault. A more portable unit is presently being constructed with the capability of magnetic tape recording. By reconstructing the total spatial characteristic of the natural EM field, it will be possible to make a better geological interpretation than with the AFMAG dip-angle data. Further investigations are in progress.

Theoretical EM Problems (A. K. Sinha)

An assessment of five airborne dipole-dipole coil arrangements has been quantitatively assessed for use in EM mapping of stratified media. The complete solution of the electromagnetic response of an arbitrarily stratified earth excited by harmonic magnetic dipoles has been obtained during the year. The generalized computer program which is included in one paper recently submitted to GSC for publication (Sinha and Collett) will be immensely useful to anyone involved with the interpretation of airborne e.m. mapping data. It is probably for the first time that a computer program like this has been published in the literature.

A theoretical assessment has been made on four basic coil configurations used in airborne surveys. For the first time, the advantages and the disadvantages of the four systems for mapping purposes has been outlined clearly. The advantages of recording the polarization parameters of an elliptically polarized field over the system of recording the mutual impedance ratios have been indicated for multi-frequency surveys. The usefulness of the currently available airborne systems for mapping purposes is being evaluated now with a view to grading them for their use in airborne mapping surveys.

Electrical Rock Properties (T. J. Katsube)

Measurements of the electrical characteristics on a suite of moist and dry igneous rocks has been carried out over the frequency range from 10^{-2} to 2×10^{8} Hz. Studies have also been made on the IP effects of rocks and sulphide minerals from 10^{-2} to 10^{5} Hz. The purpose of these investigations is to understand the conduction mechanisms in rocks in order to improve on the present measuring techniques for the detection of economic minerals in mineral exploration. The higher frequency data will help to evaluate the applicability of whether radar techniques are useful for exploration geophysics. Electrical non-linear characteristics of rocks and minerals are also being studied. This phenomena might be applicable in borehole geophysics. Over the past year measurements have been made on 5 lunar samples from Apollo 14 and 8 from Apollo 16 flights. Three papers were published in Geophysics, one paper presented at the SEG, Anaheim, California, November 29, 1972 and two papers presented at the 4th Lunar Science Conference, Houston, Texas, March 5-8, 1973.

Drilling Geophysical Test Range, Cavendish Tp. (W.J. Scott & A.V. Dyck)

Through the winter works program (1972-73), two Winkie drills have been used for putting down 100 ft. holes at an angle of 45^{o} to determine the geology of this geophysical test range. The work will end on May 31, 1973, and a report on the geology and conductors will be published soon thereafter.

Achievements

1. L. S. Collett is advisor to Department of Regional Economic Expansion (N.B., N.S., Quebec and Newfoundland) and to Department of Industry, Trade and Commerce (PAIT programs).

2. We have provided leadership in the use of natural EM fields as a geological mapping method and it has spear-headed work in multi-frequency use as a prospecting tool.

3. Variable frequency EM system (patent by A. Becker) has spurred industry to develop multiple frequency EM systems (e.g. Scintrex Tridem System).

4. We have also provided leadership in the usefulness of phase measurements for field IP surveys. Two companies are planning this option in their IP instruments.

5. A patent, Radiohm, has been licensed by Geonics Ltd. and a prototype has been built and tested. Geologists are finding this device, Geonics EM-16R, a useful tool to aid in geological mapping.

6. The Electrical Rock Property laboratory has been recognized as one of the four best laboratories on the North American continent. We have helped to set up the laboratory at the University of Utah, Salt Lake City (Dr. S. H. Ward's group). As a result of some of the studies, industry is thinking about producing multiple frequency IP systems and radar-sounding methods are beginning to look promising.

7. A good start has been made on two-layer theoretical and scale model interpretation of INPUT data.

8. A theoretical assessment has been made on 5 basic coil configurations for airborne use. For the first time, we have shown the advantages of each system for multi-layered earth.

9. We have proven the usefulness of ground and airborne VLF methods for aiding geological mapping.

10. The complex geology of the geophysical test range in Cavendish Tp. Ontario, will soon be published. This test range is used by many geophysical companies on the continent to test their various instruments and new prototypes.

Future Plans

The projects that are presently being considered for the section, some in the near-term and others for long-term, are listed as follows:

1. Borehole logging.
2. Permafrost and engineering geophysics (including seismic and borehole methods).
3. Resistivity map of Canada.
4. Handbook of resistivity of Canadian rocks.
5. Techniques to separate Cu-rich from Fe-rich sulphides and graphite, electrical properties of coal, serpentinites and frozen soils resistivities ($-10^{o}C$ to $+10^{o}C$) and polarization effects of sulphides in permafrost.
6. Development of EM system for reconnaissance purposes and thickness of overburden.
7. Comparison tests of airborne EM systems over known conductors.
8. Radar and high frequency techniques (up to 15 m. penetration) for engineering purposes, especially for ground ice detection.
9. Geophysical methods for detecting geothermal sources.
10. Marine electrical survey methods.

Personnel Notes

Dr. A. Becker - Resigned from GSC April 1, 1972. Retained as consultant for 15 weeks commencing July 3, 1972 (Project #680089 - Airborne resistivity electromagnetic system).

D. C. Butterfield - Awarded Certificate II, Senior Engineering Technician, Algonquin College, May 1972

- Awarded Certificate III, Engineering Technologist, Algonquin College, September 1972.

L. S. Collett - Principal Investigator, NASA, for one year period commencing February 1, 1973 to measure electrical properties of lunar rocks returned by Apollo 15, 16 and 17.

C. Gauvreau - Awarded Certificate II, Senior Engineering Technician, Algonquin College, June 1972.

Dr. T. J. Katsube - Co-Investigator, NASA, for one period commencing February 1, 1973 to measure electrical properties of lunar rocks returned by Apollo 15, 16 and 17.

- Awarded "Certificate of Achievement" for successful completion of laboratory seminar on "Resistivity, Insulation Resistance and Dielectric Absorption" Rutherford Research Inc., Rutherford, New Jersey, U.S.A. September 15, 1972.

Dr. W. J. Scott - Best Presentation Award, Society of Exploration Geophysicists in Mining Session for paper titled "IP field phase measurements" delivered in Houston, Texas, November 1971, and presented in Anaheim, California, November 1972.

- Awarded Ph.D. degree, Department of Mining Engineering and Applied Geophysics, McGill University, April 1972.

Attendance at Meetings, Conferences & Courses

R. H. Ahrens - attended course on Elements of English Grammar (1 day)

D. C. Butterfield - attended and successfully passed courses Math II A (Calculus) Math IV A (Advanced Calculus), Math V A (Differential Equations) and Communications I at Algonquin College during the year.

- course on Control Language, Oct. 17-19, 1972
- course on Calcomp 763 Plotter, Nov. 20 & 22, 1972
- course on Introductory Fortran, Nov. 27-Dec. 7, 1972.

L. S. Collett - attended Canadian Institute of Mining and Metallurgy Annual Meeting, Ottawa, Ontario, April 9-12, 1972: co-author of paper with A. V. Dyck and A. Becker.

- attended meetings under PAIT (Program for the Advancement of Industrial Technology), Department of Industry, Trade and Commerce, Scintrex Ltd., Toronto, May 17 and October 20, 1972.
- meetings at U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, N.H. Oct. 3, 1972 and Geophysical Survey Systems Inc., North Billerica, Mass. Oct. 4, 1972.
- meetings of Ad Hoc Committee on Geological Technology Program, Sir Sandford Fleming College, Lindsay, Ont. Oct. 17 and Nov. 23, 1972.

- 42nd Annual International Meeting of Society of Exploration Geophysicists, Anaheim, California, November 26 - December 1, 1972: co-authored paper presented by T. J. Katsube.
- attended meeting of Canadian Exploration Geophysical Society, Toronto, January 16, 1973.
- attended meeting of Ad Hoc Committee on Devco Mineral Assessment Program, Sydney, N.S. Jan. 19, 1973.
- attended 7 meetings (4 in Quebec City) on DREE programs in northwest Quebec and Gaspe.
- attended Prospectors and Developers Association Annual Meeting, Toronto, March 11-14, 1973.

A. V. Dyck
- attended Canadian Institute of Mining and Metallurgy Annual Meeting, Ottawa, Ontario, April 9-12, 1972: presented paper with A. Becker and L. S. Collett.
- attended Workshop on Data Handling Techniques by Computer, Ottawa, April 25-27, 1972.
- attended courses on Emphasis Curve and Standard Gamble, Ottawa, November 22, 1972.

J. Frechette
- attended and successfully passed course on Math M I (Introductory Calculus) Algonquin College, Dec. 1972.

C. Gauvreau
- attended and successfully passed courses on Math IV A (Advanced Calculus), Math MV C (Numerical Methods), Mini-computer PDP 8 and Pulse Circuits, Algonquin College during the year.
- attended courses on Control Language, October 17-19, 1972; PERT, Dec. 11, 1972; Databank and Massager, Dec. 15, 1972.
- attended Minicomputer Course given by Datagen of Canada Ltd., Hull, Quebec, January 22-26, 1973.

Dr. T. J. Katsube
- attended laboratory seminar on Resistivity, Insulation Resistance and Dielectric Absorption given by Rutherford Research, Rutherford, New Jersey, September 11-15, 1972.
- meetings at U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, N.H. Oct 3, 1972; and Geophysical Survey Systems Inc., North Billerica, Mass. Oct. 4, 1972.

- attended courses on Decision Analysis, Nov. 14, 1972; Standard Gamble, Nov. 22, 1972; and PERT, Dec. 11, 1972.
- attended 42nd Annual International Meeting of Society of Exploration Geophysicists, Anaheim, California, Nov. 26 - Dec. 1, 1972; presented paper co-authored with L. S. Collett.
- attended meeting of Canadian Society of Exploration Geophysicists, Toronto, Jan. 16, 1973; presented same paper that was given at Soc. of Exploration Geophysicists, Anaheim, California, by request of the president.
- attended Fourth Lunar Science Conference, Houston, Texas, March 4-8, 1973 and presented 2 papers: visited Dr. R. R. Unterberger, Texas A & M University, College Station, Texas, Dr. John C. Cook, Teledyne Co., Garland, Texas, and Dr. R. Blanck, Rutherford Research, Rutherford, N.J.

M. E. McAllister
- attended course on Control Language, Oct. 17-19, 1972.

Dr. W. J. Scott
- attended Canadian Institute of Mining and Metallurgy Annual Meeting, Ottawa, Ontario, April 9-12, 1972; presented paper with co-author, Dr. D. C. Fraser.
- defended Ph.D. Thesis, McGill University, April 18, 1972.
- attended courses on Decision Analysis, Nov. 15, 1972, Causal Analysis, Nov. 16-17, 1972, and on Emphasis Curve and Standard Gamble, Nov. 22, 1972.
- attended 42nd Annual International Meeting of Society of Exploration Geophysicists, Anaheim, California, Nov. 26-Dec. 1, 1972; received Best Presentation Award in Mining Session.
- attended courses in French at Berlitz, Fall and Winter, 1972-73.

Dr. A. K. Sinha
- attended courses in Causal Analysis, Nov. 16-17, 1972, and Emphasis Curve and Standard Gamble, Nov. 22, 1972.
- attended 42nd Annual International Meeting of Society of Exploration Geophysicists, Anaheim, California, Nov. 26-Dec. 1, 1972; co-author of paper presented by Dr. A. Becker.

Membership on Committees

L. S. Collett
- Member, Associate Committee on Geodesy and Geophysics, National Research Council.
- Member, Advisory Committee on Devco Mineral Assessment Program, Nova Scotia.
- Member, Ad Hoc Committee on Geological Technology Program, Sir Sandford Fleming College, Lindsay, Ont.
- Member, Departmental Committee Study of Mineral Resources Relative to Canadian National and Regional Economics.
- Member, Classification Evaluation Committee, Technical Category, GSC.

Dr. T. J. Katsube
- Member of Committee of American Society for Testing Materials (ASTM) Section D-9 (Electrical Insulating Materials) Philadelphia, Pa.

Dr. W. J. Scott
- Member, Working Group on Computer-based Storage, Retrieval and Compilation of Geologic Field Data (Project #710098).
- Secretary, Subcommittee on Exploration Geophysics, Associate Committee on Geodesy and Geophysics, National Research Council, October 1972.

Special Talks or Lectures

Dr. W. J. Scott
- lectured at Department of Geological Engineering, Ecole Polytechnique, Montreal, Quebec, on "Electrical and EM Methods" on Fridays from January 12 - February 16, 1973 (18 hrs) in French.

Related Projects

L. S. Collett
- Critically reviewed during the year 11 papers for outside journals, etc:

Can. Geotech. Jour.	1
Geophysics	3
Director, GSC Paper	1
CIM Bull.	2
Earth & Planetary Sci. Letters	1
Geochemica et Cosmochemica Acta	1
Can. J. Earth Science	1
Electronics	1
Total	11

Completed Manuscripts

Papers published during the year 1972-73

Becker, A., Gauvreau, C., and Collett, L. S. 1972
Scale model study of time domain electromagnetic response of tabular conductors; CIM Bull., v. 65, no. 725, p. 90-96.

Becker, A., and Sinha, A. K., 1972
Airborne resistivity electromagnetic system: Geol. Surv. Can. Paper 72-1B, p. 41-42.

Becker, A. and Sinha, A. K., 1973
Airborne resistivity electromagnetic system: Geol. Surv. Can. Paper 73-1A, p. 67.

Collett, L. S., and Katsube, T. J., 1973
Electrical parameters of rocks in developing geophysical techniques: Geophysics, v. 38, no. 1, p. 76-91.

Katsube, T. J., 1973
Electrical rock properties: Geol.Surv. Can., Paper 73-1A, p. 87-88.

Katsube, T. J., and Collett, L. S., 1972
Electrical rock properties: Geol. Surv. Can., Paper 72-1A, p. 52 and 72-1B, p. 47-48.

Katsube, T. J. and Collett, L. S., 1973
Measuring techniques for rocks with high permittivity and high loss: Geophysics, v. 38, no. 1, p. 95-105.

Katsube, T. J., Ahrens, R. H. and Collett, L. S., 1973
Electrical non-linear phenomena in rocks: Geophysics, v. 38, no. 1, p. 106-124.

Scott, W. J., 1972
Phase-angle measurements in the induced polarization method of geophysical prospecting: Ph.D. Thesis, Dept. of Mining Engineering and Applied Geophysics, McGill University, Montreal, 288 p.

Scott, W. J., 1972
VLF mapping: Geol. Surv. Can., Paper 72-1A, p. 60.

Scott, W. J., 1973
VLF mapping: Geol. Surv. Can., Paper 73-1A, p. 97.

Slankis, J. A., Telford, W. M. and Becker, A., 1972
8-Hz telluric and magnetotelluric prospecting: Geophysics, v. 37, no. 5, p. 862-878.

Papers submitted for publication in 1973

Dyck, A. V., Becker, A. and Collett, L. S.
Surficial conductivity mapping with the airborne INPUT system: submitted to CIM Bull. for publication.

Scott, W. J., Telford, W. M. and Collett, L. S.
IP field phase measurements: Accepted for publication in Geophysics, v. 38.

Scott, W. J., and Fraser, D. C.
Drilling of EM anomalies caused by overburden: Accepted by CIM Bull., Sept. 27, 1972.

Sinha, A. K.
Comparison of airborne EM coil systems placed over a multilayer conducting earth: Accepted for publication in Geophysics, v. 38.

Sinha, Ajit K., and Collett, L. S.
Electromagnetic fields of oscillating magnetic dipoles placed over a multilayer conducting earth: Geol. Surv. Can., Paper submitted to Division Chief, RGG, Jan. 15, 1973.

Papers presented at Conferences during 1972-73 but not yet published

Becker, A., and Sinha, A. K.
A proposal for a new method of airborne electromagnetic mapping: Presented at 42nd Annual International Meeting of Soc. of Exploration Geophysicists, Anaheim, California, Nov. 28, 1972.

Katsube, T. J., and Collett, L. S.
Electrical and EM propagation characteristics of igneous rocks: Presented at 42nd Annual International Meeting of Society of Exploration Geophysicists, Anaheim, California, Nov. 29, 1972, and at KEGS, Toronto, Ontario, Jan. 16, 1973.

Katsube, T. J., and Collett, L. S.
Electrical characteristics of Apollo 16 Lunar Samples: presented at 4th Lunar Science Conference, Houston, Texas, March 5-8, 1973.

Katsube, T. J., and Collett, L. S.
Electrical characteristics of rocks and their application to planetary and terrestrial EM-sounding: presented at 4th Lunar Science Conference, Houston, Texas, March 5-8, 1973.

Internal Reports to be incorporated in future papers

Ahrens, R. H., 1972
Discussion on wave structure measurements with a 3-coil system: submitted to Section Head, 6 p., January.

Ahrens, R. H., 1972
Search for utilization of 8-Hz signal of the lower mode of the Schumann resonance spectrum in geological surveys; submitted to Section Head, 17 p., March.

Ahrens, R. H., 1972
Some remarks on the spectral representation of the natural fields by A. Koziar: submitted to Section Head, October.

Scott, W. J., 1972
A preliminary geophysical survey in support of geological mapping in the Cobequid Complex, Nova Scotia: submitted to Division Chief, RGG, September 27, 1972.

Scott, W. J., and Gauvreau, C., 1972
A variable low frequency sinusoidal power source for earth resistivity measurements: submitted to Section Head.

SEISMIC SECTION

G. D. Hobson

This section is responsible for seismic research directed towards problems in shallow seismic for engineering purposes, conventional refraction-reflection methods, and marine seismic surveys.

Activities

Much of the effort of the section in 1972 was directed towards the Sverdrup Basin project under the leadership of G. D. Hobson. Six oil companies participated with the GSC in a co-operative program with the GSC as operator, involving reconnaissance refraction profiling of the sedimentary section along a survey line between Melville Island and Amund Rignes Island. Helicopter-borne operations were successfully carried out under Arctic springtime conditions during the months of April and May. In addition, a series of large explosions (2000 lb. each) were detonated at intervals along the seismic line in support of crustal seismic surveys conducted by the Earth Physics Branch. Record interpretation and analysis of the data was carried out by A. Overton assisted

by H. A. MacAulay and R. M. Gagne. Final reports to participants were completed on schedule by December 1, 1972. Plans were drawn up for continued surveying in 1973 to extend the existing line of profiles and to obtain data in additional areas.

Shallow seismic research under the direction of J. A. Hunter assisted by R. A. Burns was mainly concentrated in the Mackenzie River Valley and delta areas for the investigation of the seismic properties of earth materials in the permafrost environment. Experiments were successfully conducted into the detection of permafrost in the discontinuous zone, the correlation of seismic velocities with frozen materials and the detection of massive ice lensing at depth. Marine refraction profiling was conducted in the Mackenzie delta and Beaufort Sea to map the occurrence of sub-sea bottom permafrost. Further research is planned for 1973.

Shallow seismic surveying in Nova Scotia and New Brunswick was conducted in cooperation with the Electrical Methods Section to provide overburden thicknesses for correction of ground and airborne electromagnetic surveying. Over 15 line miles of continuous reversed profiling was completed.

In future, the aims of the section will continue to be directed towards operation, development, and assessment of a broad spectrum of seismic methods as an aid to the interpretation of geology in Canada. The application of seismic methods to geological mapping in the Canadian shield will be continued. Marine refraction-reflection techniques for use in the Great Lakes and Beaufort Sea will be developed. Research into seismic techniques for engineering studies in permafrost areas will continue to occupy a large proportion of the section's time.

Personnel Notes

G. D. Hobson continued as acting co-ordinator of the Polar Continental Shelf Project. In his absence the section head duties were shared by A. Overton and J. A. Hunter. G. D. Hobson was the special representative for CIDA to the Geological Survey of Guyana during August 1972 regarding seismic work.

Mrs. Ann McKinnon left the GSC in September 1972.

Attendance at Meetings, Courses

G. D. Hobson	- attended Society of Exploration Geophysicists meeting Anaheim, California, November 1972.
A. Overton	- attended Phase One Managerial Grid Course, March 1973.
J. A. Hunter	- Attended colloquium on Permafrost sponsored by the Permafrost Subcommittee NRC Associate Committee on Geotechnical Research, Saskatoon, May 1972.

- Attended Society of Exploration Geophysicists Annual Meeting, Anaheim, California, November 1972.

R. M. Gagne - Attended several computer programming courses given by the Department's Computer Centre.

Memberships on Committees

G. D. Hobson - Subcommittee on Exploration Geophysics of the Associate Committee on Geodesy and Geophysics, National Research Council.

J. A. Hunter - Subcommittee on Seismology and Physics of the Earth's Interior, of the Associate Committee on Geodesy and Geophysics, N.R.C.

Outside Papers

Overton, A. "Crustal Seismic Measurements Over the Appalachian Front from Shots in Labrador and Quebec". Can. Jour. Earth Sci. (Submitted July 1972)

"A Seismic Investigation of the Crust and Moho on a Line Perpendicular to the Grenville Front (A Discussion)". Can. Jour. Earth Sci.

MacAulay, H. A. "A Total Time Approach for Estimating Depth to Bedrock in Glaciated Mountain Valleys". Can. Jour. Earth Science in press.

Hunter, J. A. and G. D. Hobson
"Reflections on Shallow Seismic Refraction REcords" (Abstract), 42nd Annual Meeting of the Society of Exploration Geophysicists, Anaheim, California, November 1972.

DIGITAL COMPILATION SECTION

M. T. Holroyd

This year has seen the culmination of four years work as aeromagnetic contour maps ready for publication began to emerge from the Digital Aeromagnetic Data Automatic Processing System. Using the Departmental CDC computer, contour maps of the Timmins, Abitibi, Baraute and Jellicoe-Geraldton high resolution aeromagnetic surveys have been produced by automatic methods. Beginning with raw total field measurement and digitized flight path data, the sequence of editing, sorting, conversion to map projection coordinates, levelling, gridding and contouring has been executed by the computer with human intervention limited to submitting the various programs and the application of judgments as to the validity of questionable data when its presence was indicated by a program.

Documentation of the system is in progress and the system description and relevant programs will be published this fall.

Work will continue in the direction of the creation of a digital aeromagnetic data bank, and retrieval and processing systems to allow "one off" production of maps of any part of any region within the bank to be produced with open choice of scale, contour, interval, etc. with overnight turn around. Further facilities will allow the production of processed maps, i.e. derivative maps, filtered maps etc. on demand.

Personnel Notes

Mr. I. Butt joined the section as a programmer on a permanent basis after initial participation as a winter works employee.

Attendance at Meetings, Conferences and Courses

In January, Mr. M. T. Holroyd attended a two-day course on Data Processing by optical diffraction analysis at the University of Wisconsin extension department in Milwaukee and Mr. R. J. Langlois attended a one-week course in programming the Interdata Mini Computer held by the Interdata Company in Atlantic City, New Jersey.

MAGNETIC METHODS SECTION

P. J. Hood

This section is responsible for developing new magnetic survey instrumentation and techniques, conducting and interpreting special aeromagnetic surveys over land and sea; devising new techniques for the treatment and interpretation of aeromagnetic survey data, and demonstrating the usefulness of magnetic survey data in geological mapping.

Activities

P. J. Hood with M. E. Bower continued the cooperative ocean aeromagnetic project with the National Aeronautical Establishment. A low-level aeromagnetic survey was carried out in the Davis Strait area during June 1972 using NAE's North Star aircraft which is equipped with a cesium magnetometer. Inclement weather terminated the operation which was intended to throw light on the areal extent of the extensive offshore basalt formations, and also to evaluate a computerized electronic navigation system. However, six of the 13 lines planned were flown between Baffin Island and West Greenland resulting in the acquisition of approximately 2300 line miles of digital survey data. Interpretation of data from earlier surveys carried out under this project has indicated that the thicknesses of sedimentary rocks on the continental slopes and rises bordering the Labrador Sea and Baffin Bay exceed 20,000 feet over wide areas. On the Labrador Shelf, the sediments extend all the way along the outer part of the continental shelf and rise deepening towards Hudson Strait and are underlain to a large extent by oceanic rocks. Two sedimentary basins have been delineated on the Labrador Shelf: the Nain Basin contains more than 30,000 feet (9 km) of sedimentary rock. The Saglek Basin contains in excess of 50,000 feet (15 km) of sediments. In both basins the sediments would appear from the sea-floor spreading sequence to be mostly of Mesozoic age making these areas attractive for the petroleum industry to prospect.

During 1972 further experiments were carried out in cooperation with the National Aeronautical Establishment and the Ministry of Transport with Very Low Frequency navigation systems, and a GNS-200 system from Global Navigation Inc. was installed in the NAE North Star aircraft. The GNS-200 utilizes the U.S. Navy's worldwide network of high power communication stations to provide the pilot with distance-to-go and left-right steering information. At present 8 stations may be used - Maine, Panama, Washington State, Great Britain, Japan, Australia, Trinidad and Norway; they operate at frequencies between 12 and 24 KHz, with radiated power up to 1000 KW. Preliminary tests were carried out using the GNS in the conventional manner, as a cockpit aid to navigation in flying trips between two points and observing the error at the end point. Results were so encouraging that the outputs of the GNS receivers were wired into the Interdata computer installed on the North Star which was

programmed by Margaret Bower to output the position of the aircraft in real time. Phase differences between station pairs were recorded on the ground, during flights in the Ottawa area and on trips to Whitehorse, Victoria and the Davis Strait to determine accuracy and reliability. It was found that in general the GNS was more reliable and has smaller standard deviation than the Omega system. Although track accuracy is probably not quite good enough for conventional closely-spaced line survey work, it would be very good for Arctic and over-water flights. In addition, it is possible to fly a number of parallel tracks by using a somewhat different operating procedure, and the system can also be improved by installing a caesium time standard in place of one of the station receivers. The main advantage of this VLF navigation system is its flexibility in being able to use a number of different high-powered transmitters, rather than the three low power Omega stations now in use. For the computer-controlled navigation program, good hyperbolic intersections are obtainable anywhere in Canada and the adjacent oceans. A problem at present is that most of the stations have scheduled down times for maintenance; the Navy Communications Command is not committed to keeping them on the air for navigation purposes. Also, there are no skywave correction tables available. However, these problems can be largely circumvented by intelligent selection of stations.

The annual mineral exploration review was again prepared by P. J. Hood and published in the February 1973 issue of the Canadian Mining Journal. Tabulations of commercially-available ground and airborne magnetometers and susceptibility equipment was also compiled. These articles are essentially a service to industry and summarize for them what new equipment, techniques, etc. became available for mineral exploration during the year under review. Reprints of these articles are much sought after by industry and such agencies as CIDA and the UN to keep their personnel up-to-date. As an example, Dr. G. Gross, the Liaison Officer in the Commonwealth Geological Liaison Office requested 30 copies of the 1972 review to distribute to members of the Commonwealth Committee on Mineral Resources and Geology.

P. J. Hood is the editor for the proceedings of the Earth Science Symposium on Offshore Eastern Canada with B. R. Pelletier of the Atlantic Geoscience Centre and N. J. McMillan of the Aquitaine Company of Canada as Associate Editors. A number of difficulties arose in the publication of this 39-paper volume which have held up the publication. In addition to the slowness with which a number of authors revised their manuscripts after critical reading, there were such difficulties as the use of names for underwater features other than those approved by the Canadian Permanent Committee on Geographical Names. One author unfortunately died before submitting glossy prints of his figures. All revised manuscripts were forwarded to the GIP Division by March 5, 1973. In addition to the foregoing editorial work, P. J. Hood also critically reviewed four papers for the Canadian Journal of Earth Science, one of which was a paper presented in the Exploration Geophysics session of the 24th International Geological Congress by a Russian woman geophysicist and her colleagues.

On behalf of the Canadian International Development Agency, P. J. Hood has acted as the Technical Inspector for a 75,000 line mile aeromagnetic survey of Guyana which was flown for the Geological Survey of Guyana. Terra Surveys Ltd. of Ottawa were the successful bidders for the contract and aeromagnetic survey operations were carried out between October 7, 1971 and February 27, 1972. Up to March 31, 1973 a total of ninety-five 1:50,000 aeromagnetic maps had been issued, and these employ a new format in which the 10-gamma contours in red are overprinted on a grey topographic base with the flight lines being indicated in blue. A number of the maps covered areas presently being mapped by geologists of the Geological Survey of Guyana who go into the field early in February. In order to ensure that maximum use would be made of the maps, a visit was made to Guyana in January 1973 by Messrs. I. Tyl and M. S. Reford of Terra Surveys, the geophysicists responsible for the interpretation of the data, and by P. J. Hood and W. Knappers. Interpretation of individual sheets was discussed with the appropriate field geologist, and one day was devoted to a series of lectures by the foregoing persons on the aeromagnetic survey and the resultant end products.

During the January 1973 visit to Guyana, a ground magnetic reconnaissance was also made by P. J. Hood and W. Knappers with a Geological Survey of Guyana field party of one of the interesting anomalies discovered by the 1971-72 aeromagnetic survey. This anomaly is located on the Land of Promise coconut estate in the Pomeroon district of NW Guyana, and the reconnaissance was carried out with an Askania torsion balance. The anomaly appears to be due to a near-surface (less than 500 feet) causative body which contains a relatively high percentage of magnetite, perhaps of ore tenor. Further exploration work on the anomaly is planned by the Geological Survey of Guyana.

Mr. G. W. Cameron, a graduate of Carleton University, has been responsible for checking the interpretation of the Guyana aeromagnetic maps carried out by Terra Surveys. He has made use of the automatic least-squares multi-model method for quantitative interpretation developed in-house, and the results have been forwarded to Terra Surveys for their consideration. However, in general the results have checked reasonably well with those obtained by Terra Surveys using the ITI method developed by Compagnie Generale de Geophysique in France.

P. J. Hood acted as convenor (with E. H. S. Gaucher of SOQUEM) for Section 9 (Exploration Geophysics) for the 24th International Geological Congress. A total of 36 papers were presented over 4 days which included one paper from the USSR not originally scheduled. The 189-page volume required a considerable amount of editing by the convenors with assistance from colleagues especially those papers whose authors did not have a good knowledge of English. The sessions were well attended in comparison with others running concurrently with full-houses for a number of sessions of particular interest to the mining exploration fraternity.

P. J. Hood has also provided advice to the following members of the Department of Industry, Trade and Commerce on various matters pertaining to the development and sale of geophysical instrumentation and/or services: R. H. M. Cathcart, J. A. Kiely and J. A. Koster.

L. J. Kornik and P. H. McGrath are evaluating the usefulness of high resolution aeromagnetic surveys as an aid to detailed geological mapping programs. A test range was established during 1972 near Timmins, Ontario and aeromagnetic and ground surveys were carried out. Ground measurements included fluxgate and proton precession magnetometer surveys, in situ magnetic susceptibility surveys and the collection of oriented diamond drill cores for physical property studies. Aeromagnetic data was obtained at 500, 1000 and 2000 feet elevation along the lines of the test range using the high resolution optical absorption magnetometer system installed in the GSC Queenair aircraft. A comparison of the aeromagnetic and ground magnetometer data indicate that filtering the aeromagnetic data is necessary to enhance the amount of geological information retrievable from the aeromagnetic data. Several different types of computer filtering programs have been applied to the aeromagnetic data to maximize the retrieval of useful geological information in order to more clearly define the local small scale geological features, the so-called "fine structure".

P. H. McGrath has completed an interpretation of the magnetic anomalies in the southwestern Gulf of St. Lawrence region with the assistance of G. W. Cameron. The results of this study are published in the earth science symposium volume on offshore Eastern Canada. The magnetic data define a northerly-trending near-vertical fault in the Gulf which extends from 46° 50' N to 47° 45' N latitude in the vicinity of and parallel to 63° 25' W longitude. The area to the east of the fault is downthrown approximately 2.5 km relative to the western side. The magnetic data also suggest that the Magdalen basin is continuous from St. Georges Bay, Newfoundland, to the Cumberland basin in Nova Scotia with lateral depressions extending into George Bay, Nova Scotia and toward Malpeque Bay, Prince Edward Island. The total thickness of Carboniferous sediments is as much as 15 Km in the central part of the basin northwest of Cape Breton Island.

P. H. McGrath is also designing band pass and low-pass vertical derivative digital filters. These filters are used to enhance the magnetic effects of near-surface local sources at the expense of the magnetic anomalies of deeper sources and large scale near-surface sources. Maps compiled from data which has been filtered in this manner possess better resolution of the near-surface sources and hence are more useful to the geologist as an aid to field mapping.

Work is still proceeding on the compilation of a 1:1,000,000 regional anomaly map of the Maritimes in which the effects of the main earth's field have been removed. The 1965.0 International Geomagnetic Reference Field (IGRF) has been used for this purpose. Much more geologically significant detail is apparent on this 100-gamma regional anomaly map than on the 1:5,000,000 Magnetic Anomaly Map of Canada. Some

difficulty has been experienced in the tying together the various surveys which extend over a 20-year period because many of the earlier surveys were flown using fluxgate magnetometers and the total field values on the resultant maps were referred to an arbitrary datum. It is planned to fly a series of control lines to resolve this difficulty.

K. Ogawa of the Geological Survey of Japan has been developing an automatic computer curve-matching method for the interpretation of magnetic anomalies which is especially applicable to multiple magnetic sources having intense remanent magnetism. The technique utilizes the fact that the anomalous total field values produced by a two-dimensional uniformly magnetized body can be transformed to symmetrical and magnetic inclination independent functions by summing the squares of nth order (n = 0, 1, 2 etc) horizontal derivatives of the total field and its Hilbert transform. To evaluate the technique the method has been applied with encouraging results to a number of examples both theoretical and real where anomalies interfere. The method also appears to be cost-effective in that the cost per interpretation is comparable with the more classical graphical techniques.

The design, and construction of a vertical gradiometer for the Queenair high resolution magnetometer system is proceeding under the supervision of P. Sawatzky. The feasibility of installing a boom system on the aircraft for a vertical gradiometer was established by H. Aass Aero Engineering Ltd. of Ottawa in a report dated 5th January 1973. It is intended that fabrication of the gradiometer will take place during 1973. A number of modifications to the Queenair survey system were made during the year which included provision for the use of the Decca Navigation system as a primary navigation aid in high resolution aeromagnetic surveys.

During 1973, the GSC Queenair aircraft carried out high resolution aeromagnetic surveys in the Kirkland Lake area of Northern Ontario (8000 line miles) and the Bathurst mining camp of northern New Brunswick (13,100 line miles). The party chiefs for these two surveys were respectively P. Sawatzky and D. W. Olson, and financial support for the surveys was provided in part by the appropriate provincial agencies.

S. Washkurak has commenced work on the fabrication of a very high resolution radiometer (VHRR) and solar proton monitor (SPM) ground satellite receiving station. The VHRR will provide high resolution (0.5 mile) earth-cloud cover data covering two spectral regions: 0.6 to 0.7 microns (visible) and 10.5 to 12.5 microns (infrared). The system will operate in the S-band microwave region (1697.5 MHz) to accommodate the increased bandwidth requirements for high resolution imagery. The National Oceanic and Atmospheric Administration (NOAA-2) satellite to be launched in October 1973 will provide daily coverage with ½ mile ground resolution of the entire North American continent including the Arctic Islands in both the visible and infrared portion of the electromagnetic spectrum. For the reception of the imagery, an eight-foot parabolic dish

will be computer-controlled by an Interdata Model 74 (16 K core) in both azimuth and elevation to an accuracy of one degree. A standard low noise preamp (4.5 db noise figure) will feed a Model 1100 Microdyne telemetry receiver with two demodulators. The video output of the receiver will be recorded on a video tape-recorder and displayed on a high resolution cathode ray tube. The soft copy CRT image is converted to hard copy by a standard oscilloscope camera.

Personnel Changes

G. W. Cameron joined the Magnetic Methods Section under a CIDA contract.

Dr. K. Ogawa of the Geological Survey of Japan was attached to the Magnetic Methods Section for educational purposes on 4th September, 1972.

Attendance at Meetings

P. J. Hood

- GSC Penrose Conference on the Geological Interpretation of Recent Geophysical Data, Northern and Maritime Appalachians, Amherst, Massachusetts, May 28th to June 3rd, 1972. P. J. Hood chaired the Session G on May 29th entitled Geophysics in the Canadian Appalachians. Presented a paper during this session on the interpretation of magnetic data in the Canadian Appalachians.
- 24th International Geological Congress, Montreal, Aug. 19-30, 1972. Acted as convenor for Section 9 which lasted for the four days August 22-25 inclusive. Presented paper entitled "The application of aeromagnetic survey data to geological mapping programs" on Aug.22nd.
- Sedimentary Basin Analysis Study, Institute of Sedimentary and Petroleum Geology, Calgary, Jan. 14-17, 1973.
- Prospectors and Developers Association Meeting, Toronto, March 11-14, 1973.

Special Talks or Lectures

P. J. Hood

- Overview of the Guyana Aeromagnetic Survey 1971/72. First of a series of lectures given on January 26, 1973 by P. J. Hood, W. Knappers, M. S. Reford (Terra Surveys) and I. Tyl (Terra Surveys) to geologists of the Geological Survey of Guyana, Georgetown, Guyana.

Membership on Committees

P. J. Hood
- Chairman, Subcommittee on Exploration Geophysics, NRC Associate Committee on Geodesy and Geophysics.
- Member, NRC Associate Committee on Geodesy & Geophysics.
- Member, National Organizing Committee, 24th International Geological Congress, Montreal, 1972.
- Member, Committee for Co-operation with Government Agencies, Society of Exploration Geophysicists, Tulsa.
- Member, Working Group 7 (Geomagnetic Anomalies), Commission 3, International Association of Geomagnetism and Aeronomy.
- Member, Advisory Council, 1973 Canadian Mining and Aggregate Equipment Exhibition, Toronto.

P. H. McGrath - Secretary, Logan Club, 1973/74 season.

Completed Manuscripts

The following manuscripts were accepted and approved by the Division:

Hood, P. Mineral exploration: trends and developments in 1972; Can. Min. J., vol. 94, no. 2, p. 167-182, 1973.

Hood, P. The application of aeromagnetic survey data to geological mapping programs; in Exploration Geophysics, Section 9, 24th Int. Geol. Cong., Montreal, p. 15, 1972.

Hood, P. (Editor)
Earth Science Symposium on Offshore Eastern Canada; Geol. Surv. Can., Paper 71-23, 652 p., 1973.

Hood, P. (Chairman)
Exploration Geophysics, Can. Geophys. Bull., NRC Assoc. Comm. on Geodesy and Geophysics, vol. 25 (completed ms)

Hood, P. and Bower, M. E.
Low-level aeromagnetic surveys of the continental shelves bordering Baffin Bay and the Labrador Sea; in Earth Science Symposium on Offshore Eastern Canada, Geol. Surv. Can., Paper 71-23, p. 573-598, 1973.

Hood, P. and Gaucher, E. (Convenors)
Exploration Geophysics; Proc. Sect. 9, 24th Int. Geol. Cong., Montreal, 190 pp., 1972.

McGrath, P. H. and Bower, M.
Martin-Graham digital filters; in Rept. of Activities, Geol. Surv. Can., Paper 73-1, pt. B (completed ms)

McGrath, P. H. and Hood, P. J.
An automatic least-squares multi-model method for magnetic interpretation; Geophysics, vol. 38, no. 2, p. 349-358, 1973.

McGrath, P. H., H ood, P. J. and Cameron, G. W.
Magnetic surveys of the Gulf of St. Lawrence and the Scotian Shelf; in Earth Science Symposium on Offshore Eastern Canada, Geol. Surv. Can. Paper 71-23, p. 339-358, 1973.

Sawatzky, P., Olson, D. W., and Hood, P. J.
Experimental high-resolution aeromagnetic surveys: 1972; Geol. Surv. Can., Paper 73-1, pt. A, p. 95-97, 1973.

GEOCHEMISTRY SECTION

E. M. Cameron

This year's work of the section was dominated by the Bear-Slave Geochemical Operation. Directed by R. J. Allan with E. M. Cameron and C. C. Durham this was the first major geochemical reconnaissance of the Canadian Shield. Lake sediment samples were collected from 36,000 sq. miles of the Bear and Slave Provinces of the northern Shield at an average density of one site per ten square miles. Three helicopters and one fixed wing aircraft were used in the operation. These samples have since been analysed for some 27 major and trace elements in the section's laboratories. The results of the operation, in the form of a report and 24 map sheets, were published in April of this year. This rapid publication of the data is a tribute to the interest and efficiency of the many people involved in the work, both within this section and the G.I.P. Division.

The results of the operation have been most gratifying. Areas of mineral potential have been defined for a number of elements in places where there are no known mines or showings. Further, the bird's-eye-view of element distribution in the crust which the maps provide, show a number of features that may be used by mapping geologists for their interpretations. The data is significant to the environmental sciences, since it provides information on background levels and variation of potentially toxic elements.

In other reconnaissance work R. G. Garrett interpreted results from previous years relating to Cretaceous granitoid plutons in the Western Cordillera. This showed that plutons associated with tungsten mineralization along the N.W.T.-Y.T. border are characteristically acidic and polyphase and can be recognized on the basis of their chemistry. The lower Cambrian lime units form a favourable host for the formation of skarn deposits and intersections of such units and the acidic granitoids are favourable loci for W mineralization. Those plutons associated with Au-W-base metals in the Mayo-McQuestern area are typically granodioritic and of a completely different character geochemically and metallogenetically from those of the border area. The project has also contributed considerable useful information for dividing plutons into mappable units and recognizing regional areas of enhanced or depressed trace element content.

E. H. W. Hornbrook carried out for, and in cooperation with, the Newfoundland Department of Mines and Energy, geochemical studies of stream and lake sediments, waters, soils and till to develop and test regional and detailed exploration techniques.

The results of the E.G.M.A. winter works till and lake sediment program in the Timmins-Val d'Or region were compiled and published through open file release.

In the vapour-sensing program a series of soil-gas samples collected at Clyde Forks, Ontario over a known mercury prospect were tested by I. R. Jonasson for organo-metals and sulphur dioxide with inconclusive results. Techniques for sample collection have been developed into a quick and convenient method (with the cooperation of Mr. Dyck) such that routine sampling for soil-gases is now a practicable possibility. Geological samples collected at Calumet Island, Quebec, in both winter and summer provided further corroborative data on elemental migration chracteristics of considerable relevance to this part of the vapour's programme. Effects of severe, climatic variations on soil-gas chemical properties (snow, rainfalls, etc.) have been closely studied over the past field season yielding observations which have proved beneficial from an interpretative viewpoint. Efficient washout of mercury gas and soil haloes and the disappearance of sulphur dioxide emanations have been noted at Clyde Forks. The most rewarding aspect of the programme over the report year resulted from the search for organo-metals in snow strata overlying ore zones. Several sample sites selected over different types of mineralization produced significant metal haloes in the snow cover. Metals such as Hg, Cu, Zn, Ni, Pb, Mn were shown to migrate rapidly upwards.

Methods for the determination of He, Ne, Ar, O_2, N_2 CO_2 and CH_4 in soil gases and natural waters were developed by W. Dyck with the aid of a small mass spectrometer. To date the composition of air in 70 water samples and 40 air samples from various localities and environments has been determined. In waters the He, O_2, CO_2, and CH_4 show large fluctuations depending on environment; a clear inverse relationship between CO_2

and O_2 exists. The possibility of using He and Rn as tracers for U deposits and/or fracture zones is being investigated.

Q. Bristow continued with the development of small portable instruments for field geochemistry and with improvements to existing laboratory analytical instrumentation. Further refinements have been made to the quartz crystal microbalance mercury detector to improve the performance and its suitability for field use. The power consumption has been reduced by a factor of twenty to negligible proportions and a new auger type soil gas sampling probe and steam aspirator pump have been devised, which together weigh less than seven pounds. Field tests of the modified equipment will be made during the summer 1973 season. A number of field pH meters designed and developed in the geochemistry instrumentation laboratory saw service from Newfoundland to the sub-arctic and no problems were encountered. A flameless atomic absorption instrument with a direct digital readout in analytical units, designed specifically for analysis of mercury using the Hatch and Ott procedure has been completed and put into laboratory service. A solid state interface unit, to allow computer control and updating of the manual operation of the well-known Perkin Elmer model 303 atomic absorption spectrophotometer, has been designed and built as the first phase of a project to introduce computer control of laboratory analytical instrumentation.

The work of the section over the last decade has been largely devoted to applied geochemistry. In the main, this work has been to develop new methods of geochemical exploration for mineral deposits or for estimating the mineral potential of parts of the country. It is thus often surprising that so many of the questions posed our staff by government, industry and university are concerned with basic geochemical information. Thus, most of the queries relating to environmental problems deal with questions of what is the natural abundance of potentially toxic elements and what processes control their migration and concentration. In terms of logistical support, both in the field and the laboratory, the Geological Survey is uniquely capable of obtaining the basic information on the distributions of elements in the crust and its surface. We should make greater efforts to fill this role.

In applied geochemistry, many members of the section, and their colleagues elsewhere in the division, feel that there is a limit to the usefulness of studying known ore deposits in order to develop methods of mineral exploration or resource appraisal. A different approach involves follow-up studies of reonnaissance surveys, such as the Bear-Slave Operation, or on anomalies defined by geological and geophysical observations. This approach allows methods to be developed for new types of deposits and places the research in a more life-like setting.

Personnel Changes

In January, Mrs. G. Aslin joined the section as an analytical chemist. Previously, Mrs. Aslin was a research assistant and senior laboratory demonstrator in the Chemistry Department, Carleton University.

Attendance at Meetings

R. J. Allan, E. M. Cameron, R. G. Garrett and I. R. Jonasson - Fourth International Geochemical Exploration Symposium, London, England, April, 1972.

E. M. Cameron and R. G. Garrett - Prospectors & Developers Convention, Toronto, March, 1973.

E. M. Cameron and R. G. Garrett - 24th International Geological Congress, Montreal, August, 1972.

R. G. Garrett - Mineral Exploration Group, Vancouver, February 1973.

E. H. W. Hornbrook - Local Meeting, Geological Association of Canada, St. Johns, Newfoundland, 1973.

Lectures, Talks Given

See papers listed below by R. J. Allan, E. M. Cameron and C. C. Durham, by R. G. Garrett and by I. R. Jonasson given at the 4th International Geochemical Exploration Symposium, London, England, 1972.

Q. Bristow - The G.S.C. High Sensitivity Airborne Gamma Spectrometry System. G.S.C. Geophysics Symposium, Ottawa, 1972.

R. G. Garrett - Geochemistry of Yukon Granitoids, Mineral Exploration Group, Vancouver, 1973.

E. H. W. Hornbrook - Combined Geological Association of Canada - CIM meeting, St. Johns, Newfoundland, paper - Geochemical-Glacial Prospecting.

Membership on Committees

Q. Bristow - Algonquin College Advisory Council on Electronic Technology.

E. M. Cameron - Vice President, Association of Exploration Geochemists.

- Editor-in-Chief, Journal of Geochemical Exploration.

R. G. Garrett - Chairman, Branch Computer Facilities Committee. Also Departmental Computer Working Group.

- Computer Application Committee, Association of Exploration Geochemists.

E.H.W. Hornbrook Subcommittee on Canada-Newfoundland Mineral Development Program

- Committee on General Instructions for Field Parties.

I. R. Jonasson - Mercury, Arsenic and Antimony Panels, Subcommittee on Metals in the Environment, National Research Council.

Completed Manuscripts

The following manuscripts were accepted and approved by the Division:

Allan, R. J., Cameron, E. M., Durham, C. C.
Bear-Slave Operation, District of Mackenzie.
G.S.C. Prelim. Map 9-1972 - Uranium content of lake sediment, (3 sheets), 1973.

G.S.C. Prelim. Map 10-1972 - Zinc content of lake sediments, (3 sheets), 1973.

G.S.C. Prelim. Map 11-1972 - Lead content of lake sediments, (3 sheets), 1973.

G.S.C. Prelim. Map 12-1972 - Manganese, iron and organic content of lake sediments, (3 sheets), 1973.

G.S.C. Prelim. Map 13-1972 - Copper content of lake sediments, (3 sheets), 1973.

G.S.C. Prelim. Map 14-1972 - Nickel content of lake sediments, (3 sheets), 1973.

G.S.C. Prelim. Map 15-1972 - Potassium content of lake sediments, (3 sheets), 1973.

Allan, R. J., Cameron, E. M. and Durham, C. C.
The Bear-Slave Operation in Report of Activites, G.S.C. paper 73-1, pt. A, p. 50-52, 1973.

Allan, R. J. and Crook, R. J.
Lake sediments from permafrost regions: Zn, Cu, Ni, Co, and Pb content in the sub-2000 micron particle size ranges; Geol. Surv. Can. Paper 72-1, part B, p. 31-37, 1972.

Allan, R. J., Cameron, E. M. and Durham, C. C.
Lake geochemistry - a low sample density technique for reconnaissance geochemical exploration of the Canadian Shield. Proceedings 4th Int. Geochem. Expl. Symp. London, April 1972. "Geochemical Exporation - 1972". (Publ. 1973 I.M.M., London).

Allan, R. J., Lynch, J. J., and Lund, N. G.
Regional geochemical exploration in the Coppermine River area, District of Mackenzie, a feasibility study in permafrost terrain; G.S.C. paper 71-33, 52 p., 1972.

Allan, R. J., and Cameron, E. M.
Bear-Slave Operation proves worthy prototype for geochemical reconnaissance of Shield; in The Northern Miner, Nov. 30, 1972, p. 54.

Allan, R. J. and Richardson, K. A.
Uranium distribution by lake-sediment geochemistry and airborne gamma-ray spectrometry: A comparison of Reconnaissance techniques; Abstr. C.I.M.M. Annual General Meeting, April, 1973, Vancouver. C.I.M. Bull. vol. 66, No. 731, p. 54.

Allan, R. J., Cameron, E. M. and Durham, C. C.
Reconnaissance geochemistry using lake sediments of a 36,000 square mile area of the northwestern Canadian Shield; G.S.C. Paper 72-50, 1973.

Boyle, R. W. and Jonasson, I. R.
Geochemistry of Cadmium; Summary prepared for the Subcommittee on Metals of the Associate Committee on Scientific Criteria for Environmental Quality; N.R.C., 16 p.

Boyle, R. W., and Jonasson, I. R.
Geochemistry of arsenic and antimony; Summary prepared for the Subcommittee on Metals of the Associate Committee on Scientific Criteria for Environmental Quality, N.R.C. 39 p.

Bristow, Q.
An evaluation of the quartz crystal microbalance as a soil gas mercury sensor; Jour. Geochem. Expl. vol. 1, No. 1, pp. 55-76.

Bristow, Q.
Patent application - A flameless atomic absorption spectrophotometer with digital peak height retrieval and logarithmic analogue/digital conversion for mercury analysis.

Bristow, Q. and Jonasson, I. R.
Vapour sensing for mineral exploration; Canadian Mining Jour., 93, No. 4, p. 47 and No. 5, pp. 39-57, 85., 1972.

Cameron, E. M., and Jonasson, I. R.
Mercury in Precambrian shales of the Canadian Shield; Geochim. Cosmochim. Acta. 36, (1972), pp. 985-1005, 1972.

Cameron, E. M. and Allan, R. J.
Distribution of uranium in the crust of the northwestern Canadian Shield as shown by lake sediment analysis; J. Geochem. Explor. vol. 2, 1973 (in press)

Cameron, E. M. and Baumann, A.
Carbonate sedimentation during the Archean. Chem. Geol. vol. 10, pp. 17-30, 1972.

Cameron, E. M., and Allan, R. J.
Geochemical provinces within the northwestern Canadian Shield based on lake sediment analysis. Abst. submitted to Mineralog. Assoc. Can., Techn. Sessions, Saskatoon, 1973.

Dyck, W. Feasibility study of geochemical sampling of Arctic coastal streams by helicopter based on D.O.T. icebreaker. G.S.C. Paper 72-42, pp. 13, 1972.

Dyck, W. A soil gas sampler for difficult overburden; Jour. Geoch. Expl. vol. 1, No. 2, pp. 199-202.

Dyck, W. Radon methods of prospecting in Canada: Uranium Prospecting Handbook. Proceedings of a NATO/ASI on Methods of Prospecting for Uranium Minerals; London, England, September 21 - October 2, 1971; pp. 212-243.

Garrett, R. G.
The determination of sampling and anaylitical errors in exploration geochemistry - a reply; Econ. Geol. vol. 68, 1973, pp. 281-284.

Garrett, R. G.
Regional geochemical study of Cretaceous acidic rocks in the northern Canadian Cordillera as a tool for broad mineral exploration; Proc. 4th Inter. Geochem. Explor. Symp., London, U.K. "Geochemical Exploration - 1972" (Publ. 1973, I.M.M., London, U.K.)

Hornbrook, E.H.W.
Geochemical and biogeochemical exploration methods research in the Cobalt area, Ontario; Geol. Surv. Can., Paper 71-32, 1972.

Hornbrook, E.H.W., and Gleeson, C. F.
Regional geochemical lake bottom sediment and till sampling in the Timmins-Val d'Or region of Ontario and Quebec; Geol. Surv. Can., O.F. 112, 1972.

Hornbrook, E.H.W. and Gleeson, C.F.
Regional lake bottom sediment moving average-residual anomaly maps in Ontario and Quebec; Geol. Surv. Can., O.F. 127, 1972.

Hornbrook, E.H.W. and Gleeson, C.F.
Regional lake bottom sediment sampling in the Timmins-Val d'Or region of Ontario and Quebec; Geol. Surv. Can. Computer card format release, O.F. 112, 1972.

Jonasson, I. R.
Migration of trace metals in snow; Nature (London), vol. 241, No. 5390, p. 447-448, 1973.

Jonasson, I. R.
Potential of combined GC-MS as a sensitive tool in exploration geochemistry. Geol. Surv. Can. Paper 72-1B, pp. 37-40, 1972.

Jonasson, I. R.
Book review: Geochemistry of iodine and bromine, by B. Ya. Rozen, Nedra, Moscow, 1970; J. Geochem. Explor. 1, 137-138, 1972.

Jonasson, I. R., Lynch, J. J. and Trip, L. J.
Field and Laboratory Methods used by the Geological Survey of Canada in Geochemical Surveys. No. 12. Mercury in ores, rocks, soils, sediments and water. Geol. Surv. Can. Paper 73-21, 1973.

Jonasson, I. R. and Allan, R. J.
Snow - a sampling medium in hydrogeochemical prospecting in temperate and permafrost regions; Proc. Fourth Internat. Geochem. Explor. Symp., London, U.K., Publ. 1973 "Geochemical Exploration - 1972". (Inst. Mining & Metallurg).

Lalonde, J. P.
Dispersion of fluorine in the vicinity of fluorite deposits; G.S.C. Paper 73-1, pt. A, p. 57, 1973.

Lynch, J. J., Garrett, R. G. and Jonasson, I. R.
A rapid estimation of organic carbon in silty lake sediments; J. Geochem. Explor. vol. 2, 1973 (in press).

Timperley, M. H., Jonasson, I. R., and Allan, R. J.
Sub-aquatic gels: a medium for geochemical prospecting in the southern Canadian Shield; G.S.C. Paper 73-1A, p. 58-62, 1973.

Timperley, M. H., Horton, R. E., and Lynch, J. J.
The analysis of metals in geological materials by D. C. Arc direct reading emission spectrometry; G.S.C. Paper 73-1A-p. 63-64, 1973.

Timperley, M. H., Brooks, R. R. and Peterson, P. J.
Trend analysis as an aid to the comparison and interpretation of biogeochemical and geochemical data; Econ. Geol. vol. 67, pp. 669-676, 1972.

Timperley, M. H., Brooks, R. R. and Peterson, P. J.
The improved detection of geochemical soil anomalies by multiple regression analysis of biogeochemical data; Proc. Aust. Inst. Min. Met., No. 242, pp. 25-36, 1972.

GEOCHEMISTRY LABORATORIES

John J. Lynch, Chief Analyst

The past fiscal year has been devoted largely to the analysis of samples collected by members of the Bear-Slave operation. The productivity of the Sample Preparation, Trace Element and Direct Reading Spectrometer Laboratories are tabulated in Tables 1, 2 and 3 respectively. The rather large carry-over in Table 2 is due mainly to samples which are analysed but which have not been reported. This will be done very early in the new fiscal year. It is gratifying to note that the productivity of the three laboratories has increased rather substantially over the previous year. In particular, the spectacular increase in the Direct Reading Laboratory is due in part to the efforts of Dr. M. Timperley who developed the D.C. arc method in conjunction with a small on-line computer.

Only a modest amount of development work was carried out in the Trace Element Laboratory. Mr. R. Crook did, however, devise a number of modifications to an existing method for the determination of arsenic which increased the sample through-put greatly. This method is considerably more precise than the older Gutzeit test which had been in use for quite a number of years. It is also very applicable to water samples.

Mr. G. Gauthier applied flameless atomic absorption to the determination of zinc in natural waters. The technique proved very sensitive but somewhat time consuming. More work will be done on this technique in the coming year.

TABLE 1

Sample Preparation Laboratory

	1971-72	1972-73
Samples carried over	0	0
Samples received	3250	5049
Samples completed	3250	5049
Samples carried forward	0	0
Sizing	767	4206
Crushing	2544	434
Grinding	2534	426
Ball Milling	2650	402
Superpanner	100	384
Frantz	135	381
Heavy Liquid	0	19
Hand Picking	10	30

TABLE 2

Trace Element Laboratory

	1971-72	1972-73
Samples carried over	681	2840
Samples received	12828	16069
Samples completed	10669	14575
Determinations	60658	77092
Samples carried forward	2840	4334

TABLE 3

Direct Reading Laboratory

	1971-72	1972-73
Samples carried over	5	1081
Samples received	6823	6497
Samples completed	5207	7498
Determinations	35583	216451
Samples carried forward	1081	80

RADIATION METHODS

K. A. Richardson

This section is responsible for development and evaluation of survey techniques, particularly utilizing gamma radiation and visible and infrared portions of the electromagnetic spectrum. Activities of the section in 1972-73 have been concentrated on airborne gamma-ray spectrometry and multispectral photography.

During the summer of 1972, an airborne gamma-ray spectrometry survey was carried out southeast of Port Radium, N.W.T. covering NTS map sheets 86 A, B, C, F, G & H with 5 kilometer line spacing. The area, roughly bisected by the boundary between the Bear and Slave geological provinces, and also transected by the Wopmay Fault zone, overlapped the area of the 1972 Bear-Slave lake sediment geochemistry survey, and provided a basis for comparison of the two reconnaissance exploration techniques (Allan and Richardson, in press). Other airborne radioactivity work during the summer of 1972 included a small spectrometry survey over the Carswell structure in northwestern Saskatchewan, cross country spectrometry profiles from Ottawa to Yellowknife, and a total count profile (flown with the GSC Queenair aircraft) across northern Quebed, southern Baffin Island, Melville peninsula and District of Keewatin (Darnley,1973). The total count profile data from 1972 and the planned 1973 spectrometry coverage of northern Saskatchewan with 50 kilometer line spacing will be compared and assessed to determine the optimum type of survey for reconnaissance radioactivity coverage of Canada to locate major regions of anomalous high uranium content. The Saskatchewan project will be cost-shared with the provincial government.

Ground follow-up of the 1971 airborne gamma-ray spectrometry survey in the Mont Laurier, Quebec, area was carried out in the summer of 1972. This work demonstrated the importance of high U/Th ratio values, not accompanied by particularly high uranium values, as an indicator of potential uranium mineralization zones. Ground work in 1973 will comprise the investigation of several types of airborne radioactivity anomalies in the Fort Smith, Yellowknife and Port Radium areas, to determine the relative importance of the different types of anomalies.

Addition of a computer programmer to the staff of the section in 1972 made possible the analysis of the backlog of airborne data which had been collected in previous years and also resulted in the relatively early release of the 1972 Bear-Slave radioactivity maps and profiles. The data processing techniques had also been developed to a state that permitted the Workshop on Automatic Processing of Geophysical Data, April 1972, to be presented by R. L. Grasty, Radiation Methods Section, and M. T. Holroyd, Digital Compilation Section, for representatives of the geophysical survey industry.

Geological applications of airborne gamma-ray spectrometry are largely restricted to the snow-free part of the year. During the winter, 1972-73, the spectrometry system was utilized in an experimental program with Dept. of Environment and various Ontario Provincial agencies to determine the applicability of the method to measurement of water equivalent snow depth. The snow survey work, in conjunction with a series of laboratory and field experiments, have led to an increased understanding of correction factors that are applied to airborne radioactivity measurements to give quantitative radioelement concentrations. The theoretical basis for the new correction factors, relating observed geophysical phenomena with laws of nuclear physics are being developed. The results of this work, which will lead to improved data analysis techniques, are being prepared for presentation at the meeting of the Society of Exploration Geophysics in October 1973.

Work has been in progress since October 1972, to develop the GSC airborne spectrometer system from a 4-window spectrometer to a 128-channel spectrometer. This modification, to be tested during 1973, is aimed at increasing the system's sensitivity for uranium, providing a means of monitoring the stability of the system, and also providing a continuous measurement of background radioactivity.

The major accomplishment in the area of multispectral photography was the acquisition of exceptionally high quality colour coverage of NTS map sheet 86 F. This imagery over a significant area of the Canadian Shield provides sufficient coverage for a meaningful comparison of colour air photography with conventional black and white photography, and will contribute to interpretation of 1972 airborne gamma ray spectrometry and lake sediment geochemistry results from that area. Geological mapping of this 1:250,000 sheet will begin in 1973.

Investigation of a number of smaller more specific applications of multispectral photography are planned for 1973. These planned experiments to be conducted in cooperation with other sections of the GSC include the investigation of a geobotanical test site near Norman Wells, the application of colour and false colour imagery for recognition of surficial materials and drainage in the Mackenzie Valley, investigation of environmental effects of opencast mining near Fernie, B.C., and delineation of geological contacts associated with geochemical anomalies north of Yellowknife.

Since the launching of the ERTS-A satellite, the section has been acquiring and maintaining a file of all available, good quality ERTS photographs of Canada. An index of this coverage is displayed in the GSC library, and assistance in using ERTS imagery is provided to GSC staff. Pending receipt of suitable imagery, evaluation and comparison of ERTS imagery with conventional airphoto mosaics will be carried out.

Personnel Notes

Mrs. B. Elliott joined the staff in June 1972, with responsibility for carrying out computer processing of gamma ray spectrometry data.

K. A. Richardson received Special Commendation from Geological Society of America, February 1973 in recognition of contributions to geological training of astronauts assigned to the U.S. program of lunar exploration.

Attendance at Meetings, Conferences, Courses

K. A. Richardson
- Natural Radiation Environment Symposium, Houston, Texas, August 1972.
- Summary of Geological Investigations conducted in Manitoba, 1972. Winnipeg, Manitoba, Nov. 1972.
- Summary of Geological Investigations Conducted in the Precambrian area of Saskatchewan, 1972, Regina, Saskatchewan, November 1972.
- Prospectors and Developers Association Convention, Toronto, Ontario, March 1973.

R. L. Grasty
- Workshop on Automatic Processing of Geophysical Data. Ottawa, Ontario, April 1972.
- Soil Moisture Discussion Group, C.A.S.I. Toronto, Ontario, May 1972.
- Snow and Ice Symposium, UNESCO, Banff, Alberta, September 1972.
- Hydrological Working Group, C.A.C.R.S. Ottawa, Ontario, February 1973.

V. R. Slaney
- International Geological Congress, Montreal, Quebec August 1972.
- American Society of Photogrammetry, Washington, D.C. March 1973.

P. B. Holman
- took a course in Advanced Calculus, Carleton University, completing the requirements for his B.Sc. degree in Physics.

J. Parker
- took a course in Industrial Management, Algonquin College.

Special Talks or Lectures

K. A. Richardson - "Gamma ray spectrometric measurements over the Canadian Shield" Natural Radiation Environment Symposium II.

R. L. Grasty - "The measurement of snow-water equivalent using natural gamma-radiation". First Canadian Symposium on Remote Sensing.

Membership on Committees

V. R. Slaney - Member, Technical Subcommittee, Interdepartmental Committee on Air Surveys.

- Technical Consultant, C.I.D.A.

Publications

Allan, R. J., & K. A. Richardson
Uranium distribution by lake sediment geochemistry and airborne gamma-ray spectrometry; a comparison of techniques. CIMM Bulletin (in press).

Charbonneau, B. W.
Ground investigations of the Mont Laurier airborne radioactivity survey. GSC Paper 73-1, Part A, pp. 67-78, 1972.

Charbonneau, B. W., K. A. Richardson and R. L. Grasty.
Airborne gamma-ray spectrometry as an aid to geological mapping: Township 155, Elliot Lake Area, Ontario. GSC paper 73-1, part B, 1973.

Darnley, A. G.
The use of total radioactivity measurements for reconnaissance airborne surveys. GSC Paper 73-1A pp. 79-80, 1973.

Darnley, A. G., Grasty, R. L. and Richardson, K. A.
Airborne Radioactivity Maps and Profiles, Mont Laurier Quebec. GSC Open File No. 110, 1973.

Grasty, R. L. and Richardson, K. A.
Airborne Radioactivity Maps and Profiles, Yellowknife, N.W.T. GSC Open File No. 124, 1973.

Grasty, R. L.
Snow Water Equivalent Measurement using Natural Gamma Emission Nordic Hydrology, v. 4, pp. 1-16, 1973.

Grasty, R. L., B. W. Charbonneau and H. R. Steacy:
A Uranium Occurrence in Palaeozoic Rocks West of Ottawa. GSC Paper 73-1, Part A, 1972.

Grasty, R. L. & P. B. Holman
The measurement of snow-water equivalent using natural gamma-radiation. First Canadian Symposium on Remote Sensing. p. 633-646, 1972.

Grasty, R. L.
Airborne Gamma Ray Spectrometry Data Processing Manual. GSC Open File 109, 1972.

Richardson K. A. et al.
Radioactivity maps and profiles, District of Mackenzie, Northwest Territories (86 A, B, C, F, G, H). GSC Open File 140, April 1973.

Slaney, V. R.
Colour photography from the Yellowknife District; Proceedings First Canadian Symposium on Remote Sensing, p. 429-440, 1972.

Slaney, V. R.
Colour aerial photography east of Great Bear Lake, District of Mackenzie, Paper 73-1A, p. 98, 1973.

70 mm colour and false colour aerial photography from Uranium City, Saskatchewan, GSC Open File 98, 1973.

70 mm and 9" colour and multispectral photography from Fort Smith and Yellowknife, N.W.T. GSC Open File 99, 1973.

9" colour aerial photography of Sheets 85 I and 85 J, Yellowknife, N.W.T. GSC Open File 100, 1973.

Slaney, V. R.
GSC Open File - 9" colour aerial photography of sheet 86 F, Great Bear Lake, N.W.T.

EXPERIMENTAL AIRBORNE OPERATIONS SECTION

P. Sawatzky

This unit was set up on April 1, 1972 in order to coordinate the operation of the two aircraft which constitute the Division's most valuable capital assets, and to supply related operational and research services. The aircraft are flown and maintained by a contractor, but all scientific and related specialized navigational equipment is the responsibility of the Division. The scientific program for the equipment in each aircraft is determined by the relevant sections, namely those concerned with radiation and magnetic methods. However, there is a substantial in-between area relating to equipment maintenance and modification, interfacing with aircraft systems, and liaison with the aircraft operating contractor and his crews, that requires systematic continuing attention throughout the year.

The two aircraft operated by the Section are a Shorts Skyvan used primarily to conduct airborne gamma-ray spectrometer experiments and multi-spectral photography, and a Beech Queenair used primarily for experimental high resolution magnetometer surveys. The instrumentation in both aircraft is of a highly advanced nature with respect to the state of the art in both sensing and data recording aspects. During the year under review the operation of the two aircraft has been co-ordinated more closely by basing both at the Alert Hangars at Uplands airport, and by bringing together the personnel formerly located in two sepsrate locations into one set of labs and offices. A considerable amount of effort during the year has gone into setting up the trailer-type lab and office accommodation and in building up the related electronic servicing capability. One of the principal problems relating to modern sophisticated air survey operations is the problem of achieving reliable precise automated position fixing for every point at which scientific data is obtained. There are a number of problems peculiar to the air survey mode of operation which do not apply to any other type of military or civilian air traffic movement, and which therefore requires special development. As a result of the amalgamation of resources under one roof, the new Section is thus in a better position to make a significant contribution in this problem area than has been possible hitherto.

Activities

The SKYVAN (461 hours operation) performed several tasks during the past season. These were:

1. High level photography (at about 17,000 ft) of an area to the west of Chatham, N.B. These photographs were used to make up a photo mosaic that was subsequently used to conduct a high resolution magnetometer survey.

2. Gamma spectrometer survey in the Yellowknife area of the N.W.T.

3. Multi-spectral photography in the same general area.

4. Snow measurement studies in Southern Ontario, based out of Ottawa.

The QUEENAIR (386 hours operation) also had a busy season, the tasks performed were:

1. High resolution magnetometer survey in the Kirkland Lake area of Ontario.

2. High resolution magnetometer survey to the west of Chatham, N.B.

3. High resolution magnetometer survey close to Timmins, Ontario, at several levels to determine the best altitude for this type of survey.

4. A total count scintillometer reconnaissance flight of several weeks duration in northern Canada.

Attendance at Meetings and Courses

D. Olson - Model 70 Interdata Computer Maintenance course, Oceanport, New Jersey, U.S.A. Nov. 6-22, 1972.

P. Sawatzky - Grid management course, Cornwall, Ontario, Feb. 4-9, 1973.

Other activities outside of Ottawa

D. Flint - Trip to Wichita, Kansas in connection with obtaining confidential information from the Beechcraft. This information was vital to the designing of the gradiometer installation planned for the Queenair Nov. 28 - Dec. 2, 1973.

Personnel Changes

R. Blain - joined the Section in the Fall of 1971 under the Winter Works program and continued on as a casual, obtained a permanent position with MOT and joined them in April, 1973.

SPECIAL PROJECTS

R. W. Boyle

R. W. Boyle continued the compilation of the geochemistry of gold and its deposits. In continuation of this, field work was done in the Cordova area of Eastern Ontario, Renabie-Timmins area, Northern Ontario and mainland Nova Scotia and Cape Breton Island. A new project on fluorine as a tracer was started, with compilation of geochemical data from a field survey at Madoc, Ontario.

Membership on Committees

R. W. Boyle - International Association on the Genesis of Ore Deposits (I.U.G.S.). Treasurer

- Technical Committee, Section 10 (Geochemistry) of the Twenty-fourth I.G.C. Montreal, 1972 (Convenor).
- Associate Committee on Scientific Criteria for Environmental Quality, N.R.C.: Mercury Panel, Lead panel, Cadmium Panel, Arsenic and Antimony Panel.

Publications

Boyle, R. W. and Jonasson, I. E.
Geochemistry of Mercury: Roy. Soc. Can. Symp. on Mercury in Man's Environment, Ottawa, Feb. 1971, published by Royal Society of Canada, 1972.

Boyle, R. W. Low-level Radioactive Silver in East European Silver Bars: Nature, in press.

Boyle, R. W. and Jonasson, I.R.
Geochemistry of Arsenic and Antimony. Summary report to Associate Commiee on Scientific Criteria for Environmental Quality, N.R.C. 1973.

Boyle, R. W. and Jonasson, I.R.
The geochemistry of Arsenic and its use as indicator element in geochemical prospecting. Jour. Expl. Geochemistry, in press.

Boyle, R. W. and Shaw, D. M. (Convenors),
Geochemistry; Section 10, Proc. 24th Int. Geol. Cong. Montreal, 446 p., 1972.

TERRAIN SCIENCES DIVISION

J.G. Fyles, Chief

INTRODUCTION

The Terrain Sciences Division provides geological, geomorphological and geotechnical information on terrain and its performance in order to promote effective use of the terrain, to identify and assess natural hazards, and to facilitate maintenance and restoration of the physical environment. The divisional program deals with surface and near surface earth and rock materials, landforms, and associated stability relations and dynamic processes, and is designed to build up a geologically based fund of centralized knowledge and expertise concerning the terrain of Canada to meet ongoing national information requirements and to contribute to a variety of programs of the Government of Canada.

The scientific activities of the Division are carried under two Subdivisions: the Quaternary Subdivision which provides systematic regional information and maps on surficial geology and geomorphology, and the Geotechnical Subdivision which provides geological information applied to environmental questions, engineering, and other use-hazard topics. The reports of these two Subdivisions, below, contain further information on the objectives and activities of the Division.

The Division is involved in projects across Canada, with major activities in the northern territories. They include offshore and coastal terrain and environmental geology work in the western Arctic and Great Lakes. Late in the year, preparations were commenced for additional coastal and offshore projects on the west coast and Arctic Islands regions.

A major part of the activities of the Division, in the Mackenzie Valley and northern Yukon are on behalf of (and partly funded by) the interdepartmental Environmental-Social Program, Northern Pipelines and the Water, Forests and Land Division of the Northern Economic Development Branch. The latter relates both to pipelines and to the Mackenzie Highway. The "surficial geology and landforms" maps prepared by the Division for the Mackenzie pipeline program have been used extensively in planning for the highway. The Division has provided the Department of Northern Affairs with maps and reports depicting granular materials in the highway and pipeline corridor, involving both surficial and bedrock sources. Work of the Environmental Working Group for the Mackenzie Highway has been a major task, involving Dr. Bik on a full time basis, and part time inputs of many officers who have conducted field work in the area.

Increasing requirements for terrain information in the Arctic Islands led to expanded investigations in that area during the year, preparation of a 1:500,000 terrain sensitivity map series with assistance of Arctic geologists of I.S.P.G. to meet a request from the Northern Economic Development Branch, and development of plans for a geological input into interdepartmental environmental studies under the Environmental-Social Program, Northern Pipelines.

During the early part of the year the Division completed major "winter works" projects on mineral tracing in the E.G.M.A. area of northern Quebec and Ontario and on urban geology. Both projects have led on to work on these subjects throughout the year. Work was also continued during the year on the geoscientific information file on the New Montreal International Airport at Ste Scholastique, in co-operation with the Department of Regional and Economic Expansion and the Quebec Department of Natural Resources, as well as land inventory surveys in British Columbia jointly with the B.C. Soil Survey and the Canada Land Inventory. Joint limnogeological investigations with the Canada Centre for Inland Waters at Burlington (Department of the Environment) were also continued although on a somewhat reduced scale in view of assignment of Dr. C.F.M. Lewis to other duties in Ottawa.

Throughout the year the Division Chief has served as Departmental Co-ordinator on the Environmental-Social Program, Northern Pipelines, and has been substantially involved with the Environmental and Technical Working Groups for the Mackenzie Highway. In order to facilitate the ongoing line functions of the Division, Dr. J.S. Scott took charge of internal management of all projects related to the Mackenzie region while Dr. B.G. Craig, as Assistant Division Chief, was responsible for all other facets of the work of the Division. Late in the year this ad hoc arrangement was replaced by the current subdivision arrangement.

Many officers of the Division were heavily involved with the meetings of the International Geological Congress and the International Geographical Congress. Dr. J.G. Fyles and Dr. A.M. Stalker, with Dr. W.O. Kupsch of the Institute of Northern Studies, University of Saskatchewan were conveners of Section 12, "Quaternary Geology", and Dr. J.S. Scott, with C.B. Crawford, National Research Council, were conveners of Section 13, "Engineering Geology". Miss T.A. De-Vreeze, with Dr. Stalker and J.A. Code carried a major part of the tasks involved in reviewing, editing and preparation of abstracts and manuscripts and many scientists of the Division assisted in editing the many manuscripts submitted. In addition, Miss De-Vreeze attended both congresses to assist the conveners and the other officials and to act as interpreter for French and Russian visitors. Fifteen officers were leaders or co-leaders of field excursions.

Activities

The Quaternary Discussion Group was chaired by B.C. McDonald prior to, and R.J. Mott following the field season. In addition to discussions led by various members of the Division on their projects, the following papers were given by outside speakers:

Dr. W. Dansgaard, Geophysical Isotope Laboratory, University of Copenhagen, Copenhagen, Denmark - Stable isotope profiles through the Devon Island and Greenland ice caps.

Dr. M.G. Grosswald, Institute of Geography, Academy of Sciences of the U.S.S.R., Moscow - Some current problems of glacial geology in the Soviet Union. (Dr. Grosswald was with the Terrain Sciences Division from May, 1972 to February, 1973, as part of the official exchange program between the National Research Council of Canada and the Academy of Sciences of U.S.S.R.)

Dr. Len Hills, University of Calgary - Paleoclimatic interpretations of the Beaufort Formation.

Mr. Nigel C. Kelland, Unit of Coastal Sedimentation, Natural Environment Research Council, U.K. - Techniques of sediment mapping.

Dr. W.H. Mathews, Department of Geology, University of British Columbia - Erosion surfaces - old and new. (Dr. Mathews was with the Terrain Sciences Division during his 1972-73 sabbatical leave.)

Dr. Steven Porter, Department of Geological Sciences, University of Washington, Seattle - Quaternary glaciation and volcanism in the tropical mid-Pacific.

Dr. A.V. Raukas, Head of the Quaternary Section, Institute of Geology, Estonian Academy of Sciences, Estonian S.S.R. - Relationships between till and bedrock, with examples from Estonia.

A group of scientists of the Division, W. Blake, R.J. Fulton, N.R. Gadd, J.E. Harrison, D.A. Hodgson, C.P. Lewis, J.V. Matthews, B.C. McDonald, W.W. Shilts, and R.G. Skinner, participated in a field trip in the lower St. Lawrence lowlands and the Quebec Appalachians that was led by N.R. Gadd, B.C. McDonald, W.W. Shilts, and P. LaSalle of the Quebec Department of Natural Resources. The purpose of the trip was to examine critical exposures in the regional stratigraphic succession and to discuss regional correlation.

REPORTS ON SUBDIVISIONS AND SECTIONS

DIVISIONAL HEADQUARTERS

In addition to the Division Chief, Divisional Headquarters includes a Technical Services Unit that provides editorial, photogrammetric and cartographic services to scientists of the Division, an Administration and Financial Services Unit comprising Administrative Officer and clerical support, and a Clerical and Secretarial Services Unit comprising Clerical Assistant to Division Chief and secretarial and stenographic support that provides such services to the Division Chief, Subdivision Chiefs and Section Heads. Although not specifically concerned with the internal scientific program of the Division activities related to the Environmental-Social Program, Northern Pipelines and to the Environmental Working Group for the Mackenzie Highway are administered through Divisional Headquarters.

Attendance at Meetings, Talks

T.A. De-Vreeze: attended the meetings of the International Geographical Congress and the International Geological Congress in Montreal in August.

J.G. Fyles: presented a talk entitled "Permafrost and Northern Development" at the Fourth Northern Resources Conference in Whitehorse in April, attended and chaired a session of the Permafrost Thermal Regime Seminar in Saskatoon in May, and was convener of and chaired a session of Section 12 of the International Geological Congress in Montreal.

G. Mizerovsky: attended the International Geographical Congress in Montreal in August.

Membership on Committees

J.G. Fyles
- Departmental Committee on Recent Crustal Movements and Seismic Regionalization
- Subcommittee of Quaternary Geology, National Advisory Committee on Geological Research
- Associate Committee on Geotechnical Research, National Research Council
- Editorial board of journal, "Quaternary Research"
- Member of the National Organizing Committee, and Co-convener of Section XII, International Geological Congress
- Departmental Co-ordinating Committee on Environmental Matters
- Departmental Co-ordinator, Environmental-Social Program, Northern Pipelines

L.A. Jackson - Alternate Chairman, Administrative Support Classification and Evaluation Committee
- Member, Administrative Support Appraisal Committee

Completed Manuscripts

Fyles, J.G., Heginbottom, J.A., and Rampton, V.N.
1972: Quaternary geology and geomorphology, Mackenzie Delta to Hudson Bay; Guidebook for International Geological Congress field excursion A 30.

QUATERNARY SUBDIVISION

B.G. Craig (Head)

Activities of the Subdivision are directed towards a long term goal for completion of standard surficial mapping of Canada accompanied by stratigraphic and associated subsurface studies in order to provide appropriate standards for interpretation and correlation, paleontological investigations to aid stratigraphic correlation and interpretation of paleoenvironments, provision of radiocarbon dating service, and an expanding program of coastal and offshore studies.

Reorganization of Terrain Sciences Division in February created three scientific sections within the Subdivision: Regional Projects Section led by R.J. Fulton, Paleoecology and Geochronology Section led by W. Blake, Jr., and the Marine and Coastal Section led by C.F.M. Lewis.

At the end of the year the staff included one Research Manager, twenty Research Scientists and Physical Scientists, five Physical Scientists on term appointments, four scientists on contract, one Postdoctoral Fellow and three technicians. The scientific capability of the Subdivision was increased by the provision of field support to three professors and three graduate students on Ph.D. programs.

In addition to the staff of the Subdivision located in Ottawa, three staff scientists, three term scientists and two scientists on contract, with support personnel, were based at the Institute of Sedimentary and Petroleum Geology in Calgary, one staff scientist and one term scientist were based at the Canada Centre for Inland Waters in Burlington, and one scientist on contract was based at Kelowna, B.C. with the Soils Division, British Columbia Department of Agriculture.

Personnel Notes

M.G. Grosswald: of the Institute of Geography, Academy of Sciences of the U.S.S.R., Moscow was with the Subdivision as an Exchange Scientist, May 1972 to February 1973.

Attendance at Meetings, Conferences

B.G. Craig: attended the International Geological Congress meeting in Montreal.

V.K. Prest: attended the International Geological Congress in Montreal and was leader of excursion A 61, C 61, "Quaternary geology, geomorphology and hydrogeology of the Atlantic Provinces".

Membership on Committees

B.G. Craig - Subcommittee for Pleistocene Shorelines of the Americas, International Shoreline Commission, INQUA

Completed Manuscripts

Prest, V.K.
1973: Surficial deposits of Prince Edward Island; Geol. Surv. Can., Map 1366 A.

REGIONAL PROJECTS SECTION

R.J. Fulton (Head)

The activities of this section are largely directed toward providing a Canada-wide inventory of the unconsolidated deposits and landforms and establishing their stratigraphic and environmental history. Mapping projects are undertaken at various scales, chosen on the basis of the present state of knowledge and potential use. This information is of value to forestry, agriculture, engineering construction and the mineral industry and is used in land use and environmental impact studies.

The field mapping of surficial deposits of the Mackenzie Valley Transportation Corridor was completed with preliminary maps of most of the approximately 40 map-areas being released to the public through open file by the end of March 1973. Airborne reconnaissance mapping projects were continued in northern Manitoba and on Melville Island and a new similar project was started on Ellesmere Island.

The Special Employment Program, drift prospecting project, directed by R.G. Skinner, continued into the 1972-73 report year with drilling and sampling being completed in May. Sample analysis and data compilation and reduction phases of this extensive project had been pretty much completed by March 1973 and maps containing the raw data had been released for 77 townships.

Members of the section made substantial contributions to the International Geological Congress in Montreal. A.M. Stalker was co-convener of the Quaternary Geology section of the technical program and seven members of the section were involved in field excursions.

Personnel Notes

R.J. Fulton: was designated section head in February.

W.H. Mathews: continued his association with the section during his sabbatical leave from the University of British Columbia until the end of the field season.

Section professional strength was augumented by contract personnel N.F. Alley, stationed in Kelowna, and A.N. Boydell and P.T. Hanley stationed in Calgary. J.A. Netterville, J.A. Pilon and J.J. Veillette worked out of Calgary office on term appointments.

Attendance at Meetings, Conferences and Courses

R.J. Fulton: attended International Geological Congress in Montreal and with E.C. Halstead, Inland Waters Directorate, led a field trip across the Canadian Cordillera, participated in the Terrain Sciences Division's Lower St. Lawrence stratigraphic correlation trip and was a departmental representative at the Man and Resources Workshop in Montebello in November.

D.R. Grant: attended International Geological Congress in Montreal where he gave a paper on recent crustal submergence in Nova Scotia, attended the Coastal Geomorphology Symposium in Binghamton, New York in September and took in the American Quaternary Association meeting, Miami, Florida in early December. He also was one of the leaders of the International Geological Congress field trip A 61, C 61, "Quaternary geology, geomorphology and hydrogeology of the Atlantic Provinces".

D.A. Hodgson: participated in the Terrain Sciences Division's Lower St. Lawrence stratigraphic correlation trip.

O.L. Hughes: was a leader of International Geological Congress excursion A 11 "Quaternary geology and geomorphology, southern and central Yukon" and took part in a seminar course on permafrost at the University of Calgary.

R.W. Klassen: attended the International Geological Congress and was a co-leader of excursion C 22 "Quaternary geology and geomorphology from Winnipeg to the Rocky Mountains", attended the Annual Meeting of the Geological Society of America in Minneapolis in November, and took a short seminar course on permafrost at the University of Calgary.

V.N. Rampton: was a co-leader on International Geological Congress field trip A 11 "Quaternary geology and geomorphology, southern and central Yukon" and attended the Annual Meeting of the Geological Society of America in Minneapolis.

N.W. Rutter: was a leader of International Geological Congress excursions A 11 "Quaternary geology and geomorphology, southern and central Yukon" and of C 22 "Quaternary geology and geomorphology from Winnipeg to the Rocky Mountains", attended a seminar course on permafrost at the University of Calgary and continued his tie with the Department of Archaeology, University of Calgary by being involved in an evening seminar course.

R.G. Skinner: gave a paper "Pleistocene stratigraphy of the Hudson Bay Lowlands" at the Guelph symposium on the Hudson Bay Lowlands in March, attended the Prospectors and Developers Association conference in Toronto in March, presented a paper on Quaternary deposits of the Hudson Bay Lowlands at the International Geological Congress and took part in Terrain Sciences Division's Lower St. Lawrence stratigraphic correlation trip in October.

A.M. Stalker: attended the International Geological Congress where he and C.S. Churcher, University of Toronto, presented a paper "Glacial stratigraphy of the southwestern Canadian Prairies, the Laurentide record" and acted as a convener of Section 12, Quaternary Geology. He also was a co-leader of International Geological Congress excursion C 22 "Quaternary geology and geomorphology from Winnipeg to the Rocky Mountains", aided D.A. St-Onge with commission meeting Ca 12, Geomorphological Survey and Mapping, of the International Geographical Congress in August and attended the field conference of Eastern Section, Friends of the Pleistocene, Ithaca, New York in May.

Special Talks or Lectures

N.F. Alley: presented a series of lectures on Quaternary geology and geomorphology at British Columbia Soils Division headquarters in Kelowna, British Columbia.

R.J. Fulton: gave talks and led a discussion of terrain mapping in mountainous areas at British Columbia Soils Division, Kelowna, British Columbia in January.

O.L. Hughes (with V.N. Rampton): presented a seminar "Terrain classification and its significance in land use regulations" to the staff of the Mackenzie Forest Service, Inuvik.

N.W. Rutter: gave a talk to the Society Sigma Xi, University of Calgary on activities of Calgary based members of Terrain Sciences Division and gave talks on methods employed in Mackenzie Valley terrain studies to the environmental studies group, University of Alberta in March and to an interdisciplinary group at the University of Western Ontario in October.

R.G. Skinner: gave a paper on drift prospecting to the Geology discussion group of the Engineers Club in Toronto in March.

Membership on Committees

R.J. Fulton - Member, Canada Soil Survey Subcommittee on Classification of Landforms

O.L. Hughes - Member of the Permafrost and of the Pipeline and Land use Subcommittees, Associate Committee on Geotechnical Research, National Research Council

N.W. Rutter - G.S.C. Library Committee, Calgary
- Organization Committee of the 22nd Annual Clay Conference which will be held in Banff, October 1973

A.M. Stalker - Branch representative, Interdepartmental Committee on Salvage Archaeology.

Completed Manuscripts

Alley, N.V., and Fulton R.J.
1973: Co-operative terrain mapping, south-central British Columbia; Geol. Surv. Can., Paper 73-1, Pt. A, p. 188.

Andrews, J.T., and Barnett, D.M.
1972: Analyses of strandline tilt directions in relation to ice centers and postglacial crustal deformation, Laurentide Ice Sheet; Geograf. Ann., v. 54, ser. A, p. 1-11.

Barnett, D.M.
Authropogenic ice: notes on a climatic ephemeral cryeric landform; to be published in J. of Glaciol.

Barnett, D.M., and Forbes, D.L.
1973: Surficial geology and geomorphology of Melville Island; Geol. Surv. Can., Paper 72-1, Pt. A, p. 189-192.

1973: Terrain performance, Melville Island, District of Franklin; Geol. Surv. Can., Paper 72-1, Pt. A, p. 182.

Clarke, A.H., Grant, D.R., and Macpherson, E.
1972: The relationship of Atractodon Stonei (Pilsbry) (Mollusca Buccinidae) to the Pleistocene stratigraphy and paleoecology of southwestern Nova Scotia; Can. J. Earth Sci., v. 9, p. 1030-1038.

Crampton, C.B., and Rutter, N.W.
1973: A geoscience terrain analysis of discontinuously frozen ground in the upper Mackenzie River Valley, Canada; in Proc. 2nd Int. Permafrost Conf., Yakutsk, U.S.S.R.

Dredge, L.
1973: Surficial geology, Sept-Iles - Cap Chat, Quebec; Geol. Surv. Can., Paper 73-1, Pt. A, p. 192-193.

Fenton, M.M.
1973: Quaternary geology, Winnipeg map-area; Geol. Surv. Can., Paper 73-1, Pt. A, p. 194.

French, H.M.
1972: The proglacial drainage of northwest Banks Island; The Musk-ox, Publ. no. 10, p. 26-31.

1972: Mass wasting at Sachs Harbour, Banks Island, N.W.T.; submitted to J. Arctic and Alpine Res.

French, H.M., and Egglington, P.
1972: Thermokarst processes, Banks Island, Canada; Proc. 2nd Intern. Permafrost Conf., Yakutsk.

Fulton, R.J.
1972: Stratigraphy of unconsolidated fill and Quaternary development of North Okanagan Valley; in Bedrock topography of the North Okanagan Valley and stratigraphy of the unconsolidated valley fill, Geol. Surv. Can., Paper 72-9, Pt. B, p. 9-17.

1973: Terrain mapping in mountainous areas; Geol. Surv. Can., Paper 73-1, Pt. A, p. 194-196.

Fulton, R.J., and Halstead, E.C.
1972: Quaternary geology of southern Canadian Cordillera; 24th International Geological Congress, Guidebook for excursion A 02.

Fyles, J.G., Heginbottom, J.A., and Rampton, V.N.
1972: Pleistocene geology and geomorphology, Mackenzie and Keewatin Districts, N.W.T.; 24th International Geological Congress, Guidebook for excursion A 30.

Grant, D.R.
1972: Postglacial emergence of northern Newfoundland; Geol. Surv. Can., Paper 72-1, Pt. B, p. 100-102.

Grant, D.R., Lewis, C.F.M., McDonald, B.C., Mathews, W.H., and Scott, J.S.
1972: Coastal geomorphology and man; in Coastal Zone, v. 1 Selected Background Papers: Atlantic Unit, Water Management Service, Dept. of Environment, p. 178-188.

Grant, D.R.
1973: Canada - Newfoundland and Labrador mineral development program; Geol. Surv. Can., Paper 73-1, Pt. A, p. 196-198.

1973: Recent rise of sea level over Nova Scotia; in special volume, Nova Scotian Institute of Science.

1973: Disjunct glacial transport and marine overlap, Burin Peninsula; in Maritime Sediments.

1973: Deglaciation of Newfoundland by shrinkage,migration and separation of local ice cap; in Maritime Sediments.

Grosswald, M.G.
1973: Reconnaissance glacial geology, southwestern Grinnell Peninsula, Devon Island, District of Franklin; Geol. Surv. Can., Paper 73-1, Pt. A, p. 199-200.

Henderson, E.P.
1973: Quaternary geology, Haliburton-Burleigh Falls area, Ontario; Geol. Surv. Can., Paper 73-1, Pt. A, p. 200-202.

Hills, L.V.
1973: Beaufort Formation, western Queen Elizabeth Islands; Geol. Surv. Can., Paper 73-1, Pt. A, p. 202.

Hills, L.V., and Fyles, J.G.
1973: The Beaufort Formation, Canadian Arctic Islands; Symposium on geology of the Canadian Arctic (submitted for publication in Proceedings).

Hodgson, D.A., and Fulton, R.J.
1972: Site description, age and significance of a shell sample from the mouth of Michel River, 30 km south of Cape Harrison, Labrador; Geol. Surv. Can., Paper 72-1, Pt. B, p. 102-105.

Hodgson, D.A.
1973: Terrain performance, central Ellesmere Island, District of Franklin; Geol. Surv. Can., Paper 73-1, Pt. A, p. 185.

1973: Surficial geology and geomorphology of central Ellesmere Island; Geol. Surv. Can., Paper 73-1, Pt. A, p. 203.

1973: Central Ellesmere Island observations on ground ice, in Can. Geophys. Bull. and Ice.

Hopkins, W.S., Rutter, N.W., and Rouse, G.
1972: Geology and palynology of deformed Oligocene rocks from the northern Rocky Mountain Trench, B.C., Can. J. Earth Sci., v. 9, p. 460-470.

Hughes, O.L., Hodgson, D.A., and Pilon, J.
1972: Surficial geology of Fort Good Hope (106 I), Fort MacPherson (106 M) and Arctic Red River (106 N); maps at 1:125,000 scale; Geol. Surv. Can., Open File No. 97.

1972: Surficial geology of Ontaratue River (106 J), Martin House (106 K) and Travaillant Lake (106 O); maps at 1:125,000 scale; Geol. Surv. Can., Open File No. 108.

Hughes, O.L., Rampton, V.N., and Rutter, N.W.
1972: Quaternary geology and geomorphology of southern and central Yukon; International Geological Congress, Guidebook for excursion A 11.

Hughes, O.L., Pilon, J., and Veillette, J.
1973: Surficial geology and land classification, Mackenzie Valley Transportation Corridor; Geol. Surv. Can., Paper 73-1, Pt. A, p. 229-230.

Klassen, R.W.
1972: Wisconsin events and the Assiniboine and Qu'Appelle Valleys of Manitoba and Saskatchewan; Can. J. Earth Sci., v. 9, p. 544-560.

1972: Surficial geology of Duck Mountain (62 N) area, Manitoba-Saskatchewan; photogeologic map, scale 1:250,000; Geol. Surv. Can., Open File No. 92.

Klassen, R.W., and Netterville, J.A.
1973: Quaternary geology inventory, lower Nelson River basin; Geol. Surv. Can., Paper 73-1, Pt. A, p. 204-205.

1973: Surficial geology of Hayes River (54 C) and Kettle Rapids (54 D) areas, Manitoba; photogeologic maps, scale 1:125,000, and 24 p. ms of stratigraphic sections; Geol. Surv. Can., Open File No. 134.

1973: Surficial geology of Nelson House (63 O) and Uhlman Lake (64 B); photogeologic map, scale 1:125,000; Geol. Surv. Can., Open File No. 142.

Mackay, J.R., Rampton, V.N., and Fyles, J.G.
1972: Relic Pleistocene permafrost, western Arctic Canada; Science, v. 176, p. 1321-1323.

Mathews, W.H.
1973: Quaternary geology, Charlie Lake, British Columbia; Geol. Surv. Can., Paper 73-1, Pt. A, p. 210-211.

Mott, R.J., and Stalker, A.MacS.
1972: Palynology of the "Kansan" carbonaceous clay unit near Medicine Hat, Alberta; Geol. Surv. Can., Paper 72-1, Pt. B, p. 117-119.

Prest, V.K., Jones, J.F., MacNeill, R.H., Grant, D.R., Brookes, I.A.
1972: Quaternary geology, geomorphology and hydrology of the Atlantic Provinces; International Geological Congress, guide to excursion A 61, C 61.

Rampton, V.N.
1972: An outline of Quaternary geology of the lower Mackenzie region; in Mackenzie Delta Area Monograph, International Periglacial Comm. of International Geographical Congress, Montreal.

1972: Surficial geology Mackenzie Delta (107 C), Stanton (107 D), Cape Dalhousie (107 E), and Malloch Hill (97 F); maps at 1:125,000 scale; Geol. Surv. Can., Open File No. 96.

1972: Surficial deposits, Alaska Highway, Whitehorse to Alaska-Yukon Boundary; Geol. Surv. Can., Paper 72-1B, p. 119-122.

1972: Surficial geology and landforms, Aklavik (107 B, E½); map at 1:125,000 scale; Geol. Surv. Can., Open File No. 119.

1973: Surficial deposits of Yukon Coastal Plain and adjacent areas; Geol. Surv. Can., Paper 73-1, Pt. A, p. 237-239.

Rutter, N.W.
1972: Geomorphology and glacial history, Banff area, Alberta; in International Symposium, The Role of Snow and Ice in Hydrology, p. 92-102.

Rutter, N.W., and Christiansen, E.A. (with contributions by R.W. Klassen and A.M. Stalker)
1972: Quaternary geology and geomorphology from Winnipeg to the Rocky Mountains; International Geological Congress, Guidebook for excursion C 22.

Rutter, N.W., Geist, V., and Shackleton, D.A.
1972: A bighorn sheep skull 9,280 years old from British Columbia; J. Mammalogy, v. 53, p. 641-644.

Rutter, N.W., and Minning, G.V.
1972: Surficial geology of Mills Lakes (83 E), Trout Lake (95 A), Fort Simpson (95 H), and Camsell Bend (95 J) map-areas; photogeologic maps at 1:125,000 scale; Geol. Surv. Can., Open File No. 93.

Rutter, N.W., and Boydell, A.N.
1973: Surficial geology and land classification, Mackenzie Valley Transportation Corridor; Geol. Surv. Can., Paper 73-1, Pt. A, p. 239-241.

Ryder, J.M., and Fulton, R.J.
1973: Terrain inventory and Quaternary geology of the Ashcroft map-area, British Columbia; Geol. Surv. Can., Paper 73-1, Pt. A, p. 212.

Skinner, R.G.
1972: Data compilation maps of 77 townships in the Timmins-Val-d'Or area, northeastern Ontario and northwestern Quebec; Geol. Surv. Can., Open File Nos. 84, 104, 105.

1972: Results of an overburden drilling and geochemical program during winter 1971-1972: (a) Drift prospecting in the Abitibi Clay Belt; overburden drilling program - methods and costs (27 p. report); (b) Hole location maps, stratigraphic profiles, geochemical logs, petrographic descriptions of thin sections of drill chips from bedrock and boulders, and geochemical analyses of bedrock chips; Geol. Surv. Can., Open File No. 116.

1972: Overburden drilling and sampling and geological data compilation; Timmins-Val-d'Or area; Geol. Surv. Can., Paper 72-1, Pt. B, p. 122-123.

1972: Overburden study aids search for ore in Abitibi Clay Belt; Northern Miner, Annual Review Number, p. 26.

1973: Prospecting for diamonds in northern Ontario - a suggestion; Geol. Surv. Can., Paper 73-1, Pt. A, p. 218-219.

1973: Pleistocene stratigraphy of the Hudson Bay Lowland; to be published in the Proceedings of Symposium on the Hudson Bay Lowland, Guelph University.

Stalker, A.M.
in press Surficial geology of the Kananaskis Research Forest and Marmot Creek Basin Region of Alberta; Geol. Surv. Can., Paper 72-51.

1973: Correlation and chronology of Cordillera and Laurentide glaciations in southwestern Alberta, Canada; INQUA, New Zealand, abstract.

Stalker, A.MacS., and Churcher, C.S.
1972: Glacial stratigraphy of southwestern Canadian Prairies; the Laurentide record; Int. Geol. Cong., Montreal, Section 12, Quaternary Geology, p. 110-119.

Szabo, B.J., Stalker, A.MacS., and Churcher, C.S.
Uranium-series ages of some Quaternary deposits near Medicine Hat, Alberta, Canada; Can. J. Earth Sci. (submitted)

Thomas, M.L.H., Grant, D.R., and DeGrace, M.
1972: A Late Pleistocene marine shell deposit at Shippegan, New Brunswick; in Le Naturaliste Canadien.

Wyder, J., Hunter, J., and Rampton, V.N.
1972: Geophysical investigations of surficial deposits at Tuktoyaktuk, N.W.T.; Geol. Surv. Can., Open File No. 128.

PALEOECOLOGY AND GEOCHRONOLOGY SECTION

W. Blake, Jr. (Head)

This unit comprises Quaternary Paleoecology and Radiocarbon Laboratory. It provides analyses of fossil materials (especially pollen, mosses, wood, seeds and diatoms) and radiocarbon dates as a service to other units and individuals; a particular effort is made to identify all materials dated by the radiocarbon laboratory. The unit also determines variations in radiocarbon content of modern materials as background for other research, and investigates the chronology of fossil-bearing deposits. Research on changes in environment and in the distribution of plants, insects and marine invertebrates during the Quaternary is being conducted. A program of dendrochronological investigations, both applied and in the development of techniques, was supported between 1967 and 1970 and is being continued elsewhere in co-operation with various members of Terrain Sciences Division.

Field work by one member (R.J. Mott) of the section was undertaken in Manitoba, Ontario and Quebec, another member (T.W. Anderson) carried out field work in British Columbia, and a third member (W. Blake, Jr.) worked in the Northwest Territories.

Personnel Notes

T.W. Anderson: joined the permanent staff in July 1972 after having spent a year with the Division as a Postdoctoral Fellow. At present he is stationed at C.C.I.W., Burlington, to carry out palynological studies of cores from the Great Lakes and adjoining areas.

J.V. Matthews, Jr.: joined the staff in October 1972 as a Postdoctoral Fellow to carry out studies of fossil insects, especially in the Arctic.

Attendance at Meetings

T.W. Anderson: attended the Annual Meeting of the American Association of Stratigraphic Palynologists in Newport, Rhode Island, in October 1972 and the Second National Conference of the American Quaternary Association in Miami, Florida in December 1972.

W. Blake, Jr.: participated in the International Geological Congress excursion A 11 to the southern and central Yukon, and attended the Quaternary Sessions of the 24th International Geological Congress in Montreal, both in August 1972. He also participated in the St. Lawrence River Valley stratigraphic correlation trip of the Division in October 1972 and attended a meeting of the Northeastern North American Branch of the International Glaciological Society at Montebello, Quebec in March 1973.

S. Federovich: attended the Annual Meeting of the American Association of Stratigraphic Palynologists in Newport, Rhode Island in October 1972.

M. Kuc: attended the Second National Conference of the American Quaternary Association in Miami, Florida in December 1972.

J.V. Matthews, Jr.: participated in the St. Lawrence River Valley stratigraphic correlation trip of the Division in October 1972 and attended a planning session of the Beringian Committee in Edmonton in March 1973.

R.J. Mott: attended the Annual Friends of the Pleistocene Meeting in Ithaca, New York in May 1972, the Quaternary Sessions of the 24th International Geological Congress in Montreal in August 1972, and the Annual Meeting of the American Association of Stratigraphic Palynologists in Newport, Rhode Island in October 1972.

Membership on Committees

W. Blake, Jr. - Chairman, Geological Survey Radiocarbon Dating Committee
- Earth Sciences Grant Selection Committee, NRC

J.A. Lowdon - Geological Survey Radiocarbon Dating Committee

J.V. Matthews, Jr. - Beringian Committee

Production Statistics

Paleoecology

Organization and maintenance of the Pleistocene Palynology Laboratory is under the supervision of R.J. Mott. Field investigations were carried out during the year by both T.W. Anderson and R.J. Mott.

T.W. Anderson carried out palynological work in support of field projects by C.F.M. Lewis and P.F. Karrow (University of Waterloo), as well as for the staff of C.C.I.W., Burlington. S. Federovich continued palynological laboratory work (6 reports on 27 samples) in support of field projects by W. Blake, Jr., O.L. Hughes, V.N. Rampton, and R.G. Skinner. R.J. Mott carried out palynological work (13 reports on 32 samples) in support of field projects by D.M. Barnett, R.J. Fulton, D.R. Grant, D.A. Hodgson, V.K. Prest, A.M. Stalker, and H.W. Tipper, as well as for M. Fenton (University of Western Ontario), C.R. Harington (National Museum of Natural Sciences), P.F. Karrow (University of Waterloo), and D.R. Oliver (Entomology Research Institute).

Work was continued by S. Federovich in building up a collection of reference material for the identification of diatoms, and samples collected by N.R. Gadd, V.N. Rampton, R.G. Skinner, and W. Blake, Jr. were studied (7 reports on 22 samples). In conjunction with J.V. Matthews, Jr., work on building up a reference seed collection was continued, and a study of seeds in samples from the Watino Section, Alberta was completed for J. Westgate (University of Alberta).

During the year M. Kuc made 56 bryological reports, which included data on vascular plants and other organic remains as well as on mosses.

R.J. Mott and L. Wilson produced 80 reports on the identification of 149 samples of wood.

J.V. Matthews, Jr. produced 3 fossil arthropod reports, based on 2 samples submitted by V.N. Rampton and one submitted by C.R. Harington (National Museum of Natural Sciences).

Radiocarbon Dating

Laboratory: The Radiocarbon Dating Laboratory, under the supervision of J.A. Lowdon, has at its disposal three proportional counters, any two of which may be used at the same time. The 1-L counter was operated for one month; the 2-L for eleven months; and the 5-L for twelve months. Because of continuing problems with the stability of results from the 2-L counter, due to voltage fluctuations resulting from temperature and humidity changes in Room B-50, a new air-conditioning unit was installed.

Age calculations are now being carried out monthly by a C.D.C. 6400 computer which has replaced the C.D.C. 3100 used previously from January 1963 through December 1972; all radiocarbon age determinations reported by the Radiocarbon Laboratory quoted an age error which included an error term to account for the average variation of ± 1.5% in the C^{14} concentration of the atmosphere over the past 1100 years. Recent work

on bristlecone pine by laboratories at the University of Arizona and the University of Pennsylvania, among others, have now furnished sufficient data to provide a conversion table from radiocarbon years to tree ring (calendar) years for the last 7500 years. This data takes into account the variations in the C^{14} concentration (up to 15%) in the atmosphere during this period. Thus, it has been decided to omit the correction (factor) for fluctuations of atmospheric C^{14} concentration from G.S.C. radiocarbon dates as of January 1, 1973.

In addition to the continuing program of monitoring atmospheric fluctuations of radiocarbon at Ottawa, another research project involves testing the validity of dates obtained from bone apatite as opposed to bone collagen. Reference samples for cross-checking purposes continue to be supplied to new laboratories which are starting up, and during the past year one check sample was supplied to Brock University.

Program: Samples for age determination in the Radiocarbon Dating Laboratory were selected by an informal committee, headed by W. Blake, Jr., in consultation with J.A. Lowdon and with other members of the staff as appropriate to the samples under consideration. Most of the samples analyzed were selected to provide data for current research projects in the field of Quaternary chronology and related glacial events, to shed light on crustal movement, and to provide information on the rates of geological processes such as sedimentation and solifluction. A total of 193 age determinations were carried out on 188 samples: of these 184 were on geological samples, 9 were on samples from archaeological sites (mostly submitted by the National Museum of Canada), and in addition 11 analyses were carried out on geochemical samples. 88 samples of CO_2 gas were submitted for C^{13}/C^{12} determinations in order to determine the possible effects of carbon isotope fractionation in various materials; i.e. wood charcoal, peat, gyttja, soil, bone, and shell. These analyses were carried out by the Geochronology Section, Crustal Geology Division, under the supervision of Dr. R.K. Wanless.

Results of age determinations from the laboratory are no longer being published first in Radiocarbon and then reprinted by the Geological Survey in the Paper series. Instead, starting with list XII (1972), laboratory results are being published directly as G.S.C. Papers, so as to permit the information to be made available more rapidly and to allow more leeway in the presentation of data. List XII includes 45 age determinations on 43 archaeological samples.

Completed Manuscripts

Anderson, T.W.
1973: Historical evidence of land use in a pollen profile from Osoyoos Lake, British Columbia; in Report of Activities, Pt. A, April to October 1972; Geol. Surv. Can., Paper 73-1, Pt. A, p. 178-180.

Blake, W., Jr.
1973: Former occurrence of Mytilus edulis L. on Coburg Island, Arctic Archipelago; Naturaliste Canadien, v. 100, no. 1, p. 51-58.

Kuc, M.
1972: The response of tundra plants to anthropogenic habitats in the High Arctic; in Report of Activities, Pt. B, November 1971 to March 1972; Geol. Surv. Can., Paper 72-1, Pt. B, p. 105-112.

1973: Fossil statoblasts of Cristatella mucedo Cuvier in the Beaufort Formation and in interglacial and postglacial deposits of the Canadian Arctic; Geol. Surv. Can., Paper 72-28, 12 pp.

in press Additions to the Arctic moss flora - VI. Altitudinal differentiation of moss cover at Purchase Bay, Melville Island, N.W.T.; Revue Bryologique et Lichénologique.

Lichti-Federovich, S.
1972: Pollen stratigraphy of a sediment core from Alpen Siding Lake, Alberta; in Report of Activities, Pt. B, November 1971 to March 1972; Geol. Surv. Can., Paper 72-1, Pt. B, p. 113-115.

1973: Palynology of six sections of late Quaternary sediments from the Old Crow River, Yukon Territory; Can. J. Botany, v. 51, no. 3, p. 553-564.

submitted: Megafossil analysis; in Paleoecology of Quaternary sediments of mid-Wisconsin age in west-central Alberta, Canada, (J. Westgate, compiler); Palaeogeography, Palaeoclimatology, Palaeoecology.

Lowdon, J.A., Wilmeth, R., and Blake, W., Jr.
1972: Geological Survey of Canada radiocarbon dates XII; Geol. Surv. Can., Paper 72-7, 26 p.

Matthews, J.V., Jr.
submitted: Quaternary environments at Cape Deceit (Seward Peninsula, Alaska): Evolution of a tundra ecosystem; Geol. Soc. America, Special Paper.

Matthews, J.V., Jr., and Sher, A.V.
submitted: Fossil insects from the Early Pleistocene Olyor Suite (Chukochya River: Kolymian Lowland, U.S.S.R.).

Mott, R.J., and Stalker, A.M.
1972: Palynology of the "Kansan" carbonaceous clay unit near Medicine Hat, Alberta; in Report of Activities, Pt. B, November 1971 to March 1972; Geol. Surv. Can., Paper 72-1, Pt. B, p. 117-119, 121.

Mott, R.J.
1973: Quaternary palynology, Manitoba and Quebec; in Report of Activities, Pt. A, April to October 1972; Geol. Surv. Can., Paper 73-1, Pt. A, p. 180-181.

1973: Palynological studies in central Saskatchewan - Pollen stratigraphy from lake sediment sequences; Geol. Surv. Can., Paper 72-49, 18 p.

MARINE AND COASTAL SECTION

C.F.M. Lewis (Head)

Activities of the Division concerning the seafloor and coasts of the Pacific region, Great Lakes region, and Arctic Island channels, and liaison activities with other groups and agencies undertaking related work are the responsibility of this section. As the section becomes more fully staffed and organized its projects should provide inventory information about the seafloor and coast, their stratigraphic sequence and environmental history and develop regional understanding of geodynamic, geomorphic, sedimentary and geochemical processes and the engineering attributes that control the stability and character of coastline, seafloor and sediments. Such information will be utilized in offshore and coastal engineering planning for pipeline and cable routes, anchoring and wellhead completion problems; environmental and ecological studies; dredging and waste disposal management; mineral resource estimates including aggregate sources; fishery management; and in defence considerations.

Offshore studies in the Beaufort Sea area, under the direction of J.M. Shearer, continued to provide information on permafrost beneath the seafloor, sediment scour by floating ice, sediment thickness and stratigraphy, and evidence of an Holocene transgression of the sea across a previous land surface.

Studies of Great Lakes sediments were also continued, through palynological investigations of sediment sequences and buried marsh zones by T.W. Anderson (Paleoecology and Geochronology section); stratigraphic coring and engineering analyses by C.F.M. Lewis et al.; core description and X-radiography by J.R. Horsman. Much of this work was done at Burlington, Ontario, co-operatively with staff and facilities of Canada Centre for Inland Waters. Contract studies by Professor P. Fritz (University of Waterloo) produced new data on the late Quaternary environmental history of Lake Erie from analysis of stable oxygen and carbon isotopes in fossil molluscan shells.

From December to February C.F.M. Lewis spent considerable time with Y.O. Fortier and J.O. Wheeler compiling and writing a Departmental marine geoscience program for the Pacific region.

Personnel Notes

C.F.M. Lewis: was transferred from Burlington to Ottawa in September to organize a Divisional program of marine and coastal activities, and was appointed head of the section in February.

P. McLaren: was employed on a professional fee basis from mid-January to the end of the year while at the University of South Carolina in order to carry out preparations for an Arctic Islands project during the 1973 field season.

Attendance at Meetings, Conferences

C.F.M. Lewis: attended the Thirteenth International Conference on Coastal Engineering in Vancouver in July, the meetings of the International Geological Congress in Montreal in August and the Geomorphology Symposium on Coastal Processes in Binghamton, New York in September.

Membership on Committees

C.F.M. Lewis
- Member, EMR Task Force on Eastern Offshore Geoscience Program
- Member, EMR Western Offshore Program Committee

Completed Manuscripts

Thomas, R.L., Kemp, A.L.W., and Lewis, C.F.M.
1973: The surficial sediments of Lake Huron; Can. J. Earth Sci., v. 10, p. 226-271.

Lewis, C.F.M., Wootton, A.E., and Davis, J.B.
1973: Stratigraphic and engineering studies of unconsolidated sediments in central Lake Erie near Erieau, Ontario; in Report of Activities, Pt. A, April to October 1972; Geol. Surv. Can., Paper 73-1, Pt. A, p. 205-210.

Shearer, J.M.
1973: Surficial geology and geomorphology, Mackenzie Bay - continental shelf; in Report of Activities, Pt. A, April to October 1972; Geol. Surv. Can., Paper 73-1, Pt. A, p. 242.

GEOTECHNICAL SUBDIVISION

J.S. Scott (Head)

The Subdivision is responsible for those aspects of the Division's scientific program directed toward the provision of use-hazard information on surface and near surface earth and rock materials. This information includes the characterization of geological and geotechnical properties and the determination of active geological and geomorphic processes that contribute to terrain hazards or other terrain attributes that influence man's use of the land mass.

Sections within the newly organized Subdivision viz. Sedimentology and Mineral Tracing, Engineering and Environmental Geology, and Urban Geology have evolved primarily from the former Engineering Geology and Geodynamics Section. These sections reflect the scope of activities within the Subdivision and the formation of an Urban Projects Section for the first time within the Branch serves to emphasize the growing importance of the application of geoscience to planning and related activities within the ever expanding urban centres of Canada.

Operation of the Sedimentology-Engineering Geology Laboratory, Flume Laboratory and Geomathematics Unit all of which serve the scientific projects of the Division are included within the responsibilities of the Subdivision.

During the year the Subdivision continued to direct a major part of its effort to projects in the Mackenzie Valley designed to provide information on material properties and terrain performance related to potential oil or gas pipeline routes and to construction of the Mackenzie Highway. Field work on these projects was concentrated during the summer period, however, late winter field operations involving drilling and geophysical surveys were carried out in the Fort Simpson, Norman Wells and Tuktoyaktuk areas.

Personnel Notes

J.A. Code: resigned from the Geological Survey in December to accept employment with the consulting firm of Dames and Moore in Calgary.

J.E. Harrison: joined the Geological Survey in June from the staff of the Department of Geology, University of Calgary.

B.C. McDonald: was appointed Head, Sedimentology and Mineral Tracing Section in February.

E.B. Owen: was on full time secondment to the Water, Lands and Forests Division of the Department of Indian and Northern Affairs to assist DINA in the evaluation of application of land use permits.

D.A. St-Onge: was appointed Head, Urban Projects Section in February.

Attendance at Meetings, Conferences, Courses

E.B. Owen: was a co-leader of International Geological Congress Trip C 51b on "Engineering Geology in Eastern Canada - southern Ontario".

J.S. Scott: attended a Grid Organization Development seminar in Cornwall, Ontario in April; attended the International Geological Congress in Montreal in August and was a co-convener of the technical section on Engineering Geology.

Special Talks or Lectures

E.B. Owen: presented a lecture on "Construction of a hot-gas pipeline in Fort Liard area, N.W.T." to several audiences in Ottawa and to members of the Department of Geological Sciences, Brock University.

Membership on Committees

E.B. Owen
- Vice-chairman, Mackenzie Highway Granular Materials Working Group
- Member, Mackenzie Highway Environmental Working Group

Completed Manuscripts

Owen, E.B.
1972: Geology and Engineering description of soils in the Welland-Port Colborne area, Ontario; Geol. Surv. Can., Paper 71-49.

1973: Dam site investigations, Yukon and District of Mackenzie; Geol. Surv. Can., Paper 73-1, Pt. B, p. 236-237.

St-Onge, D.A., and Scott, J.S.
1972: Geoscience and Ste-Scholastique; Can. Geograph J., v. 85, no. 1, p. 232-237.

SEDIMENTOLOGY AND MINERAL TRACING SECTION

B.C. McDonald (Head)

This section is concerned with the study of active geomorphic and sedimentologic processes and with the development of mineral prospecting techniques that use glacial drift as the prospecting medium. Laboratory and computer functions that support these and other analytical and technical requirements of the Division are also located in this section.

Field study of sedimentary and geomorphic processes were carried out in fluvial and coastal environments of the Yukon coastal zone and were supported by the Environmental-Social Program, Northern Pipelines, of the Task Force on Northern Oil Development, Government of Canada.

Field work on drift prospecting was carried out in the District of Keewatin with a primary objective being study of the influence of permafrost and the active layer on trace-element distribution in the glacial sediments near the ground surface.

Attendance at Meetings, Conferences, and Courses

D.E. Field: attended a D.E.M.R. training course on the "Fundamentals of Supervision".

C.P. Lewis: attended a Symposium on Coastal Processes at the State University of New York at Binghamton in September.

B.C. McDonald: attended the Symposium on Coastal Processes at the State University of New York at Binghamton in September; attended the International Geological Congress in Montreal and was a co-leader on trip C 44 on "Quaternary geology and geomorphology in southern Quebec".

W.W. Shilts: attended the International Geological Congress in Montreal and was a co-leader on trip C 44 on "Quaternary geology and geomorphology in southern Quebec"; attended the 6th Annual Meeting of the North-central section of the Geological Society of America at DeKalb, Illinois in May and participated in a pre-meeting field trip; attended the Midwest Section meeting of Friends of the Pleistocene in Danville, Illinois, in May; attended the Prospectors and Developers Association meeting in Toronto in March; and attended the March meeting of the North-eastern Section of Geological Society of America in Allentown, Pa.

Special Talks or Lectures

B.C. McDonald: "Geomorphic and sedimentary processes of rivers and coast, Yukon coastal zone" presented to Departments of Geology at University of Pennsylvania, Philadelphia, and Queens University, Kingston.

W.W. Shilts: "Trace element dispersal in till from southern Quebec" presented to Northeastern Section of Geological Society of America, DeKalb, Illinois, and to Department of Geology, University of Western Ontario, London.

Membership on Committees

B.C. McDonald
- Member, Hydraulic Design Assessment Committee of the Mackenzie Highway Environmental Working Group
- Member, Interdepartmental Working Group to study environmental consequences of channel improvements on the Mackenzie River

Sedimentology-Engineering Geology Laboratories

D.E. Lawrence

Analysis and tests are undertaken in three laboratories. The majority of testing is carried out at the Spencer Street laboratory where facilities are the most extensive. In Calgary, a similar facility on a smaller scale exists to serve members of the Division stationed there.

The Booth Street facilities are mainly used for non-routine jobs or those requiring close supervision. Technique development is also undertaken at Booth Street.

Increased production this year was mainly a function of an increase in the number of technicians employed at the Spencer Street laboratory, under the supervision of R.G. Kelly. Production of the laboratory is summarized as follows:

		No. samples	
Operation		1972-73	1971-72
Grain size analysis,	sieve only (2mm-64μ)	492	64
,	complete sieve + pipette (2mm-2μ)	516	395
,	sand, silt, clay ratios	675	600
,	by rapid sediment analyser (4mm to 50μ only)	-	364
,	pipette or hydrometer	-	357
Moisture content		1928	598
Atterberg Limits		208	108
Carbonate Analysis,	(Chittick) Calcite dolomite ratio	3	780
,	Total and organic carbon (ashing)	56	36
Heavy minerals,	separations	80	101
,	slides		70
Clay minerals,	slide preparation	860	824
,	analyses (by X-ray mineralogy section)	8	8
,	<2μ material recovered	123	205
pH		142	16
Bulk density		288	
Specific gravity		181	6
Sample pre treatment,	HCC - H_2O_2	-	131
,	Freeze drying	1213	596
,	Pebble washing	384	

Drift Prospecting Laboratory

W.W. Shilts

This laboratory, located at 601 Booth Street, is used to process raw samples for chemical and mineralogical analyses required for drift prospecting programs. The staff of between two and seven persons is supervised by Ms. D.M. Campbell. Production of the laboratory during 1972-73 is summarized as follows:

Operation	No. samples
Heavy-mineral separations of particular size-fractions	1728
Magnetite separations	800
Heavy-mineral slide preparations	625
Separates ground for chemical analyses	2664
Centrifugal separation of $< 2\mu$ fraction	936
Sieving to $< 63\mu$	760
Clay slide preparations	250
Soil pH determination	348
Atterberg-limit determinations	120

Completed Manuscripts

Mackay, J.R.
1972: The world of underground ice; Ann. Assoc. Am. Geograph., v. 62, no. 1, p. 1-22.

1972: Application of water temperatures to the problem of lateral mixing in the Great Bear-Mackenzie River system; Can. J. Earth Sci., v. 9, no. 7, p. 913-917.

1972: Offshore permafrost and ground ice, southern Beaufort Sea, Canada; Can. J. Earth Sci., v. 9, no. 11, p. 1550-1561.

Mackay, J.R., Rampton, V.N., and Fyles, J.G.
1972: Relic Pleistocene permafrost, western Arctic Canada; Science, v. 176, p. 1321-1323.

Mackay, J.R., and Mathews, W.H.
1973: Geomorphology and Quaternary history of the Mackenzie River valley near Fort Good Hope, N.W.T., Canada; Can. J. Earth Sci., v. 10, no. 1, p. 26-41.

Mackay, J.R.
1973: Some aspects of permafrost growth, Mackenzie Delta area; Geol. Surv. Can., Paper 73-1, Pt. A, p. 232-233.

McDonald, B.C., and Lewis, C.P.
1973: Sedimentary and geomorphic processes, Yukon Coastal Plain; Geol. Surv. Can., Paper 73-1, Pt. A, p. 233-235.

McDonald, B.C., and Shilts, W.W.
in press Interpretation of faults in glaciofluvial sediments; in "Glaciofluvial and glaciolacustrine sedimentation"; Soc. Econ. Paleontol. Min., Spec. Pub.

Shilts, W.W.
1972: Research methods in Pleistocene geomorphology; in Yatsu, E., and Falconer, A. (ed.), Research Methods in Pleistocene Geomorphology; Dept. Geography, Univ. Guelph, p. 237.

1973: Drift prospecting; geochemistry of eskers and till in permanently frozen terrain: District of Keewatin; Northwest Territories; Geol. Surv. Can., Paper 72-45, 34 p.

1973: Trace-element dispersal in till from southern Quebec (abst); Program Abstracts, Northeastern Annual Mtg, Geol. Soc. Am., Allentown, Pa.

1973: Till indicator train formed by glacial transport of nickel and other ultrabasic components: a model for drift prospecting; Geol. Surv. Can., Paper 73-1, Pt. B, p. 213-218.

ENGINEERING AND ENVIRONMENTAL GEOLOGY SECTION

J.S. Scott (A/Head)

This section is responsible for studies of the physical and engineering properties of soil and rock materials and for the evaluation of active geological and geomorphic processes that influence terrain performance.

During the year, studies were carried out in the Mackenzie Valley to evaluate thermal properties of frozen soils, provide information on the type and mechanism of landslides in a permafrost environment and to develop methods for evaluating the sensitivity of permafrost terrain to disturbance by natural and man-made causes. A major activity consisted of the preparation of granular material resource maps for the Mackenzie Valley to assist the Department of Indian and Northern Affairs in the assessment of granular materials for construction of the Mackenzie Highway and other proposed engineering projects in the Mackenzie Valley.

Other activities included the delineation of the extent of deposits of the Champlain Sea to assist the Quebec Department of Natural Resources in evaluating landslide hazard potential and the initiation of a study of environmental geology of active coal mining areas in the East Kootenay area of British Columbia.

Attendance at Meetings, Conferences, and Courses

J.A. Code: attended the Rapid Excavation and Tunnelling Conference, Chicago, in June.

N.R. Gadd: attended the International Geological Congress in Montreal in August and was co-leader of excursion C 44 "Quaternary Geology and Geomorphology in Southern Quebec" and the New England Intercollegiate Geological Congress Field Trip on "Strandline Features and Late Pleistocene Chronology of Northwest Vermont" in Burlington, Vermont in October.

J.A. Heginbottom: attended the Permafrost Thermal Regime Seminar in Saskatoon in May, the International Geographical Congress in Montreal in August, and the Arctic Land Use Research Program Meeting, Toronto, in October.

R.M. Isaacs: attended the 25th Annual Geotechnical Conference in Ottawa in December.

P.J. Kurfurst: attended the Permafrost Thermal Regime Seminar in Saskatoon in May and the 25th Annual Geotechnical Conference in Ottawa in December.

D.E. Lawrence: attended the International Geological Congress in Montreal in August and the 25th Annual Geotechnical Conference in Ottawa in December.

Special Talks or Lectures

N.R. Gadd: "Landslides in Eastern Canada" in March, to Macoun Field Naturalist Club, Ottawa.

J.S. Scott: "Geotechnique - a Canadian Perspective", a Public Service Commission sponsored lecture presented to the Dept. of Geology, University of Ottawa in March.

Membership on Committees

J.S. Scott
- Member, Mackenzie Highway-Granular Materials Working Group, Dept. Indian and Northern Affairs
- Member, Pit Slope Project Selection Committee, Mines Branch, EMR
- Member, Subcommittee on Shallow Foundations and Near Surface Structures Advisory Committee on Rock Mechanics
- Member, EMR Co-ordinating Committee on Environmental Matters
- Member, Interdepartmental Land Use Committee, National Capital Commission
- Vice President (North America), International Association of Engineering Geologists

Completed Manuscripts

Gadd, N.R.
1973: Distribution of marine deposits, Ottawa - St. Lawrence Basin; Geol. Surv. Can., Paper 73-1, Pt. A, p. 183.

1973: Quaternary geology, southwest New Brunswick; Geol. Surv. Can., Paper 71-34.

Gadd, N.R., LaSalle, P., Dionne, J-C., Shilts, W.W., and McDonald, B.C.
1972: Quaternary geology and geomorphology of southern Quebec; Guidebook A 44-C 44, International Geological Congress, Montreal.

Gadd, N.R., McDonald, B.C., and Shilts, W.W.
1973: Glacial recession in southern Quebec; Geol. Surv. Can., Paper 71-47.

Harrison, J.E.
1973: Environmental geology - mountain coal mining, Alberta and British Columbia; Geol. Surv. Can., Paper 73-1, Pt. A, p. 184.

Heginbottom, J.A.
1973: Erosion in a permafrost environment; Geol. Surv. Can., Paper 73-1, Pt. A, p. 225-226.

in press Some effects of surface disturbance on the permafrost active layer at Inuvik, N.W.T.; in Canadian contributions to 2nd International Permafrost Conference, Yakutsk, U.S.S.R.

Heginbottom, J.A., and Kurfurst, P.J.
1973: Terrain sensitivity and mapping, Mackenzie Valley Transportation Corridor; Geol. Surv. Can., Paper 73-1, Pt. A, p. 226-229.

Isaacs, R.M.
1973: Engineering geology, Mackenzie Valley Transportation Corridor; Geol. Surv. Can., Paper 73-1, Pt. A, p. 230-231.

Kurfurst, P.J.
1972: Terrain sensitivity evaluation and mapping, Mackenzie Valley Transportation Corridor; Geol. Surv. Can., Paper 72-1, Pt. B, p. 113.

Lawrence, D.E.
1973: Granular resource inventory - Mackenzie Valley; Geol. Surv. Can., Paper 73-1, Pt. A, p. 231-232.

Minning, G.V.
1972: Drilling in surficial deposits near Fort Simpson, Northwest Territories; Geol. Surv. Can., Paper 72-1, Pt. B, p. 115-116.

Minning, G.V., Rennie, J.A., and Domansky, J.L.
1973: Granular material inventory-southern Mackenzie Valley; Geol. Surv. Can., Paper 73-1, Pt. A, p. 236.

URBAN PROJECTS SECTION

D.A. St-Onge (Head)

The section is involved in the development of methods of geological investigation and data presentation for urban planning. The geoscientific study of the New Montreal International Airport Region carried out in co-operation with Q.D.M. and D.R.E.E. and the 1971-72 winter works Special Employment Program have provided the major basis for the development of the section.

During the year major emphasis was placed on production of a user's manual for the geoscientific data bank of the N.M.I.A. region. Fifty copies of this report were produced in December 1972 and distributed to planners, co-operating agencies and to libraries. Special effort was also made to edit the urban data file compiled during 1971-72. Computer programs were written to speed up this process and to allow the mapping of the data on a drum platter.

The field mapping of the surficial geology of the Ottawa-Hull region was essentially completed at a scale of 1:50,000. This information will be compiled at a scale of 1:125,000 for inclusion in an urban geology atlas of the Ottawa-Hull region.

Attendance at Meetings, Conferences, and Courses

D.A. St-Onge: attended the International Geographical Union Congress in Montreal and was organizer of the field symposium for the I.G.U. commission on geomorphological survey and mapping; spent ten days with Dr. L.B. Leopold and others studying hydraulic geometry of the Green and Colorado Rivers, Utah; attended the 85th Annual Meeting of the Geological Society of America to take part in a Symposium titled Tampering with the Earth; attended the 40th Annual Congress of l'Association Canadienne-française pour l'Avancement des Sciences in Ottawa.

Special talks or lectures

D.A. St-Onge: a talk entitled "Geoscience for Planning, the New Montreal Airport Region" was given at l'Université du Québec à Chicoutimi, University of Waterloo, University of Ottawa, and the National Conferences on Urban Engineering Terrain Problems.

Membership on Committees

D.A. St-Onge
- Member, International Geographical Union commission on Geomorphological Survey and Mapping
- Geological Sciences representative of the Ottawa Geotechnical Group
- GSC representative on Joint Environmental Co-ordinating Committee of the North Pickering Community Development Project
- GSC representative on Federal Interdepartmental Soils Subcommittee of the National Capital Commission
- NRC Earth Sciences Grant Selection Committee
- Member, Centre National de la Recherch Géomoph. Belgique
- NRC Ass. Committee on Quaternary Research

Completed Manuscripts

Kugler, M., and St-Onge, D.A.
1973: Composantes du mouvement de rebondissement isostatique d'apres des données de remblaiements alluviaux (Exemple de la rivière Saskatchewan Sud); Can. J. Earth Sci., v. 10, no. 4, p. 551-556.

Kugler, M. (under the direction of D.A. St-Onge)
1972: Etude géoscientifique, région Nord de Montréal, Géologie 1971-1972, Banque de Données, Manuel de l'Utilasateur; 58 p. (50 copies printed).

St-Onge, D.A.
1972: Sequence of glacial lakes in north-central Alberta; Geol. Surv. Can., Bull. 213, 16 p.

1973: Geoscientific studies, New Montreal International Airport Region; Geol. Surv. Can., Paper 73-1, Pt. A, p. 185-186.

St-Onge, D.A., and Kugler, M.
1972: Geoscience for planning: six months from first sample to final map; (abst.) Geol. Soc. Am., Abstr. with Programs, v. 4, no. 7, p. 652.

St-Onge, D.A., Kugler, M., and Morin, F.
1973: Une fenêtre sur l'avenir; Geos., Dept. Energy Mines and Resources, Winter 1973, p. 12-14.

Scott, J.S.
1973: Environmental geology prototype study - Ottawa-Hull region; Geol. Surv. Can., Paper 73-1, Pt. A, p. 186-187.

CANADIAN CENTRE FOR GEOSCIENCE DATA

C. F. Burk, Jr., National Coordinator

1. Objectives and Programme

Difficulties in meeting all objectives for the Centre as approved by its Advisory Board and presented in the 1971-72 Annual Report (p. 217-218) led to a general review of CCGD operations by the Assistant Deputy Minister (Science and Technology), the Director and Dr. S. C. Robinson. The NACRGS Subcommittee on Computer Applications (D. A. Sharp, Chairman) carried out a parallel review. A schedule of activities was then drawn up, designed to establish a more realistic framework in which the Centre can operate. The main components are:

1. Secretariat Services
   - 1.1 Support for NACRGS working committees on mineral deposits data and geological field data.
   - 1.2 Editorial services, including computer-based text editing and photocomposition, for technical publications.
   - 1.3 CCGD Newsletter (planned).
   - 1.4 Mail and office consultation.
   - 1.5 Secretary, COGEODATA (IUGS Committee on Storage, Automatic Processing and Retrieval of Geological Data).

2. Canadian Index to Geoscience Data
   - 2.1 File maintenance and update.
   - 2.2 Coordination of input from contributing agencies.
   - 2.3 Thesaurus (keyword) control.
   - 2.4 Providing products, including published indexes, custom indexes, tapes, material for other publishers, etc.

3. Tools for Systems Intercommunication
   - 3.1 National index to computer-processable data files.
   - 3.2 Development of low-cost, personal, generalized data-base management system.
   - 3.3 Development of a multilingual thesaurus for geology (IUGS project).
   - 3.4 Liaison and participation with activity outside Canada, especially COGEODATA (IUGS), CODATA (ICSU), GEO.REF (AGI), GeoArchive (Geosystems), and with major professional societies (GAC, CSPG, GSA, etc.).
   - 3.5 Application of national computer communications networks to transfer of geoscience data.

2. Canadian Index to Geoscience Data

The Index continued as the major activity. File size grew to more than 32,000 titles, with input received from nine Canadian agencies, including the first representative from industry (Brinco Ltd., Montreal). After considerable delay due to production problems, Edition 71/1 was published in September 1972. It included over half a million pages, divided into 14 volumes and a thesaurus. The demand for custom indexes increased and over 27 were produced. Included was a complete index to publications of the Ontario Division of Mines for 1966-72, which this agency set in type by computer photocomposition methods for publication under its own name.

With increasing maturity and size of the file, the Centre looked into more effective ways of marketing products, including microform publication and on-line retrieval. A demonstration of on-line retrieval to representatives of the mining industry and the Ontario Division of Mines was held in Toronto on 6 October 1972.

3. Guidelines for Mineral Deposits Data Files

The Centre provided administrative, technical and secretarial assistance to the NACRGS Working Committee on Mineral Deposits Data (R. V. Longe, Chairman), including arranging for six meetings. At year's end the Working Committee was assembling a first draft of its recommendations and guidelines for building computer-based files of mineral and fuel deposits data. Tentative plans were made to present a final report to the Conference of Provincial Ministers of Mines in September 1973.

4. MINDEX: Mineral Deposits Data File Index

The Centre collaborated with K. L. Gunn, Mineral Resources Branch, and retained the services of J. P. W. White, in a project to identify and index all known mineral and fuel deposit files in Canada. Over thirty were identified. Using the RAID system, a coordinate index was prepared as a basis for assessing the current status of files in Canada, which was particularly useful to the aforementioned Working Committee. A publication is planned for 1973.

5. Geological Field Data Systems

Under the chairmanship of W. W. Hutchison and, later, W. D. McRitchie, the NACRGS Working Committee on Geological Field Data continued to work closely with the Centre. One meeting was held, at which progress from 13 Canadian agencies was reported.

The Centre also participated in meetings of the GSC Field Data Committee under W. W. Hutchison.

6. Invertebrate Paleontological Data

A CCGD research contract held by the Royal Ontario Museum has as its objective the determination of standards for the measurement of invertebrate fossils, beginning with the ammonites. Work commenced in September 1972, under the direction of D. H. Collins, Head, Department of Invertebrate Palaeontology. Objective measurement data derived from the study will be integrated with ROM's computer-based curatorial system.

7. Generalized Data-Base Management System

At its 9 March 1972 meeting, the Centre's Advisory Board recommended a general evaluation of the widely-distributed SAFRAS system to be followed, if warranted, by recommendations on improving or augmenting the system. The SAFRAS Evaluation Study Group was convened under G. D. Williams, and a detailed report submitted to the Centre on 16 May 1972. As a result, specifications were agreed to on the design of a basic low-cost, personal data-base management system, based on SAFRAS concepts, which could be made available to the public by late 1973. In consultation with the University of Western Ontario, copyright owners of SAFRAS, work was begun in October under the direction of A. M. Kelly, GSC Geomathematics Group, with financial assistance from the Centre. Meanwhile, research and development on SAFRAS continued at the University of Western Ontario under P. G. Sutterlin.

8. Publications Programme

Most of the year's editorial effort was expended on about thirty manuscripts submitted to IGC Section 16, "Computer-based Storage, Retrieval, and Processing of Geological Information". Partly as a result of this priority, several manuscripts submitted earlier were returned at the authors' request in order to realize faster publication elsewhere. One manuscript was edited, "MANIFILE: University of Manitoba File of World's Nonferrous Metallic Deposits" by P. Laznicka; a supplementary bibliography for 1970-72 on computer-based storage and retrieval was also completed in manuscript form.

To improve the efficiency of processing manuscripts and to provide for the future publication of a CCGD Newsletter, the Centre installed a typewritter terminal connected with Alphatext Limited -- an integrated computer-based text editing and photocomposition system. Because of the change in secretarial personnel referred to below, the system did not realize its full potential, but several documents were edited and favourable results obtained.

9. Workshops and Training

The Centre co-sponsored and financially assisted with IGC Excursion C50 -- "Computer Applications Workshop", held at the University of Western Ontario, 1-5 September 1972. Twenty-two participants representing nine countries were present. On-hand experience with file building, mathematical geology, and graphic display was offered, and accepted enthusiastically by all present.

The Centre continued its training function for indexers planning to contribute to the Canadian Index, especially in the case of summer students working for existing contributors, and for the one new agency, Brinco Limited.

10. Consultation

An estimated 20-25% of staff time is occupied by receiving visitors and answering telephone and mail inquiries on the wide spectrum of activities of interest to the Centre. These sources of interest range from individuals within the Branch, to other branches and departments, provincial agencies, mining and petroleum companies, universities, and other countries. The focus of their interest may lie in substantive geoscience data,

storage and retrieval methods for data, tools for locating and accessing data, or solely in the methods and techniques applied.

11. International Liaison

In order to benefit from, and contribute to, work going on beyond Canada's borders, the staff plays an active role in key international and U.S.-based organizations. These include:

1. COGEODATA (Committee on Storage, Automatic Processing and Retrieval of Geological Data), sponsored by IUGS, Secretary.

2. CODATA (Committee on Data for Science and Technology) sponsored by ICSU, Conference Chairman.

3. ICSU Abstracting Board and IUGS Committee on Geological Documentation, Committee on Multilingual Thesaurus.

4. American Geological Institute, Committee on Publications.

5. Geological Society of America, Committee on Publications.

12. Personnel Notes

Mrs. Linda St. Pierre, Secretary, resigned on 8 September 1972, to take a teaching position at Algonquin College, but continued on a part-time basis until 30 November. Her position was replaced on a casual basis on 27 September by Miss Martha McLean, and the continuing position was filled by Miss Kaye E. Meikle on 12 March 1973.

13. Attendance at Meetings

C. F. Burk, Jr.

1. SAFRAS Evaluation Study Group, Toronto, 7 April 1972.

2. 24th International Geological Congress Organizing Committee, Ottawa, 8 April 1972.

3. Canadian Institute of Mining and Metallurgy Annual Meeting, Ottawa, 10-12 April 1972.

4. Canadian Petroleum Assoc., Well Data Committee, Calgary, 23 May 1972.

5. NACRGS Mineral Deposits Working Committee, Calgary, 24-25 May 1972.

6. Canadian Information Processing Society Annual Meeting, Montreal, 1-3 June 1972.

7. Geological Society of America Bibliography Working Group, Washington, 6 June 1972.

8. Geosystems, London, England (for Geological Society of America), 20-23 June 1972.

9. 3rd International Conference of CODATA, Le Creusot, France, 26-29 June 1972.

10. Geological Society of America, Committee on Publications, Boulder, 31 July - 1 August.

11. 22nd International Geographical Congress, Workshop I, Montreal, 11 August 1972.

12. 22nd International Geographical Congress, Workshop II, Montreal, 15 August 1972.

13. 24th International Geological Congress, Montreal, 21-25, 28-29 August 1972.

14. Computer Workshop, 24th IGC Excursion C-50, London, 1-5 September 1972.

15. Official opening, Heroy Geological Laboratory, Syracuse University, Syracuse, 5 October 1972.

16. CCGD Thesaurus Committee, Toronto, 6 October 1972.

17. SAFRAS Evaluation Study Group, Ottawa, 19-20 October 1972.

18. Ontario Petroleum Institute Annual Conference, Toronto, 23-24 October 1972.

19. Geoscience Information Society Annual Meeting, and Geological Society of America Annual Meeting, Minneapolis, 13-15 November 1972.

20. NACRGS Mineral Deposits Working Committee, London, 16-17 November 1972.

21. American Geological Institute, Committee on Publications, Washington, 13-14 December 1972.

22. NACRGS Mineral Deposits Working Committee, Ottawa, 18-19 December 1972.

23. NACRGS Mineral Deposits Working Committee, Ottawa, 23-24 January 1973.

24. NACRGS Mineral Deposits Working Committee, Vancouver, 7-8 February 1973.

25. NACRGS Subcommittee on Computer Applications, Vancouver, 8 February 1973.

26. GSC Field Data Committee, Ottawa, 19-20 February 1973.

27. NACRGS Geological Field Data Committee, Ottawa, 26-27 February 1973.

28. Prospectors and Developers Assoc. Annual Meeting, Toronto, 12-14 March 1973.

29. NACRGS Mineral Deposits Working Committee, Toronto, 15-16 March 1973.

30. Geological Society of America, Committee on Publications, Boulder, 22-23 March 1973.

B. A. McGee

1. 24th International Geological Congress Registration Committee, Montreal, 15 April 1972.

2. 24th International Geological Congress, Registration Committee, Montreal, 11 May 1972.

3. CCGD Thesarus Committee, Regina, 24-25 May 1972.

4. ICSU Abstracting Board, Working Committee on Multilingual Thesaurus, Ustaoset, Norway, 23-29 June 1972.

5. 24th International Geological Congress, Registration Activities, 14-31 August 1972.

6. IUGS/ICSU AB Subcommittee for a Multilingual Thesaurus, Montreal, 24-25 August 1972.

7. CCGD Thesaurus Committee, Toronto, 6 October 1972.

8. American Society for Information Science, Annual Meeting, Washington, 23-27 October 1972.

9. Geological Society of America, Annual Meeting, Minneapolis, 13-15 November 1972.

14. Special Talks

C. F. Burk, Jr.

1. "Application of computer-based information services to petroleum exploration in Canada", 11th Annual Conference, Ontario Petroleum Institute, Toronto, 24 October 1972.

15. Membership on Committees

C. F. Burk, Jr.

1. Member, NACRGS Subcommittee on Computer Applications.
2. Ex officio member, NACRGS Working Committees on Mineral Deposits Data and Geological Field Data.
3. Ex officio member, CCGD Thesaurus Committee.
4. Member, GSC Branch Computer Facilities Committee.
5. Member, Interdepartmental Committee on UNISIST.
6. Member, 24th IGC National Organizing Committee; Co-convener Section 16; and co-leader Field Excursion C50.
7. Member, NACMMR Subcommittee on Information.
8. Secretary, COGEODATA (IUGS Committee on Storage, Automatic Processing and Retrieval of Geological Data).
9. Chairman, Geological Society of America Committee on Publications, and Chairman, Working Group on Bibliographies and Information Dissemination.
10. Member, American Geological Institute Committee on Publications.
11. Past-President, Geoscience Information Society.
12. Chairman, Policy and Objectives Committee, Geoscience Information Society.
13. Member, Editorial Board, Geoscience Documentation.
14. Member, Branch Review Committee for EMR Research Agreements.

B. A. McGee

1. Member, ICSU/AB - IUGS Working Committee for a Multilingual Geoscience Thesaurus.

2. Chairman, CCGD Thesaurus Committee.

3. Chairman, 24th IGC Registration Committee.

16. Outside Publications

C. F. Burk, Jr.

1. Application of public computer-based information services to petroleum exploration in Canada: Proc. 11th Annual Conference Ontario Petroleum Inst., Toronto, 9 p.; reprinted in Geoscience Information Soc. Newsletter, no. 22 (Feb. 1973), p. 9-12 (1972).

2. Storage and retrieval of geological data in Canada: Earth Science Rev., v. 8, no. 1, p. 153-155 (1972).

3. Development of a national computer-based network of basic information on Canadian mineral deposits: Canadian Mining Jour., v. 93, no. 4, p. 34-38 (1972).

4. Computer-based storage, retrieval and processing of geological information (Editor): 24th International Geological Congress, Section 16, 222 p. (1972).

B. A. McGee

1. New key to mineral exploration: Canadian Index to Geoscience Data: Canadian Mining Journal, v. 93, no. 4, p. 43-47 (1972).

National Advisory Committee on Research in the Geological Sciences

Thomas E. Bolton, Secretary

The annual compilation of current research projects in the geological sciences in Canada for 1971-72 was published in September, 1972 (Geol. Surv. Can., Paper 72-5). It records information on current research by the universities, federal and provincial Department of Mines, Research Councils and Museums, and a few petroleum companies. Compilation of data supplied for the period 1972-73 is underway.

Since November, 1971, support for extramural Research and Development within established Canadian research organizations has been provided through the Departmental Research Agreement programme. Applications are evaluated according to the project's relevancy and contribution to the Department's objectives. The Survey reviewed 159 applications to the 1972-73 and 156 to the 1973-74 programmes; support was recommended for 36 ($278,000 available) and 52 ($383,000 available) Research Agreements. Bolton continued as Secretary of the Departmental Grants Review Committee.

The National Research Council of Canada annually awards grants-in-aid of geological research to Canadian universities on a more substantial scale. As a representative of the Survey and Department, Bolton acted as an observer at the February, 1973, Earth Sciences Grant Selection Committee meetings, and continued as the liaison for the Department to the Information Exchange Centre for Federally-Supported University Research and the new NRC Projects Research Applicable in Industry (PRAI) grant programme. The Department also was represented at the annual meeting of the Water Research Incentives, Department of the Environment.

During the year, Bolton acted as IGC Technical Programme Coordinator, a member of the IGC Science Film Festival, and a leader of IGC Excursion B 23 "Palaeozoic Rocks of the Ottawa Lowlands". In March, 1973, he attended the Ontario Stratigraphic Committee regional meeting at the University of Western Ontario.

THE 24TH INTERNATIONAL GEOLOGICAL CONGRESS, 1972-73

J. E. Armstrong - Secretary-General

The Secretariat of the 24th Session of the International Geological Congress was located at 601 Booth Street and during the fiscal year was staffed by 3 permanent employees of the Geological Survey: J. E. Armstrong, Secretary-General; I. M. Stevenson, Assistant Secretary-General (April 1/72 to September 30/72); and Mrs. Pauline Moyd, Organizing Secretary. In addition, the Survey supplied summer students for 55 man months. The 24th Congress, itself, paid for 12 full-time employees from April 1/72 to August 31/72, and for 6 from September 1/72 to March 31/73. The Congress also contracted for the services of at least 100 people for periods of one to two weeks during the Session in Montreal.

The 24th Session was held in Montreal from August 20 to 31 inclusive. Forty-seven hundred geoscientists from 110 countries registered for the Session, of these, 3,900 attended the meetings in Montreal. They were accompanied by 1,500 wives, children, and guests.

The technical program was published in 20 volumes prior to the Session. These consist of 19 section reports and one volume of abstracts. The section reports total 6,100 pages, consisting of 654 complete papers with abstracts. The abstract volume consists of 570 pages, made up of 1,086 abstracts. Scientists from 64 countries contributed to the technical program. This program had 38 conveners, 14 of them members of the Survey. Twenty-two members of the Survey, including some conveners, chaired technical sessions of the Congress.

A 230-page program was published prior to the Session.

Sixty-four major geological excursions, in all parts of Canada, were planned, and guidebooks prepared in English and French. The English editions consist of 4,404 pages and 89 fold-in maps, and were published prior to the Session. The French editions will all be published by July, 1973. These excursions were pre- and post-Session, some were run twice, and a few were cancelled. The number of participants totalled 1,646. Two hundred and five leaders and co-workers contributed their time to preparing and conducting these excursions, 56 were members of the Survey.

Twenty-nine one- and two-day geological excursions were planned for the Montreal, Quebec City and Ottawa areas, during and immediately before and after the Session. With repeats, 48 separate excursions were carried out, in which 926 geoscientists participated. Twenty-one bilingual guidebooks, totalling 1,215 pages, were published. Three members of the Survey acted as leaders on these excursions.

The Minister of Energy, Mines and Resources, the Honourable Donald S. Macdonald, addressed the Congress twice, once at the opening ceremonies, and once at the state dinner sponsored by the Department, in particular, the Survey.

Twenty-four members of the Geological Survey were on the National Organizing Committee. Six were also members of the Executive Committee.

SECRETARIAL SERVICES

Mrs. B. Richard

Summary of work executed by the Secretarial Services Section for the year 1972/73.

Letters from stenorette	49
Letters from manuscript	2,986
Letters (French)	253
Pages of reports from stenorette	190
Pages of reports from manuscript	11,972
Pages of reports (French)	473
Pages of preliminary reports	5,524
Pages of preliminary reports (French)	64
Publication lists	274
Tabulated pages	1,724
Tabulated pages (French)	140
Envelopes and Lables	1,572
Cards and forms	1,336
Total of carbon copies produced	5,282
Secretarial relief supplied (days)	198.5
Daily average number of operators in pool 6.76	7.55
Daily average of personnel on secretarial relief duties .79	
Daily time factor for corrections, placing figures and illustrations in reports, cutting and pasting of preliminary reports and setting up tables	25%

Approximate assessment of work:

Letters - 45 to 50 lines of single spacing, 1-inch margin, 6½ x 8-inch type area, including address and salutation,

Reports - 32 to 36 lines of double spacing, 1-inch margin, 6½ x 11½-inch type area.

Tabulated pages - numerical statistics, correlation tables etc.

Cards and forms - IBM type cards, geological records, bibliographies.

Total output of work increased considerably in the past year, due to hard work, better working conditions and general morale.

An IBM Mag Card Executive typewriter has been installed; it provides permanent records and has taken some of the load off the IBM Executive typewriters.

BRANCH REGISTRY

R.D. Robillard

Following is a summary of the project activities carried out by the Branch Registry during the past year.

1. Approximately 2,500 field notebooks dating from the years 1901 to 1925 were transferred to the Public Archives of Canada for safe keeping. This now brings the total number of field notebooks that have been transferred to approximately 5,000.
2. A continuous disposal of obsolete housekeeping records is taking place, in keeping with the framework of the Public Records Disposal Schedules.
3. A new up-to-date Records File Classification Key was prepared and distributed to Branch Staff.
4. Mr. Robillard, Registry Supervisor, has been appointed Chief Building Emergency Officer (for disasters and fire emergencies).

APPENDIX 1

STAFF LIST

Geological Survey of Canada

(as supplied by reporting units; June 15, 1973)

DIRECTOR'S OFFICE

McLaren, D.J., Director
Blouin, Mrs. L., Secretary
Lord, C.S.
Robinson, S.C.
Birtch, Mrs. E.J.
Carr, Mrs. E.J.
Wright, G.M.
Hall, E.

Special Projects

Douglas, R.J.W.

Secretary Natl. Adv. Comm.

Bolton, T.E.

Canadian Centre for Geoscience Data

Burk, C.F.
McGee, B.A.
Meikle, Miss K.E.

International Geol. Congress

Armstrong, J.E.
Moyd, Mrs. P.

Administrative Services

Pollit, K.
Bigras, Mrs. D.B., Secretary

Financial Services

Hickson, J.R.
Going, Mrs. M.I.
Koops, Mrs. M.F.
Deslauriers, Mrs. I.

Office Services

Lajoie, L.J.

Vehicles & Inventory

Ricketts, E.B.
Rozon, R.
Salter, I.C.

Stationery & Office Supplies

Bourque, J.R.
Charlebois, G.J.
Moreau, V.
Davidson, D.O.
McBryde, Miss. L.

Branch Registry

Robillard, R.D.
Atkinson, Mrs. C.M.
Begin, Mrs. G.M.
Ganim, T.

Secretarial Services

Jones, Mrs. L.E.
Crump, Miss J.
Koops, Mrs. A.
White, Miss M.
Parnham, Mrs. S.J.
Connors, Mrs. M.E.
Sheppard, Mrs. M.

CENTRAL LABORATORIES AND TECHNICAL SERVICES DIVISION

Maxwell, J.A., Chief
Parke-Taylor, Miss A.H., Secretary
Lapp, J.H., Admin. Officer

Analytical Chemistry

Abbey, S.

Chemical Laboratories

Courville, S.
Sen Gupta, J.G.
Bouvier, J.L.
Seymour, Miss.L.J.
Belanger, Mrs. G.C.
Watson, Mrs. F.J.
Grushman, Mrs. V.
Vickers, G.

Spectrographic Laboratories

Champ, W.H.
Church, K.A.
Bender, G.A.
Brown, D.A.
Belanger, P.G.

Mineralogy

Traill, R.J.

Mineralogical Studies

Lachance, G.R.
Plant, A.G.
Stenson, Mrs. A.P.

Mineralogical Studies (cont'd)

Gasparrini, Miss. E.
Delabio, R.N.
Bonardi, M.
Gravel, J.

Mineral Separation and Sample Preparation

Paris, J.C.
Machin, B.D.
Charbonneau, R.
Brown, A.G.
Huot, J.M.R.

National Collections

Steacy, H.R.
Ansell, H.G.

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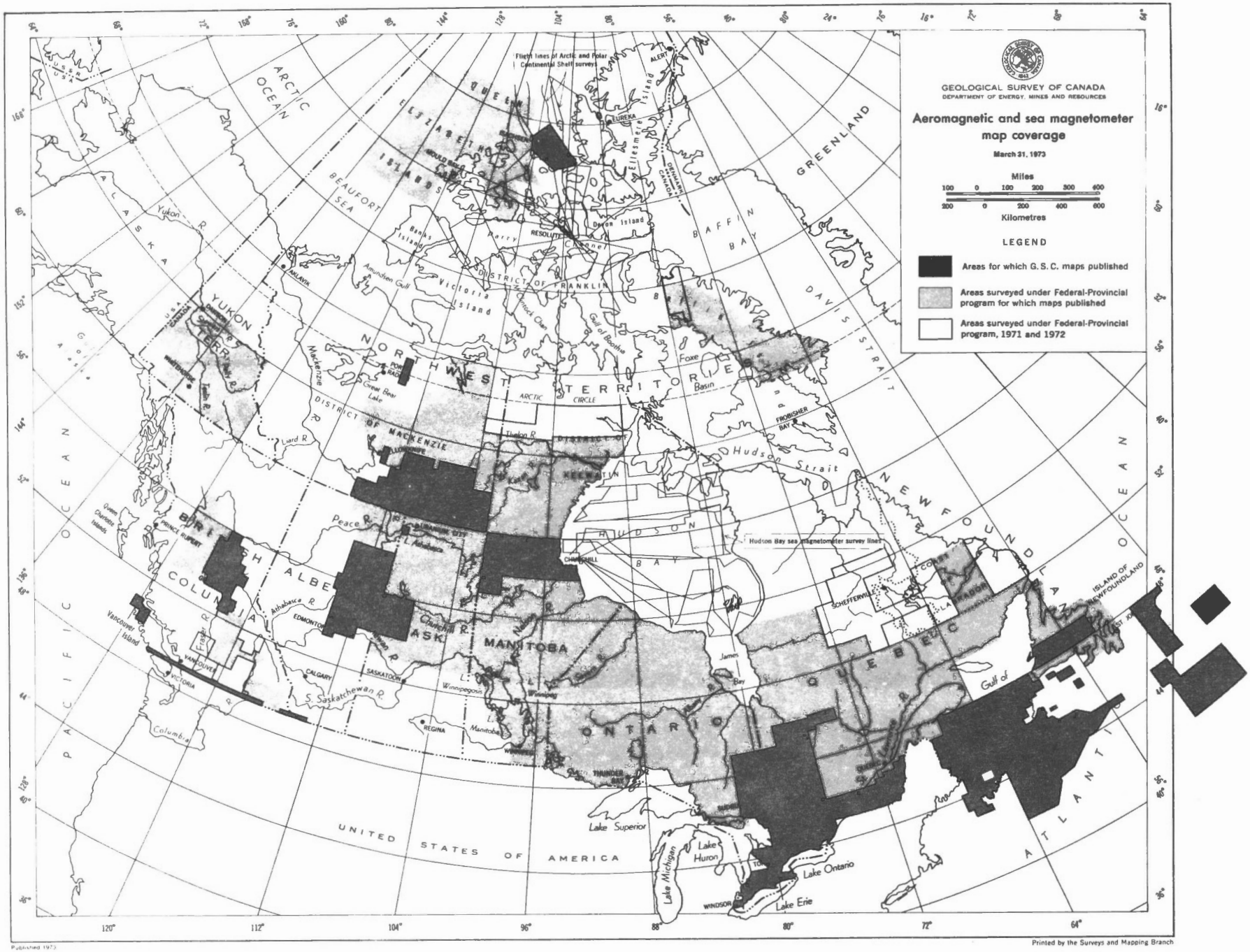

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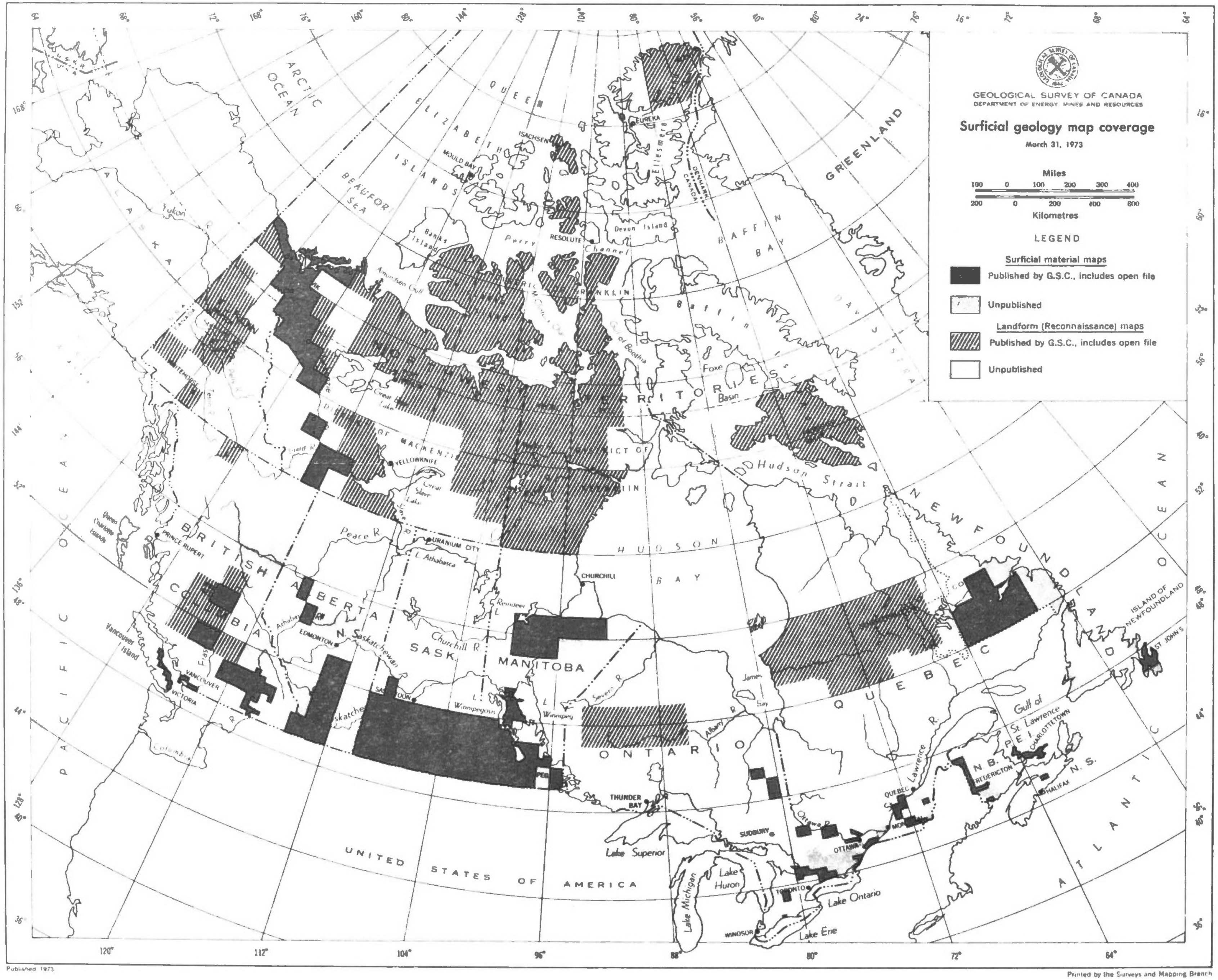
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DEPARTMENT OF ENERGY, MINES AND RESOURCES
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March 31, 1973
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200 0 200 400 600
Kilometres
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104°
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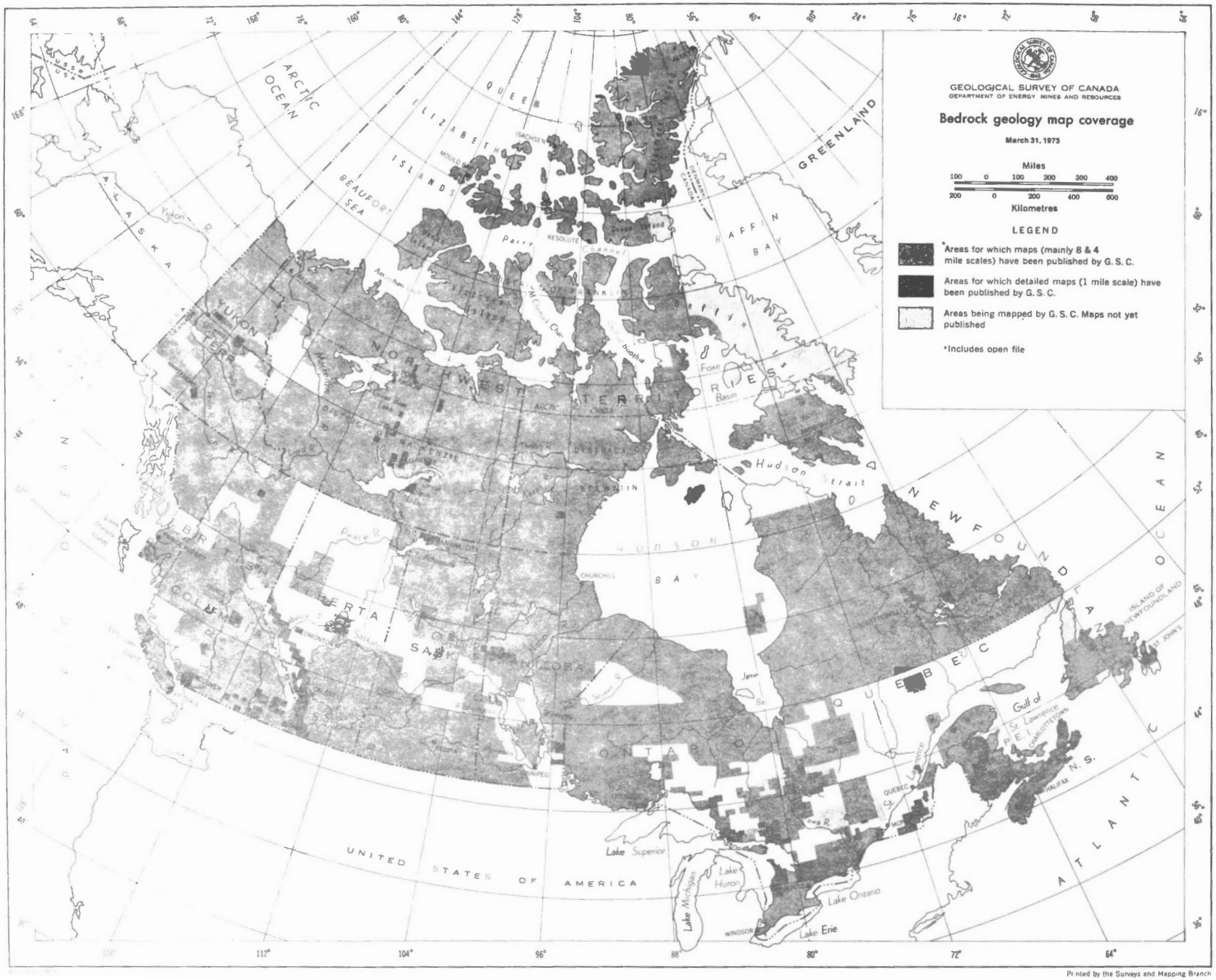

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