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DEPARTMENT OF ENERGY,
MINES AND RESOURCES

GEOLOGICAL SURVEY OF CANADA

ANNUAL REPORT

APRIL 1, 1986 TO MARCH 31, 1987

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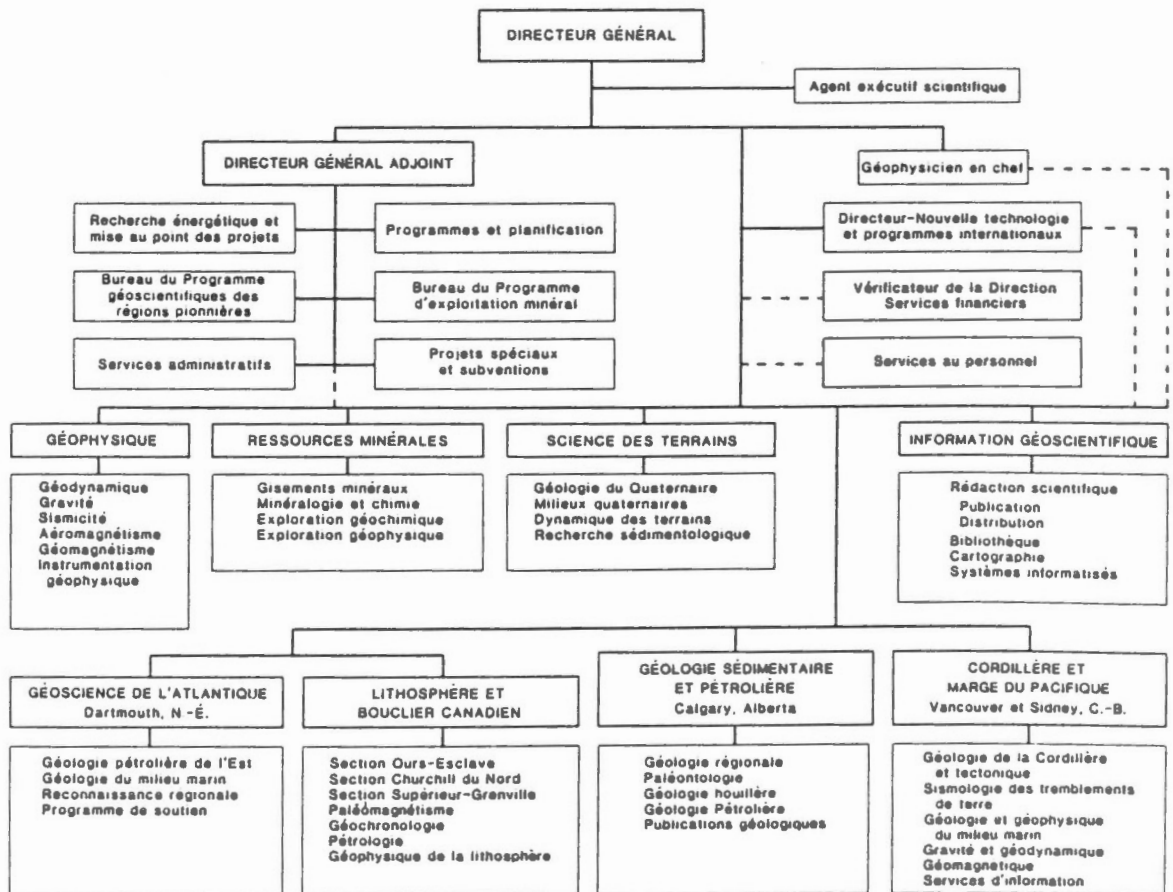
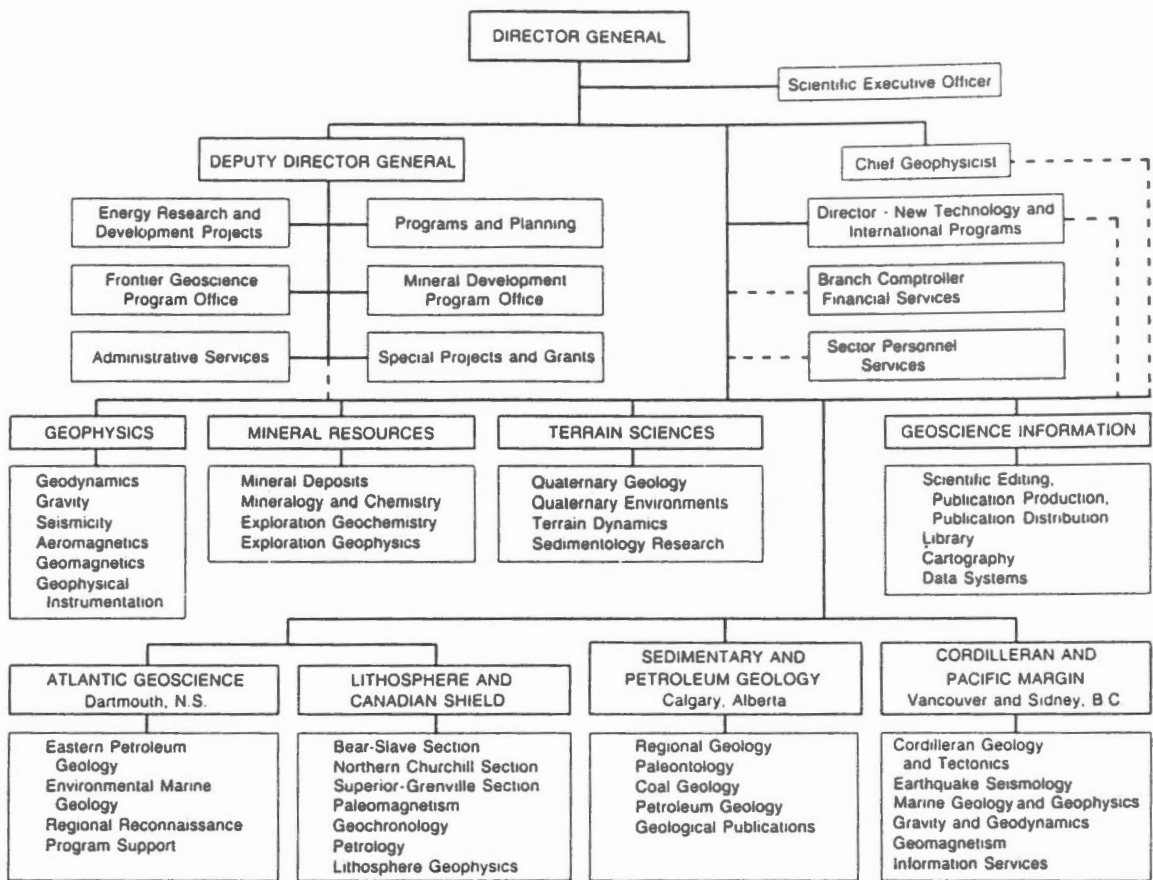
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1987

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INTERNAL ANNUAL REPORT 1986-87

Introduction

On 15 January 1986 the Deputy Minister announced that the Earth Physics Branch and the Geological Survey of Canada were to consolidate into one organization. The decision resulted from studies conducted to reduce expenditures while maintaining and improving service to the public.

In his announcement Deputy Minister de Montigny Marchand stated that "The merger of the two branches under a single management structure will provide not only greater management efficiency but an opportunity to reorganize and to take better advantage of an internationally renowned scientific and technical staff. The result of this merger and reorganization will be stronger, more vital units in a multi-disciplinary branch capable of meeting the challenge of providing high levels of service with limited resources. Increased management efficiency, a sharing of common services and better coordination of logistics support will allow a greater proportion of resources to be directed into core research and technical surveys programs. The larger organization will have greater resilience and flexibility to exploit new program opportunities while still retaining the established core activities."

To effect the merger by the announced date of 1 April 1986, many planning sessions were held by the 11 divisions of the two branches and although many details remained unresolved by the implementation date, it was possible to start the new fiscal year as a "New" Geological Survey.

The Earth Physics Branch had its formal beginnings in the late 19th century when the Federal Government needed a national time service and other astronomical data to guide the topographical surveying of its vast territory. When the forerunner of the Earth Physics Branch, the Dominion Observatory, was created in 1905 it included in addition to the astronomical functions, a Geophysics Unit organized into Seismology, Terrestrial Magnetism and Gravity Sections. During the next 65 years the Observatory expanded the scope and stature of its activities.

The Geological Survey of Canada has been in existence for nearly 150 years. It predates Canadian Confederation by a quarter of a century. Originally it was responsible for an area limited to the southern parts of present-day Ontario and Quebec; but by the late nineteenth century the size of its area of responsibility had expanded ten-fold; and as Canada began to exercise jurisdiction over its offshore territory in the second half of this century the area of the territory for which the GSC was responsible again nearly doubled.

The organizational structure of the Geological Survey of Canada, and its position with the organization of the Government, has always been the outward expression of the nature and scope of its mission. At various times during its history the GSC spawned numerous other agencies including: the National Museum, the Surveys and Mapping Branch, the Mines Branch which was the parent of CANMET, and the Canada Centre for Remote Sensing.

The reorganization of the Survey announced on 15 January 1986 reflects several of the conditions that triggered past reorganizations. The amalgamation of the Earth Physics Branch and the Geological Survey was a decision of the Government in response to one of the recommendations contained in the Study Team Report on Major Surveys to the Task Force on Program Review chaired by the Deputy Prime Minister, the Honourable Erik Nielsen. This recommended the termination of the Geothermal Program of the Earth Physics Branch and the amalgamation of the remaining EPB activities with those of the Geological Survey to reduce the potential for duplication of geophysical activities, to reinforce scientific programs and to achieve economies of scale. The order to merge the two Branches included direction to effect a 10 per cent reduction in the 1985-86 resources of the Earth Physics Branch, to effect the merger on 1 April 1986 and to establish four multidisciplinary regional divisions.

The objective of the "new" Geological Survey of Canada remained similar to past objectives: to ensure the availability of comprehensive geological, geophysical and geochemical knowledge, technology and expertise concerning the Canadian landmass and offshore areas, including the mineral and energy resources and the conditions affecting land and seabed use, as required for effective exploitation of mineral and energy resources, estimation of the resource base of Canada, land use, public safety and security, and formulation of policies.

The "new" Geological Survey of Canada has an authorized strength of nearly 1000 and comprises eight divisions, three less than existed in the two branches prior to the amalgamation. The Geothermal Energy Program has been eliminated, but there has been no reduction in the overall strength of the scientific program because scientific expertise in geothermics plays a fundamental role in multidisciplinary teams charged with studies of sedimentary basins, the nature and evolution of the lithosphere, and permafrost and gas hydrates. The reorganization has provided new opportunities for bringing together, within individual divisions, certain complementary scientific disciplines that had previously been managed separately; and for coordinating activities between and among divisions.

The eight divisions comprising the "New" Geological Survey of Canada are: Atlantic Geoscience, Geophysics, Geoscience Information, Lithosphere and Canadian Shield, Mineral Resources, Terrain Sciences, Sedimentary and Petroleum Geology, and Cordilleran and Pacific Margin. The Director General's Office in Ottawa includes the Deputy Director General (who is responsible for Program and Planning, Administrative Services, Frontier Geoscience Program, Mineral Development Program, Office of Energy Research and Development and for Special Projects and Grants), the Chief Geophysicist, the Director of New Technology and International Programs, and the Scientific Executive Officer.

The responsibilities and objectives of some divisions remained relatively unchanged but others, as their names suggest, have new or enhanced responsibilities. These are described more fully in divisional reports that follow.

Less than one year later it was possible for the Director General to write in GEOGRAM "It is now almost one year since the merger of the Survey and the Earth Physics Branch. Looking back over the year it has been extremely gratifying to see the quiet efficiency with which the staff of the two Branches have met the challenge of implementing the many changes involved."

OFFICE OF THE DIRECTOR GENERAL

R.A. Price

Attendance at Meetings, Conference and Courses

Visit Pacific Geoscience Centre and Cordilleran Geology Division to discuss reorganization following GSC/EPB merger, Sidney and Vancouver, B.C., April 9-10, 1986.

Meeting on Ocean Drilling Program; and visit to Institute of Sedimentary & Petroleum Geology, Calgary, April 20-22, 1986.

Independent Industrial Advisory Committee to Earth Sciences meeting; and visit to Cordilleran Geology Division, Vancouver, B.C., May 7-10, 1986.

Branch Management Committee Meeting, Ottawa, Ontario, May 15, 1986.

Council of Chairmen of Canadian Earth Science Departments Meeting, Carleton University, Ottawa, Ontario, May 18, 1986.

National Geological Surveys Committee meeting, Skyline Hotel, Ottawa, Ontario, May 19, 1986.

GAC/MAC/CGU Annual Meeting, Carleton University, Ottawa, Ontario, May 19-21, 1986.

Canadian Geoscience Council Annual Meeting, Quebec City, May 22-23, 1986.

Prospectors & Developers Association Technical Advisory Committee Meeting, GSC Headquarters, Ottawa, Ontario, May 28, 1986.

Mining Association of Canada Annual Meeting, Westin Hotel, Ottawa, Ontario, May 28, 1986.

Canadian Mineral Outlook Conference, Westin Hotel, Ottawa, Ontario, May 29, 1986.

International Conference on Geoscience Information: Speaker - "Geoscience Information - The Framework Formulating and Implementing Policies on Resource Development"; and visit to Bureau of Mineral Resources and Canadian High Commission, Adelaide and Canberra, Australia, June 1-7, 1986.

Visit to Geological Survey of Finland, signing of Memorandum of Understanding, Helsinki, Finland, June 13-17, 1986.

Meeting of the Ad Hoc Planning Group on Global Change, Stockholm, Sweden, June 18-19, 1986.

Visit to Institute of the Lithosphere (at the invitation of the Academy of Sciences), Leningrad, USSR, June 20-July 1, 1986.

Tenth International CODATA Conference, Westin Hotel, Ottawa, Ontario, July 14-17, 1986.

Branch Management Committee Meeting, Ottawa, Ontario, July 24-25, 1986.

Basins of Eastern Canada and Worldwide Analogues Symposium: Chairman - Technical Programme on "Appalachian Foredeep and Foreland Basins", Halifax, Nova Scotia, August 13-15, 1986.

Branch Management Committee, Calgary, Alberta, September 9-10, 1986.

Conference on The Canadian Mineral Industry: Emerging Challenges and Opportunities: Speaker - "Canada's Mineral Resource Potential"; Banff, September 11-14, 1986.

ICSU General Assembly, Berne, Switzerland, September 16-19, 1986.

Steering Committee Planning Meeting for Conference on Scientific Ocean Drilling (COSOD-II), July 6-10, 1987, Strasbourg, France, September 30 - October 2, 1986.

Ocean Drilling Program National Workshop, University of Montreal, Montreal, Quebec, September 26-27, 1986.

First Meeting of Steering Committee for Second Conference on Scientific Ocean Drilling (COSOD-II), Strasbourg, France, September 30 - October 2, 1986.

Earth Sciences Sector Strategic Planning Seminar, Ottawa, Ontario, October 8-10, 1986.

Ocean Drilling Program Council Meeting, Pacific Geoscience Centre, Sidney, B.C., October 14-16, 1986.

Quaternary Discussion Group: Speaker - "Geological Perspectives on the Proposed International Geosphere-Biosphere Program on Global Change", Ottawa, Ont., October 22, 1986.

NSERC Meeting on Lithoprobe, Phase II, Ottawa, Ont., October 30, 1986.

Meeting of the IUGS Advisory Board for Research Development, San Antonio, Texas, November 9, 1986.

GSA Annual Meeting: Speaker - "Lithoprobe Seismic Reflection Images of Deep Crustal Structure, Southeastern Canadian Cordillera", San Antonio, Texas, November 10-13, 1986.

LITHOPROBE, Phase II, Management Review Subcommittee Meeting, Ottawa, Ontario, November 18, 1986.

Saskatchewan Provincial Open House, Regina, Saskatchewan, November 18-19, 1986.

Manitoba Provincial Open House, Winnipeg, Manitoba, November 20-21, 1986.

Independent Industrial Advisory Committee to Earth Sciences meeting, Ottawa, Ontario, November 28, 1986.

LITHOPROBE Steering Committee meeting, Ottawa, Ontario, December 1, 1986.

Quebec Provincial Open House, Quebec City, P.Q., December 1-2, 1986.

Canadian Geoscience Council Standing Committee on International Relations meeting, (AM); and Canadian Geoscience Council Canadian National Committee meeting, (PM), Ottawa, Ontario, December 5, 1986.

American Geophysical Union Council Meeting; and inaugural meeting of AGU Committee on Earth-as-a-System (Chairman: R.A. Price), San Francisco, California, December 7-12, 1986

Atlantic Geoscience Centre Program Review, Halifax, Nova Scotia, December 17, 1986.

Signing of Memorandum of Understanding between GSC and the Canada-Newfoundland Offshore Petroleum Board, St. John's, Newfoundland, December 18, 1986.

University Corporation for Atmospheric Research (UCAR) workshop on "Arctic Interactions: Air, Land, Water and Life", Boulder, Colorado, January 5 and 6, 1987.

Branch Management Committee Meeting, Ottawa, Ontario, January 14 (PM) - 15, 1987.

Current Activities Forum, Ottawa, Ontario, January 19 (PM) - 22, 1987.

National Geological Surveys Committee Annual Meeting, Ottawa, Ontario, January 22, 1987.

Deep Observation & Sampling of the Earth's Continental Crust (DOSECC), Program Review Meeting, University of California (Riverside), February 23-25, 1987.

Meeting with University of Quebec and EMR officials, re: Francophone hiring at GSC, Quebec City, February 27, 1987.

Prospectors & Developers Association Annual Meeting: Speaker - "The New Geological Survey of Canada", Toronto Ontario, March 9 - 11, 1987.

Geological Association of Canada Annual Meeting, Sidney, B.C., March 16, 1987.

Visit staff at Pacific Geoscience Centre, and Cordilleran and Pacific Margin Division, Sidney and Vancouver, B.C., March 17, 1987.

Interview Board, Director, Cordilleran & Pacific Margin Division, Vancouver, B.C., March 18, 1987.

Visit staff at Institute of Sedimentary & Petroleum Geology, Calgary, Alberta, March 19, 1987.

The Financial Times Conference on "Research and Development: Science and Society", Westin Hotel, Toronto, Ontario, March 24, 1987.

DEPUTY DIRECTOR GENERAL

J.G. Fyles

Attendance at Meetings, Conferences and Courses

OERD Review Committee Meeting, June 24, 1986.

Northern Canada field trip with Director, USGS, and other USGS personnel, June 25-July 2, 1986.

Branch Management Committee Meeting, Calgary, September 9-10, 1986.

Canadian Geoscience Council Meeting, Drumheller, Sask., September 17, 1986.

Program Review meeting, Calgary, Alberta, September 18, 1986.

Program Review meeting, AGC, Dartmouth, September 22, 1986.

B.C. Yukon Advisory Committee to GSC meeting, Vancouver, October 28, 1986.

Program Review meetings with CGD, Vancouver and Victoria, and Program meeting with B.C. Geological Branch, October 29-November 2, 1986.

Consultation between USGS and GSC on Arctic Research, in conjunction with U.S. Arctic Five-Year Research Plan Consultative Workshop, Anchorage, Alaska, November 18-19, 1986.

Manitoba Open House, November 20-21, 1986.

MDA Management Committee meetings, Regina and Winnipeg, Nov. 24-25, 1986.

Program Review meeting, AGC, December 15-16, 1986.

B.C. Yukon Chamber of Mines, Cordilleran Round-up, Vancouver, B.C., January 26-28, 1987.

GSC/KEGS meeting, Toronto, March 9, 1987.

Symposium "Recent crustal movements in the Pacific Northwest", Sidney, B.C., March 27, 1987.

Special Assistant

G.W. Cameron

Membership on Committees

OERD (Task) Review Committee Meetings:

Permafrost and Gas Hydrates, Ottawa, February 7, 1986.

Coal Supply, Ottawa, May 1, 1986.

Petroleum Geoscience Research, Calgary, June 24, 1986.

Coal Supply, Ottawa, July 22, 1986.

Oil Sands and Heavy Oil, Ottawa, July 24, 1986.

Permafrost and Gas Hydrates, Ottawa, July 28, 1986.

Petroleum Geoscience Research, Calgary, December 11, 1986.

Program Review Meeting, AGC, Dartmouth, N.S., September 21-23, 1986.

Western Canada Coal Geoscience Forum, Calgary, Alberta, November 17-19, 1986.

Branch Management Committee Meetings.

Membership on Committees

GSC Branch Management Committee.

Secretary, Energy Research Advisory Committee, Task 6.1.2, Permafrost and Gas Hydrates Research.

Secretary, Energy Research Advisory Committee, Task 6.1.1., Petroleum Geoscience Research.

GSC CARP Committee.

SPECIAL PROJECTS

T.E. Bolton

Attendance at Meetings, Conferences and Courses

Geological Association of Canada, Annual Meeting, Ottawa, Ont., May 19, 1986.

Canadian Paleontology and Biostratigraphy Seminar, Albany, N.Y., September 1986.

Membership on Committees

Chairman, Canadian Society of Petroleum Geologists, Lexicon Committee, Central Canada and St. Lawrence Lowlands.

Member, International Association for the Study of Fossil Cnidaria, International Paleontological Association.

Corresponding Member, IUGS Subcommittee on Silurian Stratigraphy,

Convener, Association of North American Paleontological Societies (ANRPS).

Co-chairman, North American Ordovician Chronostratigraphy Working Group, IUGS Subcommittee on Ordovician Stratigraphy.

A.V. Okulitch

Andrew V. Okulitch's primary assignment continues to be editing and coordination of the Geological Atlas of Canada Program. To support and manage a program of this magnitude, he has implemented a micro-computer system for database management and computer-aided drafting. Under his direction, compilation of eight maps and correlation charts from the Precambrian Shield of Ontario and N.W.T. west of Hudson Bay has been completed to editorial review stage. Two of these are under production by cartographic staff. Seven maps and

Highlights

charts from the Arctic Archipelago are also ready for editorial review. Sixteen other maps are under compilation, although progress on several has been minimal in the past year primarily because of final stages of work on the DNAG publications by Okulitch and other compilers. Cooperative agreements with three provincial agencies have resulted in contributions to the atlas in the form of bedrock geology maps, mineral occurrence maps and external critical review. Nearly one-third of the entire Atlas is under production. Several more maps should be submitted to cartography in 1987.

Atlas compilation of the Arctic Archipelago has permitted Okulitch to continue to make contributions to DNAG in the form of 1:2,000,000 and 1:5,000,000 scale maps of the region that are derived from the most modern (often unpublished) data. These maps provide the first integration of onland and offshore bedrock geology in map format. Additional contributions to DNAG include sections of the Innuitian Region volume on structure and tectonics which provide integration of geophysical and geological data that suggests resolution of long-standing tectonic problems of the region.

He also has undertaken editorial duties in support of the geoscience community outside the GSC by becoming an associate editor (structure) for the Canadian Journal of Earth Sciences, for Geology (Geological Society of America), and for a series of structure papers in Geoscience Canada.

Attendance at Meetings, Conferences and Courses

CODATA '86 Conference, Ottawa.

Lithoprobe Workshop (Southern Cordillera), Pacific Geoscience Centre.

Cordilleran Tectonics Workshop, McGill University, Montreal.

Russian 301, 305, University of Calgary.

Membership on Committees

Councillor, Structural Geology and Tectonics Division, Geological Association of Canada.

Associate Editor (structure), Canadian Journal of Earth Sciences.

Associate Editor (structure and Canadian Cordillera), Geology,

Series Editor (structure), Geoscience Canada.

GSC representative for joint compilation of regional maps and a 1:10,000,000 scale circum-polar bedrock geology map, Program of Scientific and Technical Cooperation between the USSR and Canada on Problems of Arctic and Northern Study Development.

Talks

"Mesozoic compression and Tertiary extension along the western margin of the Shuswap Metamorphic Complex, southeastern B.C." Invited paper presented at the University of Calgary, November, 1986.

"Preliminary evaluation of Tertiary extensional structures along the proposed Lithoprobe transect east of Okanagan Lake, B.C." presented at the Cordilleran Tectonics Workshop, McGill University, February, 1987.

NEW TECHNOLOGY AND INTERNATIONAL PROGRAMS

A.G. Darnley

This new unit was established effective April 1, 1986 as part of the Director-General's Office to be responsible for technology development and transfer, and international programs including CIDA and IDRC sponsored activities.

Activities were largely focussed on the future of airborne geophysics, both nationally and within GSC. The air survey industry, with its associated equipment manufacturers, is in a depressed economic state a workshop took place to bring together members of the air survey industry; meetings were held to discuss the status of airborne gravity; further attempts were made to obtain access to an airship for geoscientific evaluation purposes; and bids were obtained for engineering work to extend the range of GSC's Skyvan aircraft. In addition recommendations were made to ameliorate potential difficulties concerning aircraft operations.

The office of technology transfer under Mr. L.S. Collett has maintained a high level of activity although the level of mineral exploration activity has decreased. Inquiries for advice and information on the R & D grant system of the Federal Government, particularly the Industrial Research Assistance Program (IRAP), the Unsolicited Proposals (UP) and the Natural Sciences and Engineering Research Council of Canada (NSERC) programs were handled.

During 86/87, nine IRAP projects were managed with involvement in a tenth in a liaison capacity.

Liaison was provided for two NSERC/CRD grants during the year, one with the University of B.C. and the other with the University of Calgary.

Advice was given to: the Canada Centre for Inland Waters on geophysical techniques re pollution in the St. Clair River; the Canadian Hydrographic Service on airborne EM for ice thickness and "though the ice" bathymetry in the Arctic; the Canadian Electrical Association on electrical resistivity of Canadian soils, the Alberta Research Council and NSERC.

International Programs

The Thailand Airborne Survey continued to be the largest on-going commitment. It is an inherently difficult technical operation, rendered more difficult by the administrative complexity of the project management arrangements and the sometimes conflicting priorities of the participating national, international and commercial organizations. Data collection for the three main components of the airborne survey was completed by the industry contractor in March 1987. Deliveries of compiled data are 2 years behind schedule, with the backlog increasing. GSC's role continued to be that of technical adviser and inspector, and general consultant for the project in matters concerning recruitment of specialists and training.

During the year there were preliminary enquiries regarding possible GSC involvement in a major mineral development project in Saudi Arabia, and the extension of CIDA sponsored aeromagnetic surveys in Zimbabwe.

Memoranda of Understanding were signed during the year between GSC and the Geological Surveys of Finland and Israel.

Episodes Secretariat

The Episodes Secretariat, headed by Dr. A.R. Berger (Editor) continued to compile, publish and distribute Episodes, the quarterly newsmagazine of the International Union of Geological Sciences (IUGS), and other IUGS publications, and to carry out public relations and promotion work on behalf of the Union.

Displays were mounted at several national and international conferences. The Episodes Secretariat also continues as the main distribution point for the New Publication Series of IUGS.

The Episodes staff consisted of Mrs. Barbara Collis (Executive Secretary) and Mrs. Jeanne Spencer (Production Consultant); Mrs. Elizabeth McIlwaine (Bookkeeper, Circulation Manager), and Mrs. Jean Jenness (Editorial Assistant). Scientific reviewers and advisors on publication policy provided useful assistance. A.R. Berger continued until September 30, 1986, in the part-time position of Executive Director with the Geological Association of Canada, based in St. John's, Nfld.

Geobriefing Unit

A new internal newsletter for GSC scientific staff was compiled, edited and circulated in French and English by A.R. Berger and C. Patenaude in November, 1986, and February, 1987.

Personnel Notes

Mr. B.E. Manistre retired on October 17, 1986, on the completion of almost 13 years service with GSC. Most of this time was spent as CIDA Coordinator in RGG Division, involving projects in Brazil, Pakistan, Indonesia, Thailand, Zimbabwe, Kenya, West Africa, Central America and elsewhere.

Attendance at Meetings, Conferences, and Courses

A.R. Berger

GAC-MAC Annual Meeting, Ottawa, May 1986.
GAC Executive Board Meeting, Banff, September 1986.
GSA Annual Meeting, San Antonio, November 1986.
IUGS Executive Meeting, Paris, February 1987.
GSC Branch Management Meeting, Calgary, September 1986.
GSC Branch Management Meeting, Ottawa, January 1987.

A.G. Darnley

Thailand Mineral Resources Development Project. Project Review Meetings, Bangkok, October 5-11, 1986 and February 26-March 5, 1987.

IAEA Advisory Group Meeting on "The use of airborne radiometric data to define the natural radiation environment". Vienna Austria November 3-7, 1987.

CIM Regional Meeting, Winnipeg, Manitoba, October 31-November 1, 1986.

Exploration '87 Organization Meetings, Toronto, June 4 September 16, 1986, January 7, March 24, 1987.

Branch Management Committee, Calgary, September 9-10, 1986.

Membership on Committees

A.R. Berger

Editor, Episodes.
Member, IUGS Advisory Board for Publications.
Executive Director, Geological Association of Canada, to September 30, 1986.

Member, Board of ICSU Press.

L.S. Collett

Member of Selection Committee for IRAP (NRC) representing the GSC.

Member, Advisory Committee on Soil Resistivities, Canadian Electrical Association, Montreal.

A.G. Darnley

Chairman, IAEA Consultants Advisory Group on Airborne Radioactivity Surveys.

Member, Organizing Committee for Exploration '87.

Chairman, Organizing Committee for Ottawa '87 CIM Regional Meeting.

Convenor and Chairman, Exploration Geophysics Session, CIM Regional Meeting, Winnipeg.

Talks and Lectures

A.G. Darnley

CIM Regional Meeting, Winnipeg - The future for exploration technology. Introduction to Exploration Geophysics Session.

L.S. Collett

CIM Regional Meeting, Winnipeg, October 30-November 1, 1986; "AEM Resistivity Mapping".

Ottawa Mineral Exploration Group, Ottawa, December 17, 1986; "History of the Development of the Airborne EM Method".

Official Visitors to GSC

Drs. C.D. Masters and K. Robinson, U.S. Geological Survey (USGS), met with Drs. R.M. Procter and G.C. Taylor, ISPG, to discuss a CCOP-IUGS sponsored workshop to be presented in Kuala Lumpur, Malaysia, April 21-29, 1987.

Messrs. Sun Renyi and Qiu Xianghua, Deputy Director and Project Office, respectively, of Foreign Affairs Bureau, Ministry of Geology and Mineral Resources, and Mrs. Miao Peishi, Academy of Geological Sciences, P.R.C., met with GSC Mineral Resources Division staff in Ottawa April 28 and 29, 1986 and with Institute of Sedimentary and Petroleum Geology staff in Calgary April 30, to discuss scientific exchange projects under The Memorandum of Understanding between GSC and the Ministry.

Mr. Sedat Uz, Deputy Head of Mineral Exploration, Mineral Research Institute of Turkey visited GSC to discuss airborne and borehole methodologies in uranium exploration.

Dr. Carlos Garcia, Exploration Coordinator of the Colombian Petroleum Institute toured ISPG facilities on May 6.

Mr. Dunoyer de Segonzac, Science Counsellor, French Embassy, and Messrs. Laredo and Huther, members of the French Delegation visited the GSC on May 4, 1986 to discuss research areas of interest contained in the French proposal for cooperative Arctic studies.

Mr. Nie Fengjun, Institute of Mineral Deposits, Academy of Geological Sciences, P.R.C., visited GSC May 22, to June 5, 1986.

Representatives of the Korean Institute of Energy and Resources, visited EMR on June 18, 1986.

U.S. Geological Survey Delegation, led by Dr. D. Peck, USGS Director and including Dr. R. Hamilton, Chief Geologist; Mr. L. Starr, Chief, National Mapping Division; and Mr. J. Devine, Assistant Director, Engineering Geology, met with senior officials of EMR/GSC, June 24-July 3, to discuss cooperative ventures, and new opportunities for cooperation, particularly in Arctic resources and programs. A visit to the High Arctic, including the Ice Island research station and the Polaris mine, was made following their visit to ISPG.

A delegation from the Institute of Geology and Mineral Exploration in Greece, completed a two-week study of coal systems at ISPG.

A.Y. Smith, Division of Nuclear Fuel Cycle, IAEA, Vienna, visited GSC in August to discuss and organize the program for an IAEA Advisory Group meeting on use of airborne radiometric data to define the natural background radiation environment.

Drs. Norbert W. Roland and Horsts Aust of the German Federal Institute for Geosciences and Natural Resources (BGR), visited various Canadian federal government agencies and private companies from late August to mid-October to examine the Canadian experience in Arctic mineral and petroleum exploration and exploitation.

Mrs. Osamu Goukon of Mitsui and Company, Tokyo, visited ISPG on September 11 to discuss the coal resources of the southern Rocky Mountains of Canada.

Miss Edita Macalalad, Senior Research Chemist, Bureau of Mines and Geosciences, Philippines, visited GSC Mineral Resources Division analytical laboratories on September 24 to investigate the organization and management procedures.

Four senior scientists from the Bureau of Geology, Chinese Ministry of Nuclear Industry, were taken on a tour of some of Canada's uranium deposit areas by Dr. D.R. Boyle in September 1986. They also visited federal, provincial and commercial departments, laboratories and Crown Corporations carrying out research in uranium exploration technology.

A group of energy specialists from the Association of South East Asian nations (ASEAN) countries visited ISPG on Oct. 3, 1986, as part of an ASEAN-Canada development cooperation project. Representatives of Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand met with staff of the Petroleum Resource Appraisal Secretariat to discuss Canada's petroleum resources and how resource evaluation activities are undertaken.

Soviet scientists, Drs. Basov, Dagens and Dundo began a two week visit to the GSC on October 23, 1986, for the preparation of Triassic and Jurassic correlation charts under the Canada/USSR Arctic Science Exchange Program.

Dr. V.A. Krashennikov, Deputy Director, Geological Institute, Soviet Academy of Sciences, Moscow, visited ISPG October 21, 1986, to discuss Canadian activities in high latitude micropaleontology.

A delegation from the Chinese Ministry of Nuclear Industry visited on October 20, 1986, to discuss geophysical equipment prior to purchasing two geophysical airborne systems.

Three representatives of the Japanese National Oil Corporation, visited ISPG October 22 and 23, to learn about GSC's methodology for assessing hydrocarbon resources.

The Japanese Rare Metals Mission visited EMR on November 17 to discuss with representatives of EMR, EA, DRIE, NRC and AECL, resources, market trends and, in particular, processing technologies for a variety of rare metals. The delegation included representatives of metal producers as well as government agencies.

Mr. P. Navarra, Chief, Evaluation Department, Atomic Energy Commission, Argentina visited Mineral Resources Division on November 25, 1986, to discuss GSC's uranium exploration techniques (borehole logging).

Dr. Kelzo Fujii, Geological Survey of Japan, and Dr. Kiyoko Okada, Coal Mining Research Centre, Japan, visited ISPG on November 21, 1986, to review available geological and coal quality data for western Canadian coals that may be suitable for liquefaction.

Chief Geologist J.C. Chatupa and Principal Geologist F. Phiri of the Geological Survey Department, Zomba, Malawi, visited the GSC on November 27, 1986, for discussions concerning airborne and borehole geophysics.

On December 1, 1986, Mr. Andradjati, from the Indonesian Embassy in Ottawa, discussed implementation of the existing MOU with Indonesia.

Four Soviet gas hydrate specialists visited Ottawa, Calgary and Edmonton, December 5 to 12, 1986 for discussions with Canadian scientific counterparts in government, industry and universities and visits to Canadian research institutions. A Canadian delegation including two from GSC made a return visit on the same subject in March 1987.

On January 5, 1987, three Chinese geophysicists/computer scientists visited Mineral Deposits Division, to discuss airborne geophysical surveys. They were interested in all operating aspects, including instrumentation, survey techniques, data handling and map-making.

On February 3, 1987, two scientists, Mrs. Zhang Sai Zhen and Mr. Ou Ren Shang, from the Geophysical Institute of the Academy of Sciences, Beijing, visited GSC to discuss borehole electrical methods, especially as applied to mineral exploration.

Mr. Zheng Chuncai, Ministry of Geology and Mineral Resources, Beijing, China, visited Mineral Resources Division from February 27 to March 3, 1987, to discuss the GSC approach to mineral deposit studies, as well as joint projects on stratiform lead-zinc and Archean gold deposits.

Overseas Visits by Staff of the GSC

Some 30 foreign conferences at various locations throughout the world were attended by more than 40 scientists. In addition, 117 personnel were on foreign travel 166 times.

Overseas Visits in Support of CIDA and IDRC

Bogota, Columbia, G. Buchbinder, Geophysics Division, February 9-19, 1987, CIDA.

Lilongwe, Malawi, R.L. Christie, ISPG Division, June 19-29, 1986, CIDA and IDRC.

Bangkok, Thailand, A.G. Darnley, New Technology & International Programs, October 3-12, 1986, CIDA.

Thailand, A.G. Darnley, New Technology & International Programs, January 30-February 14, 1987, CIDA.

Kingston, Jamaica, R.G. Garrett, Mineral Resources Division, July 21-August 9, 1986, CIDA.

Bangkok, Thailand, W.A. Knappers, Geophysics Division, July 17-August 7, 1986, CIDA.

Bangkok, Thailand, G.J. Palacky, Mineral Resources Division, January 5-25, 1987, CIDA.

Rio de Janeiro, Brazilia, J.G. Tanner, Director General's Office, April 7-19, 1986, IDRC.

MINERAL DEVELOPMENT PROGRAM OFFICE

The Mineral Development Program Office is responsible for co-ordination of GSC activities within the federal-provincial mineral development agreements and within the two federal programs in Quebec (the Asbestos Initiatives program and le Plan de Développement Economique, Canada/Gaspésie et Bas St-Laurent). Co-ordinators work with GSC comptroller and divisions implementing the projects on the one hand, and with staff of the provinces and EMR Mineral Policy Sector on the other hand.

FEDERAL-PROVINCIAL MINERAL DEVELOPMENT PROGRAMS

Mineral development agreements (MDA), subsidiary to the umbrella Economic Regional Development Agreements (ERDA), have been signed with all provinces except Alberta. An MDA with Yukon is subsidiary to the umbrella Economic Development Agreement (EDA). MDA's are being developed for Alberta and Northwest Territories.

GSC implemented projects under the MDA's in Newfoundland, Nova Scotia, New Brunswick, Ontario, Manitoba and Saskatchewan, plus an aeromagnetic project in British Columbia and a regional geochemistry project in Yukon.

Newfoundland MDA - W.H. Poole, Co-ordinator

The third year of the 5-year program was marked by full activity levels in 14 projects and the year of highest cash flow of the program. Metallogenic studies continued in Labrador in the Central Mineral Belt and western Labrador and on the Island in the lead-zinc deposits of the western Carbonate belt, in the ophiolitic rocks throughout the Island, and in the base metal and gold-bearing volcanic-sedimentary belt of central Newfoundland. Geological mapping continued in the Grenville inlier of western Newfoundland and in the crystalline rocks of southwestern Newfoundland. Stream sediment and water samples were collected in the northern tip of Labrador to complete regional geochemical coverage of Labrador (and of the entire province). An airborne gamma ray spectrometer and VLF-EM survey was contracted to cover the entire Grenville inlier of western Newfoundland (outside Gros Morne National Park). An aeromagnetic gradiometer-VLF-EM survey was contracted to cover part of western Notre Dame Bay. Study of the ice flow history and drift composition continued in Labrador.

Outputs consist in part of 14 papers in Current Research and 10 open files. Seventeen posters of GSC projects were displayed at the Newfoundland annual review of activities.

Nova Scotia MDA - W.H. Poole, Co-ordinator

Year 3 in the Nova Scotia program showed maximum activity in 21 projects with the highest cash flow of the 5 years. Seismic surveys in the Springhill coalfield and Cumberland Basin continued, mainly by contract. Coal data continued to be placed in the National Coal Inventory of ISPG. Metallogenic studies continued in the Meguma terrane, highland areas and Carboniferous Basins. They included structural studies in the Tangier gold district, lithochemical studies of the metalliferous Goldenville-Halifax transition zone, studies of several gold deposits, mapping of the metalliferous Cheticamp area, study of the Lime

Hill and Kirkmount zinc deposits, study of vein deposits associated with the Chedabucto-Cobequid fault zone, lithochemical study of the Precambrian carbonates, and continued study and report preparation of Yava lead mine. A catchment basin study relating stream sediment geochemistry and bedrock chemistry in the Cobequids was continued as well as a data integration study of the Guysborough-Antigonish area. Information on mineral occurrences was placed in CAMINDEX file. Several final reports of geological projects were critically reviewed and returned to the author for revision, including those on the Lunenburg, the Shelburne, and the Port Mouton areas. Final reports on the Antigonish area and on northern Cape Breton Highlands were received. Stratigraphic and sedimentological study of the Stellarton Basin and a petrological study of eastern Meguma granites were continued. A study of Hadrynian rocks in the Cobequids and a sedimentological investigation of the Goldenville-Halifax transition zone in Mahone Bay were started. Aeromagnetic gradiometer-VLF-EM survey of the Cobequids was contracted and the release of the results of a contracted survey in the Musquodoboit area were delayed. An airborne gamma ray spectrometer-VLF-EM of the Cape Breton Highlands was contracted. Follow-up studies of some spectrometer anomalies continued, and the GSC Skyvan conducted detailed surveys of selected small areas. Down-hole geophysical logging was carried out in the Yava sandstone Pb deposit.

Outputs consist in part of 11 papers in Current Research and four open files. Eighteen posters of GSC projects were displayed at the Nova Scotia annual review of activities.

New Brunswick MDA - F.D. Anderson, Co-ordinator

Like the Newfoundland and Nova Scotia programs, year 3 of the New Brunswick saw operations at full capacity, with the highest cash flow of the 5 years. Metallogenic studies continued in the northern half of the province with a study of the mainly vein deposits near Woodstock and a lithochemical study of the red manganese slate-chert and black graphitic chert-slate within the Miramichi zone. Metallogenic study of the Chaleur Bay volcanic belt continued as well as a study of the uranium mineralization at Long Lake, central Miramichi zone. Two mafic-ultramafic bodies in northern Miramichi zone were mapped and sampled and petrology of the St. Stephen intrusion (in southern part of the province) was completed.

Regional geology studies continued in several widely distributed localities: late Precambrian granites and volcanics in the Caledonian Mountain zone, granite-volcanic assemblage in the Welsford pluton, and structure and diagenesis of the Carboniferous Albert Formation, all in the southern part of the province; and detailed structural studies in the Bathurst mining camp, and lithochemical studies of selected granites, both in the northern Miramichi zone. Two new projects were started: a lithochemical study of the sediments in the Miramichi zone and a physical volcanological study of the Lower Devonian volcanics near Passamaquoddy Bay.

A stream sediment and water geochemical survey was carried out in the Caledonian Mountain zone. An aeromagnetic gradiometer-VLF-EM survey was

contracted for northern New Brunswick and an airborne gamma ray spectrometer-VLF-EM survey was carried out of an area in northern New Brunswick and in southwestern New Brunswick, and follow-up studies of airborne spectrometer anomalies were initiated. Mapping ice flow history and till geochemistry continued in the northwestern half of the province.

Outputs consist in part of nine papers in Current Research and one open file. Fifteen posters of GSC projects were displayed at the New Brunswick annual review of activities.

Prince Edward Island MDA - W.H. Poole

The PEI MDA was signed in January 1986 to extend for 3 years (January 1986 to January 1989) and comprises an onshore aggregate resources program and public information program. PEI implements the programs and GSC has no formal part. Total budget is \$300,000, 80% of which is contributed by EMR. During the first year, PEI worked on a literature compilation, airphoto interpretation, reconnaissance mapping, geophysical testing (conductivity/resistivity measurements and hammer seismic) and data storage and retrieval.

During 1986/87, about \$70,000 was diverted from GSC A-base for the program.

Ontario MDA - S.B. Green, Co-ordinator

The 5-year Ontario MDA extends from April 1985 to March 1990. Of the Geoscience Program, GSC will spend \$6550K or 36% of the total \$18,350K. EMR will contribute \$2485K to the province.

1986-87, year 2 of the program, was the first year of fully active GSC projects. Within the Eastern Ontario district, work was initiated on the lithochemical study of zinc in siliceous dolomites, an evaluation of sillimanite deposits, the Twin Lakes Titanium deposit, a data integration study, and surficial geology mapping. In the Ignace area, work on the deposits at Sturgeon Lake was continued. Mapping and study of the Nipissing Diabase, Logan Sill and associated copper-nickel deposits were initiated in the Sudbury-Cobalt area. In the Beardmore-Geraldton area, mapping of surficial deposits and till composition studies were initiated, and plans were developed for an aeromagnetic gradiometer-VLF-EM survey. In the Kenora-Ft. Frances area, study of the gold occurrences in the Gagné Lake area was started, samples were collected for U-Pb zircon geochronology, mapping of surficial deposits and till geochemistry were undertaken, and a contract for an aeromagnetic gradiometer-VLF-EM survey was requisitioned. In the Timmins-Chapleau area, a variety of projects were active: mapping of the surface geology around the Hollinger, McIntyre and Coniaurum mines was completed, samples of scheelite in gold veins were collected for determination of age; studies of Quaternary stratigraphy, age determination of organic layers and core-drilling were initiated, the Val Gagné test site was surveyed in detail with a ground electromagnetic instrument and shallow reflection seismic in order to develop a method to determine the thickness of overburden, and about 800km of contracted helicopter EM-VLF-magnetometer were surveyed, and lake sediment and water samples were collected and analyzed over 31000 sq. km.

Outputs consist in part of two papers in Current

Research and one open file. One poster was displayed at the GSC Current Activities Forum.

Manitoba MDA - A.G. Galley, Co-ordinator

Twenty projects were carried out in Manitoba during 1986-87, the third year of a five year mineral development agreement. Projects supervised by the Lithosphere and Canadian Shield Division included alteration, metamorphic and geochronological studies in the Lynn Lake and Flin Flon-Snow Lake regions, geochronological and deformation studies in the Thompson region and a sub-Phanerozoic compilation of the Precambrian Shield in the region flanking the Flin Flon-Snow Lake belt. The Mineral Deposits Subdivision of the Mineral Resources Division (MRD) continued gold and massive sulphide studies in the Flin Flon-Snow Lake and Bissett regions, PGE and chromite studies in mafic-ultramafic rocks of the Lynn Lake, Flin

Flin-Snow Lake and southeastern Superior regions, and a remote-sensing program in the Lynn Lake Gold Belt. The Exploration Geochemistry Subdivision of MRD completed regional lake sediment and water surveys in the northeastern Superior region and the Terrain Sciences Division carried out till sampling and surficial mapping in the Sherridon-Nokomis and Flin Flon regions as well as compilation of surficial geology in the northeastern Superior region. Aeromagnetic surveys under contract to the Geophysics Division were completed in the Rice Lake, Moose River and Hargrave Lake regions.

Outputs from this fiscal year include three GSC publications and one Manitoba Energy and Mines publication, four GSC open files, eleven external publications, twenty presentations/displays at the GSC and Manitoba annual reviews of activities, as well as thirteen outside field trips and presentations.

Saskatchewan MDA - A.G. Galley, Co-ordinator

Five projects were carried out during 1986-87, the third year of a five year mineral development agreement. A correlation of stratigraphy in the Kiseynew Metamorphic Terrane was continued by the Lithosphere and Canadian Shield Division. The Mineral Deposits Subdivision of the Mineral Resources Division (MRD) continued gold studies in the LaRonge and Flin Flon regions, while the PGE potential of mafic-ultramafic intrusions was studied in the LaRonge, Rottenstone and Peter Lake structural domains. The Exploration Geochemistry Subdivision of MRD completed regional lake sediment and water surveys in the north Mudjatik structural domain.

Outputs for the fiscal year include two GSC open files, and six Saskatchewan Geological Survey short papers, plus presentations/displays at the Gold '86 symposium and GSC and Saskatchewan annual review of activities, as well as several outside presentations on PGE potential within the province.

British Columbia MDA

Within the 5-year, 1985-90, British Columbia MDA, GSC is responsible for an aeromagnetic survey project and a geoscience data system. A survey on Vancouver Island carried out by contract completed coverage of the Island. The adjacent islands were covered using A-base funds. Maps

will be published in 1987. O&M expenditure was \$250K, the full amount allotted.

Yukon MDA

Within the 4-year Yukon MDA (1985-89), regional geochemical maps of stream sediments and waters of samples collected in 1985 and earlier were released on open file. Samples were collected under contract in western Yukon in 1986 and the results will be released in July 1987. O&M expenditures totalled \$555K, with a \$5K anticipated overexpenditure.

Other MDA's

Mineral development agreements are being developed for Northwest Territories and for Alberta.

FEDERAL PROGRAMS, QUEBEC

Asbestos Initiatives, Geoscience Program- F.D. Anderson, Co-ordinator

1986-87 was the third and final year of the Geoscience Program under the Asbestos Initiatives. Five projects were active. Study of the stratigraphy of the Quaternary strata and distribution of the gold placers was continued with overburden drilling, sampling of till exposures and analyses. Maps showing analyses of heavy mineral concentrates collected in 1985 were released on open file. A multiparameter helicopter-borne geophysical survey (active EM, VLF and vertical gradiometer) was contracted to cover the Mont Stokes area, chosen in consultation with staff of Ministère de l'Énergie et des Ressources du Québec. A portable magnetic gradiometer was used to test its applicability in detecting magnetite concentrations (and gold) in buried river valleys. The Sterrett Mine, a former chromite producer, was mapped and studied.

Outputs consisted in part of six papers in Current Research and two open files. Four posters were displayed at the GSC Current Activities Forum.

Plan de Développement Économique, Canada/Gaspésie et Bas Saint-Laurent, Volet Mines - Y.T. Maurice, co-ordinateur

La somme de \$504,000 a été répartie sur dix projets au cours de l'exercice financier 1986-87. Environ 80% du montant global a été dépensé pour des travaux exécutés à contrat.

Les projets métallogéniques de la mine Madeleine, du gisement Candego et de la zone-E à Mine Gaspé se sont poursuivis sur le terrain pour une dernière saison et les rapports finals sont attendus au cours de la prochaine année. L'étude des formations siluriennes dans la région de Témiscouata en était également à sa dernière année. Cette étude a réussi à identifier clairement les sources des sédiments qui constituent les principales formations de la région.

Dans le domaine de la géochimie et de la géologie des dépôts meubles, un contrat a été accordé à l'Institut de recherche en exploration minérale pour vérifier l'hypothèse que l'or alluvionnaire qu'on retrouve dans la région de Matapédia aurait une origine glaciaire. On a complété l'échantillonnage et les analyses chimiques reliés au projet de lithogéochimie régionale et l'interprétation des données est en bonne voie. Les travaux de vérification sur le terrain, reliés

à la préparation d'une carte de compilation de la géologie du Quaternaire de toute la péninsule gaspésienne sont achevés à 85% et l'étude des dispersions glaciaires du centre de la péninsule est en phase de rédaction.

Du côté production, onze rapports ont été préparés pour publication dans des revues scientifiques et trois ont été placés en circulation comme dossiers publics de la Commission géologique. Vingt-huit cartes aéromagnétiques ont été publiées et quatre conférences ont été présentées sur des sujets variés.

Une somme additionnelle de \$1 million a été accordée au programme suite à une demande au Ministère de l'Expansion Industrielle Régionale. Ces fonds ont été attribués pour de nouvelles initiatives conçues par la CGC en collaboration avec l'industrie minière et le Ministère de l'Énergie et des Ressources du Québec et seront dépensés en 1987-88 et en 1988-89. Le Ministre Marcel Masse en a fait l'annonce officielle le 17 décembre à Murdochville.

CO-OPERATIVE PROGRAMS, NOVA SCOTIA AND NEWFOUNDLAND - W.H. POOLE

Nova Scotia The Canada-Nova Scotia Co-operative Mineral Program 1981-1984 ended March 31, 1984. Some publications were released during 1985-1986. Other unfinished projects and publications were carried forward under the Canada-Nova Scotia Mineral Development Agreement. The Co-operative Program has terminated.

Newfoundland The Federal Mineral Program in Newfoundland (Canada-Newfoundland co-operative mineral program 1982-1984) ended March 31, 1984. Some publications were released during 1985-1986. Other unfinished projects and publications were carried forward under the Canada-Newfoundland Mineral Development Agreement. The Federal Mineral Program has terminated.

OTHER PROJECTS

Deep Seismic Reflection Profile, Quebec and Maine W.H. Poole, Co-ordinator

Data manipulation, compilation and interpretation along with report preparation continued among the Canadian and American participants during the year. In February, A.G. Green, C.P. Spencer, M.C. Thomas and W.H. Poole met with P. St-Julien in Quebec City to discuss interpretation and report preparation schedules for the Canadian part of the co-operative project.

Personnel Notes

At year-end, the Office consisted of W.H. Poole, in charge of the Office and of the Newfoundland and Nova Scotia mineral development agreements; Y.T. Maurice for Plan de Développement Économique, Canada/Gaspésie et Bas-St-Laurent, Volet Mines; A.G. Galley for the Manitoba and Saskatchewan mineral development agreements; F.D. Anderson (part-time) for the Asbestos Initiatives geoscience program and for the New Brunswick mineral development agreement; part time administrative officer, J.G. Arnold; and a full time clerk, S.J. Gallant. Dr. Maurice and Mr. Galley also carried out scientific studies.

Attendance at Meetings, Conferences and Courses

F.D. Anderson

Management Committee meetings, Canada-New Brunswick Mineral Development Agreement, Fredericton, November 17, 1986; Ottawa, March 31, 1987.

New Brunswick annual review of activities, Fredericton, November 17, 18, 1986.

Séminaire d'information sur les activités du Ministère de l'Énergie et des Ressources du Québec, Québec, 2,3 décembre, 1986.

GSC Current Activities Forum, Ottawa, January 19-21, 1987

Meeting of Advisory Committee of New Brunswick Prospectors and Developers Association, Fredericton, December 12, 1986.

S.J. Gallant

"Financial Management Level 1", 3 day course, August 26-28, 1986.

"Computer Usage" - Knowledge of IBM PC, specifically the Lotus 123 Business Package, 2 day course, August 14 & 15, 1986.

Basic French language training, September 1986 to June 1987, 6 hours per week.

A.G. Galley

Gold '86, International Symposium on the Geology of Gold Deposits, Toronto, September 28-October 1, 1986.

Management Committee meetings, Canada-Manitoba Mineral Development Agreement, Winnipeg, November 25, 1986; Ottawa, March 3, 1987.

Management Committee meetings, Canada-Saskatchewan Mineral Development Agreement, Regina, November 24, 1986; Ottawa, March 12, 1987.

Manitoba Meeting with Industry, Winnipeg, November 20, 21, 1986.

Saskatchewan annual review of activities, Regina, November 19, 1986.

Manitoba Mineral Liason Committee meeting, Winnipeg, November 20, 1986.

GSC Current Activities Forum, Ottawa, January 19-21, 1987.

Meeting on evaluation of Manitoba MDA, Winnipeg, January 26, 1987.

Meeting with industrial liaison committee, Saskatchewan MDA, Saskatoon, February 13, 1987.

Y.T. Maurice

Comité Exécutif du Plan de développement de l'Est du Québec, 14^e réunion, Montreal, avril 1986.

Canadian Institute of Mining and Metallurgy, Annual General Meeting, Montreal, May 1986.

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986.

Séminaire d'information sur les activités de la direction générale de l'exploration géologique et minérale du Ministère de l'Énergie et des Ressources, Québec, décembre 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Mineral Exploration Research Institute Seminar: gold dispersion in surficial media, Montreal, March 1987.

Prospectors and Developers Association, Annual Convention, Toronto, March 1987.

Annual Meeting of Members of the Mineral Exploration Research Institute, November 1986.

Meeting of the Board of Directors of the Mineral Exploration Research Institute, Montreal, November 1986.

W.H. Poole

Meetings on development of Northwest Territories MDA, Yellowknife, September 4 and October 6, 1986. Management Committee meetings, Canada-Newfoundland Mineral Development Agreement, St. John's, November 5, 1986; Ottawa March 6, 1987.

Management Committee meetings, Canada-New Brunswick Mineral Development Agreement, Fredericton, November 17, 1986; Ottawa, March 31, 1987.

Management Committee meetings, Canada-Nova Scotia Mineral Development Agreement, Halifax, November 19, 1986; Ottawa, March 19, 1987.

Management Committee meeting, Canada-Manitoba Mineral Development Agreement, Ottawa, March 3, 1987.

Management Committee meeting, Canada-Saskatchewan Mineral Development Agreement, Ottawa, March 12, 1987.

Management Committee meeting, Canada-British Columbia Mineral Development Agreement, Ottawa, March 7, 1987.

Management Committee meeting, Canada-Ontario Mineral Development Agreement, Ottawa, March 25, 1987.

Annual Review of Activities, Newfoundland, St. John's, November 6, 1986; New Brunswick, Fredericton, November 17, 1986; and Nova Scotia, Halifax, November 19, 20, 1986.

Meeting of Technical Liaison Committee of Newfoundland and Labrador Explorationists, St. John's, November 25, 1986.

Meeting of Advisory Committee of New Brunswick Prospectors and Developers Association, Fredericton, December 12, 1986.

Meeting of Advisory Committee of Nova Scotia Chamber of Mineral Resources, Halifax, January 29, 1987.

GSC Current Activities Forum, Ottawa, January 19-21, 1987.

Special Talks and Lectures

F.D. Anderson

"Federal Geoscience Program, project activities 1986-87". Presented at New Brunswick annual review of activities, Fredericton, November 17, 1986.

A.G. Galley

"Activities of the Geological Survey of Canada in Manitoba during the 1986/87 field season". Presented at "Manitoba Meeting with Industry", Winnipeg, November 20, 1986.

Membership on Committees

F.D. Anderson

Member, Geoscience Subcommittee, Canada-New Brunswick Mineral Development Agreement.

A.G. Galley

Co-chairman, Geoscience Subcommittees, Canada-Manitoba Mineral Development Agreement and Canada-Saskatchewan Mineral Development Agreement.

Federal representative, Manitoba Mineral Exploration Liaison Committee.

Y.T. Maurice

Geology of Canada Series, French Edition; member of Advisory Committee.

Membre du Comité Exécutif du Plan de Développement Economique, Canada/Gaspésie et Bas St-Laurent.

Member, Board of Directors, Mineral Exploration Research Institute.

W.H. Poole

Member, Management Committee, Canada-Newfoundland Mineral Development Agreement.

Member, Geoscience Subcommittees, Canada-Newfoundland Mineral Development Agreement and Canada-Nova Scotia Mineral Development Agreement.

CHIEF GEOPHYSICIST'S OFFICE

J.G. Tanner - Chief Geophysicist

R.R. Riddihough - Scientific Executive Officer

Principal Activities

The principal task of the office during the year was to set up organizational mechanisms whereby national geophysical programs and priorities could be coordinated across the Branch. The principal achievement was the establishment of the Branch Geophysical Committee, chaired by the Chief Geophysicist and composed of the Division Directors responsible for geophysical programs. The committee met a number of times and examined the national programs of the Branch, in particular, aeromagnetic and gravity surveys, and deep crustal geophysics. A series of working groups reporting to the Committee on instrumentation, data bases and observatory operations was also established. A draft 3-year plan for major geophysical programs was produced and will be examined and revised on an annual basis.

Other activities of the office during the year were the establishment of an External Advisory Committee for Geophysics, initiation of a Geophysical Atlas and planning toward a volume entitled Geophysical Framework of Canada. The office was also very active in support of Dr. Tanner's presidency of the Geophysics Commission of the Pan-American Institute of Geography and History (PAIGH) and production of the Gravity Anomaly Map of North America.

PROGRAM OFFICE

The GSC Program Office headed by Dr. Benson continued its traditional function of monitoring and reviewing the Project Management System; preparing the Activity Approval Document and mid-year and year-end progress reports for the ADM; assembling the catalogue of scientific and technical projects, the field program catalogue, and the biennial map of "status of mapping"; and providing input to MOSST, STATSCAN, etc. The project system and other program documents were adjusted to reflect the structure and needs of the new GSC.

Dr. Camfield, (program officer in the former Earth Physics Branch) was designated Planning Officer and assigned responsibility for ensuring that the planning and program requirements of EPB are met in the new GSC. He carried responsibility for several ongoing EPB functions (e.g. EPB Capital Plan, Yellowknife Array Treasury Board submission); he also prepared the long term plans, the new subactivity objectives and other planning documents for the new GSC.

Attendance at Meetings, Conferences and Courses

D.G. Benson

GSC Current Activities Forum, Ottawa, January 22-23, 1987.

IGCP-CNC Twelfth Annual Meeting, Toronto, March 9, 1987.

M.A. Petre

GSC Current Activities Forum, Ottawa, January 22-23, 1987.

P.A. Camfield

GAC-MAC-CGU Annual Meeting, Ottawa, May 19-21, 1986.

Membership on Committees

D.G. Benson

Member, I.C.C.C.S.

Secretary-Treasurer, Canadian National Committee, IGCP.

P.A. Camfield

Secretary-Treasurer, Canadian Geophysical Union

Scientific Secretary, NSERC Grant Selection Committee for Earth Sciences.

FRONTIER GEOSCIENCE PROGRAM

D.D. Picklyk

D.D. Picklyk's primary assignment continues to be the program officer responsible for the administration of the Frontier Geoscience Program. This responsibility includes acting as secretary to the departmental Frontier Geoscience Senior Management Committee as well as for the Technical Advisory Committee which is comprised of representatives from other government departments, provincial agencies, universities and private industry.

With one exception, all program projects are performed by survey officers attached to the various regional offices. Operational activities and scientific results are reported by the regional divisions and are identified as part of the Frontier Geoscience Program.

Attendance at Meetings, Conferences and Courses

Branch Management Committee Meeting, Ottawa, May 15 and 16, 1986.

Frontier Geoscience Technical Advisory Committee Meeting, Ottawa, May 22, 1986.

Branch Management Committee Meeting, Calgary, September 9 and 10, 1986.

Frontier Geoscience Management Committee Meeting, Ottawa, December 19, 1986.

Branch Management Committee Meeting, Ottawa, January 14 and 15, 1987.

Membership on Committees

Frontier Geoscience Management Committee (Secretary).

Frontier Geoscience Technical Advisory Committee (Secretary).

ADMINISTRATIVE SERVICES

Y. Claude

Administrative Services in the Geological Survey is comprised of four units, namely the Procurement, Chemicals and Stationery Stores; Building Maintenance, Inventory and Vehicle Services; Branch Records and Messenger Services; and the Word Processing Centre. The responsibility of these sections is to provide administrative support to the Ottawa based Divisions as well as functional guidance and advice to the Regional Offices.

Administrative Services also provides administrative guidance and advice to the Geological Survey on all administrative matters by assessing the implications of new and changing Treasury Board policies and guidelines and departmental directives upon the administrative support staff and the operational Divisions and implementing them as they relate to the GSC. The Units also coordinate and administer the accommodation plans; the Energy Conservation Program; Security/Safety and Emergency Disaster programs; Field logistic requirements; and controls the Branch Parking allocation.

Attendance at Meetings, Conferences and Courses

Joint Occupational Safety and Health Committees
Departmental Parking Committee
Departmental Suggestion Award Committee
Departmental Cafeteria Committee
GSC Branch Management Committee
GSC Administrative Officers' Committee
GSC Emergency Organization
Departmental Field Equipment Committee
Facilities Planning and Management Committee

Personnel Notes

Staff changes include: Arrivals - David Hayes to the Records and Messenger Services Unit; Dennis Loshuk to the Procurement, Chemical and Stationery Stores Unit; and Francine Mellor to the Word Processing Centre. Departures - Jim Clarke from the Records and Messenger Services Unit; Daniel Chenier from the Procurement, Chemicals and Stationery Stores Unit; and Claudia Clarke from the Word Processing Unit.

ATLANTIC GEOSCIENCE CENTRE

M. J. KEEN

The Division's objectives are briefly to ensure that geological information and expertise are available for the offshore regions of Atlantic and Arctic Canada, the sedimentary basins of the Appalachian region, and for the ocean basins in general when necessary. The knowledge and information is directed to national needs of the following sorts: identification of the base of resources available; the formulation of mineral and energy policy; making exploration for Canadian resources easier; and enhancement of the nation's intellectual base in the earth sciences.

We meet these objectives by: undertaking geological, geophysical and geochemical research, including surveys, regional interpretation and synthesis; establishment of appropriate national and international standards for geological chronology, correlation, reference materials and surveys; identification of the characteristics and probable locations of occurrences of coal, oil and gas resources and estimates of their abundance; identification of the characteristics of the terrain offshore for its safe and proper use; development of methods and technologies to improve the effectiveness of marine geoscience surveys, discovery of resources and the determination of terrain properties; the dissemination of information.

The Division is organized into five Subdivisions: Administration, Eastern Petroleum Geology, Environmental Marine Geology, Regional Reconnaissance and Program Support. The staff consists of one EX, four Senior Managers, 50 Research Scientists, Physical Scientists, Engineers and Computer Scientists, 37 Scientific and Technical Support staff, 14 Administrative, Secretarial and Clerical support staff.

Administration Subdivision

C. E. Racine

The objectives of the Administration Subdivision are to provide efficient and effective financial, personnel and general administrative guidance and support to the Atlantic Geoscience Centre. The Subdivision consists of the Director's Office, Personnel Office and Finance Office with each section supplying the general administrative support necessary to ensure a smooth operation.

Personnel Notes

The Subdivision consists of a permanent staff of a Director, Assistant Director and a Secretary; an Administrative Officer, three Financial Clerks, a Personnel Clerk and a Secretary.

Attendance at Meetings, Conferences, Courses

M.J. Keen

EMR Coordinating Committee on Marine Geoscience Research, Ottawa, July 23, 1986

Basins Symposium, Halifax, August 13-15, 1986

GSC Branch Management Committee meeting, Calgary, September 8-9, 1986

Ocean Drilling Program meeting, Calgary, September 11-12, 1986

AGC Program Review, Dartmouth, September 22-24, 1986

Ocean Drilling Program Workshop, Montreal, September 25-26, 1987

Ocean Drilling Program Executive Committee meeting, Victoria, October 14-17, 1986

EMR Coordinating Committee on Marine Geoscience Research, Ottawa, November 4, 1986

GSC Current Activities Forum, Ottawa, January 20-21, 1987

Ocean Drilling Program Budget Committee meeting, San Francisco, February 25, 1987

EMR Coordinating Committee on Marine Geoscience Research, Ottawa, March 24, 1987

D.I. Ross

Boundary Disputes meeting, Ottawa, April 22, 1986

GSC Branch Management Committee meeting, Ottawa, May 15, 1986

3rd Annual Marine Geotechnical Conference, St. John's, June 13, 1986

Panel on Energy Research & Development meeting, Calgary, June 24, 1986

Basins Symposium, Halifax, August 13-15, 1986

AGC Program Review, Dartmouth, September 22-24, 1986

Membership on Committees

M.J. Keen

DFO/EMR Guiding Committee on Offshore Surveys

BIO Directors Committee

Dalhousie University, Adjunct Professor

Atlantic Regional Interdepartmental Committee on Environmental Issues

DFO Atlantic Management Committee (observer)

Canadian Geoscience Council: Chairman, Marine Geosciences Committee

Ocean Drilling Program: Canadian Executive Committee

Ocean Drilling Program: Canadian Representative on Budget Committee

Ocean Drilling Program: Alternate Canadian Member, International Executive Committee

EMR Coordinating Committee on Marine Geoscience Research

Advisory Board, Newfoundland Institute of Cold Ocean Sciences (NICOS)

Physics Committee, Atlantic Provinces Inter-University Council on the Sciences

D.I. Ross

Canadian National Committee for the Engineering Committee of Oceanic Resources (ECOR)

Marine Technical Society, Canadian Maritime Section

CSA Task Force on Foundations

Environmental Marine Geology Subdivision

D.J.W. Piper

The subdivision is responsible for the surficial marine geology of eastern and northern Canada. Field surveys provide a knowledge base of the distribution and characteristics of surficial sediments and shallow bedrock offshore and in the coastal zone, and an understanding of the processes responsible for the deposition and reworking of coastal and marine sediments. Results from this work are published both as maps and papers. The work allows the subdivision to provide advice for the rational management of marine areas and the identification and development of natural resources.

The core program of the subdivision is funded by the Geological Survey of Canada out of the regular A-base budget. In addition, the subdivision receives funds under several special programs such as the Conventional Energy R&D Task of the Office of Energy Research and Development (OERD), the Frontier Geoscience Program (FGP), and the Northern Oil and Gas Action Plan (NOGAP), in order to carry out or accelerate specific research programs.

Projects within the subdivision are organized into geographic and discipline groups: this organization is utilized in the following descriptions of individual projects.

Core Program (funded out of A-base)

1. Coastal Projects (Taylor, Forbes)

Aerial video and ground surveys were carried out along the coast of Loughheed and Mackenzie King Islands and adjacent areas in the Arctic Archipelago. Raised delta terraces on Melville Island were surveyed and datable material was collected in order to assess fluvial sediment delivery to the coast and sea-level change over the past 8000-9000 years. A resurvey of selected beaches, first examined 15 years ago in the eastern Arctic, indicated that little net morphological change has occurred and that only two beaches exhibited new beach ridge development comparable to the adjacent raised beach features.

Coastal air video for part of the west coast of Newfoundland was released on Open File; and a cooperative project with the New Brunswick Department of Natural Resources resulted in aerial video coverage

for the coastline of that province. Surveys of beach and cliff sites on the Nova Scotia and Newfoundland coasts provided further information on rates of coastal change (up to 3 m/yr.) and a better understanding of sediment supply, sea level, and other factors affecting beach stability and the evolution of gravel-dominated coastal deposits. Studies of sediment distribution and dynamics included the discovery on the inner shelf of anomalous and as yet unexplained seafloor depressions in mud and further work on the mobility and the nature of large scale wave-formed gravel ripples.

2. Coastal Inlets and Deltas (Syvitski, Schafer)

Meetings were held to coordinate the SEDFLUX project, the objective of being the determination of sediment transport from the landmass of Canada to the continental shelf. Field work in support of this project was carried out in the St. Lawrence Estuary and Gulf region; a series of surficial geology maps have been completed for the Baie des Chaleurs; sediment flocs were measured *in situ* with a floc camera, and an image analysis system has been developed to analyze the data. In addition, the study of basin sedimentation and slumping in Saguenay Fjord was continued. Distinctive differences between 19th and 20th Century spring discharge characteristics of the Saguenay River are reflected in the textural and magnetic susceptibility values of bottom sediments.

"Fjord Sedimentation", a new book by J.P.M. Syvitski and co-authors, and numerous other publications have resulted from a continued swift analysis of various fjord settings, in particular on Baffin Island. Some results of the work include: delta-front failure on both sands and muds has led to turbidite sedimentation in Itebilung Fjord; whales and seals rework bottom sediment, and arenaceous foraminifera species showed a distinctive inverse correlation with bottom-water temperatures. On land, glacial sedimentation rates were measured from raised delta sequences on northern Baffin Island.

3. Geochemistry (Buckley, Cranston)

The geoscience characteristics of several potential high-level nuclear waste disposal sites in the deep ocean have been assessed using site qualification criteria developed by the Nuclear Energy Agency (NEA) Seabed Working Group. Detailed geochemical analysis has been completed of long cores from two such sites - the Madeira and Southern Nares abyssal plains. These show that early diagenetic reactions involving the oxidation of organic matter and the reduction of labile metals are the main control on the diffusion and precipitation of metals.

4. Regional Geology: Southeastern Canada (Fader)

Work was begun to update mapping capability in the nearshore zone of the Atlantic continental shelf. Existing data were compiled and the AGC data base for the inner shelf around the Atlantic Provinces was cleaned up.

Regional mapping of the Grand Banks continued with a two-week cruise on CSS HUDSON; large areas of gas escape craters (pockmarks) were mapped, and evidence was found that the entire area of the Grand Banks was glaciated during the Wisconsinan. Compila-

tion of the surficial geology of the area south of Newfoundland was partly completed under contract, and a detailed map of the geology of the Hibernia region of Grand Bank was released on Open File.

5. Regional Geology: Eastern Arctic & Subarctic
(MacLean, Josenhans, Vilks, Mudie)

Work began this year on a new assessment of the Quaternary geology of Hudson Bay - a key area in the understanding of the Laurentide ice sheet. This work was carried out in conjunction with an investigation of bedrock geology under the Frontier Geoscience Program. Twenty-five hundred kilometres of high resolution seismic profiles were obtained from CSS HUDSON and 40,000 km of old 3.5 kHz profiles were discovered and partly compiled and interpreted as part of the preparation for this field program.

Compilation of the 1:1 million map series of the Labrador Shelf was completed. Samples and seismic data from fjords on the northern Labrador Shelf were analyzed to correlate marine and terrestrial stratigraphies in the area. Submersible data, collected from the test trench across the Strait of Belle Isle (for the Newfoundland hydro-power cable) and a recent grounding site of an iceberg on the Labrador Shelf (part of DIGS program - see Energy R&D Program), provided valuable groundtruth of sediment dynamics and ice scouring processes in these areas.

Coring and mapping of thick sequences of glacio-marine and postglacial sediments in Lake Melville suggest a minimum age of 8KyBP (based on radiocarbon data) and an extrapolated date of 10KyBP (based on a sedimentation rate of 1m/1,000 yrs) for the beginning of proglacial lake sedimentation.

The geology and geotechnical properties of inter-island seabed sediments in the Arctic were examined using the CSS HUDSON and helicopter-transported boats. The results are elaborated under the NOGAP program.

6. Regional Geology: Western Arctic (Blasco, Hill)

Although limited amounts of A-base funds and funding for investigating bilateral boundary disputes were used, the work in the Beaufort Sea was largely supported by outside funding. The research is therefore reported under the OERD and NOGAP Programs.

Frontier Geoscience Program

Four activities within the subdivision are funded by the Frontier Geoscience Program. They include: (1) east coast offshore mapping, lithological and biostratigraphic investigations; (2) initiation of a physical sediment properties and geotechnics project; (3) sea floor mapping and sampling of the Arctic Basin from an Ice Island platform; and (4) participation in the Ocean Drilling Program (ODP) in which the subdivision has played a significant role.

A new, automated x-ray diffraction system was acquired during the year using FGP funds. This replaces the obsolete diffractometer that the subdivision has worked with over the last 25 years. The equipment will be used in support of the Division's A-base and FGP programs, including diagenesis and basin studies by Eastern Petroleum Geology subdivision and investigations by EMG physical properties

and early diagenesis.

1. Acceleration of Offshore Mapping Projects
(Josenhans, Fader)

The Frontier Geoscience Program has provided funds to carry out field work on the Grand Banks, to accelerate studies of biostratigraphy in the east coast offshore, and to accelerate compilation and release of regional data on the Labrador Shelf. These are described above under the core program. The FGP funds have also been used to initiate a series of 1:250,000 computer-based Open File surficial geological maps of the east coast offshore. A prototype series of five map areas, covering a range of geological settings and data density, have been prepared under contract on a digital database.

2. Physical Properties and Geotechnics Project
(Moran)

The physical properties and geotechnics research program, sponsored by FGP, has four major components: (1) basic research; (2) mapping; (3) geological processes research; and (4) technological developments. The ongoing basic research is focussed on the consolidation or stress history of sediments with respect to the geological history; the strength and stress-strain behaviour of sediments under geological and man-made loading conditions; and on the correlation of sediment physical and acoustic properties. Mapping of the geotechnical properties of the continental shelves is ongoing by "zoning" regions of similar physical properties. Geological process topics which are currently being investigated include the analysis of slope instability on the Scotian slope, the determination of sediment settlement history as an input to sea-level history, and an evaluation of the changes in sediment properties due to iceberg scouring.

3. Ice Island - Arctic Basin Project (Mudie)

The Ice Island was occupied during a two-month summer field season. The coring facilities were upgraded. The Ice Island moved only a short distance on the Axel Heiberg Shelf. Seismic profiles, cores, grabs and bottom photographs show a thin Pleistocene cover over Tertiary bedrock. Unique siliceous sponge reef communities occur in 95-140 m water depth on the shelf; they resemble Precambrian reefs on Ellesmere Island previously regarded as subtropical. Isotopic studies show fully marine conditions have existed on the Axel Heiberg Shelf only over the last eight thousand years.

4. Ocean Drilling Program

Participation by K. Moran in ODP Leg 110 to the Lesser Antilles Forearc, where an active margin was drilled and sampled, allowed further basic research on sediment stress-strain behaviour. This geologic setting provided a known strain rate for the sediments within the accretionary prism for more controlled laboratory testing. For similar research goals, P. Hill and J. Marsters (a recent M.Eng. graduate from Technical University of Nova Scotia) participated in ODP Leg 112 to the Peru-Chile Trench. In addition to tectonic interests, the sediments sampled in Leg 112 indicated early diagenesis at very shallow depths below the seabed which will provide better understanding of this mechanism.

Energy R & D Programs

The energy R&D Program involves work in both the Beaufort Sea and East Coast Offshore under the Offshore Geotechnics Program, and work on the continental slope and development of the Long Coring Facility under the Long Term Studies in Marine Geology Program.

1. Beaufort Sea Geotechnics Program (Blasco)

The assessment of surficial geology and seabed stability problems on the Beaufort Shelf continued. Field work included the acquisition of deep borehole and shallow seismic data on the eastern shelf and entrance into Amundsen Gulf. Seabed rescouring rates by ice keels in water depths of 14m to 35m are high with 90% of the seafloor rescoured in less than 110 years. The thickness of post late Miocene sediments exceeds 3000m north of the Mackenzie Delta, but thins to less than 200m to the west on the Yukon Shelf. Seabed sediments on the Yukon Shelf are greater than 53ka, in contrast to the main shelf where the upper 100m is less than 25ka. The Mackenzie Trough has been excavated to greater than 500m below sea level by the repeated action of glacial ice tongues during the Pleistocene. Seismic-borehole correlations confirm the validity of the in-situ continuous cone penetration test (CPT) as a high resolution stratigraphic tool. A strong correlation exists between the physical property characteristics and the sediment facies units mapped along a deep borehole transect across the inner shelf. Six permafrost cycles have been recognized in the 700m thick sequence of ice-bearing sediments offshore.

2. East Coast Geotechnics Program (Parrott, Lewis, Amos)

Work continued on the analysis of data from the Dynamics of Iceberg Grounding Study (DIGS), supported by the Environmental Studies Research Fund. Re-mapping of scours on the Grand Banks was carried out from CSS HUDSON. Estimates of ice scour frequency made by four different methods have been completed; they vary by two orders of magnitude, but suggest low scour rates for the Grand Banks. Mineralogical analyses of core samples from the Hibernia area have shown that Tertiary sediments were subaerially weathered and modified during Pleistocene low stands of sea level.

The GSC successfully negotiated with Petro-Canada to have a geologist aboard to log, photograph and sub-sample material from a 35 m long borehole to be drilled to investigate seabed stability prior to setting down the jack-up rig. Two boreholes were analyzed in this way: a 36 m long borehole at COMO P21 and a 60 m long borehole at PANUKE F99. The borehole at PANUKE was extended by GSC from 35 m to 60 m due to the outstanding seismic stratigraphy at this site. The lithostratigraphy correlated well with the seismic section and so results can be extrapolated to other sites of potential development. A Tertiary delta has been identified at the site of the proposed Hibernia oil development and other features of the Tertiary sediments of the Grand Banks identified. On a 10-day cruise to the Grand Banks, data was collated to study iceberg grounding rates through repetitive mapping. The possible drowned barrier island at Hibernia was examined further. Sediment

transport rates have been determined for the Hibernia area.

A sidescan sonar system was added to the Brutiv Towfish to provide direct correlation of the revised and sonar data resolves, and a system (UCON) developed to provide the correct attitude of the visual data.

Proceedings on the workshop on ice scour research have been published and provide a summary of research in this field in Canada.

3. Continental Slope Project (Piper)

Field work was carried out in Flemish Pass, the western Grand Banks Slope, and the Scotian Slope to further investigate sediment stability. A geophysical investigation of the Sackville Spur slope indicated that, at present, the Labrador Current and Western Boundary undercurrent are the two major hydrodynamic forces controlling sedimentation patterns. Detailed geotechnical investigations are being carried out at several sites on the Scotian Slope. A ten thousand year old shelf-crossing glacial event profoundly influenced sedimentation on the slope off St. Pierre Bank. Analysis of industry seismic data from the central Scotian Shelf suggests that interstratal deformation is widespread in the Plio-Pleistocene section.

4. Long Coring Facility Project (Manchester, Piper)

Construction of the barrel release system for the Long Coring Facility was completed by the University of Rhode Island (who are leaders of a consortium that also includes the Dutch Geological Survey). Testing of the 30 m system was deferred until 1987 because of the cancellation of two weeks of shiptime by DFO. The project was initially funded to support studies of deep sea fans: work has continued on facies distribution on the Laurentian Fan. In joint field work with Lamont Doherty, seven dives were made in DSRV Alvin to investigate sediment facies developed in the 1929 turbidity current event, and a Seabeam map of the Eastern Valley of Laurentian Fan was prepared.

Northern Oil & Gas Action Program

1. Arctic Island Channels Project (MacLean, Vilks, Sonnichsen)

Two programs were undertaken to investigate the geology and geotechnical properties of seabed sediments in interisland channels of the Canadian Arctic Archipelago.

One of these, carried out from CSS HUDSON, obtained extensive shallow and high resolution seismic and other acoustic data and samples in Wellington, Byam Martin and Austin channels. Data were also obtained in parts of Sophia and Queens channels, Barrow Strait and northern Viscount Melville Sound.

A second program, carried out by a helicopter-transported small boat, obtained acoustic data and samples through leads in the permanent sea ice of the Loughheed-Cameron-Melville island region.

Results indicate the widespread occurrence of unconsolidated sediments of apparent glacial origin which lie on top of variably dipping sedimentary bedrock and lie beneath a surface layer of silt, clay and coarser sediment. Total sediment thickness is commonly less than 10 m in Wellington Channel, somewhat more in Byam Martin and Austin channels, and greatest in eastern Barrow Strait where sediment locally reaches 100 m thick.

These surveys provide regional information on sediment composition, thickness and geotechnical properties and seabed conditions, necessary for government and industry policy and decision making relating to future oil and gas developments in this region.

2. Beaufort Sea Coastal Zone Geotechnics (Hill)

Work has continued on the geology and geotechnics of the nearshore zone of the Beaufort Sea. Data from the King Point Sediment Transport Study were analyzed using spectral analysis for comparison with a hindcast model. Results indicated that King Point is dominated by longshore transport and that the wave regime is best predicted using a hindcast from offshore winds, rather than locally measured winds.

Cliff and beach profile measurements were carried out at numerous sites from Komakuk Beach to Cape Dalhousie. These established new baseline data for cliff erosion and beach profile measurements, and obtained retreat rates for previously measured sites.

A study to determine the optimum seismic configuration for profiling in the shallow water areas of the Beaufort Sea was conducted under contract. Based on the results of this contract, seismic and sidescan surveys, with coring and water sampling, were carried out from CCGS NAHIDIK on a one-week cruise in September. Seismic coverage was obtained from Kugmallit to the Mackenzie Delta. Preliminary analysis suggests substantial sediment accumulation of sediment in the coastal zone, the presence of a drowned valley seaward in Kugmallit Bay and useful correlations between seismic and sediment facies.

Provision of Advice

Provision of scientific and technical advice continues to be a major part of the work of the subdivision, as is clearly reflected in the industry-supported special programs. The subdivision has been involved in preliminary environmental assessments for hydrocarbon exploration on Georges Bank and the Northumberland Strait causeway-bridge crossing. There has been increased demand for information on the offshore for advice on: a possible power cable to Maine from Nova Scotia; telecommunication cables across the Bay of Fundy and the Scotian Shelf; and review of ocean dumping applications for the Atlantic region. In the coastal zone, there is increased demand for information on nearshore sediment because of interest in placer gold, aggregates, silica and titanium placer. Advice on shoreline stability and shore protection measures are provided to National Parks to assist in preserving national monuments and facilities, and the planning of new parks. Advice is also provided to local shorefront property owners who are suffering from increased shore erosion.

The subdivision has completed its part of the Geology of Canada volume: the subdivision was responsible for three chapters: Quaternary Geology, Sedimentation Processes, and Constraints to Development; and five 1:5 million scale maps, which will provide a useful reference to a variety of users.

International

On an international scale, the subdivision provides background scientific information for the selection of potential deep ocean waste disposal sites, is involved in cooperative research of gravel beach dynamics with scientists from Northern Ireland, and is planning a sediment dynamics study of two inlets on the south coast of Hainan Island with the Chinese government.

Personnel Notes

Denis Bonifay completes his contract in June 1987, and will shortly be returning to France. He has been with us over a year working on continental slope stratigraphy.

Paul Durling left the subdivision in August 1986 to join the Regional Reconnaissance subdivision.

Dave Mosher joined the subdivision in May 1986 to provide technical assistance to the PERD East Coast Offshore Geotechnics Program.

Kevin MacKillop completed his term position in April 1987; he worked on the Beaufort coast and nearshore minerals in Nova Scotia.

John Shaw joined the subdivision in September 1986 as a Postdoctoral Fellow working on sea level and coastal change.

Attendance at Meetings, Conferences, Courses

C.L. Amos

2nd Symposium on Turbid Coastal Environments, Plymouth, U.K., September 1-4

S.M. Blasco

GAC Annual meeting, Ottawa, May 19-21

3rd Annual Marine Geotechnical Conference, St. John's, June 10-12

Canadian Ocean Drilling Program Workshop, Montreal, September 25-27

International Arctic Drilling Workshop, Dartmouth, December 15-17

Special presentation: Late Quaternary geology and sea level history of the Canadian Beaufort continental shelf, Dalhousie University, Halifax, January 8

D.E. Buckley

International Ocean Institute Summer Training Program, Halifax, June 19

Canadian Ocean Drilling Program Workshop, Montreal, September 25-27

Chemical Institute of Canada - Chemical Society of Canada meeting, Halifax, November 19

Nuclear Energy Agency, Seabed Working Group Site Assessment Task Group meeting, Albuquerque, New Mexico, December 12-18

International Centre for Ocean Development Offshore Non-fuel Minerals Resources: Assessment and Planning: a short course, Halifax, March 4

H. Christian

3rd Canadian Conference on Marine Geotechnical Engineering, St. John's, June 6-13

G.B. Fader

Departmental Committee on Ocean Mining meeting, Ottawa, May 28-29

3rd Canadian Offshore Geotechnical Conference, St. John's, June 1986

12th International Congress on Acoustics, Symposium on Acoustic Imaging, Halifax, July 1986

Basins of Eastern Canada Symposium, Halifax, August 1986

Canadian Offshore Resources Exposition (CORE), Halifax, October, 1986

Nova Scotia Department of Mines and Energy Open House, Halifax, November 1986

Departmental Committee on Ocean Mining briefing session to industry, Vancouver, December 1986

Presented talk at local high school, "Careers in the Geological Survey of Canada", December 1986

Presented talk to University of Maine, "The Quaternary Geology of the Eastern Gulf of Maine and Adjacent Scotian Shelf", March 24, 1987

Presented lecture at Dalhousie University, "Geological Aspects of the Canada-United States Border Dispute in the Gulf of Maine

R.A. Fitzgerald

Scientific suppliers Exposition and Congress on Advances in Spectroscopy and Laboratory Science, Toronto, October 5-10

D.L. Forbes

ACROSES Meeting, Ottawa, April 16-17

SEPM Conference on Shelf Stratification, Vancouver, May 20-June 2

ACROSES/C²S² meeting, Ottawa, June 25-30

ACROSES meeting, Montreal, September 24-25

ACROSES meeting, Quebec, March 12-13

P.R. Hill

Ocean Drilling Program Workshop, Montreal, September 24-27

W.H. Josenhans

Institute of Arctic and Alpine Research Workshop, Boulder Colorado, April 23-28

DIGS Meeting, September 3-5

Dynamics and History of the Arctic Shelves and Slopes Workshop, Woods Hole, December 1-4

GSC Current Activities Forum, Ottawa, January 19-22

GAC Newfoundland Section Annual Meeting, St. John's, March 18-20

C.F.M. Lewis

C-CORE Associates Workshop, St. John's, October 7-10

B. MacLean

Canadian Society of Petroleum Geologists (presented paper), Calgary, June 1986

N.W.T. Geoscience Forum (presented paper), Yellowknife, December 1986

R. Miller

Workshop on Geotechnical Aspects of Grand Banks Geology, St. John's, June 10-13

Canadian Offshore Resources Exposition (CORE), Halifax, October 1986

Nova Scotia Department of Mines & Energy Open House, Halifax, November 1986

K. Moran

Pressuremeter Symposium, Texas A&M Univ., Texas, May 6

Ocean Drilling Program Workshop, Montreal, September 25-27

P.J. Mudie

Lincoln Sea Workshop, Ottawa, July 26-29

Second International Congress on Paleoceanography, September 6-14

Ocean Drilling Program Workshop, Montreal, September 25-27

American Association of Stratigraphic Palynologists Meeting and Workshop, New York, Oct. 28 - Nov. 1

D.J.W. Piper

GAC Council Meeting, Ottawa, May 16-21

International Association of Sedimentologists meeting, Sydney, Australia, Aug. 21 - Sept. 1

Canadian Ocean Drilling Program Workshop, Montreal, September 25-27

K.R. Robertson

University of Cape Breton Advisory Board Meeting, Sydney, October 24

C.S. Schafer

Canadian Committee on Climate Fluctuations and Man, Ottawa, January 29-30

Natural and Man Made Hazards Conference, Rimouski, August 3-9

J.P.M. Syvitski

15th Arctic Workshop, INSTAAR, Boulder, Colorado, April 23-24

R.B. Taylor

SEDFLUX Meeting, Dartmouth, January 1987

Membership on Committees

S.M. Blasco

Chairman, PERD: Offshore Geotechnics Committee

Member, PERD: Marine Engineering Committee

Member, PERD: Permafrost and Hydrates Committee

Member, NRC ACGR Subcommittee on Permafrost Research

Member, USGS/GSC Arctic Geoscience Working Group

D.E. Buckley

Ph.D. Thesis Research Committee (S. Niven, Dalhousie University)

Regional Ocean Dumping Advisory Committee

Bedford Institute of Oceanography Hazardous Chemicals Committee

OECD-NEA Seabed Working Group, Site Assessment Task Group

G.B. Fader

Scientific Advisor to the NRC-PILP Project "SUPER-TECH" with Earth and Oceans Resources Ltd.

Member, Environment Canada Working Group on the PEI - Northumberland Strait Fixed Crossing Project

Member, COGLA Georges Bank Screening Committee for the Evaluation of Petroleum Drilling on Georges Bank

AGC Representative, Departmental Committee on Ocean Mining

Member, Organizing Committee on the 1987 meeting of the NATO Advanced Study Institute on Late Quaternary Sea-level Correlation

AGC Advisor to National Film Board for production of

"A New World Below"

Member, AGC Seismic Committee

Member, Atlantic Geoscience Society sponsored Nova Scotia Geological Highway Map Committee

D.L. Forbes

Member, National Research Council Associate Committee for Research on Shoreline Erosion and Sedimentation (ACROSES)

Editor and Subcommittee Chairman, ACROSES Bulletin

Member, Steering Committee, Environmental Atlas for Beaufort Sea Oilspill Response

W.H. Josenhans

Associate Editor, Geophysique et Quaternaire

C.F.M. Lewis

Chairman, Seabottom Ice Scour Committee, Environmental Studies Research Fund

Technical Advisor, Centre for Cold Ocean Resources Engineering, Memorial University of Newfoundland

Coordinator, PERD Hibernia - Sable Offshore Geotechnics Program

K.M. Moran

Chairperson, Ocean Engineering Committee, Association of Professional Engineers of Nova Scotia

Member, Canadian Standards Association Committee on Code for Offshore Structures

Member, NRC Subcommittee on Marine Geotechnical Engineering

P.J. Mudie

Member, Canadian Geoscience Council Committee on Quaternary Research

Member, Sediment and Ocean History Panel, Ocean Drilling Program

Member, Royal Society of Canada Ad Hoc Committee on Global Change

R. Parrott

Member, Association of Professional Engineers of Nova Scotia (APENS) Ocean Engineering/Energy Committee

Member, Marine Applications Council

Member, BIO Ship Users Committee

Chairman, AGC High Resolution Seismic Committee

D.J.W. Piper

Member, Bottom Sediment Transport Committee, Environmental Studies Research Fund

Chairman, Membership Review Committee, Geological Association of Canada

Member, Organizing Committee, INQUA 87

Member of Editorial Boards for Sedimentology, Geomarine Letters, Canadian Journal of Earth Sciences, and Thalassographica

Chairman, Local Organizing Committee, GAC-MAC 1992 Joint Annual Meeting

K.R. Robertson

Member, University College of Cape Breton Environmental Technology Advisory Committee

Member, University College of Cape Breton Chemical Technology Advisory Committee

C.T. Schafer

Member, Canadian Committee on Climate Fluctuations and Man

Member, Nova Scotia Climate Advisory Committee

Member, Pt. Lepreau Environmental Monitoring Group

Member of Organizing Committee, Impact of Climate on Fisheries in Nova Scotia Workshop

Member, Abstracts Review Committee, Oceans 87

J.P.M. Syvitski

Chairman, IUGS Committee on Grain Size Analysis of Sediments

R.B. Taylor

Chairman, Terrain Subcommittee of the Sable Island Environmental Advisory Committee (an interdepartmental federal and provincial agency)

Laboratory Statistics

Sedimentology Laboratory

Manual Sieve Analysis - 15
Sieve and Pipette Analysis - 193
Settling Tube Analysis - 636
Sedigraph Analysis - 301
Coulter Analysis - 1,452
Organic Carbon Analysis - 2,915

Geochemistry Laboratory

Elemental Analysis, Organic - 1
Elemental Analysis, Inorganic - 27,017

Radiographic Laboratory

X-radiographs of Sedimentary Core - 1,218
X-ray Diffraction Analysis - 83

Ocean Dumping

Permit Evaluations - 81

Eastern Petroleum Geology Subdivision

M. E. Best

The Subdivision is responsible for the subsur-

face geology of the sedimentary basins of eastern Canada and contiguous areas. The objectives are: to increase our knowledge of subsurface geology of the sedimentary basins of offshore eastern Canada and contiguous areas, to interpret the hydrocarbon potential of these basins, and to undertake periodic appraisals of such resources. Studies of the upper Paleozoic basins of the Atlantic Provinces and their coal and hydrocarbon resources are also undertaken.

Offshore eastern Canada encompasses an area stretching from 41°N to 76°N. Specific areas include: Baffin Bay, Davis Strait, Hudson Bay, Hudson Strait, Labrador Shelf, Northeast Newfoundland, Grand Banks, Gulf of St. Lawrence, Scotian Shelf, and the Bay of Fundy. Contiguous areas studied by the subdivision scientists include the North Atlantic, Labrador Sea, western Europe, the U.S. continental margin, as well as onshore sedimentary basins of the Atlantic Provinces.

Twenty-five scientific projects are carried out in one of three main categories within the subdivision. Basin analysis and petroleum geology utilize the disciplines of petroleum geology, geophysics, lithostratigraphy, geochemistry, sedimentology and biostratigraphy. Resource appraisal draws heavily on seismic stratigraphy and geochemical information. Biostratigraphy includes palynology and micropaleontology. Data bases span these major disciplines and provide a link between them.

The resource appraisal program is part of EMR's inter-branch assessment. It has been carried out in collaboration with the federal regulatory agency, Canada Oil and Gas Lands Administration (COGLA), staff of the Petroleum Resource Appraisal Secretariat (PRAS) at ISPG in Calgary and the Canada-Newfoundland Offshore Petroleum Board (CNOBPB) in St. John's. Future resource assessment studies are likely to involve the subdivision staff in working with other regional regulatory agencies as they are formed.

Highlights

The Frontier Geoscience Program (FGP) has provided a unique opportunity for scientific research within the subdivision. For example, FGP funding has allowed additional biostratigraphic analyses of 20 wells. The increased exploration activity along the east coast during the early 1980's has caused a significant backlog of biostratigraphic analyses. The present industry slowdown, coupled with FGP funding, should allow the subdivision to catch up on eastern Canada biostratigraphic analyses within two years. Another example of FGP funding is the additional 250 km of marine seismic data that was acquired and processed to supplement the interpretation of the hydrocarbon potential in the St. Pierre et Miquelon moratorium area.

The petroleum industry slowdown has also enabled subdivision staff to obtain data and interpretations normally considered confidential. Several major companies supplied complete interpretations, processed seismic data and advice in areas where they have expertise and knowledge. Several companies are allowing staff to participate on the scientific working committees set up for the basin atlas project.

Last August, a symposium on Basins of eastern Canada was held in Halifax. This very successful symposium, sponsored by AGS, CSPG and IUL, attracted participants from throughout the western world. Several EPG scientists were involved with its organization and also presented papers.

Basin Atlases

The Atlantic Geoscience Centre's output for the Frontier Geoscience Program will consist of a series of basin atlases of the East Coast of Canada. The atlases will cover five areas: Scotian Shelf, Grand Banks, Gulf of St. Lawrence, Labrador Shelf, and Hudson Bay. They will consist of maps, sections and other graphical forms (e.g., geodynamic models, petrophysical logs, etc.) with appropriate text. Three subdivisions in AGC will each supply data for the atlases. A project leader has been assigned to each of the five atlases, with responsibility to coordinate and schedule the work from all three subdivisions. Contributions from the Eastern Petroleum Geology subdivision are discussed below.

The Labrador Shelf atlas is well underway and should be ready to go to the printer by the end of 1987. Biostratigraphy and lithostratigraphy analyses on 17 wells were carried out under contract using FGP funding. The two data sets were merged and correlated by EPG scientists in conjunction with the contractors. A sequence of paleogeographical maps is being generated from this data base. Presently, a retired Petro-Canada employee, working under contract, is generating time structure maps from Petro-Canada's seismic data base of the Labrador Shelf. Dr. S. Bell is overseeing this work and has provided considerable input to the project. A working scientific committee consisting of industry and government members has been set up to review the data before being finalized for the atlas.

The Scotian Shelf atlas can progress fairly rapidly since this area has received the most attention within the subdivision. Most time structure maps have been compiled for this area and all the shot point location information has been hand digitized. Further biostratigraphy analyses will be carried out under contract during the next year. The main emphasis for the atlas during the next year will be to generate a velocity data base to convert time maps to depth maps, to correlate lithostratigraphic and biostratigraphic data and to generate appropriate text. In addition, a number of companies in Calgary have been approached for data and interpretations.

The Grand Banks basin atlas will require much more effort. Work on the Jeanne d'Arc basin is relatively advanced, but for other basins, for example the S. Whale and Carson basins, it is minimal. Regional time and depth structure maps have to be generated. During the last year, the seismic data base has been expanded significantly to accommodate this requirement. Negotiations with companies in Calgary for digital shot point and velocity data are underway. Since the timing of this atlas is the end of 1988, support from industry will be needed if it is to be completed on time. A stratigraphic nomenclature for the Jeanne d'Arc Basin that is consistent with CNOBPB has been developed and a paper is expected to be ready for publication by July.

Some work on the Gulf of St. Lawrence atlas is underway. A contract with SOQUIP to produce time structure maps, geological sections and geochemical maps using their data base and expertise in the Gulf of St. Lawrence is in progress.

Industry seismic data has been acquired in anticipation of the Hudson Bay atlas. Interpretation of this data will begin this year. Some biostratigraphic analyses will be required before the atlas is ready for printing.

Resource Appraisal

During the last year, a resource appraisal of the St Pierre et Miquelon moratorium area was carried out by the Petroleum Resource Appraisal Secretariat (PRAS) and scientists in the subdivision. An additional 250 km of seismic data was acquired and processed and added to the data previously collected by EPG. This data, along with industry data at the boundaries of the moratorium area, was used to produce an integrated seismic interpretation (time structure maps). A meeting with CNOBPB, COGLA and PRAS was held in late March to go over the regional interpretation and to define play types and reservoir parameters. The data and interpretation within the moratorium block is unique in that it is the first study carried out in the area. A report on the geology and geophysics has been forwarded to External Affairs.

The Jeanne d'Arc appraisal was delayed last year until the formation of CNOBPB was complete. The new schedule for the completion of the appraisal is the end of 1987. A first meeting with CNOBPB, PRAS, the Newfoundland Petroleum Directorate and EPG took place recently. A work schedule was developed at that meeting for the remainder of the appraisal.

Biostratigraphy

The objectives of the biostratigraphy section are to develop, refine and implement detailed biostratigraphic zonations for Paleozoic, Mesozoic and Cenozoic rocks of the sedimentary basins of eastern Canada and contiguous regions. Successful and effective biostratigraphy requires an integration of sub-disciplines such as paleocology, paleobiogeography, paleoceanography and taxonomy; and thus studies in these areas are also undertaken by subdivision scientists. A long term objective is to develop detailed qualitative and quantitative zonations for the eastern Canadian offshore and adjacent ocean basins and consequently to develop paleocologic, paleobiographic and paleo-oceanic models for these areas.

Although the rate of offshore drilling for hydrocarbons has decreased considerably in the recent past, extensive and deep drilling in the late 1970's and early 1980's has left the subdivision with a large backlog of wells for which basic biozonation is required. The biostratigraphic needs of the basin atlas program enhanced the need to reduce the backlog as quickly as possible. This reduction is being achieved through in-house and especially contractual studies in both palynology and micropaleontology, the two major disciplines of biostratigraphic research in the subdivision.

During the last year, emphasis was placed on the Labrador Shelf and adjacent areas to comply with the Labrador Shelf basin atlas schedule. Palynological and micropaleontological examination of 17 wells on the Labrador Shelf was completed. The inclusion of these wells now provides a complete biostratigraphic analysis of all wells on the Labrador Shelf.

Three high priority wells on the Scotian Shelf (Alma F-67, Chebucto G-90 and Sambro I-29) were also examined for both palynology and micropaleontology. In addition to this contractual work, in-house staff have provided palynological analyses on one entire well on the Scotian Shelf and partially on several other wells. Samples from HUDSON cruise 85-027 have also been examined and have yielded acritarchs and chitinozoa indicative of late Ordovician age. In-house staff have also provided partial micropaleontological analyses on a sequence of Scotian Shelf wells.

Quantitative stratigraphic analysis is proceeding from the development stage to the practical implementation stage. Several studies using the statistical methods developed earlier are being carried out in the subdivision. For example, a paper on the first probabilistic biostratigraphic zonation using deep water agglutinated forams in the Central North Sea has been submitted for publication.

General

Work on the data bases has been limited to updating and simple modifications. The emphasis during the last year has been to input data as quickly as possible. Several new programs have been written to display and manipulate data from the data bases. Some effort has been put into integrating data from several data bases to provide graphical plots and representations.

Several subdivision scientists are involved with the Ocean Drilling Program (ODP). A number of proposals have been submitted for upcoming legs. In October, a workshop was organized to discuss Canadian contributions to ODP cruises. The workshop notes were compiled and edited (Dr. F. Gradstein from the subdivision was a co-editor) and will be used as a basis for Canadian content at the COSOD II meeting in July 1987.

Personnel Notes

The subdivision has a permanent staff of sixteen scientists, six technicians, two draftsmen and one secretary. During the year, one scientist (P.A. Macquebard) has been working on a one-third time contract and three technicians have been employed on a temporary basis or through contracts.

Three new staff have joined the subdivision during the last year. Dr. M.E. Best, formerly with Shell Canada Limited and Technica Resource Development Limited, is the subdivision head. Mr. A. Edwards and Dr. C. Cant, both previously involved in the petroleum industry in Calgary, with their contacts in industry and their expertise in petroleum geology and geophysics, will greatly benefit the subdivision. Dr. A. Fricker has recently transferred from Program Support to EPG, where he is developing a strategy with Dr. M. Best for geological/geophysical

work stations using seismic, petrophysical and geological data. This is the first phase of an ongoing effort to update the technology within the subdivision.

Graham Williams is on change of work station status at Amoco in Tulsa, Oklahoma from October 1986 until July 1987.

Attendance at Meetings, Conferences, Courses

P. Ascoli

Benthos 86 International Symposium, Geneva, September 22-26

M.S. Barss

American Association of Stratigraphic Palynologists Annual meeting, New York, October 1986

Palynodata Steering Committee meeting, New York, October

USGS/GSC Palynologists meeting, Reston, Virginia, October

M.E. Best

Canadian Society of Exploration Geophysicists, Calgary, May 1986

Society of Exploration Geophysicists Education Course, Houston, July 1986

Seminar, Reservoir Engineering Principles, Halifax, March 1987

D. Cant

International Association of Sedimentologists Congress, Canberra, Australia, August-September 1986

A. Fricker

Geological Association of Canada Annual Meeting, Ottawa, May 1986

Canadian Society of Petroleum Geologists Annual Meeting, Calgary, June 1986

Atlantic Geoscience Society Annual Meeting, Fredericton, February 1987

F.M. Gradstein

Principles of Application of Quantitative Stratigraphy Special Lecture Course, Aberdeen, U.K., April 1986

Jurassic Micropaleontology of Portugal and Grand Banks - Special Lecture, London, U.K., April 1986

2nd International Workshop on Agglutinated Foraminifera, Vienna, Austria, June 1986

2nd International Paleooceanographic Conference, Woods Hole, September 1986

A.C. Grant

Basins of Eastern Canada Symposium, Halifax, August 13-15, 1986

Ocean Drilling Program Workshop, Montreal, September 25-27

GSC Current Activities Forum, Ottawa, January 20-22

P.A. Hacquebard

Canadian Coal Petrology Group Workshop, Ottawa, May 22-23

Basins of Eastern Canada Symposium, Halifax, August 13-15

Nova Scotia Department of Mines and Energy Open House, Halifax, November 20

R.D. Howie

Forum on GSC Activities in Oil, Gas and Coal in Canada, Calgary, February 10-16

L.F. Jansa

International Sedimentological Congress, Canberra, Australia, April 21, 1986

D. McAlpine

Canadian Society of Petroleum Geophysicists Annual Convention, Calgary, June 1986

Atlantic Provinces Inter-University Committee on the Sciences Workshop, Fredericton, February 1987

Membership on Committees

P. Ascoli

Member, Organizing Committee, Benthos 86

Member, Working Group on the Jurassic-Cretaceous Boundary

Member, Tethyan Working Group on Cretaceous Stratigraphy

M.S. Barss

Member, Organizing Committee for ASAP Annual Meeting

Member, Palynodata Steering Committee

J.S. Bell

Member, Ocean Drilling Program Downhole Measurements Panel

Liaison Member, Ocean Drilling Program Tectonics Panel

Associate Editor, Bulletin of Canadian Petroleum Geology

Vice-chairman, AGS-CSPG-IUL Basins of Eastern Canada Symposium

Member, Scientific Program Committee, AGS-CSPG-IUL Basins of Eastern Canada Symposium

M.E. Best

Member, Enforcement Review Committee, Association of Engineers, Geologists and Geophysicists of Alberta

Associate Editor, CSEG Journal

Member, Production Seismology Committee, Society of Exploration Geophysicists (SEG)

D. Cant

Associate Editor, Bulletin of Canadian Petroleum Geology

Member, Editorial Board, International Association of Sedimentologists

Program Coordinator, Atlantic Geoscience Society

A. Fricker

Member, University of New Brunswick Computing Science Co-op Program Advisory Committee

President, Atlantic Geoscience Society

Chairman, Atlantic Geoscience Society Video Committee

Business Manager, Maritime Sediments and Atlantic Geology

Member, Organizing Committee, Canadian Association for Information Science - Halifax Chapter

F.M. Gradstein

Chairman, International Commission on Quantitative Stratigraphy

Member, Canadian National Committee, Ocean Drilling Program

Member, SCOR 82

P.A. Hacquebard

Member, Canadian Coal Petrology Group

Member, International Committee on Coal Petrology

R.D. Howie

Member, AGC Curation Advisory Committee

Member, Organizing Committee, 1986 CORE Show

L.F. Jansa

Member, Ocean Drilling Program Atlantic Regional Panel

Member, Dalhousie University Graduate School in Geology Examination Committee

Associate Editor, Sedimentary Geology

Member, AGC/Dalhousie University Distinguished Lecture AAPG Committee

Laboratory Statistics

Drafting

In-house original figures drafted - 311
Contract original figures drafted - 32
Revisions in person hours - 280

Micropaleontology

Samples picked - 1,567
Slides prepared - 2,553
SEM photographs - 280
Microscope photographs - 50

Coal Petrology

Polished stubs prepared - 159
Reflectance analyses - 129
Maceral analyses - 22

Palynology

Palynology samples processed - 1,737
Kerogen samples processed - 869

Sedimentary Petrology

Thin sections - 417
Compilations (figures) - 12
Films printed - 4

Regional Reconnaissance Subdivision C. E. Keen

The primary objective of the Regional Reconnaissance subdivision is to study the deep geology and geophysical properties of the continental margins and adjacent offshore regions in order to understand the processes controlling their development and evolution. While effort is focused on the contemporary margins, this has inevitably led to studies of the adjacent continental and oceanic regions, and to interests in analogous features globally. To accomplish this, subdivision scientists carry out detailed studies in key areas, using seismic and potential field data collected from ships, aircraft, satellites, and Arctic ice camps. Findings are integrated with the results of work done elsewhere or derived from complementary data types. Geodynamic modelling to test conceptual models is a key element of our program. Cooperative effort is an important aspect of the work, involving ongoing contract and collaboration with other federal government agencies, universities, industry, and foreign institutions.

The subdivision presently comprises thirteen geophysicists, five technicians, three postdoctoral fellows, and one secretary. It is divided into three groups organized broadly according to methodology: seismic surveys, potential field studies and geodynamics/tectonic modelling. While common problems are approached in a coordinated fashion, each group concentrates largely on the development and application of techniques for the collection, analysis and interpretation of the different classes of data that fall within its respective purview.

Lithoprobe and Related Investigations

Over the past year, the Atlantic Geoscience Centre has continued to interpret deep seismic

reflection data collected across the basins and margins of the Grand Banks and across the Appalachians; has acquired and processed new seismic data in the Gulf of St. Lawrence; and has initiated the development and use of in-house interpretation tools. The Grand Banks study is part of the FGP East Coast Task, while work northeast of Newfoundland and in the Gulf of St. Lawrence is part of the GSC's contribution to LITHOPROBE. The latter, therefore, involves staff and students from Canadian universities. All the seismic data has been acquired and processed by GSI, Calgary, under contract to AGC.

Grand Banks

Deep seismic data in the Grand Banks region crosses two important tectonic features - Mesozoic-Cenozoic sedimentary basins and the rifted continent-ocean boundary. Our primary objective is to understand the origin and evolution of these features and to apply that understanding to thermal history models of the sediments, an important factor in source rock maturity. Among the more important results are the following: (1) Sediment thickness range from about 8 to at least 20 km, and about 80 of these sediments are syn-rift. (2) The rift basins are half-graben whose bounding faults appear to extend deep within the crust. These faults may either terminate in the lower crust or at the Moho. There is no evidence that the faults cut the Moho. The faults reflect reactivation of older lineaments. (3) Strong reflectors occur in the lower crust over parts of the seismic lines. There is no evidence that this highly reflective zone is a product of extension. (4) There is some Moho topography, but changes in Moho travel time do not appear to correlate with the overlying basin depth. (5) There is no evidence for Wernicke-style extension below the crust. (6) There appears to be more than one type of lithosphere produced during extension. Rift basins on the Grand Banks exhibit stretching which was mainly confined to the crust. In contrast, the lower lithosphere was severely thinned below the continental slope basins, which are closer to the focus of final breakup. (7) Near the continent-ocean boundary, the most important observation is the presence of landward dipping reflectors within the oceanic crust. These occur where oceanic crust appears to terminate against the continent. We propose that the dipping reflectors mark the continent-ocean boundary and that they may represent magmatic material which has underplated or intruded the rifted and thinned lower continental crust adjacent to the boundary. Other significant seismic results include the presence of strongly reflective zones in the lower continental crust near the continent-ocean boundary. Also, the oceanic crust exhibits a complexity of reflections, some of which may be due to compositional zonation during magmatic crystallization. Finally, our results may have important consequences for continental pre-drift reconstruction, an oceanic crust appears to extend farther landward in the Newfoundland Basin than some recent studies have indicated.

Appalachians, Gulf of St. Lawrence and Northeast Newfoundland

Approximately 1,600 km of deep seismic reflection data, recorded to 15-20 seconds two-way travel time along lines north of Newfoundland (1984 survey) and in the Gulf of St. Lawrence (1986 survey),

provide unique and powerful constraints on deep crustal structure and plate tectonic models of the Canadian Appalachians. The seismic lines cross all major tectonostratigraphic zones of the orogen, as well as the Magdalen basin (the largest Carboniferous basin in the Appalachians; interpreted as a pull-apart basin). These seismic data have been interpreted together with gravity, magnetic and industry seismic data.

Our general conclusions include: (1) the Late Precambrian-Early Cambrian rifted margin of the Grenville craton can be traced beneath Taconian and Acadian overthrusts and parallel to the St. Lawrence promontory - Quebec reentrant configuration of the present orogen, and probably reflects an initial rift-transform-rift geometry; (2) the abrupt offset of tectonostratigraphic zones from Newfoundland to the mainland is localized near the transform segment of the underlying Grenville cratonic margin; (3) deformation of terranes accreted during the Taconian and Acadian orogenies may have been accommodated in the northern Canadian Appalachians by post-Taconian delamination and tectonic wedging of the lithosphere; (4) a tripartite division of the lower crust into Grenville, Gander, and Avalon blocks (or terranes) is suggested by both 1984 and 1986 data sets; (5) the Dunnage zone may be completely allochthonous, having been thrust westward onto the Grenville lower crustal block and eastward onto the Gander lower crustal block; and (6) the Magdalen basin may not be a simple pull-apart basin, but rather may be detached at mid-crustal levels and have a foreland basin component.

Development of Methods for Seismic Interpretation/Processing

Over the past three years, several problems with the standard processing method used by the seismic industry have severely limited our ability to interpret the deep seismic data. These problems are threefold: (1) short period ringing due primarily to water-borne multiples in shallow, hard bottom environments; (2) long period (deep water) multiples in regions such as Orphan Basin; and (3) problems in correctly imaging the seismic structure in regions of rapid dips, such as the continental slope. This year we tried to solve some of these problems by contracting out the reprocessing of selected line segments which illustrate the three problems. Two companies independently reprocessed the same data, using state-of-the-art methods. To date problem #1 appears to have been solved, while the others have not. We intend to pursue these problems using computer facilities provided by the LITHOPROBE Data Centre and the Memorial University processing facilities. Methods to assist seismic interpretation in-house such as the use of ray tracing in 2 and 3-dimensions and line drawing migration have also been implemented.

Seismic Refraction Studies of Margins of the Grand Banks and Flemish Cap

Further analysis and interpretation of the refraction data from the transform margin south of the Grand Banks have provided detailed information on the crustal structure across the ocean-continent boundary. Highlights are a rapid thinning of continental crust over a 20 km transition zone and its overplating and eventual replacement by oceanic

material, and no evidence for a deep crustal layer formed by plutonic solidification of partial melt from the mantle, in contrast to observations on rifted margins. The data from the survey south of Flemish Cap have been processed and analysis and interpretation are underway. It appears that a sharp ocean-continent boundary is present about 20 km seaward of the continental slope and that a wide zone which had been suggested as continental in nature is in fact underlain by thin oceanic crust. The full significance of the results obtained from these two margins should become apparent when detailed comparative studies have been carried out on other segments of the margin.

Seismic Refraction Survey of Orphan Basin

A major experiment was undertaken across Orphan Basin and the adjacent margin, along the 1984 Lithoprobe reflection profile. The new Lithoprobe Ocean Bottom Seismometers (OBS) were used in this operation, together with the new airgun array. Both of these previously untried systems worked well and provided over 27,000 refraction shot traces, although the extremely soft sediments of the sea floor within the central part of the basin unfortunately caused several OBS's to fail to separate from the bottom after release. This is now believed also to have been the cause of earlier OBS losses in the same area. The technique adopted for this work was to obtain a dense coverage of both shot points and receivers along the profile, which should enable resolution of the two-dimensional velocity structure across the extensional basin for correlation with the structural features observed on the deep reflection records. The refraction data were completely processed within two months of acquisition, demonstrating the effectiveness of our in-house processing system now that development is complete. Excellent crustal and mantle arrivals were obtained throughout the data set, and it is apparent that the quantity and quality of the data represent a major advance in the application of seismic refraction to continental margins. Analysis and interpretation of the data is underway and will clearly be a major undertaking to complete. At this stage, it can be seen that Orphan Basin is underlain by thinned continental crust, as determined by previous studies, and there is considerable lateral variation in the structure. The main problems of interest, at least initially, are the topography of the Moho under the basin and the presence or absence of a deep intermediate layer and its lateral structure. The results, particularly when combined with the deep reflection observations, should provide new insight into the formation and evolution of marginal basins.

A particularly detailed data set was obtained across the adjacent ocean-continent boundary; preliminary analysis shows complex velocity structure and indicates good agreement between mantle depths as determined from the refraction data and events previously identified a Moho on the reflection records.

Geodynamic Modelling

The Geodynamics Modelling Group, in cooperation with researchers at Dalhousie University, is currently working on significantly upgrading its ability to conduct numerical experiments using

supercomputer technology. The key to this progress has been the acquisition of a state-of-the-art finite element analysis program called ADINA, which can take advantage of the large memory and fast processing speed of the modern supercomputer. Continued progress in understanding the evolution of structure in the earth's crust, such as sedimentary basins, requires this enhancement to our computational capabilities. Previously, the scope and completeness of our models was limited by the capacity of even scientifically orientated mainframe computers. Simplified models, with corresponding limitations, were implemented with these smaller computers, but we quickly reached the point where greatly increased programming effort yielded less and less scientific progress. We have restructured our approach to one where a strong emphasis is placed upon modularity of design. Personal work stations communicate with both mainframe and distant supercomputers. Each component carries the job it is best suited to perform. For example, the numerically intensive solution to problems in continuum, mechanics is done on the supercomputer, while graphics, post processing and problem redesign are all handled by the work station. We have just completed the implementation of ADINA on a supercomputer in Dorval, Quebec. We are currently formulating the scientific problems this new capability allows us to investigate. Our focus is on the geologically complex problem of rifting associated with the breakup of continents and the formation of continental margin sedimentary basins and the resulting hydrocarbon source regions therein.

Potential Fields

Laurentian Channel

High resolution aeromagnetic data collected in the Laurentian Channel area and south of Newfoundland in 1985 were interpreted by Paterson, Grant and Watson Ltd.

Structural trends were identified with possible onshore linkages, and lithofacies were determined at several crustal levels through magnetic zonation. Three types of magnetic basement were recognized: deep crustal, underlying Meguma and Avalon; younger and shallower, consisting of Late Precambrian to Devonian rocks; at least two later magnetic horizons corresponding to Triassic-Jurassic dykes and Early Cretaceous volcanics.

The Long Range - Cabot Fault system is the only system continuous from Newfoundland to Nova Scotia. The prominent Orpheus Fault extends towards Burin Peninsula, but is terminated before reaching Newfoundland. The newly identified Sydney Fault may represent the Humber/Gander boundary.

Northeast Newfoundland Shelf

High resolution aeromagnetic data collected in 1985 by a GSC/Industry consortium were subjected to preliminary interpretation by Allan Spector and Associates. This study was sponsored by the GSC and four of the original five industry participants.

Main products of the study were maps showing: precarboniferous magnetic basement elevation, structure, and thickness; total sedimentary thickness. Nineteen zones of depressed basement were identified

from depth to basement analyses.

Southeast Labrador Sea

Concurrent with the 1985 survey operation on the Northeast Newfoundland Shelf, regional aeromagnetic data were collected by the GSC over the adjacent oceanic region to the northeast.

These data were merged with existing magnetic data in the area and analyzed in-house with the following results: the boundary between continental and oceanic crusts has been delineated with greater confidence than before; two major fracture zones have been mapped across the deep ocean, with possible extensions onto the shelf; magnetic lineations show the motion of Iberia relative to the Grand Banks in a more quantitative fashion than previously possible; the data have contributed to an understanding of some deep crustal features seen in Lithoprobe lines that were shot in the area.

East Coast Marine Magnetic Data Set

Through a contract with Arkani-Hamed of UBC, a method was developed for reducing magnetic data to the pole over a broad geographic area, then applied to the entire set of AGC's marine magnetic data off the east coast. Following that procedure, a generalized inversion technique was applied to the data in order to determine the variations in the apparent magnetic susceptibility of the crust. Two crustal layer models were used, one thin, the other thick. Long wavelength components of susceptibility variations were enhanced in both models, whereas short wavelength components were pronounced in the thick model only. The oceanic crust was delineated as a low magnetic area in both models.

Satellite Altimetry

In a contracted investigation carried out by the University of New Brunswick, data sets derived from sea surface gravity measurements and satellite altimetry observations were compared to determine levels of bias between the data sets, as well as their respective frequency contents. Regional biases of up to 10 milligals may be present in the data, for reasons so far undetermined. Satellite altimetry data show good resolution of features for wavelengths above about 50 km, whereas marine gravity data resolve features down to about 5 km.

A by-product of the investigation was the development of a technique that may prove useful in the spatial decomposition of the geoid signal for separating geoid height anomalies by source depth.

Admittance Studies

An investigation was launched to analyze the isostatic response of the earth to topography by studying the linear transfer function (admittance) between gravity anomalies and bathymetry. Observed admittance can be compared with admittance computed for models based on different methods of compensation, to determine the state of isostasy and some physical parameters of the lithosphere such as flexural rigidity.

Sept. Iles Batholith

Gravity and magnetic data were collected on a high resolution survey designed to map the horizontal extent of the Sept. Iles batholith. The operation was carried out aboard CSS DAWSON with participation from staff of the Geophysics Division in Ottawa. The requirement for precise navigation necessitated the use of four different positioning systems during the survey, at a considerable cost in logistical and processing complexity. Data have not been reduced, edited, and merged in the National Gravity Data Base preparatory to detailed interpretation.

DNAG East Coast Gravity and Magnetic Maps

Final colour prototype maps were produced at a scale of 1:5 million to portray the regional gravity and magnetic fields over the continental margin of eastern Canada. The maps extend from the Gulf of Maine in the south to the Lincoln Sea in the north, and will accompany AGC's forthcoming volume in the DNAG series.

The gravity map combines observations that were made on land, on the sea floor, on the surface, and by satellite. The magnetic map combines observations collected by ships and aircraft. A companion map portrays bathymetry and dry land topography. Taken together, these maps will facilitate the study and intercomparison of regional features, as well as the correlation of continental and organic structures.

Ness Gravity Maps

With the final adjustment of AGC marine gravity data and margins of this data set in the National Gravity Data Base, routine production of all east coast NESS gravity maps became feasible. Five maps were prepared at the publication scale of 1:1 million, for regions in the Labrador Sea and off southwestern Nova Scotia.

Computing and Data Processing

Various hardware upgrades were implemented to provide a facility for producing high quality colour plots in both screen and hard copy formats, and to improve the group's capacity for producing black and white large format plots.

Communications were upgraded in two ways: through extension of our network to connect with the BIO Image Processing VAX (facilitating access to a machine well suited to large batch jobs), and to the BIO Shore MicroVAX (for auxiliary processing); through expansion of I/O to support an increased number of terminals and PC's, including the Seismic Group's PC-based CAD system. Substantial effort was expended in the implementation and adaptation of software to perform a variety of tasks on our potential field data: gridding and contouring, smoothing and filtering, merging and adjustment, and display in contour and profile form. The programs have been assembled into an integrated package featuring reasonably consistent dialogue, and compatible file formats.

A comprehensive package of potential field modelling software was purchased from Geosoft Inc. The package performs gridding, data manipulation in

the frequency domain, and forward/inverse modelling of magnetic and gravity anomalies. The full package runs on MicroVAX computers, with a subset of programs executable on a personal computer.

Shipboard Systems

A comparison carried out aboard CNAV QUEST indicated that the KSS-31 (successor system to the KSS-30) is about twice as accurate as our existing KSS-30. The evaluation project was drawn to a close with the KSS-30, and presented at the XII meeting of the International Gravity Commission.

The CIGAL (Computer Integrated Geophysical Acquisition and Logging) system was used on three cruises: a minimum of supervision and no operator intervention were required on the last two. In recent developments: software was overhauled to improve processing efficiency, reliability, and future maintenance; a method was implemented to link CIGAL to a shipboard MicroVAX for the automatic transfer of data from logging to processing environments.

A contract was let to convert SHIPAC, our shipboard geophysical data processing package, to run on BIO's new generation of MicroVAX shipboard computers. With the advent of CIGAL, some front-end redesign was necessary to handle new data formats. Other modifications were coded in to capitalize on the increased processing power of the MicroVAX, and to make effective use of a proprietary graphics software package.

ODP Leg 105

Interpretation of data from this leg continued. In Baffin Bay, ODP Leg 105 drilled Site 645 (2018 m water depth), recovering 1147 m of lowermost Miocene to Quaternary sediments. The drilling results, a regional multichannel seismic net, and industry wells on the Greenland margin and in Davis Strait allow us to reconstruct the Late Paleogene-Quaternary tectonic and sedimentary history in southern Baffin Bay. A deep regional seismic reflector (R3) that extends across the central part of Baffin Bay and lies at a depth of about 1540 mbsf in the vicinity of Site 645 was not reached, but our results suggest a Late Eocene-Early Oligocene age for the horizon. That age, depositional sequences in seismic records and results of a preliminary subsidence model for the site indicate that subsidence, following rifting of the basin, began between 63 and 55 Ma, and that spreading ceased by the Oligocene, in agreement with plate tectonic models for the region. This basin probably was not a major conduit for water-mass exchange between the Arctic and Atlantic Oceans prior to the Eocene.

Silty and sandy mud and muddy sand (porosities 20-30%), deposited in relatively deep water at rates of 30 to 140 m/my, dominate the sedimentary sequence at Site 645. Organic carbon contents average near 1% over much of the sequence, with a maximum of 3%, but the organic matter has low hydrogen indices and is predominantly of terrestrial origin. The paucity of siliceous and calcareous biota, the neritic aspect of diatom and dinocyst floras and other indicators suggest that cool, subsaline, low-productivity surface waters predominated from at least the Miocene to the present.

Personnel Notes

R. Boutilier joined Regional Reconnaissance Subdivision as Geodynamics Tectonic Modeller; G. Dakey and P. Bugden have joined the subdivision as Geological Research Assistants; and P. Durling as a Marine Geoscience Technologist.

Two staff members are on educational leave - Brian Nichols at Durham University and Ruth Jackson at University of Oslo.

Dr. B. deVoogd joined the subdivision as an NSERC Fellow.

Attendance at Meetings, Conferences, Courses

R. Boutilier

Basins of Eastern Canada and Worldwide Analogues, Halifax, August 13-15

American Geophysical Union Fall Meeting, San Francisco, December 1986

C.E. Keen

Acadia High School Seminar, "The Deep Earth", May 1986

Geological Association of Canada Annual Meeting, Ottawa, May 1986

Canadian Society of Petroleum Geologist Annual Meeting, June 1986

2nd International Symposium on Deep Seismic Reflection Profiling of the Continental Lithosphere, Cambridge, U.K., July 1986

R. Macnab

Canadian Hydrographic Conference, Burlington, February 18-19

F. Marillier

American Geophysical Union Annual Meeting, San Francisco, December 1986

S.P. Srivastava

Geological Association of Canada Annual Meeting, Ottawa, May 1986

Ocean Drilling Program Leg 105 Post Cruise Meeting, Texas, May 28-31

Canadian Society of Petroleum Geologists Annual Meeting, Calgary, June 2-4

Ocean Drilling Program Workshop, Montreal, September 25-27

G. Stockmal

Geological Association of Canada Annual Meeting, Ottawa, May 1986

Basins of Eastern Canada and Worldwide Analogues Symposium, Halifax, August 13-15

J.M. Woodside

12th Meeting of International Gravity Commission

Membership on Committees

C.E. Keen

Member, CNC, Lithosphere

Member, Working Group 3 of ILP

Member, CMG, IUGS

Member, Lithoprobe Steering Committee

Member, NSERC Commission on Strategic Grants

Member, Wilson (CGU) and Miller (Royal Society) Medal Committees

Member, Ocean Drilling Program Atlantic Panel

Associate Editor, Canadian Journal of Earth Sciences

R. Macnab

Member, GSC Geophysical Data Base Committee

S.P. Srivastava

Member, Working Groups I-1 and I-4, International Association of Geomagnetism and Aeronomy

Canadian Representative on Ocean Drilling Program Tectonic Panel

Member, Ocean Drilling Program Canadian National Committee

Member, Working Group 2B, International Geological Congress

G. Stockmal

Member, Executive Committee and Scientific Program Committee, Atlantic Geoscience Society Symposium on Basins of Eastern Canada and Worldwide Analogues

Secretary, Executive Committee, Atlantic Geoscience Society

Member, Lithoprobe East Transect Committee

Associate Editor, Maritime Sediments and Atlantic Geology

J.M. Woodside

Member, Board of Directors, Bureau of Gravimetric International

Program Support Subdivision

K. S. Manchester

The mandate of Program Support subdivision is to provide effective central support in electronic and mechanical engineering, data management, information systems, planning, coordination, development and maintenance, field logistics and field equipment

maintenance.

To meet this mandate the Subdivision is divided into three sections:

The Technical Services Section is responsible for providing, operating and maintaining all geophysical equipment, seismic refraction and reflection instruments, sidescan sonar survey systems, and magnetic and gravity instruments as well as marine geological sampling equipment such as piston, gravity, rock and vibrocorers; Shipek, Van Veen and Echman grab samplers and rock dredges. This section also provides the Division's primary logistic support for all field projects and equipment by providing, outfitting and maintaining field vehicles, ATVs, trailers, launches, boats and freight and laboratory containers.

In recent years staff in this section have taken on responsibility for the management of significant contracts for maintenance and enhancement of systems, have cooperated with engineers and scientific staff in the improvement of systems and equipment and have adjusted to the increasing use of computers as integral components in many systems.

The Instrument Development Section designs, develops and tests electronic and mechanical equipment to enhance existing systems or to meet the requirements for new instrumentation made necessary by new scientific objectives of the Division.

This group works in close cooperation with scientific investigators during planning, design, development and implementation of new systems.

The Data Management Section is responsible for the safe archiving and cataloging of data and samples and provision of reasonable accessibility; the administration of data release and provision of better methods of data release; the development and maintenance of AGC institutional software and provision of assistance in software development; the management of institutional information systems and advising and implementing policy on AGC computer usage.

Highlights

The 1987/87 season was busy and varied, with staff involved in field projects or cruises in geographic areas from the Arctic Ocean in the north to Nova Scotia in the south and to the Beaufort Sea in the west. Subdivision staff supported 39 separate field and cruise projects, of which 11 were in support of AGC-supported university projects and/or AGC contract field operations, for a total of 1,042 person days in the field.

Ice Island Project

The Ice Island was occupied by AGC staff for the complete field season from April to August. A major commitment of the subdivision was the assignment of M. Gorveatt for the whole period to coordinate the logistics and field operations on the Ice Island. In his place, M. Hughes acted as Head of the Technical Services Section of the subdivision.

OBS Operations and Maintenance Contract

A Standing Offer contract was arranged for a three-year period with Seakem Oceanography Ltd. to operate and maintain the 24 ocean bottom seismometers on all our field use during the contract period. The contract staff was given training in the lab prior to the field season. B. Chapman is the manager of this contract.

Long Coring Facility (LCF) Installed on CSS HUDSON

The University of Rhode Island LCF was installed on CSS HUDSON in March 1987 to be used in April and September 1987 by AGC staff to get longer and larger diameter piston corer samples than had previously been possible. The LCF is a large piston coring system that has been developed by the University of Rhode Island with support of AGC over the last three years to ultimately be capable of taking cores up to 50 metres in length in full ocean depths. A reduced system was installed on HUDSON with a corer weight of 4000 kg which will be used in water depths of up to 4000 metres. This reduced system is the maximum that can be handled on CSS HUDSON's 3/4" diameter cable and winch system, and is possible only because the HUDSON has the largest cable and winch available on any North American research vessel. If the 1987 tests are successful, it is anticipated that the 50 metre system will be used on HUDSON in 1988 or 1989, depending on funding available.

Polar-8 Icebreaker

K. Manchester represented EMR in discussions with the Ministry of Transport's "Polar Icebreaker Project". This consisted of writing the "Scientific Facilities" section for the Statement of Requirements document that was prepared to go to the shipyard which would be contracted to design and construct the Polar-8 icebreaker for delivery in 1992/93. The Statement of Requirements calls for excellent laboratory facilities, deck and over-the-side handling and scientific winch facilities, and a moon-pool capability for handling instruments, ROV's, etc. A ship of this sort will enable a whole new area of Arctic marine geoscience research to be undertaken.

New Class II Research Vessel Design

The Department of Fisheries & Oceans, as part of its Vessel Acquisition and Replacement Plan (VASP) issued a contract in the summer of 1986 to design a new Class II research vessel for the replacement of both the CSS DAWSON and CSS BAFFIN here at BIO in the early 1990's. The statement of requirements for this design was produced with major input from the BIO Ship Users Committee on which AGC is represented. A smaller four-person BIO Class II Design Committee was formed that would directly deal with the contract ship designers. K. Manchester of AGC is a member of this committee. The conceptual designs have been completed for a 76-metre vessel which will have excellent marine geoscience capabilities, including a small moon pool to allow geotechnical drilling in the future.

Browser

Program Support Subdivision Systems Development Section has been involved in managing an Unsolicited Proposal with Brooke Ocean Technology to develop a system to produce a sea floor photographic mosaic of

the sea floor over a 30-metre diameter circle. The machine has shown great promise in water depths of up to 30 metres in producing a detailed photo mosaic that has many applications to AGC research. D. Heffler is the scientific authority on the project. The plan is to make BROWSER an operational tool in shelf depths to 100 metres with mosaic depths of 60 to 100 metres.

Geographical Information Systems

Investigations continued in 86/87 into applications of Geographical Information Systems for AGC. A one-day workshop was organized with participants from AGC, other GSC Divisions and outside organizations, including local consulting firms and the Nova Scotia College of Geographical Sciences to discuss the application of automated mapping technology to the Basin Atlas project and AGC projects in general, and to provide some direction for future work.

Cooperation with the Nova Scotia College of Geographical Sciences resulted in the completion of a second cooperative project investigating the use of Geographical Information Systems in the compilation and preparation of manuscript surficial geology maps.

Coastal Information System

Continued cooperation between coastal geomorphologists in Environmental Marine Geology Subdivision and Program Support's Data Section has culminated in the production of an atlas of coastal information for the Avalon Peninsula of Newfoundland. Two cooperative student work terms have completed software development for the basic CIS, including map production software. A re-design of the data input modules is in progress.

Word Processing

Data Section, in cooperation with Administration and AGC Secretaries, conducted investigations on options for the replacement of AGC's word processing equipment. Secretaries were extensively involved in the definition of requirements and evaluation of systems. A final recommendation was made to management and accepted. Data Section will be involved in 87/88 with the implementation of the chosen system.

Curation

AGC has continued to improve its systems for cataloguing and storage of geophysical records and samples. The associated standard record and sample information has been maintained with the upgraded RECINV and Sample Inventory (SID) data bases respectively. These systems have both been designed to ensure quality and inventory control of sample and record material as it is acquired by AGC Curation. In 1986, 13 sampling cruises and 3 field programs obtained samples from more than 626 locations, with more than 990 metres of core sampler, with 20,000 metres of associated analog records recovered.

Microfilming of Geophysical Records

On behalf of the Geological Survey of Canada, the Atlantic Geoscience Centre has a mandate to preserve all analog acoustic records for future

geoscientific study. Some 150,000 metres of underway geophysical records are presently curated by the Program Support Subdivision of the Atlantic Geoscience Centre represent both an invaluable and irreplaceable resource. Every effort and resource has therefore been devoted to the adequate curation and preservation of these records such as in the initiation of a microfilming contract utilizing a Iamenan TFC 6000 flow camera. Records from the 1985 field season have now been processed and inspected for defect in the information image. All records are routinely logged in a data base and transmitted to and from the contractor under strict guidelines to prevent damage or loss. Microfilm quality is being maintained and controlled by adequate inspection which includes evaluation of workmanship, equipment performance and materials measured by accepted standards. During the 1987/88 fiscal year, records up to 1962 will be processed ending with the reproduction of 1986 and 1987 records for convenience. Processed microfilmed records retained for permanent or archival purposes will be distributed as GSC Open Files with a master copy housed at the Public Archives of Canada and a working copy accessible on site.

Contractor System for Sample Storage

The installation of a high density storage system for ambient sample holdings in the Atlantic Geoscience Centre core repository has increased overall warehousing space capacity by about 45%. Rolled racking utilizing existing shelving can readily move by mechanical control and leave only one access aisle open, which is available upon demand. Hence, the same surface is being utilized, but the capacity has been almost doubled. More than 200,000 processed marine sediment samples will be stored in this manner in 28 bays of pallet racks.

Personnel Notes

The Subdivision consists of a permanent staff of one senior manager, one secretary, two engineers, two physical scientists, two computer scientists, twelve technologists & technicians plus one librarian and one clerk seconded to the BIO Library and one draftsman seconded to BIO drafting group.

Miss Deborah Langdon, a computer scientist, left Program Support to take a position with the Department of Environment, Atmospheric Environment Service. Mr. J.R. Currie, a computer scientist, joined Program Support coming from the Department of Fisheries & Oceans. Mr. Wayne Prime, a computer scientist, also joined our Subdivision coming from Regional Reconnaissance Subdivision of AGC.

Attendance at Meetings, Conferences, Courses

J.R. Currie

National Computer Show, Toronto, November 18-19, 1986

M.E. Gorveatt

Arctic Delta Failure Experiment (ADFEX) Meeting, Quebec City, February 23, 1987

I.A. Hardy

Micro-recording Technology Course, Ottawa, Ontario, April 21 - 25, 1986.

Presented talk on The Atlantic Geoscience Centre Sample Management System, at open meeting for Society For The Preservation of Natural History Collections, Smithsonian Institute, Washington, D.C., June 9, 1986.

Conducted tour of AGC curation facilities for participants of the International Centre for Ocean Development (ICOD) Short Course in Non-fuel Offshore Minerals, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, March 5, 1987.

Career Track Seminar, Halifax, Nova Scotia, March 24, 1987.

D.E. Heffler

Ocean Drilling Program Engineering Section Meeting on pressuremeter development, College Station, Texas, April 30 - May 2, 1986.

Met with Geophysics Division, GSC on Microprocessor Development, Ottawa, Ontario, October 23, 1986.

Lateral Stress Tool Development Meeting, Texas A & M University, College Station, Texas, December 7 - 9, 1986.

Visited White Technology in Phoenix, Arizona, December 9 - 11, 1986.

Arctic Delta Failure Experiment meeting, Quebec City, Quebec, February 23, 1987.

W.G. MacKinnon

Met with Long Coring Development Project personnel to coordinate logistics for coring on CSS Hudson cruise in October at the University of Rhode Island, Quonset Point, Rhode Island, June 5 - 9, 1986.

K.S. Manchester

Remote Operated Vehicle (ROV) Conference, Aberdeen, Scotland, June 24 - 26, 1986.

Deep Water ROV meeting, Pat Bay, B.C., September 3 - 5, 1986.

Technical and Engineering Development Committee of the Ocean Drilling Program meeting, College Station, Texas, September 16 - 19, 1986.

Canadian Ocean Drilling Program National Workshop, Montreal, Quebec, September 25 - 27, 1986.

EMR/DFO Project Remote Operated Vehicle (ROV) Project Technical meeting at International Submarine Engineering, Vancouver, B.C., December 17 - 19, 1986.

Geophysical Instrument Committee meeting, visit Ministry of Transport for discussions on Arctic-8 vessel and discussions on Seabed II, Ottawa, Ontario, January 29, 1987.

Deep Remote Operated Vehicle handling equipment

meeting, Victoria, British Columbia, March 13, 1987.

S. Merchant

Micro-recording Technology Course, Ottawa, Ontario, April 21 - 25, 1986.

A.G. Sherin

Curators' meeting in Ottawa, Ontario, May 22, 1986.

10th International Conference of the Committee on Data For Science and Technology (CODATA), Ottawa, Ontario, July 13 - 18, 1986.

Featured Speaker on Planning, Software Acquisition Management Seminar, Technical University of Nova Scotia, Continuing Education Division, Halifax, Nova Scotia, August 18 - 19, 1986.

National Computer Show, Toronto, Ontario, November 18 - 19, 1986.

Lecture and demonstration for the International Centre for Ocean Development (ICOD) short course in Non-fuel Offshore Minerals at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia, March 5, 1987.

Visited United States Geological Survey to observe their Geographical Information Systems and mapping technologies, Reston, Virginia, March 26 & 27, 1987.

8th International Symposium on Automation and Cartography, Baltimore, Maryland, March 29 - April 3, 1987.

Memberships on Committees

A.S. Atkinson

Member, BIO Electronic Stores Committee

M.E. Gorveatt

Member, BIO Safety Subcommittee

I.A. Hardy

Member, AGC Curation Advisory Committee

Member, Society for Preservation of Natural History Collections

Chairperson, Society for Preservation of Natural History Collections Computer Use Committee

M.D. Hughes

Member, BIO Safety Subcommittee

K.S. Manchester

Member, Technical and Engineering Development Committee (TEDCOM), Ocean Drilling Program

AGC Representative on Bedford Institute of Oceanography Ship Users' Committee

Member, Department of Fisheries & Oceans Class II Reserch Vessel Design Committee

A.G. Sherin

Member, BIO Computer Advisory Committee

Member, Halifax Y.M.C.A. Computer Studies Advisory Committee

Member, Organizing Committee for Graphics Interface 1990 (to be held in Halifax, Nova Scotia)

Member, Atlantic Provinces Council on the Sciences (APICS), Computer Science Committee

Data Requests:

	Internal	External
General Information	225	35
Reproductions	450	3
Computer	3	0
GSC/EPB Open File	10	8
Purchasing Services	9	0
Stationary	8	0

Data Management Statistics**Requests for Services:**

Samples - 1100 internal
- 150 external

Sample plots/prints - 80 internal
- 75 external

Samples acquired 1986 field season:

Lehigh Cores - 16
Gravity Cores - 130
Piston Cores - 136
Push Cores - 42
Grab - 167
Box Cores - 10
Tri Core - 2

Subsampling: Internal

Erratics/provenance - 92
x-radiographs - 120
Foraminifer - 651
Palyology - 820
Diatoms - 58
Coccoliths/smear slides - 463
Lithologic analyses - 615
Thin sections - 89
Core photographs - 187
Paleomagnetic - 621
Acetate peels - 25

Geotechnical

Atterburg's Limits - 56
Water content - 282
Sediment Slabbing - 111
Shear Vane - 342
Tor vane - 49
Consolidation - 35
Porewater chemistry - 21
Velocimetry - 6
Bulk Density - 10
Thermal Conductivity - 8

Dating

Th/U - 134
C14 - 382
Stable Organic Isotopes - 769
Total Organic Matter - 7
O18 - 84
Lead 210 - 123
Magnetic Susceptibility - 48
Thermoluminescence - 17
Trace Fossils - 21

Sediment Size Analysis

Heavy Minerals - 190
Trace Elements - 33

CORDILLERAN & PACIFIC MARGIN DIVISION

D. Tempelman-Kluit

The Cordilleran and Pacific Margin Division is responsible for geological and geophysical studies in most of the Canadian Cordillera, the continental margin, and the adjacent deep ocean. Our mandate is to increase the knowledge of the composition, age and origin of the earth's crust in the region, so as to permit accurate assessments of the mineral and hydrocarbon potential and guide mineral and hydrocarbon exploration. It will also help identify and predict geological hazards on land and on the seafloor and will provide the knowledge needed for planning and orderly development of land use.

The Division operates from offices in two locations - Vancouver and Sidney, B.C. It incorporates personnel who were part of the Geological Survey of Canada and the Earth Physics Branch before April 1986. Amalgamation of the two groups is now complete and we are operating as one Division with three sections - one concerned with mainland geology and geophysics, a second with the geology and geophysics of the offshore and a third focussed on neotectonics and seismicity.

The Cordilleran and Pacific Margin Division has 70 full-time employees, 28 at Vancouver and 42 at Sidney. The Vancouver office includes 15 scientists and 13 staff in administration, sales library and technical support services. In addition one scientist from the Mineral Resources Division and two from Terrain Sciences Division are stationed at Vancouver. At Sidney the staff consists of 17 scientists and 25 support and administrative staff.

Efforts in mainland geology involve a broad spectrum of studies aimed at the bedrock geology of the region that hosts most of Canada's western mineral deposits. This work, which involves mapping the rock unit distribution and detailed studies of the stratigraphy, age, biostratigraphy, petrology, metamorphism and structure, is done in Vancouver. The geophysics of this region - its gravity and magnetic fields, heat flow and paleomagnetism - is done by scientists based in Sidney. The aim is to improve the geoscience data base, and to extrapolate surface geology to depth, for better mineral and hydrocarbon assessments and for effective exploration.

The geology of potential hydrocarbon basins on the Pacific Continental shelf and that of the surficial sediments of the Pacific Continental Shelf and deep seafloor are studied by our scientists based in Sidney. Efforts in the hydrocarbon basins are concentrated on the stratigraphy, biostratigraphy, thermal history, and source and reservoir rock characteristics of the basinal strata - the data permits assessment of the hydrocarbon potential. Study of the surficial sediments aims to determine the resources and to identify hazards to development in the coastal zone.

Our work in neotectonics and seismicity involves monitoring west coast earthquakes in Canada's most active region. Hence we operate the western Canada

telemetered seismic net from our Sidney office to determine the magnitude, locus, frequency, and origin of earthquakes. To determine past seismicity we study the surficial sediments on the west coast. The ultimate aim of these efforts is prediction of major earthquakes.

The Division maintains an excellent research library which is open to the public and operates a Sales Office where Departmental publications and maps are available.

Highlights

Studies of the Nazko Cone, about 50 kilometres southwest of Quesnel, show that it is a composite product of pre- intra- and post-glacial volcanic activity ranging from 3.4 Ma (K/Ar) to 7000 years (C-14). With dates yet to be obtained the study will constrain the volcanic and glacial history (Souther and Clague).

Additional studies of Quaternary volcanism established that several pre- and intra-glacial volcanic assemblages of the northern Garibaldi belt extend almost to the Interior Plateau. The largest of these, near Bridge Glacier, was built on a high plateau above icefilled valleys. Pillow lavas and lahars, deposited in a marginal lake and during deglaciation, produced rotational slumps and landslides.

In the Skeena Mountains (north central British Columbia) basaltic caps on peaks (about 4 Ma) up to 200 m thick rest on sediments of the Bowser Lake Group. Their sources are preserved in two groups of volcanic necks in the northwestern part of Bowser Basin. Correlation of the flow sequences suggests that they were extruded onto a west-sloping surface that has since been uplifted and deeply dissected. The data will permit estimates of the denudation rate of this part of the Cordillera.

Analysis of 1986 Prince George earthquake (M=6) and its aftershock sequence reveals that the fault on which it was centred is a blind thrust 10 to 13 kilometres deep with northeast over southwest vergence.

The megathrust potential of segments of the Cascadia subduction zone was compared with similar zones around the world. It suggests that very large earthquakes are possible on the Cascadia subduction zone.

Conodont studies continue to provide critical information. An exciting discovery of visually identifiable conodont microfossils on bedding surfaces of chert in the Sicker Group suggests that cherts should be carefully examined in the field for these fossils. Triassic conodonts from Queen Charlotte Islands not only provide critical biostratigraphic information but their Colour Alteration Index (CAI) gives paleotemperature data on these hydrocarbon source beds.

Careful studies of existing ammonoid collections (Tipper and Paul Smith of UBC on contract) has advanced zonation information on the

Lower Jurassic faunas. They are preparing a bulletin that will have broad international interest and will permit the accurate zonation of related microfossils.

During a summer that saw excellent cooperation and shared logistics with ISPG and DIAND staff, mapping of the Dawson area (116 B-C) north of the Tintina Trench was completed. The newly acquired geological data demonstrates that large thrust faults have overlap in excess of 100 km and that some juxtapose contrasting facies, but not distinct terranes. Early extension faults (Proterozoic) are related to copper- and uranium-bearing breccias now the subject of a thesis study. The improved geological understanding will permit a better appraisal of the mineral and hydrocarbon potential of a large region of northern Yukon.

Field work was completed on a transect of the Selwyn Basin which began with the IMPP project in Nahanni area and continued into Sheldon Lake and Tay River areas. The work has demonstrated that certain stratigraphic marker horizons can be traced across the entire basin and thus provide better control for the search for mineralized strata. The structure is dominated by flat imbricated thrust faults. The mid-Cretaceous South Fork volcanics comprise a thick intracaldera fill that hold some promise as targets for gold exploration. Tertiary volcanic rocks with local gold mineralization are more widespread than previously known.

In Carmacks area the locus of the Big Creek Fault is now recognized to be the edge of a collapsed late Cretaceous volcanic magma chamber. Known gold deposits, including some past producers, follow this feature and the fault warrants more focussed exploration for undiscovered occurrences.

Whitehorse Trough in Laberge and Whitehorse map areas has Mesozoic strata that include likely source rocks for hydrocarbons as well as reservoir rocks and structural traps all at conditions near the optimum for hydrocarbon generation. This region warrants exploration for oil and gas.

During the 1986 field season detailed and regional mapping in the Spatsizi (104H) map area documented tight folding and related thrust faulting which accommodated a great amount of northeasterly shortening of the Jurassic and Cretaceous stratigraphic sequence. A thrust fault which places Lower Jurassic volcanic rocks on mid-Cretaceous nonmarine strata indicates significant tectonic burial of rocks which are a potential source for hydrocarbons. Different structural levels of the contractional deformation are exposed in blocks bounded by steeply dipping, dip-slip faults.

Stratigraphy in the northernmost part of the Bowser Basin was traced southward to the Klappan anthracite coal deposits. An Upper Jurassic(?) shallow marine to nonmarine succession that overlies the Ashman Formation (marine) in the north, may be correlated with the coal-bearing sequence farther south. The implication is that rocks of the Ashman Formation essentially filled the northern part of the Bowser Basin, and younger sediments were deposited in an estuarine to fluvial deltaic environment. In this model the coal deposits are

expected to be restricted to the facies belt marginal to a coeval marine basin farther south. Substantial anthracite coal, possibly not previously known, is exposed in Spatsizi Provincial Park north of the Klappan deposit.

Work in the difficult terrain and weather of the Iskut map area is beginning to delineate stratigraphic units, plutonic complexes and structural features that present some obvious foci for mineral exploration.

Several features indicating instability were noted on the seafloor of Queen Charlotte Sound. These include 28 km² of slope failure deposits, sand-wave fields on banks and probable occurrences of shallow gas. No evidence of Holocene faulting was found. About 80 km² of titaniferous sand deposits were delineated. As they may be several metres thick, their economic potential requires further investigation.

On the Fraser Delta the assessment of hazards to a submarine sewer outfall being installed by the Greater Vancouver Sewerage and Drainage District was completed; as was a study in conjunction with Fisheries and Oceans and the Port Corporation of the impact of the Roberts Bank coal-port development on intertidal surface stability. In the southwestern part of the Fraser Delta a team of geoscientists (Cordilleran, Terrain Sciences and SFU) defined the seismic stratigraphy, now being tested by drilling. The seismic work, which shows that the soft sediments of the modern delta are a thin veneer above hard Pleistocene deposits, will form the basis for a much improved assessment of the seismic risk but much remains to be done. A seismic line run by ship in the main Channel of the Fraser River westward from Dease Island suggests that about 300 m of Quaternary sediments, probably mainly Pleistocene, overlie an irregular "bedrock" surface, possibly of Tertiary sediments.

Analysis of current- and tilt- sensor data from instruments recovered from a channel on the bottom of Bute Inlet reveal the existence of strong, episodic density currents that flow at least 30 km from the head of the inlet to a lobate depositional area.

Joint Canadian-U.S.-Chinese research in the Bohai Sea using two Chinese vessels during the annual flood of the Huang Ho (Yellow River) gathered sedimentological and geotechnical data that will be applicable to assessment of hazards in the Beaufort Sea off the McKenzie delta where similar data are difficult to obtain. It was found that normal delta-front clayey silts regularly failed and accumulated on the lower delta front where they are compacted to a higher density than those higher on the front.

On the Queen Charlotte Islands biostratigraphic studies, based on foraminifers, was conducted on Jurassic and Cretaceous strata. On Cumshewa Inlet on Moresby Island previously unrecognized Jurassic petroliferous strata were studied in detail. This discovery extends the known extent of hydrocarbon source beds and suggests that these rocks may be expected to underlie part and perhaps much of Hecate Strait and

may represent an oil-prone sedimentary basin. On northwestern Graham Island a very thick mid-Cretaceous section contains strata that range from shallow marine to bathyal. These potential reservoir rocks may be as much as 5000 m thick. The contained microfauna common in the Gulf of Mexico north to Kansas suggest a paleolatitude far south of their present position.

Compilations of existing long-range sidescan sonar mosaics over the Juan de Fuca ridge system and the continental slope is complete. They provide a powerful tool for locating the ridge axis, for observing changes in morphology along trend, for determining the relative ages of volcanic deposits and for locating mounds of possible hydrothermal origin. On the slope the data shows the deformation front, the surface expression of active faults, and modes of mass transport on the slope and at its base.

An integrated geophysical/geological study was completed in the sedimented rift valley of the northern Juan de Fuca Ridge where sedimented hosted sulfide deposits were discovered the previous season. A suite of over 500 heat-flow measurements was completed to map the regional pattern of hydrothermal circulation, including locations of fluid recharge and discharge. Two major currently active discharge sites were well characterized with the surface heat-flow measurements, and their structure at depth was imaged with ocean-bottom magnetometer receiver/controlled current source electrical resistivity soundings. The distribution of sulfide outcrop was mapped with a video (real-time) and still-camera system; bottom photography also revealed a number of active high-temperature (black-smoker) vents at one of the high-heat-flow sites. A bottom-powered rock drill was deployed with modest success at two of the sulfide deposits. The site has been proposed, reviewed, and highly ranked for an ODP drilling leg. Investigators included Davis, Law Nobes (PGC), Franklin, Goodfellow, Jonnason (GSC Ottawa), Villinger (AW Polar Institute), Ryan, Kappaell (Lamont), Ryall (Dalhousie).

Processing and compilation of data for a set of fourteen 1:250,000 map sheets has been completed. The detailed bathymetry and acoustic imagery will be released as GSC maps in summer 1987. Compilation of magnetic and gravity data for certain part of this area is underway.

The successful completion of the GPS survey of the Juan de Fuca horizontal control network was significant on several counts. First, it was a cooperative project involving the Geological and Geodetic Surveys of Canada, working with the USGS Earthquake Hazards Group at Menlo Park. Using seven TI-4100 GPS receivers simultaneously, a total of 21 control points were surveyed over a period of 10 days. Field operating costs averaged \$1.5 K per survey site, which is about one-half of current trilateration costs in special-order surveying. Secondly, the quality of the Data was excellent. The standard deviation of the network adjusted baseline lengths which ranged from 18 to 90 km was 3.9 mm. This represents an average precision of 1 part in 10 million, which is unprecedented in GPS surveys to date. Finally, these data have allowed

the determination of horizontal shear strain as a function of distance from the deformation front of the Cascadia subduction zone through comparisons with older first-order triangulation surveys (see attached figure from Lisowski et al., 1987). These strain estimates are consistent with a model of accumulating elastic strain across a locked subduction zone.

In summary, this project has shown the GPS survey method to be an efficient, cost-effective tool for monitoring regional horizontal deformation. The quality of the data of this survey suggests that comprehensive shear-strain mapping on the west coast can be carried out now by reoccupying older (pre-1950) first-order triangulation networks. The shear-strain estimates for Juan de Fuca Strait indicate strain is accumulating in this region; hence, some urgency exists for mapping the spatial extent of the strained area, and in monitoring this strain accumulation on a more regular basis.

Heat-flow measurements were made along the LITHOPROBE PHASE I Vancouver Island Profile and continuing across the Coast Plutonic Complex using offshore wells, boreholes drilled for mineral exploration and for geothermal energy assessment and using oceanic techniques in fjords. The heat flux under Vancouver Island shows a gradual decrease from average values on the Canadian Pacific shelf to very low values to the east of Vancouver Island, and an abrupt increase in heat flux from the low values under the coast of the mainland to high values 20 km seaward of the Garibaldi Volcanic Belt. Our analysis of the thermal budget for the subducting oceanic lithosphere indicates that the water produced by dehydration of the oceanic crust must be flowing updip, probably along the zone of seismic reflectors with low electrical resistance, to where it is absorbed in hydration reactions reproducing the heat originally required to dehydrate the crust. In this manor, heat is being "transported" seaward, and a large zone of the subduction complex is being altered.

Wells Gray Park was thought at one time to be the eastern end of the Anahim Volcanic Belt and the present location of a hot spot. In the region west and south of Wells Gray Park we measured the heat flux and found it is linearly related to the heat generation, similar to southeastern British Columbia. The recent volcanics are not heating the crust in general in this region.

For studying the ages of sediments and sedimentation rates in the oceans using core samples, a technique is required for ages greater than can be determined using C14 procedures. We measured the amounts of daughter products of thorium-230 and radium-226 on more samples from two cores using gamma-ray spectroscopy. These isotopes come from the large, constant reservoir of Uranium-238 in the ocean, and are deposited with the sediments at a constant rate. The results are self-consistent for each core, but two C-14 dates on one core are in disagreement. This requires further investigation as the result is very important.

Two scientists came from the South China Sea Institute of Oceanology to observe how we make heat flux measurements on the shelf where variations in the temperature of the bottom water disturbs the equilibrium heat flux. They need to measure the heat flux under similar conditions in the shallow seas around China where the maturation of hydrocarbons depends on the temperatures within the basins.

Raised and subsided beaches on the west coast of Vancouver Island have been identified, surveyed and dated.

The megathrust potential of the various segments of the Cascadia subduction zone have been compared with similar zones around the world suggesting very large earthquakes may be possible.

In the Yukon Territory 824 new gravity observations were made, under contract, at intervals of about 10 km. The regional gravity survey covered the area between the Dempster corridor and the Alaska border and north from Dawson (about 64°N) to the Beaufort Sea. Satellite-based GPS was used for positioning. The gravity survey is the largest of its kind in Canada to have used this new positioning system.

Detailed gravity traverses were also conducted, in-house, across the Richardson Mountains at about 66°33'N and across the Kaltag Fault and the Old Crow batholith along the Alaska border. Station spacing averaged about 1 km and 126 gravity observations were made.

A total of 142 additional in-house gravity observations were made; the first survey was over the Gun pluton in collaboration with the Vancouver office mapping program in the Mackenzie Mountains, the second survey was along several inlets on the mainland coast in southern B.C. as part of ongoing multiparameter studies at PGC/UBC.

With the Ottawa office four new gravity control stations were established in the central Yukon to facilitate the planned 1987 regional gravity survey. An additional gravity-control survey also tied precise gravity stations on Vancouver Island to the national base network.

Terrain corrections were computed at PGC for about 100 Cordilleran gravity observations. These will be added to the national gravity data base.

Software/hardware. A 2-D gravity modeling program was made user friendly and given an interactive graphics capability. With some further refinements now being completed, this software package will be put on open file in 1987. A digital automated-data acquisition system has been developed for use on-station during field surveys. At each station the system samples and stores barometric elevation, atmospheric temperature, humidity and stores the gravity-meter dial reading. Each day, these data are transferred electronically to field computer memory for processing, thereby facilitating quality control and minimizing office processing.

Preliminary crustal-density structure models have been prepared for (1) the LITHOPROBE profile

across Vancouver Island and adjacent marine areas, (2) three profiles across the Tintina Fault in the Yukon, and (3) the FGP deep-reflection profile across the Mackenzie Delta.
(Contact: D.A. Seemann, J.F. Sweeney).

Personnel Notes

Dr. R.B. (Dick) Campbell, Director of the former Division retired on 31 March, 1987. Dr. D. Tempelman-Kluit took on the duties of Division Director; Dr. J. Roddick and Dr. L. Law are the subdivision heads at Vancouver and Sidney respectively. Dr. D. Chapman joined the Division in July 1986. Michael Force, storeperson, resigned June 30, 1986 to return to university full time. L.W. (Skip) Rines formerly of INAD joined the staff in August 1986 as storeperson. Louise Fox was appointed an indeterminate employee as administrative clerk effective August 1986.

Attendance at Meetings, Conference, Courses

R.G. Anderson

Geological Association of Canada, Cordilleran Section, Short Course No. 9, "Introduction to Quaternary Sediments and Environments as Applied to Mineral Exploration", April 18, 1986, Vancouver, B.C.

GEOEXPO '86 meeting, May 12-14, 1986, Vancouver, B.C. (sponsored by Association of Exploration Geochemists and G.A.C., Cordilleran Section).

Canadian Institute of Mining and Metallurgy, Branch 6 Meeting, October 2-4, 1986, Victoria, B.C.

B.C. and Yukon Chamber of Mines, Cordilleran Geology Round Up, January 26-28, 1987, Vancouver, B.C.

B.D. Bornhold

International Association of Sedimentologists, Canberra, Australia, August 1986. (Presented 4 papers).

American Geophysical Union, Fall Meeting, San Francisco, December 1986.

C.J. Dodds

B.C. and Yukon Chamber of Mines, Cordilleran Geology Round Up, January 26-28, 1987, Vancouver, B.C.

H. Dragert

AGU Spring Symposium, Baltimore, Maryland, May 19-23, 1986. Oral Presentation: "The fall (and rise) of central Vancouver Island: 1930 to 1985".

Oregon State University Workshop on Earthquake Potential in Oregon, Momouth, Oregon, February 27-28, 1987.

PAC-GAC Annual Symposium, Sidney, B.C., March 27, 1987. Organizer, convener, session chairman, and speaker: "Contemporary crustal deformation measurements on central Vancouver Island".

C. Evenchick

Geological Association of Canada/Mineralogical Association of Canada, Ottawa, May 19 to 21, 1986.

Symposium on Recent Crustal Movements in the Pacific Northwest, Geological Association of Canada, Pacific Section, March 27, 1987.

Cordilleran Geology and Exploration Roundup, Vancouver, January 26-29, 1987.

Cordilleran Tectonics Workshop, Montreal, February 1987.

H. Gabrielse

Cordilleran Roundup, B.C. and Yukon Chamber of Mines, January 1987.

S.P. Gordey

Short Course - Geotechnical data collection for Exploration Geologists by Dennis C. Martin; Cordilleran Section, Geological Association of Canada, October 30, 1986, Vancouver, B.C.

Conference - Cordilleran Exploration Roundup; British Columbia and Yukon Chamber of Mines, Geological Survey of Canada, British Columbia Department of Energy, Mines and Petroleum Resources, and Department of Indian and Northern Affairs, January 26, 1987, Vancouver, B.C.

T.J. Lewis

Canadian Geothermal Energy Association Annual Meeting, Pacific Geoscience Centre: Organized meeting and presented a paper on the LITHOPROBE Heat Flux Profile.

Third Canadian/American Conference on Hydrogeology, Banff: Presented paper on the importance of determining thermal parameters within sediments.

LITHOPROBE Workshop on the Canadian Southern Cordillera, Pacific Geoscience Centre: Presented the heat flow results and participated in the discussions of future plans.

Fall American Geophysical Union Meeting, San Francisco: Presented an invited contribution to the DNAG section on Neotectonics in North America.

J.L. Luternauer

Several meetings as scientific advisor to Fraser River Delta Roberts Bank Environmental Review Committee and Provincial Order in Council 908 Environmental Committee which impact of development on the delta foreshore.

One meeting as west coast advisor to EMR Departmental Committee on Ocean Mining.

J.W.H. Monger

British Columbia and Yukon Chamber of Mines, Cordilleran roundup, January 26, 1987.

Lithoprobe Workshop, Pacific Geoscience Centre, October 1986.

Circum-Pacific Energy and Mineral Resources Conference, Singapore, August 1986.

Commission on Geological Map of World, Paris, February 1987.

M.J. Orchard

Pander Society, Southeast - South Central, Geological Society of America Meeting, Memphis, Tennessee, 2-6 April 1986.

Cordilleran Geology and Exploration Roundup; Vancouver, January 26, 1987.

J.A. Roddick

Comdex, Las Vegas, California, November 10-13, 1986.

Cordilleran Geology and Exploration Roundup; Vancouver, January 26, 1987.

G.C. Rogers

Papers presented at Conferences:

PNAGU - September 1986. "Megathrust potential of the Cascadia Subduction Zone".

AGU - December 1986. "Seismotectonics of Western Canada".

How Volcanoes Work. January 1987. "The effect of plate motions on Cascade volcanism".

GAC-PAC - March 1987. "Megathrust potential of the Cascadia subduction zone".

D.A. Seemann

Colloquium IV Technical Program, Lake Louise, April 23-24, 1986. Met with representatives from industry to discuss recent GPS (Global Positioning System) advances and techniques.

GSC-B.C. Yukon Chamber of Mines Round-Up, Vancouver, B.C., January 26, 1987. Presented (with J. Sweeney) a recent gravity compilation of the Canadian Cordillera.

J.G. Souther

Geological Association of Canada, West Coast Division Symposium on Juan de Fuca Ridge.

Canadian Geothermal Resources Association, Annual Meeting, March 26, 1987.

Symposium on Recent Crustal Movements in the Pacific Northwest, Geological Association of Canada, Pacific Section, March 27, 1987.

L.C. Struik

Geological Association of Canada, Ottawa, Annual Meeting (Speaker), May 21-23, 1986.

Basins of Eastern Canada and Worldwide Analogues, Atlantic Geoscience Society, Halifax (poster presentation), August 13-15, 1986.

Cordilleran Geology and Exploration Roundup, Vancouver (poster), January 26-28, 1987.

J.F. Sweeney

CC-8/SC-2, Kiel, Federal Republic of Germany, August 1986. Presented rationale for Arctic Transect for GGT.

GSA National in San Antonio, Texas, U.S.A., November 1986. NACOTP wrap up - invited talk and poster.

Mackenzie Delta Workshop in Calgary, Alberta, November 1986. Presented preliminary gravity map and 2S models of upper crust.

LITHOPROBE Workshop at PGC, September 1986. CPC coordinator and southern Cordillera gravity background.

GSC Vancouver office - April 1986. Invited gravity tutorial.

Arctic Strategic Planning Meeting, ADM office, Ottawa, January 1986. Presented long-term science objectives.

H.W. Tipper

Cordilleran Geology and Exploration Roundup, Vancouver, January 26-28, 1987.

R.I. Thompson

Banff Conference on Future of Canada's Mining Industry.

Cordilleran Geology and Exploration Roundup, Vancouver, January 26-28, 1987.

Geological Association of Canada, West Coast Division Symposium on Juan de Fuca Ridge.

Geoscience Forum in Ottawa.

J.O. Wheeler

Geological Society of America Annual Meeting, San Antonio, Texas, November 10-13, 1986.

British Columbia and Yukon Chamber of Mines Roundup, Vancouver, B.C., January 26-28, 1987.

G.J. Woodsworth

Geology and Exploration Roundup; British Columbia and Yukon Chamber of Mines, Vancouver, January 1987.

Cascades and Southern Coast Mountains Workshop; University of Western Washington, Bellington, May, 1987.

Lithoprobe Workshop; Pacific Geoscience Centre, Sidney, September, 1986.

Special Talks and Lectures

R.G. Anderson

"Update on 1985 fieldwork: LITHOPROBE transect, Gun Pluton project and Iskut River regional mapping projects"; part of Pacific Geoscience Centre symposium series, May 1, 1986.

"New ideas on Dawson map area granitic rocks and on the Iskut map area"; in-house seminar at Cordilleran and Pacific Margin Division, Mainland Subdivision, September 26, 1986.

B.D. Bornhold

"Surficial geology of the western Vancouver Island continental shelf". University of Victoria, Extension Course Lecture.

"Sedimentary Processes in British Columbia fjords". Geology Department, Western Washington University and Geological Survey of Canada, Vancouver.

"Sedimentary Processes on the modern Huanghe (Yellow River) Delta". Pacific Geoscience Centre.

H. Dragert

A series of six geophysics lectures on gravity for fourth-year physics students. University of Victoria, Department of Physics, March 1987.

C. Evenchick

"Potential Hosts to Platinum Group Element Concentrations" talk given at the Cordilleran Geology and Exploration Roundup, Vancouver, January 26, 1987.

S.P. Gordey

Origin, composition and identification of sedimentary rocks (2 hrs. - lab and lecture); British Columbia and Yukon Chamber of Mines Prospecting School, Sept. 30, 1986, Vancouver, B.C.

Origin, composition and identification of metamorphic rocks (2 hrs. - lab and lecture); British Columbia and Yukon Chamber of Mines Prospecting School, Oct. 2, 1986, Vancouver, B.C.

Precambrian history of the Cordilleran miogeocline (40 mins.); University of British Columbia, Department of Geology, part of the senior undergraduate course Geology 425, January 14, 1987, Vancouver, B.C.

Paleozoic - Mesozoic history of the Cordilleran miogeocline (40 mins.); University of British Columbia, Department of Geology, part of the senior undergraduate course Geology 425, January 14, 1987, Vancouver, B.C.

New regional geologic maps for east-central Yukon and implications for gold exploration (20 mins.); British Columbia and Yukon Chamber of Mines, Geological Survey of Canada, British Columbia Department of Energy, Mines and Petroleum Resources, and Department of Indian and Northern Affairs, Cordilleran Exploration Roundup, January 26, 1987, Vancouver, B.C.

Evolution of the Selwyn Basin Region (1 hr.); Pacific Geoscience Centre, February 24, 1987, Sidney, British Columbia.

J.L. Luternauer

Invited to make oral presentation describing GSC activities at the Fraser River delta for Fraser River.

Estuary Workshop, Feb. 24-25, Vancouver Sponsored by the Federal/Provincial Fraser River Management Program.

Interviewed by the Canadian Science News Service re published report on the sedimentary controls on a major ground fish resource on the western Canadian continental shelf.

Interviewed by local radio, newspaper and T.V. reporters re Fraser River delta drilling.

Performed to upgrade knowledge of delta history and improve assessments of seismic risk.

J.W.H. Monger

"Terranes in Northern British Columbia" and "Structural Evolution southern British Columbia" at the University of Arizona.

"Evolution of S.W. British Columbia - Hope - Ashcroft map-area" at Western Washington University and Washington University.

University of British Columbia; 2 lectures on terranes for Cordilleran course.

Gallagher Visiting Scientist: University of Calgary: Lectures (1) on terranes and mountain building; (2) evolution of tectonic concepts; (3) terranes in Northern British Columbia; (4) terranes in south British Columbia; (5) Global Geoscience Transects project.

Cordilleran roundup: Setting of platinum deposits in Ashcroft-Hope map-area.

M.J. Orchard

"The nature and application of conodonts" - 2 lectures at University of British Columbia, March 1987.

G.C. Rogers

B.C. High School Science Teachers Convention.

Seminar at Cordilleran Subdivision of GSC.

Seminar at Simon Fraser University.

Seminar at University of British Columbia.

Seminar at Pacific Geoscience Centre.

Public lecture in University of British Columbia - Heaven and Earth Series.

Public lecture in University of Victoria - Geology of Vancouver Island Series.

Canadian Water Resources Association Workshop on Dam Safety.

Vancouver Island Chapter of Engineering Institute of Canada.

Greater Victoria Chapter of IEE.

National Earthquake Prediction Evaluation Council in U.S.A.

D.A. Seemann

GSC Vancouver office - seminar on 'Gravity Surveys', November 7, 1986.

J.G. Souther

"Mid-Cretaceous to Eocene volcanism in the Canadian Cordillera", University of British Columbia.

"Neogene Volcanism in the Canadian Cordillera", University of British Columbia.

L.C. Struik

University of British Columbia course Geology 425 - 2 lectures on Plate Tectonics, January 1987.

R.I. Thompson

"Evolution of the Ogilvie Mountains, Yukon": Geoscience Forum, Ottawa, January 22nd.

"The Canadian Cordillera: What and How": One day short course; Exploration Roundup, Vancouver January 28th.

"The Canadian Cordillera: What and How": One day short course; CSPG, Calgary, February 6th.

"Extension and its influence on miogeocline evolution, Ogilvie Mountains, Yukon"; Pacific Geoscience Centre, February 27th.

"An introduction to the Earth Sciences": A mini course consisting of ten two-hour lectures presented to grade eight students at Point Grey High School; January through April.

"Developments in the Earth Sciences": A four hour lecture and workshop session presented to high school science teachers in the Vancouver School Board as part of their continuing education program; May.

"Cordilleran geology for prospectors": B.C. and Yukon Prospectors Course; two hour lecture; October.

Advances in the Earth Sciences": Spectrum '86; October.

J.O. Wheeler

"Kootenay and Slide Mountain Terranes" - lecture, University of British Columbia, Geology 425 course.

"Mountain Building: Eastern Cordilleran" - lecture, University of British Columbia, Geology 425 course.

G.J. Woodsworth

"The Coast Plutonic Complex"; University of British Columbia, April 1986.

"Geology of the Canadian Cordillera"; University of British Columbia, Geology 425, Co-organizer, Spring, 1987.

Membership on Committees

R.G. Anderson

Past-President of Geological Association of Canada, Cordilleran Section.

Thesis Supervision: on thesis committees for M.Sc. theses by candidates Derek Brown and Charlie Greig in conjunction with U.B.C., Department of Geological Science faculty.

Member of Local Organizing Committee for the G.A.C.-M.A.C. Vancouver '90 annual general meeting in the capacity of Technical Program Chairman.

B.D. Bornhold

Member, Ocean Drilling Program, Southern Oceans Panel.

Member, Departmental Coordinating Committee on Ocean Mining.

Member, Advisory Committee on Undersea Feature Names.

Vice-Chairman, Canadian Sedimentology Research Group.

National Correspondent, International Association of Sedimentologists.

Member, Advisory Committee, Geology of Canada Series, French Edition.

E.E. Davis

Associate Editor, Marine Geology.

Member, Ocean Drilling Program: Central and Eastern Pacific Panel.

Liaison Member, Ocean Drilling Program: Lithosphere Panel.

National Science Foundation: Marine Geology and Geophysics Division Review Panel.

Member, Committee on Scientific Ocean Drilling: Crustal Fluids Working Group.

Workshop Discussion Leader, Oceanography and Technology.

H. Dragert

Principal Investigator, NASA Crustal Dynamics Project.

Corresponding Member, NACCSM (Advisory Committee for Surveys & Mapping).

Member of executive, Pacific Section - GAC.

Contributing member, IAG, Special Study Group 2.85 (precise gravity).

H. Gabrielse

Douglas Medal Committee - Canadian Society of Petroleum Geologists.

Nominations Committee - Geological Society of America.

S.P. Gordey

Member - British Columbia and Yukon Chamber of Mines Safety Committee.

T.J. Lewis

Member:
Geological Association of Canada
American Geophysical Association
Canadian Geophysical Union
Canadian Geothermal Energy Association

Director, Canadian Geothermal Energy Association and Editor of the Newsletter.

J.L. Luternauer

Committee member on several Simon Fraser University, Ph.D. and Master's thesis programs and S.F.U. Adjunct Professor.

J.W.H. Monger

Chairman, Coordinating Committee 7 (on Global Geoscience Transects) of Inter Union Commission on Lithosphere.

M.J. Orchard

Corresponding member, International Subcommission on Permian Stratigraphy, IUGS.

Adjunct Professor, Department of Geological Sciences, University of British Columbia.

J.A. Roddick

Editor, IGCP Project 220: correlation and resources evaluation of tin/tungsten granites in southeast Asia and the Western Pacific Region.

G.C. Rogers

Member, Canadian Earthquake Prediction Evaluation Committee.

Member, Greater Victoria Schoolboard Committee on Earthquake Safety.

Coordinator, Juan de Fuca and Queen Charlotte Transform Map Series.

J.G. Souther

Member GSA Bulletin Board of Associate Editors.

Member of Canadian Earthquake Prediction Evaluation Committee.

Member A. Charland Ph.D. Thesis Committee, McGill.

Member Canadian Geothermal Resources Association.

J.F. Sweeney

Canadian representative, Arctic Subcommittee of ILP (CC-8/SC-2).

Canadian coordinator, Theme I, Project 2 (Arctic tectonic map/X-section). Canada/USSR Arctic Scientific & Technical Cooperation Program.

Secretary-Treasurer, Pacific Section - GAC.

Member, Steering Committee, Global Geoscience Transects Project (GGT) of ILP (CC-7).

R.I. Thompson

General Chairman of GAC Annual Meeting (1990).

Member, B.C. and Yukon Chamber of Mines Science and Technology Committee.

Member of Canadian Lithosphere Committee.

J.O. Wheeler

Geological Society of America Centennial Project Steering Committee.

Geological Society of America Committee on Committees.

Commission on the Geological Map of the World Canadian delegate.

Alberta Research Council Review Committee on Geological Atlas of Western Canada.

G.J. Woodsworth

Member, Canadian Permanent Committee on Geographic Names.

Member, Advisory Committee on Glaciological and Alpine Nomenclature.

Research Library

M. Akehurst

Free access to the Library's holdings is permitted on condition that visitors register at the information desk, i.e name, affiliation, telephone no. During the 1986-87 fiscal year 3,780 visitors from industry and the academic community made full use of the Library's facilities.

Borrowing privileges are extended to visitors who are affiliated with companies located in the lower mainland, provincial and federal offices, as well as to university faculty and graduate students.

Technical Services

Technical services is still plagued by a shortage of staff in all functions of the Library's cataloguing operations; namely, (1) cataloguing and classification, (2) physical preparation of material for use, (3) maintaining catalogue records in the Library. At present, the performance of these functions is handled entirely by the Division's Librarian with the assistance of one occasional term employee.

During the year steady progress was made in cataloguing the Library's collections by making use of the Division's Fortune (UNIX) computing System. The information contained in the name, subject and series authority files has now been transferred to UNIX for eventual on-line retrieval of information in cataloguing the Library's holdings. This eliminated the procedure of typing and maintaining hard copy authority cards.

Automated reproduction of catalogue cards via terminal/laser printer will begin as soon as the Library acquires a suitable laser printer. This will eliminate the tedious and time-consuming practice of typing the main entry master card, reproducing the catalogue cards via the xerox 1045, and typing in the added entries on the typewriter.

The entire cataloguing project is being geared to the final phase of producing a fully automated on-line card catalogue of the Library's holdings. Cataloguing format and technical procedures have been established and maintained for the eventual transfer of all information contained on the main entry master card to UNIX files via electronic scanning equipment. The G.S.C. libraries in Calgary and Ottawa would be able to receive this information via telephone, magnetic tape or diskette.

The Library's theses holdings have been transferred to UNIX files. In-house research scientists now have on-line access to this information via author, title, keyword subject/area, and by NTS.

A file of references for Cordilleran and Pacific Margin geology and marine geosciences currently contains more than 5000 entries and continues to grow. Computer retrieval is now available. The Division has acquired the MINFILE data base completed the input of this information into a 6-megabyte UNIX file for in-house use. Computer retrieval on the basis of any character string was enabled at the beginning of 1987.

Space Shortage

The Library's holdings have now grown beyond the limit of available stack space for the storage of journals, series, monographs, maps, open files and translations. To alleviate the problem, less-used sets of journals, reports, and second copies of G.S.C. publications were moved to a storage area in the basement. That space is now completely used up.

Heavy use of the Library's facilities is made by the mining and academic communities and there is a shortage of space for working with the Library's collections. The lack of a reading room and tables for the laying out of maps is a popular complaint from outside users. At present, the board room is used by the public when it is not being used by the Division for meetings and talks. The Library's serious space problems will be solved once its request for additional space on the fifth floor has been approved, and is in the hands of Public Works.

Publications and Sales Office

Olga Langenhaun

The office is responsible for providing information on geology in British Columbia and Yukon, as well as the sale and distribution of published reports and maps issued by the Department of Energy, Mines and Resources, British Columbia Ministry of Energy, Mines and Petroleum Resources and the Geological Association of Canada, Cordilleran Section.

Sales Statistics April 1, 1986 - March 31, 1987

1. Geological Survey of Canada	
Geology maps	\$ 8,303.50
Aeromagnetic maps	\$ 1,780.50
Open files	\$ 5,572.00
Rock & mineral sets	\$ 3,788.00
2. Surveys & Mapping Branch maps	\$ 71,499.05
3. Energy, Mines & Resources Publications	\$ 13,882.53
4. B.C. Ministry of Energy, Mines & Petroleum	\$ 2,469.00
5. Geological Asso. of Canada Publ.	\$ 1,778.00
Total sales	\$109,072.58
Provincial sales tax	\$ 5,249.45

Total Revenue

\$114,322.03

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The statistics above show that the total value of sales during the past year increased from \$106,000.00 to \$114,322.03 (increase of \$8,322.03).

The following Open Files were released and sold by this office during the period April 1, 1986 to March 31, 1987:

- O.F. 1157: Nearshore sedimentation and recent tectonics, Virago Sound, Northern Graham Island: Offshore surveys and positioning services Ltd. Scale 1:25,000;
- O.F. 1235: Extensive postglacial debris flow on the central continental shelf off British Columbia: J.L. Luternauer, K.W. Conway. 2 sheets; Scale variable.
- O.F. 1242: Geological map, legend and crosssection, central MacMillan Fold Belt, Yukon (105 O/3); M.P. Cecile. Scale 1:50,000.
- O.F. 1272: Geological maps of Southern Vancouver Island, Lithoprobe (92 C/10, 11, 14, 16; 92 F/1, 2, 7, 8); A. Sutherland Brown, C.J. Yorath, R.G. Anderson, K. Dom. 10 maps; Scale 1:50,000.
- O.F. 1280: Bathymetry, Surficial sediments and seabed morphology off Northwestern Graham Island, Queen Charlotte Islands, British Columbia: Offshore Survey and Positioning Services Ltd. 3 maps; Scale 1:50,000.
- O.F. 1329: Distribution of surficial sediment and major bedforms Goose Island Bank, Queen Charlotte Sound, central continental shelf off British Columbia; D.M. Duggan, J.L. Luternauer; 1 sheet.
- O.F. 1352: Geology of the Midge Creek area, Nelson (82 F/7, 10) map area, Southeastern British Columbia; A.D. Leclair, 3 sheets; Scale 1:50,000.
- O.F. 1379: Terrain inventory, Finlayson Lake, Yukon (105 G); L.E. Jackson, Jr.; 1 maps; Scale 1:125,000.
- O.F. 1380: Terrain inventory, Tay River, Yukon (105 K); L.E. Jackson, Jr.; 1 map; Scale 1:125,000.
- O.F. 1433: Potential hosts to Platinum group element concentrations in the Canadian Cordillera; C.A. Evenchick; S. Friday, J.W.H. Monger; 1 map; Scale 1:2,000,000.

The present policy of selling Open Files pertaining to the geology of the Canadian Cordillera continues to be very well received by the public.

GEOSCIENCE INFORMATION DIVISION

R.G. Blackadar

During 1986-87 the division comprised five sections: Scientific Editing, Publication Production and Publication Distribution; Library Services; Cartography and Reproduction Services (including Technical Photography and Photomechanical Services); Data Systems; and Divisional Administration.

The effect of the near-doubling of the Operational budget of the GSC resulting from Mineral Development Agreements and Frontier Geoscience Program continued to be felt especially in the processing of Open File material. More than 500 separate maps were handled. To meet our obligations to provincial agencies multiple copies of both transparent and paper copies are required. To handle the increased load one PY was transferred from within the division to create a clerical position to meet this need. This was staffed in early January. During the report period about 6000 pages were forwarded for printing including more than 1800 pages published in "Current Research" and 660 pages of French scientific publications. The demands placed on the publishing program led the Branch Management Committee to assess the purpose of "Current Research" and to decide that only "Current Research" Part A should be published and that it be issued in several volumes reflecting regional interests. The purpose of this change was to eliminate some unnecessary publications and to divert some resources to cope with costs associated with Geology of Canada (DNAG).

During the report period the long-delayed renovation of the Photographic Section was carried out by DPW. The studios were temporarily housed in the Cartographic Section from early December 1986 to June 1987. Despite the disruption the staff were able to meet demands for specialized service; much routine work was handled using outside services.

The Division produced a major display "Quaternary Geology and Terrain Hazards" which was used at the GAC Annual Meeting in Ottawa and which will be the nucleus of the GSC display at INQUA in July 1987. A display illustrating the steps followed in producing a coloured geological map was also prepared. This was used in Logan Hall, in the foyer of the Earth Sciences Sector offices and, along with a series of display maps, at the GAC in Saskatoon in May 1987.

During the year we published

3	memoirs
5	bulletins
27	papers
4	economic geology reports
14	multicoloured maps
6	preliminary maps
11	miscellaneous reports (guidebooks etc.)
348	geophysical maps
146	open files

In the Library the on-line catalogue was made available to users. Integration of maps from the former Earth Physics Branch collection was

completed and cataloguing of what is now the Geophysics Collection was completed. It is interesting to note that since 1981 there has been an 86 per cent increase in information delivered by the Library with only a 13 per cent staff increase. The 48 717 documents delivered to users represents a 68 per cent increase and the 8971 documents catalogued represent an increase of 161 per cent.

Attendance at Meetings, Conferences, Courses

R.G. Blackadar
Decade of North American Geology Steering Committee, San Antonio, Texas, November 1986.

Pre-retirement Course; Touraine, January 1987.

Memberships on Committees

R.G. Blackadar
- Branch Management Committee
- Earth Sciences Sector Communications Committee
- DNAG Steering Committee
- Chairman, GEOSCAN Management Subcommittee.

P.J. Griffin
- GAC/MAC 1986 Annual Meeting Special Events Committee.

SCIENTIFIC EDITING, PUBLICATION PRODUCTION AND PUBLICATIONS DISTRIBUTION SECTION

W.C. Morgan

The role of this section is in large measure that of the division - to make the results of the scientific program of the Geological Survey available to users in government, industry, academia and to the general public in a timely and cost effective manner.

During the year visits were made to the Ontario Geological Survey to evaluate their publication production systems and to various demonstrations of "desk-top" publishing systems. M.J. Kiel continued his examination of various printing processes to improve the quality of our publications without major cost increases.

In association with the editorial staff at ISPG, the Ottawa editors proceeded with a major revision of the "Guide to Authors". W.C. Morgan chaired an ad hoc committee established to advise Branch Management on ways to facilitate the production of the French-language edition of "Geology of Canada" in a timely manner and to ensure linguistic quality.

DISTRIBUTION DATA

Maps	64 326
Reports	29 776
Indices, lists, posters	137 947
Total distribution (free and paid)	232 049

Requests for information, publications, rock and mineral sets	19 353
Visitors (cash sales 981)	
Visitors (others 2147)	3 128

Revenue

Derived from sales of reports, maps,
rock and mineral sets, photographs,
Open Files \$ 134 878.39
Value of products supplied to
regional offices \$ 93 537.00

Personnel Notes

J.L.L. Touchette, Head Publication Distribution Unit retired on 31 December after nearly 35 years in the Public Service.

Madeleine Middleton was the successful candidate at the board held to replace Mr. Touchette and joined the GSC on 1 April 1987.

Susan Fowler, editorial assistant, resigned her position and left the Section in early April.

Jim Clarke transferred from Administrative Services to accept the newly-created position designed to handle open files.

Attendance at Meetings, Conferences and Courses

L.-E. Vincent
Association Canadienne Francaise pour
l'Avancement des Sciences; Montreal, 19-21 May,
1986.

Membership on Committees

M.J. Kiel
- GAC-MAC '86 Publications Committee

DATA SYSTEMS SECTION

P.B. Charlesworth

The role of the Data Systems Section is to provide advice and assistance to GSC management and staff in the broad areas of Information Systems policy, hardware and software. In addition, the section head, in the role of Sector Informatics Advisor and representative of the ADM, provides GSC input into departmental informatics policy and guidelines. With the merger of the GSC and Earth Physics branches and the subsequent reorganization, the workload increased significantly.

Section staff continued to provide assistance in the selection and installation of computer hardware, the specification and acquisition of purchased or developed computer software, and the development of computer systems. The GSC Information Technology and Systems Plan (ITSP) was compiled and submitted to the departmental secretariat for inclusion in the overall annual ITSP. Computer acquisitions continued to be monitored to ensure that Treasury Board policies were followed, and to assist staff in obtaining the required approvals.

Major issues addressed included the investigation of local methods for enhancing digital transect data, and planning the upgrades of the Branch VAX computer installation and the Branch word processing facility. Program development included a system for indexing the photographic negative collection, a publications index system and a cartographic management information system.

Personnel Notes

Richard Butterfield joined the Section in March to do database design programming primarily on the HP3000.

Attendance at Meetings, Conferences and Courses

P.B. Charlesworth

- First Meeting of the International Consortium of Geological Surveys at USGS in Reston, Virginia; October 1986
- Professional Development Institute Conference on Data Management in Ottawa; March 1987
- Integrating Voice and Data (Course); May, 1986
- Gartner Group Canadian Government Conference; January 1987
- CODATA Conference; July 1986

J.E. Glynn

- Autocarto 8 Conference in Baltimore, Maryland; March 1987
- First Meeting of the International Consortium of Geological Surveys at USGS in Reston, Virginia; October 1986

T. Scaga

- Professional Development Institute Conference on Data Management in Ottawa; March 1987

Membership on Committees

P.B. Charlesworth

- International Consortium of Geological Surveys for Earth and Computer Sciences
- Sector Informatics Advisor Committee
- Chairman, EMR Computer Users' Committee
- VAX Facilities Management Committee
- GSC Computer Management Committee
- HP3000 Facilities Management Committee
- GSC Data Integration Committee
- Geophysical Data Management Committee
- Telecom Special Interest Group

J.E. Glynn

- GSC Data Integration Committee

LIBRARY SERVICES

A.E. Bourgeois

The GSC Library's role is to provide information services in support of the research mandate of the Geological Survey and to maintain a national resource collection in earth sciences and related disciplines to support Canadian geoscience research. The Library and the National GEOSCAN Centre continue to perform the activities related to the selection, acquisition, analyses and description, processing, retrieval and dissemination of literature which are required to meet demands for high quality and immediate information.

The integration of the former Earth Physics Branch Library together with the loss of one PY from their staff increased our overall workload. The Library operated with three less staff for six months of the year due to resignations and French language training. However through the effective use of special programmes such as the Cooperative Student Program and Challenge '86 and the automation of routine procedures the Library was able to increase its outputs during the year. Information delivery increased by 2% and document delivery by 2%; 21% more documents were analyzed and 9% more volumes were added to the collection.

Information Services

In addition to its on-going activities the following projects were undertaken:

Reference and Circulation

1. The menu driven on-line catalogue was finalised and introduced to the public.
2. Documentation was written for the Interlibrary Loans database.
3. Weeding of the periodicals was continued as a space-saving measure.

Map Library

1. A feasibility study on the automation of Map Library Systems was completed.
2. All maps of the former Earth Physics Branch have been transferred to the Map Library; upgrading of these records and integration of the maps are currently in progress.
3. The NTS map collection formerly held in the Cartography Section has been transferred to the Map Library in order to provide and maintain better control of this collection.

Technical Services

Acquisitions

1. The ordering and payment of invoices for the GSC main collection and the Geophysics collection were integrated with no disruption of services.
2. All subscriptions and standing orders for the Geophysics collection were entered into the online acquisitions system.
3. Various activities have been revised to take advantage of the automated system thus greatly reducing clerical processing time.

Cataloguing/Indexing

1. The integration of the Geophysics collection cataloguing was carried out with no disruption in services; the Geophysics collection records are, at present, searchable in a separate database but are now being integrated into the main collection database GEOCAT. Their serial records are now being converted to machine readable format and integrated into the library's online catalogue.
2. A major review of GSC records in GEOSCAN was undertaken and approximately 10 000 records had been revised by the end of the project.
3. All GSC Library's serial records have been converted into a machine-readable format and are available online.
4. Series and Name Authority files are now available online. Input of new records and revision of old ones is proceeding according to schedule.

Systems Management

1. The former Earth Physics Branch catalogue was converted and loaded into GEOCAT, a MINISIS-based system.
2. The user menu for the online catalogue was installed and is functioning.
3. Programmes were developed which produced the microfiche catalogue of holdings from the online catalogue.
4. The GSC library's acquisition system (HERMES) has been installed for CANMET library and is now being tested prior to acceptance.
5. Continued system support was provided by the GSC Library to CCRS and HQ libraries for their MINISIS-based systems.

National GEOSCAN Centre

NGC continued to provide support for all aspects of the management of the GEOSCAN/MINISIS Project, a cooperative federal-provincial program. This included batch and online data entry, thesaurus loads and updates, training indexers and searchers, maintaining communications with participating agencies, processing information and product requests, maintaining documentation, ensuring quality control, promoting GEOSCAN, and administering the facilities management contract with Systemhouse Ltd.

In addition the following major tasks were undertaken:

1. British Columbia became a participant in GEOSCAN and 12 015 BC records were converted and loaded into the database.
2. NGC assumed responsibility for the indexing of GSC publications including the contributions series and an indexing position was created.
3. The GEOSCAN indexing manual was completed and distributed and all other system documentation was revised and reissued during the year.
4. The GSC component of GEOSCAN was made available to the GSC Library clientele for direct searching through the Library's online menu-driven system.
5. The National GEOSCAN Centre produced two topical bibliographies (GEOSCAN Gold Bibliography and GEOSCAN Platinum Bibliography) for distribution at the Gold '86 meeting and the Prospectors and Developers Annual Meeting in Marcy 1987.
6. GEOSCAN was promoted at the following professional meetings: Gold '86, GAC/MAC Annual Meeting, GSC Current Activities Forum and the Prospectors and Developers Annual Meeting.

Personnel Notes

Anne Barkworth was appointed in January to the position of GEOSCAN Data and Products Coordinator.

Jacques Berube accepted a new position as Reference Librarian at CANMET in July 1986.

Diane Bouchard, National GEOSCAN Secretary, left NGC in October to work in the office of the Assistant Deputy Minister, Earth Sciences Sector.

Marielle Larche replaced Brian McDonald in July as photocopier operator.

J.C. Levesque and Louise Simpson joined the GCS Library as part of the Earth Physics Branch integration.

Wendy Stark, Database Manager/Library Systems left the GSC in October 1986 to take on new responsibilities as Head, Technical Services at the Labour Canada Library.

Attendance at Meetings and Conferences

S. Alexander

Ontario Library Association, Annual Conference, November 1986, Toronto.

MINISIS Users' Group Meeting, 1986, Ottawa.

A. Bourgeois
3rd International Geoscience Information
Committee, June 1986, Adelaide, South
Australia.

Geoscience Information Society, November 1986,
San Antonio, Texas.

Annual Conference of the Council of Federal
Libraries, October 1986, Ottawa.

Geological Association of Canada Conference,
May 1986, Ottawa.

A. Barkworth
MINISIS North American Users' Group Meeting,
November 1986, Ottawa.

A. Kopf-Johnson
MINISIS North American Users' Group Meeting,
November 1986, Ottawa.

Prospectors and Developers Annual Meeting,
March 1987, Toronto.

R. Pleasant
Ontario Association of Library Technicians,
Annual Meeting, May 1986, Ottawa.

D.S. Reade
Geological Association of Canada Annual
Meeting, May 1986, Ottawa.

R. Swan
Canadian Library Association annual Conference,
June 1986, Quebec, Quebec.

D. Tedford
British Lending Library, Workshop on
Interlibrary Loan, September 1986, York,
England.

J. Wilks
Canadian Association for Information Science
Annual Conference, May 1986, Vancouver, British
Columbia.

Membership on Committees

S.O. Alexander
- Ottawa-Hull Utlas Users' Committee
- EMR Cataloguers working Committee

A.E. Bourgeois
- Geoscience Information Society Executive
Committee (President)
- Council of Federal Libraries Representative on
the National Library Advisory Board's Resource
Sharing Committee
- Chair, 4th International Geoscience Information
Conference, 1990, Organization Committee
- EMR Standing Committee of Head Librarians

L.A. Frieday
- Ottawa-Hull Utlas Users' Committee
- EMR Cataloguers working Committee

E. Klobouk
- National GEOSCAN Data Base Committee

A. Kopf-Johnson
- National GEOSCAN Data Base Committee

T. Naraynsingh
- Association of Canadian Map Libraries'
Bulletin, Ontario editor

D. Reade
- National GEOSCAN Data Base Committee
- GEOSCAN Management Subcommittee of the
National Geological Surveys Committee

W. Stark
- Application Managers' Group, GSC
- Council of Federal Libraries, Systems and
Network Committee
- Council of Federal Libraries, Microcomputer
Users' Network

R. Swan
- Council of Federal Libraries. Committee on
Conservation/Preservation of Library Materials

J. Wilks
- CAN/SDI Centres Committee

STATISTICS: 86/87

1. GSC LIBRARY

A. Information Delivery	
Supplied by Library	17 506 (97%)
Referred to other sources	602 (3%)
TOTAL	18 108

B. Document Delivery	
Items requested	48 717
Items supplied	
- from GSC collection	45 935 (94%)
- from other libraries	1 498 (3%)
TOTAL	47 433

Requests referred	303 (1%)
Items not supplied	981 (2%)

C. Document Analysis	
Monographs, serials, etc.	7 986
Maps	395
GSC Publications	590
TOTAL	8 971

D. Collection Growth	
Monograph volumes	1 535
Map sheets	4 881
Microforms (reels/sets)	2 654
Serial volumes	2 000
(issues: 11 996)	
(new titles: 40)	
TOTAL	11 070
Linear meters	282.6

2. NATIONAL GEOSCAN CENTRE

A. Database Growth	
Records added to database	15 972
Total records in database	94 302

B. Information Delivery	
Custom indexes	28
On-line retrievals	
(by GSC 83)	
(by other agencies 300)	383

C. Participating Agencies	12
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CARTOGRAPHIC AND REPRODUCTION SERVICES SECTION

J. Bill

The Section provides a comprehensive cartographic/graphic, photomechanical and photographic service to the GSC. A broad variety of products are produced ranging from simple white prints to the production for offset printing of highly complex multicolour geology maps. Also produced are: colour graphics for displays and slides for talks and presentations; charts and illustrations for published reports; base maps for field work and map manuscript preparation. Also available is a general and specialized technical photographic service.

A considerably higher than usual number of high priority multicolour projects were produced during the year within very short time periods, with deadlines being met in all cases. Among these were maps 1649A and 1661A.

Renovations to the Technical Photography Units accommodations on the 5th floor resulted in some reduction of services from early December through to the end of the fiscal year. Basic services continued to be provided through temporary accommodations elsewhere within the section, with a return to the 5th floor and full production anticipated by June 1987.

Some notable products released were:

- 900A - English and French - Principal Mineral Areas of Canada 36th Edition
- Map 1649A - Stratabound Sulphide Deposits in the Appalachian - Caledonian Orogen
- Map 1661A - Index to National Geochemical Reconnaissance Surveys
- Map 1701A - Physiographic Map of the Canadian Cordillera

The cartographic production for DNAG started with the receipt of manuscripts for page and pocket figures for several chapters for each of two Geology of Canada volumes: the Geology of the Continental Margin of Eastern Canada volume and the Quaternary Geology of Canada and Greenland volume.

Manuscripts were received and production started for 2 map sheets in the "new" 1:1 000 000 Atlas Series from Dr. Okullitch. Separate English and French editions are in preparation for the Lake Nipigon and Timmins map sheets.

Significant increases to several key workload components occurred. The more than 1900 miscellaneous requests processed by the photomechanical unit, an increase of 20% over previous year, represents a full range of reprographic services provided directly to employees of all divisions of the Survey. The receipt of 32 multicolour geological map manuscripts was a large increase over previous year's 15, providing a major workload increase and carry-over to fiscal year 87-88.

The computerization of the Section's reporting system (labour and materials accounting) was finally completed with all production data for 86-87 having been recorded in time for the compilation of this annual report. This greatly

facilitates the calculation of production costs upon project completion or at any point in the production process, and also provides a valuable production management tool in the form of various timely output reports.

PRODUCTION DATA

Cartography:

Maps and illustrations received during the fiscal year:

	<u>1985-86</u>	<u>1986-87</u>
Multicoloured geological maps	15	32
"B" Series Maps	3	1
Figure illustrations (pocket)	31	10
Figure illustrations (page)	147	585
Geophysical Maps and Indexes	61	175
Special Projects		
- Beaufort Sea Atlas	31	0
- Misc. Maps	0	14
- Panels for Displays	0	7
- MDA Maps	0	57
Open File Maps	14	377
Multicoloured geological maps		
- reprints	4	0

Maps and Illustrations completed by the Cartography Section:

	<u>1985-86</u>	<u>1986-87</u>
Multicoloured geological maps	19	15
"B" Series Maps	2	8
Figure illustrations (pocket)	28	22
Figure illustrations (page)	145	152
Geophysical Maps reprinted	18	177
Multicoloured geological maps		
- reprinted	2	0
Indexes to Publications revised	30	40
Open Files Maps and Profiles	40	105
Special Projects		
- Panels for Display	0	7
- Beaufort Sea Atlas	0	0
- Misc. Maps	0	11
- MDA Maps	0	57

Carry-over of maps and illustrations in progress at the end of the fiscal year:

	<u>1985-86</u>	<u>1986-87</u>
Multicoloured geological maps	25	46
"B" Series Maps	11	4
Figure illustrations (pocket)	18	13
Figure illustrations (page)	270	501
Open Files Maps and Indexes	12	272
Geophysical Maps and Indexes	70	31
Special Projects		
- Beaufort Sea Atlas	77	77
- Misc. Maps	0	3

There were 484 miscellaneous (Z numbered) drafting jobs completed during the year, which took 10 750 person hours.

A total of 526 requisitions for digital typesetting services for Ottawa Cartographers were keyed and coded in-house for processing at S&M Branch. This is a considerable increase over previous year's 375 which also included all of Calgary's requirements.

Photomechanical:

	<u>1985-86</u>	<u>1986-87</u>
Camera		
Film and paper-line copies	7 416	7 290
Direct B & W prints (PMT)	853	1 999
Direct colour prints (PMT)	129	147
Halftones	237	168
Continuous tones	249	30

Contact

Film and papers	29 820	29 208
Keys	872	938
Peelcoats	302	474
Transfers	0	14
Final Pre-Screen	715	484
Colour Proofs	90	313
White Prints	7 400	8 500

In addition to the normal map production operations, the photomechanical unit processed 1 918 (1 660 in 85-86) miscellaneous (X numbered jobs for various authors and divisions.

There were 655 master topographic negative packs requisitioned from S&M Branch for reproduction in Photomechanical for authors and cartographers in Calgary, Ottawa and Vancouver.

Automation Unit:

	<u>1985-86</u>	<u>1986-87</u>
Digitizing:		
Point Mode - R.G.G.	105	MRD 93
E.G.M.	0	TS 8
T.S.	0	LCSD 6
		GEO 3
		110
Line Mode - R.G.G.	6	
E.G.M.	10	
T.S.	10	
Total days	131	

Twenty projections at various scales were prepared with the cooperative assistance of the S&M automation systems.

Checking Unit:

	<u>1985-86</u>	<u>1986-87</u>
'A' Series maps checked at proof stage	15	19
'B' Series maps checked at proof stage	10	3
Pocket, page figures, misc.	67	37
Atlas pages	0	39
		(maps & text)
	92	98

Photography:

	<u>1985-86</u>	<u>1986-87</u>
Photographs Produced		
Equipment-Labs-Portraits-etc.	264	144
Continuous tone maps-charts	1 205	1 888
Line copies	186	215
Rock & mineral specimens	646	536
Thin sections	545	381
Fossil negatives	289	249
Colour slides	5 464	4 998
B & W slides	1 115	624
Duplicate slides	1 400	1 443
B & W negs. from colour slides	1 122	1 101
Overhead Transparencies	17	-
Reverse text slides	36	-

Prints and Enlargements

B & W	9 666	8 225
Colour	1 338	723
Prints from Photo Centre	3 894	2 459

Other Operations

Prints and enl. number and stamped	3 949	1 712
Prints and enl. to outside agencies	1 022	557
Slides mounted	7 120	6 844
Requisition processing-rolls	52	104

Personnel Notes

Jeanne White retired from the Photography Unit in September, having joined this group in 1953.

Gilles Barbary retired from his position of sub-unit supervisor, after 36 years of service with the GSC.

Bernie Mainville a cartographic checker also retired after 36 years of service.

Bob Wilkinson resigned from his position as camera operator in the Photomechanical Unit, after 11 years with the GSC.

Ian Coulthart was promoted by competition to sub-unit supervisor in Drafting Unit C.

Sylvia Junginger-Frohberg left on maternity leave in August, 1986 with her return expected by February 1988.

Attendance at Meetings, Seminars and Courses

Cartographic Workshops - Cartotechniques VI - OICC - Ottawa, May 1984 - 1 day

19 Cartographers attended

Aqfa-Gevaert Copy Colour and Copy Proof Course - Toronto, October 1986 - 2 days

G. Wylie
R. Clairoux

Safety Workshop - Algonquin College, Ottawa - 1/2 day

R. Mackenzie
F. Williams

Preparing for Competitions - EMR - Ottawa

2 employees

Long Term Financial Planning Workshop - EMR - Ottawa

1 employee

French Language Training - Ottawa - evenings

J. Baldock
P. O'Regan

Offset Stripping - Graphic Arts - Algonquin College - Ottawa - 15 evenings

K. Blacklock

Layout and Design I - Graphic Arts - Algonquin College - Ottawa - 15 evenings

K. Blacklock

Auto Carto London - London, England - September 1986

J. Bill

An interdepartmental photomechanical training program initiated last year was continued, and several sessions were held during this year. This program was designed to accommodate the exchange of knowledge and ideas primarily between similar work units at GSC and Agriculture Canada. Units from other departments have occasionally participated as well.

Membership on Committees

J. Bill

- Advisory Committee for the Surveying and Mapping Technology Program - Algonquin College
- Classification Standard Review Committee - Drafting and Illustration Group - Treasury Board

F. Williams

- EMR Reproduction and Quality Assurance Advisory Committee
- GSC JOSH Committee

V. Foster

- Board of Directors, Ontario Institute of Chartered Cartographers
- EMR Interdepartmental Topographic Map Design Committee

L. Renaud

- Board of Directors, Ontario Institute of Chartered Cartographers

F. Heney

- GSC JOSH Committee

M. Enright

- GSC JOSH Committee

GEOPHYSICS DIVISION

M.J. Berry

General

The Division was formed on April 1, 1986 from the national surveys and observatories components of the former Earth Physics Branch, and the aeromagnetic surveys program of the former Resource Geophysics and Geochemistry Division. The new Division's role is to conduct programs that will provide data and expertise concerning geophysical realms and processes on a continent-wide scale, from which a better understanding of the Earth's near-surface and deeper structure, dynamics and potential hazards can be obtained.

In 1986-87 the Division's activities were organized under three subdivisions: Seismology and Geomagnetism comprising the Seismology, Geomagnetism and Geophysical Instrumentation Sections; Gravity and Geodynamics Subdivision composed of those two respective Sections; and the Aeromagnetism Subdivision. Their operations were supported by an Administration Section. The Division's program was conducted by its continuing staff of 115, supported by two term positions assigned to Frontier Geoscience Program activities, and two term positions under the Manitoba and New Brunswick federal-provincial MDA Programs. The research program was complemented by four NSERC post-doctoral fellows. The Division's facilities are concentrated on the Observatory Campus of the Central Experimental Farm, at the Anderson Road Geomagnetic Laboratory on the eastern edge of Ottawa and at the Geological Survey building at 601 Booth Street. Smaller groups operated from City Centre, and from the Alert Hangar and the National Aeronautics Establishment at Uplands. Seven personnel were stationed at the geophysical observatories at Priddis near Calgary, at Yellowknife and at Mould Bay and Alert in the Arctic Islands.

The Division is the national archive and data centre for seismicity and geomagnetic studies, and gravity and aeromagnetic surveys. In addition it provides instrumentation and computer facilities to the Lithospheric Geophysics Section of the Lithosphere and Canadian Shield Division, and supports the seismographic networks based at the Pacific Geoscience Centre.

HIGHLIGHTS

(Division Summary)

Following a magnitude 6.6 earthquake in the Nahanni region, N.W.T. in October, 1985, three accelerographs were installed to record aftershocks in the Mackenzie Mountains. On December 23, 1985, the instruments recorded a shallow (6 km deep) earthquake of magnitude 6.9. One recorder, installed on competent bedrock of Devonian limestone, appeared to be situated directly above a centre of strong energy release of this thrust-type earthquake. Processing and analysis of the strong motion accelerograph data has defined the largest recorded earthquake ground motion. The analog photographic record of an acceleration exceeding twice that of gravity was reproduced on the cover of EOS (September 23, 1986). The October, 1985 earthquake triggered an avalanche of 5-7 million cubic meters of massively bedded limestone, the fourth largest landslide in Canada in this century.

The Nahanni results are considered typical of design seismic ground motion that would result from a large earthquake in eastern Canada and are relevant, therefore, to building and engineering design codes. Nahanni sites were reoccupied for further analysis of aftershock distribution in 1986. Eleven months after the first earthquake, 300 events up to magnitude 4.5 were recorded in a 2 week period.

The Yellowknife seismic array will operate as the principal seismograph station in Canada contributing data to monitor a global, comprehensive, nuclear test ban. Following a Cabinet decision in January, 1986, Treasury Board approved in July a submission for \$2.46 M in capital and \$0.72 M in operating funds to upgrade the facility over FY 1986-87 to 1988-89. Progress in 1986-87 included preparation of comprehensive system- and software-design documents, construction of 4 broad band seismometer vaults, acquisition of state-of-the-art, broad band and short-period seismometers, radio-transmission and receiving hardware and computer systems for data acquisition. Contracts for a new centre of operations building and for software design have been awarded, and an RFP issued for satellite transmission from Yellowknife to Ottawa. The facility, which will ultimately comprise a total of 32 broad band and short-period seismometers, will provide a design example that may be adopted by other countries.

A very successful Workshop on Magnetic Observatory Instruments, sponsored by the International Association of Geomagnetism and Aeronomy (IAGA) was held at the Anderson Road Geomagnetic Laboratory, August, 1986. Forty-one participants from 17 countries were able to observe and compare a number of operating observatory instruments. A Proceedings Volume is nearing completion, and contains a compilation of data collected during the Workshop, plus recommendations concerning ideal specifications for digital magnetometers in observatories. The instruments employed in virtually all countries, including Canada, fall short of these ideals at present.

The initial field testing of the absolute gravity meter was begun. In an international intercomparison at the Joint Institute for Laboratory Astrophysics, Boulder, Colorado, the Canadian and U.S. instruments of similar design recorded absolute values within 25 μ Gal of one another. Subsequently, as a prelude to occupying several selected stations of the Canadian Gravity Standardization Net, an absolute gravity site was established at Calgary. A network of D-meter stations was established in the Ottawa area to monitor changes in gravity around the proposed Canadian Absolute Gravity Site.

"Interpretation of Gravity and Magnetic Anomalies for Non-Specialists", organized initially by Division personnel as a CGU Short Course at the 1986 Joint Annual Meeting of GAC, MAC and CGU, was given again in-house for a group of approximately 35 GSC personnel. The CGU is reprinting 100 copies of the course notes for sale at \$35.00, and the notes are being translated into Spanish as part of Canada's continuing contribution to the Pan-American Institute of Geography and History.

The rock properties studies in support of AECL's Nuclear Fuel Waste Management Program has concluded in the Geophysics Division with the compilation of

Level II Concept Assessment Documents for the Underground Research Laboratory, Atikokan and East Bull Lake research areas. During the eight years of the program, significant advances and developments were achieved in automation of modal analyses of core samples, techniques for identification and characterization of microcracks that could influence radionuclide migration, and in the experimental production and detection of thermally induced microcracks.

The horizontal gradient map of North America (Bouguer on land, free-air offshore), compiled in the Gravity Section, was featured on the cover of EOS (July 8, 1986). The shaded image, artificially illuminated from the southwest, depicts zones of high gradient as raised features, similar in appearance to ridges or domes on shaded relief maps. These gravity features correspond to the flanks of relatively short wavelength gravity anomalies which in turn reflect discrete lateral crustal density variations of geological interest, such as suture zones, rifts, major faults and intrusions. Gravity gradient information is useful in delineating and understanding structural relationships in the craton, particularly in areas in which Precambrian rocks are covered by Phanerozoic sediments.

The first fringes from observations at the Algonquin Radio Observatory (ARO) and Penticton Dominion Radio Observatory (DRAO) have been obtained using the newly developed prototype of the Canadian Long Baseline Interferometry (LBI) System, and represent the culmination of several year's research and experiment jointly undertaken by GSC (Geophysics), NRC, University of Toronto and York University. To successfully obtain fringes from two observatories simultaneously recording faint signals from distant quasars, recording, playback, data processing and correlation modules of the LBI system must be operational and in phase. This significant achievement is a confirmation of the unique Canadian system design, which should prove more economical in acquisition and operational costs than standard (US) VLBI systems.

The Canadian contribution - data compilation - to the Magnetic Anomaly Map of North America has been completed and colour separates delivered to the USGS for printing and publishing at a scale of 1:5M. Compilation of this, the first magnetic anomaly map of an entire continent, required considerable skill in editing, amalgamating, levelling, projection transformation etc., of data from diverse sources.

A total of 268 aeromagnetic maps were issued, and 6 others released as open file reports. Map production included 6 maps of the 1:1M scale series, total field coverage of Canada for regions of northern Alberta and British Columbia, and for the Yukon-District of MacKenzie border, and brings to 45 the total number of maps published in this series. High resolution aeromagnetic total field and vertical gradiometer survey maps at scales of 1:20,000, 1:25,000 and 1:50,000 cover areas in British Columbia, Manitoba, Saskatchewan, Quebec, Nova Scotia, New Brunswick, and Newfoundland, and are the products of the Federal-Provincial Mineral Development Agreement program.

Attendance at Meetings, Conferences and Courses

Division members participated in:

Federation of Global Seismographic Networks Founding Meeting, Karlsruhe, FRG, April, 1986.

Semiannual Meetings of the NASA Crustal Dynamics Working Group, Washington, D.C., April and Oct., 1986.

Fourth international Geodetic Symposium on Satellite Positioning, Austin, TX, April, 1986.

Seismological Society of America (SSA) Annual Meeting, Charleston, S.C., April 1986, and Santa Barbara, CA, March, 1987.

Canadian National Committee for IUGG, Vancouver, May, 1986.

GAC-MAC-CGU Annual Meeting, Ottawa, May, 1986.

U.S. Defense Advanced Research Projects Agency/U.S. Air Force Geophysics Laboratory Seismic Verification Research Symposium, Colorado Springs, May, 1986.

ISC Executive Committee, Newbury, U.K., June, 1986.

International Symposium on Applications of Space Techniques for Geodesy and Aerodynamics, Toulouse, France, July, 1986.

Group of Scientific Experts, Geneva Conference on Disarmament, Geneva, July, 1986.

International Workshop on Magnetic Observatory Instruments, Ottawa, August 1986.

Circum-Pacific Energy and Mineral Resource Conference, Singapore, August 1986.

Second Canadian Conference on Marine Geotechnical Engineering, St. John's, Sept., 1986.

International Symposium on Space-Time Structure of the Geomagnetic Field, Wittenberg, GDR, Sept., 1986.

Meteoritical Society Annual Meeting, New York, Sept., 1986.

International Workshop on the Exchange of Waveform Data, Ottawa, October 1986.

Eastern Section Seismological Society of America, Ottawa, October 1986.

Society of Exploration Geophysicists, Houston, TX, November 1986.

Great Lakes Interdisciplinary Studies (GLIMPCE) Meeting, Madison, Wisc., December 1986.

Geoscience Seminar and Open House of the Ontario Geological Survey, Toronto, December 1986.

American Geophysical Union (AGU) Fall Meeting, San Francisco, December 1986.

GSC Current Activities Forum, Ottawa, January 1987.

Cordilleran Tectonics Workshop, Montreal, February 1987.

Earthquake Engineering Research Institute Annual Meeting, San Diego, February 1987.

ADMINISTRATION SECTION

This section, comprising the Director, Assistant, Secretary, Administrative Officer, clerical and procurement staff, draftspersons and photographer, provides general administrative support and financial and personnel management for the Division, and support where required for staff of other divisions resident on the Observatory Campus, particularly drafting and photography.

Membership on Committees

M.J. Berry

International Seismological Centre; Chairman, Executive Committee

International Commission on the Lithosphere; Chairman
Committee of National Representatives, Coordinating Committee No. 6

Federation of Global Seismographic Networks; Chairman
IASPEI; Co-Chairman, Commission on Earthquake Hazards
Canadian National Committee for the International
Lithosphere Program (CANDEL); Chairman

P.B. Robertson

NRC Associate Committee on Meteorites; Secretary
Canadian Geophysical bulletin; Editor

SEISMOLOGY AND GEOMAGNETISM SUBDIVISION

P.W. Basham

SEISMOLOGY SECTION (P.W. Basham)

The national seismology program operates a network of 100 seismograph stations throughout Canada to monitor earthquakes on the Canadian landmass and adjacent offshore regions. The network is capable of locating all earthquakes above magnitude 3 throughout Canada; in southwestern and southeastern regions, digital, telemetered networks monitor lower magnitude seismicity in regions of industrial activity and high population density. Data are maintained in national analogue seismogram, digital waveform and seismicity databases and are available in a variety of forms. Fields of research include earthquake hazard estimation; earthquake mechanisms and neotectonics; whole-earth seismology; modern seismograph instrumentation; and seismic verification of a ban on underground nuclear explosions, including operation and modernization of the seismic array at Yellowknife, N.W.T.

Monitoring of Seismic Ground Motion

The 15 standard and 44 regional stations of the Canadian Seismograph Network, maintained by the Division and operated largely through agreements and contracts with other agencies and individuals, achieved seismograph records over 98% recording time. Thirteen stations, largely in the Northwest Territories were visited as part of the periodic recalibration program.

Seismological Data Analysis and Management

Analogue seismogram records received in Ottawa in 1986-87 (approx. 40,000) from the standard and regional network stations, were archived on microfilm in the Geophysics Division Archive and copies prepared and disseminated to meet approximately fifty requests.

The digital data laboratory operated smoothly, incorporating data from the eastern telemetered networks and the CANSAM event detector at Yellowknife, and digitized field data from Charlevoix, the GAC borehole seismometer, and portable array data from field monitoring operations and surveys (Nahanni).

Seismological Studies of Earth Dynamics

Seismic data from ECTN and other networks in eastern and northern Canada were analyzed and combined with data from WCTN to provide information on all locatable earthquakes in Canada, and summary seismicity bulletins prepared on a quarterly basis. There were no large felt events in eastern Canada that required collection of 'felt' reports or the launching of aftershock surveys. A shorter, more effective earthquake questionnaire has been prepared to aid in collecting future field observations. Seismic monitoring of reservoir sites for Ontario Hydro, Hydro-Quebec and SEBJ detected no significant changes in seismic activity attributable to hydrostatic crustal loading.

Conversion of software from CYBER to in-house (VAX) for economy and efficiency is complete in some areas, and the INGRESS database is now fully operational.

Analysis of S-waves from 1985 Charlevoix data has been completed and supports the interpretation of a reasonably dense system of vertical microfracturing in the rock mass of this seismically active region. P-wave analysis of the data for the same period confirm that the array can be expected to observe dilatancy.

The annual meeting of the Eastern Section, Seismological Society of America, was held in Ottawa, October 1986, organized and hosted by the Geophysics Division and the GSC.

The move to offshore exploration in Canada's east coast requires a more thorough knowledge of seismic hazards in the offshore regions. Four contracted studies were carried out to assess the effects of the 1929 Grand Banks earthquake in the Atlantic region, and three others compiled historical seismicity data for the comparable area. A relocation study of instrumented offshore earthquakes is continuing. The temporary seismographs at St. John's, Cornerbrook and Guysborough, to locate current seismic events, recorded a swarm of mag. 5 events over the New England seamount region. Data and recommendations towards the development of safe seismic design criteria for offshore platforms were provided to Technical Committee 1, CSA standard S471. An overview of the seismotectonics in eastern Canada has been published.

Preliminary results from a finite element modelling study of glacial induced stress at shallow depths indicate that the shape of the ice margin and nature of the underlying material are important factors.

The leaking mode analysis technique was successfully employed in a number of published studies concerning seismic wave propagation and attenuation.

The design document for Canadian Digital Seismograph Station (CANDIS) was prepared. The CANDIS network (goal of 6 stations by 1990) will form the Canadian component of the international broad band seismograph network. It will increase the capability of accurately recording large earthquakes in Canada as seismographs of the current network go off-scale for earthquakes of magnitude greater than 5.7. While CANDIS is approved in principle, the delay in obtaining funding approval is causing concern.

Geoscience of Nuclear Explosions

The Yellowknife seismological array and data processing laboratory were maintained and operated to international standards. Scientific advice on all matters pertaining to seismological verification of a ban on underground nuclear explosions was provided on a regular basis to the Department of External Affairs and the Conference on Disarmament Seismic Experts Group, Geneva.

A workshop on the Exchange of waveform Data, hosted in Ottawa, October 6-8, 1986, by EMR (Geophysics Division, GSC) and External Affairs, was attended by participants from 17 countries, including Canada, USA, UK, USSR, Japan, FRG and GDR. Working groups compiled a number of recommendations on means of communication, communication protocol and waveform message field formats, and direct connections using the international packet-switched data network were established between the Ottawa Seismological data laboratory computer and computers in eight other nations.

Research on discrimination of earthquakes and nuclear explosions continued using high quality data on earthquakes, mine blasts and rockbursts recorded primarily by ECTN. Progress was made through in-house and contracted studies to investigate whether high frequency seismic energy propagates efficiently enough in the Canadian Shield to enable detection of decoupled underground explosions.

Special Talks and Lectures

P.W. Basham

"International Seismological Verification", presented at symposium on "Nuclear Weapons Tests: Cessation or Limitation?", sponsored by the Stockholm International Peace Research Institute and Canadian Institute for International Peace and Security, Montebello, Quebec, October 1986.

"Canadian Earthquakes, Seismic Hazards and Seismic Verification Programs in the Geological Survey of Canada", GSC Current Activities Forum, January 1987.

A.E. Stevens

"Périls et risques séismiques au Canada", International Symposium - Natural and Man-made Hazards / Symposium international - Périls et catastrophes", Rimouski, August 1986.

"Périls séismiques au Canada", National symposium organized by Emergency Preparedness Canada on Risk Management / Symposium national parrainé par Protection civile Canada: La gestion du risque: mesures et normes, Arnprior, Ontario, October, 1986.

H.S. Hasegawa

"Neotectonic movements in southern Canada with emphasis on the role played by glacial loading and unloading", Nordic Liaison Committee for Atomic Energy symposium on Geological Problems Related to the Disposal of Radioactive Waste in Precambrian Terranes, Helsinki, December, 1986.

Membership on Committees

P.W. Basham

Group of Scientific Experts, Geneva Conference on Disarmament, Canadian Delegate
Seismological Society of America, Board of Directors
CSA Technical Committee N289, Seismic Qualification of CANDU Nuclear Power Plants
CSA Technical Committee Z276, Liquefied Natural Gas Storage
CSA Technical Committee S471, Fixed Offshore Production Structures

R.G. North

Group of Scientific Experts, Geneva Conference on Disarmament, Canadian Delegate

J.E. Adams

National Research Council, Canadian National Committee on Earthquake Engineering

A.E. Stevens

Earthquake Engineering Research Institute, Board of Directors

GEOMAGNETISM SECTION (R.L. Coles)

The Geomagnetism Program monitors the geomagnetic field over the Canadian landmass and offshore areas and conducts research on the nature of the magnetic field of the earth and its variations.

Twelve magnetic observatories provide up-to-date information on the magnetic field across Canada. On a two-to-four year basis, a Canada-wide network of geomagnetic repeat stations is reoccupied to supplement the determination of the secular variation of the geomagnetic field from the observatories. From these data, magnetic declination and its secular variation are routinely monitored, and revised magnetic charts are published every five years. This information is also included on topographical and aeronautical charts published by the Surveys and Mapping Branch of EMR.

On a shorter time scale, transient changes in the earth's magnetic field can cause economic loss by disrupting or degrading magnetic exploration surveys, electrical power transmission, radio communication. Accordingly, a magnetic activity forecasting service is provided to exploration companies, to power and communications utilities, and to other users.

Geomagnetic Observatories and Surveys

The 13 stations of the Canadian Geomagnetism Observatory Network have been operated smoothly and to accepted international standards through contracts and by on-site Division personnel, providing over 98% data recovery. An internal report was prepared compiling magnetic differences between an external reference point and the standard pier for the 9 stations inspected in 1986.

Twelve stations located in western and northern Canada, that comprise part of the 60 station repeat network, were reoccupied for secular variation studies, and declination, horizontal and vertical field intensity data have been incorporated in the geomagnetic database.

Geomagnetic Data Management

Geomagnetic data from all sources in the geomagnetic program have been acquired and stored without difficulty or loss. International data commitments to World Data Centres in the USA, USSR and Japan have been fulfilled according to interval schedules from twice monthly to annually. Magnetic observatory data have been provided in the form of digital magnetic tape to December, 1985, and microfilmed magnetograms to December, 1986. Requests for spot declination values were comparable with previous years, although fewer were received from oil exploration companies.

Studies of the Geomagnetic Field

An analysis of recurrent patterns of solar phenomena and their observed interactions with the geomagnetic field was completed and forms the basis of an improved technique for medium-term forecasting of magnetic activity at latitudes above 55°N. A related study has reduced the subjective judgement factor in geomagnetic forecasting through a linear prediction filtering technique using ground magnetic data from Canadian observatories.

Both techniques have been incorporated in the preparations and issuing of three-week, three-zone (polar cap, auroral, subauroral) forecasts of magnetic activity to 230 subscribing agencies and institutions. The automated, 72-hour telephone forecasts (992-1299) are consulted 20-30 times/week, and 6 Alert messages on very large magnetic disturbances of potential consequences to electric utility agencies were issued during the year.

Geomagnetic Studies of Earth Structure

Instrumentation was maintained and prepared for four field operations carried out by PGC and LCSD and for laboratory paleomagnetic measurements. Good progress was made on design and fabrication of a prototype magnetotelluric data logger in support of future surveys by PGC and LCSD.

Special Talks and Lectures

R.L. Coles

"Canadian Geomagnetic Programs", presented at Space Environment Services Center, NOAA, Boulder, CO., December, 1986

"The Geomagnetic Field Monitoring Program in the GSC", GSC Current Activities Forum, Ottawa, January, 1987

J. Hruska

"Canadian Geomagnetic Programs", presented at Space Environment Services Center, NOAA, Boulder, CO., December, 1986

G.V. Haines

"Modelling the geomagnetic field by the method of

spherical cap harmonic analysis", International Symposium on Space-Time Structure of the Geomagnetic Field, Wittenberg, GDR, September, 1986

Membership on Committees

R.L. Coles

NRC Associate Committee on Space Research
Canadian National Committee for IUGG

Program Committee for International Workshop on Magnetic Observatory Instruments, Ottawa, August, 1986

Local Organizing Committee, International Workshop on Magnetic Observatory Instruments, Chairman

INSTRUMENTATION SECTION (D.F. Trigg)

The Instrumentation Section, located at the Anderson Rd. Geomagnetic Laboratory, provides maintenance and development support primarily for the observatories and field surveys activities of the Seismology and Geomagnetism programs of the Division, and for the Lithospheric Geophysics Section of the Lithosphere and Canadian Shield Division. In addition, considerable developmental work is undertaken for the west coast seismic monitoring networks operated from the Pacific Geoscience Centre, and for marine geophysics carried out at that institute. Support is also provided, where needed, for paleomagnetism studies carried out by LCSD at the Anderson Rd. laboratory.

Seismic Networks

Despite heavy snow and icing in eastern Canada, operations of the Eastern Canada Telemetry Network (ECTN), the Charlevoix array and the Sudbury Local Telemetered Network (SLTN) were maintained, and provided digital seismic data telemetered to Ottawa with greater than 90% data recovery. SLTN was expanded to three stations as part of a Canada-Ontario-Industry program for enhanced study of rockbursts in mines in the Sudbury Basin. Development of the new, portable seismograph arrays was completed for installation at Charlevoix and PGC.

A number of hardware developments were incorporated in the seismic data laboratories in Ottawa and PGC in the continuing plan for upgrading and standardizing data acquisition, transmission, storage and manipulation, and economy of computerized operations.

The Section is responsible for the operation of the Yellowknife seismograph array facilities, and much of the work in upgrading these facilities in preparation for Canada's participation in verification studies connected with a comprehensive nuclear test ban was initiated during 1986-87. (See Division Highlight Summary)

Seismic Field Instrumentation

Fifty-five lunch box seismic recorders, developed in the instrumentation laboratory and commercially produced following a technology transfer agreement, were deployed in a seismic reflection survey in the Mackenzie Delta by LCSD and ISPG. Agreement was reached on a similar technology transfer to industry for production of the model 501 master digital clock,

a portable, convenient, extremely stable, inexpensive clock developed in the instrumentation laboratory, and successfully employed in seismic field studies.

Division staff paid a return visit to Colombia to participate with CIDA in assisting the Colombian Government in establishing two volcano seismic monitoring networks. The project has reached the stage where a contract has been let to establish specifications for the instrumentation, and a program to train scientific and technical personnel in Canada will begin in the near future.

Geomagnetic Studies of Earth Structure

Excellent progress was made on the design and fabrication of a prototype magneto-telluric data logger in support of MT surveys by PGC and LCSO. Designing and building of an entirely new ocean bottom magnetometer (OBM), similarly in support of marine geophysics surveys by these Divisions, was begun.

Membership on Committees

K.I. Beverley

Federation of Digital Broad Band Seismometer Networks,
Specification of Broad Band Systems Working Group

GRAVITY AND GEODYNAMICS SUBDIVISION

R.A. Gibb

GRAVITY SECTION (R.A. Gibb)

The national gravity mapping program provides gravity coverage of the Canadian landmass and continental shelves for both regional and detailed geophysical investigations. Approximately 85% of the landmass and 75% of the offshore have been covered by gravity measurements at a grid interval of 15 kilometres or better. Data are maintained in a national gravity database containing 600,000 gravity observations and are available on magnetic tape or as line-contoured or solid-colour maps at various scales. Fields of research include gravity instrumentation and systems development; absolute gravity measurements for crustal stability studies and maintenance of the Canadian gravity standardization net; gravity field modelling; data representation for thematic gravity maps; interpretation of broad scale gravity features in terms of crustal/lithospheric structure and evolution; impact processes and crustal genesis; Arctic investigations.

Gravity Mapping

The S56 recording gravity meter was deployed on the Canada Ice Island and operated throughout the 1986 season with full data recovery. Difficulties in merging navigation and bathymetry with the gravity data are being resolved. The meter was reinstalled on the ice island in March, 1987, with improved data logging capabilities for the 1987 season.

All gravity mapping projects were completed as scheduled. Results of the ice-based survey over the Gulf of Boothia were compiled and released in open file maps. A contracted survey (825 stations) in northwestern Yukon, experienced some positioning

problems due to the mountainous relief where sighting of critical satellite constellations was obstructed from valley stations. The open file compilation and maps of the regional (5 km) gravity mapping of P.E.I. released in March, 1987, reveal a flat field with a maximum 20 mGal relief in the Bouguer anomaly.

While the underwater gravity surveys of Trinity and Bonavista Bays, Newfoundland, were completed successfully, merging of additional data for the region provided by Memorial University will delay release of the open file compilation. Division personnel assisted LCSO and AGC in a survey of the Artillery Lake, NWT, area and in a sea surface survey of the Sept-Iles region, respectively.

Evaluation of the potential for testing an airborne gravity system progressed slowly due to the departure of the principal scientist. It is apparent, however, that current capabilities for providing continuous positioning for fixed-wing and helicopter surveys, particularly in the vertical component, are not adequate for the precision required for the gravity data, but may be sufficient for dirigible surveys.

Gravity Standards and Database

Compilation of the 1:5M DNAG Gravity Map of the East Coast, in collaboration with AGC, has been completed and colour screens prepared for the final printing in 1987. Marginal notes and references, and revision of the contour colour scheme, were completed as part of the Canadian commitment in the compilation of the 1:10M DNAG Gravity Map of North America, to be published in 1987.

Database operations proceeded smoothly. Requests for standard retrievals can still be met within 10 working days, despite a 15% increase in demands. A total of 472 colour, standard Applicon plots were prepared to user specifications. The scope of production of thematic maps has been significantly enhanced through the development of a system using software applicable to a combination of computers, plotters and graphics terminals. Twenty-six maps covering areas of the east and west coasts and the prairies were edited in the 1:1M Gravity Map Series for publication in 1987. The gravity reference calibration standards were maintained. Defects in the standard gravity network on the east coast of Hudson Bay were repaired through field measurements, and four LCR land gravity meters were calibrated over the Calgary-Inuvik line.

Gravity Studies of Earth Structure

Compilation of the horizontal gradient map of Bouguer anomalies over North America (cover of EOS, July 8), which delineates lateral discontinuities in upper crustal density and/or thickness associated with suturing and rifting, has provided a means for detecting and delimiting major structural boundaries that may be poorly exposed or completely buried.

Studies of the relationship between gravity, topography and elastic lithosphere thickness over North America, carried out in collaboration with Brown University, culminated in the award for the best student paper in tectonophysics at the 1986 Spring Meeting of the American Geophysical Union.

Advances in gravitational field modelling, analysis and interpretation have been achieved through application of fast Fourier transforms and development of a 3-dimensional interpretation program for personal computers. The former technique will prove valuable in completing the gravimetric geoid map of Canada.

Data from several Arctic projects (most recently, CESAR, in 1983) have been used in the compilation of maps and scientific papers dealing with the physiography, bathymetry, structure, density and gravity of the Arctic Ocean and its submarine features, which will appear in a number of compendium volumes devoted to Arctic studies.

In collaboration with scientists at AGC, petrographic and structural studies of the Montagnais structure, submerged on the Scotian Shelf, confirm an impact origin. Future research on this, the first submarine impact structure recognized, could resolve controversy concerning the nature of oceanic impacts, iridium anomalies in the sedimentary record associated with mass extinctions, and the seismic potential of major impacts.

Through a contracted study with the University of Saskatchewan, seismic reflection data from the Houghton impact structure reveal the nature and extent of faulting that provide clues to interpretation of structural elements that are obscured by a blanket of allochthonous breccias.

Analysis of microscopic planar dislocations in quartz at the Vredefort impact structure, South Africa, supports a single shock event followed by one or more episodes of thermal metamorphism, in contradiction to a published study that promoted multiple endogenic shock events. A related study has established a quantitative scheme to distinguish shock-produced planar dislocations from those resulting from other dynamic processes, from which evidence for a major impact associated with the K/T boundary is strengthened.

A world map and compilation of the currently recognized 120 terrestrial impact structures was prepared for the International Union of Geological Sciences and has been published in its journal, *Episodes*.

Geophysics Division Contribution to Geophysical Activity of Nuclear Fuel Waste Management Program

The level of geophysical activity in the form of airborne, surface and downhole surveys has diminished significantly at the WNRE, Atikokan and East Bull Lake research areas, with a consequent reduction in the need for management and coordination of such activities. Management and development of the related database has continued with regular updating of digital data files and the document library. Preparation of a proceedings volume from the Symposium on Geoscience Aspects of NFWMP organized for the 1986 GAC/MAC/CGU meeting, is in progress for publication in the Canadian Journal of Earth Sciences. Two out of three Level 2 documents, summarizing geophysical activities over a period of ten years at three research areas, have been completed in draft form for the Concept Assessment stage of the Canadian Nuclear Fuel Waste Management Program.

Special Talks and Lectures

R.A. Gibb

"Gravity Program at GSC", GSC Current Activities Forum, Ottawa, January, 1987

R.A.F. Grieve

"Large Scale Impacts and The Terrestrial Biosphere", Science Colloquium, NASA Goddard Space Flight Center, Washington, May, 1986.

Membership on Committees

R.A. Gibb

Canadian National Committee for International Union of Geodesy and Geophysics, ex-officio
Canadian Geophysical Bulletin, Editor
International Commission on the Lithosphere, Working Group 3 of the International Lithosphere Project
EMR Departmental Management Committee for Canadian Nuclear Fuel Waste Management Program

R.A.F. Grieve

University Space Research Association - Lunar Science Council
NASA - Organizing Committee 17th Lunar and Planetary Science Council
NASA - Microgravity Science Committee, Impact Cratering Working Group
NASA - Lunar Handbook Committee
IUGS/NASA - Planetary Meetings Committee
IUGS - Commission on Comparative Planetology, Secretary
ICSU - Coordinating Committee on Moon and Planets
American Society of Petroleum Geologists - Astrogeology Committee
Meteoritical Society - Barringer Committee
GLIMPCE - Potential Field Committee
IUGG - Organizing Committee - Sputnik Commemorative Symposium
Geoscience Council of Canada - Committee on International Geoscience Relations

R.K. McConnell

International Gravimetric Commission, Working Groups 3 and 7
Pan-American Institute of Geography and History
Gravity Anomaly Map of North America Committee, DNAG Project, Geological Society of America

GEODYNAMICS SECTION (J. Popelar)

The Geodynamics Program provides data and carries out research on whole-earth dynamics and on the long-term deformation of the Canadian landmass. Regular measurements of position and gravity at a number of Canadian sites are carried out in conjunction with more frequent measurements of the Earth's orientation in space. Analysis of these data will lead to an understanding of stress build-up in seismic areas, vertical crustal movements, and variations in the Earth's rotation linked to the dynamics of the atmosphere, the oceans and the 'solid' earth.

Earth rotation is monitored by satellite Doppler and photographic zenith tube (PZT) observations at Ottawa and Calgary. Radio astronomical observations using very long baseline interferometry (VLBI) between Algonquin Park and Penticton observatories will

supersede the classical techniques in the near future. Contemporary plate tectonics are studied under the NASA Crustal Dynamics Project and in cooperation with the Geodetic Survey of Canada through regular VLBI measurements at four Canadian stations. Vertical crustal movements are monitored by high-precision gravity measurements, spirit levelling and global positioning system (GPS) observations. Earthquake processes are studied by regular observations of crustal deformation and gravity change in the seismically active regions of coastal British Columbia and Charlevoix, Quebec in cooperation with the Geodetic Survey.

Generation, Management and Analysis of Global Geodynamic Data

Operation of the satellite Doppler stations at Shirleys Bay, Ont. and Priddis, Alta., that monitor the earth's rotation through satellite orbital tracking, was maintained with 90% data recovery from both observatories. Upgrading of the dual-tracking facility to monitor ten satellites on their four daily passes has increased data availability by 10%. Implementation of a new refraction channel processing system at Shirleys Bay provides increased flexibility in data handling.

The Photographic Zenith Tube (PZT) operations at the two observatories similarly functioned with no major problems, with photoplate records obtained for the cloudless nights (55-59%). Data transmissions were contributed weekly to the International Time (BIH, France) and Polar Motion (IPMS, Japan) services.

Details of the Canadian monitoring program, including operation of the TRANET II satellite tracking operations and a comparison of Global Positioning System (GPS) and Doppler navigation were presented at the Fourth International Geodetic Symposium on Satellite Positioning.

Several potential applications of GPS in geodesy and geodynamics have been examined. It was confirmed through experiment that GPS alone cannot remove the non-inertial acceleration component of vertical acceleration, essential for airborne gravity measurement techniques. Also, it was demonstrated that it is difficult to obtain a relative accuracy of less than one part per million over distances under 50 km, due mainly to the effect of troposphere refraction, so that it is unsuited for relative positioning in short baseline dynamics experiments. Several improvements were achieved in GPS related software, including the pre-processing of data to permit detection of cycle-slipping in GPS phase measurement employing a single receiver.

Satellite positioning for the Ice Island Research Station was carried out through March to October, 1986, and reinstated in March, 1987, for the new field season. The lack of dedicated computer facilities on site reduced the effectiveness of the real-time positioning aspect, leading to delays in analysis of data from all geophysical activities, an aspect that should be remedied for the 1987 season.

Dynamics of the Earth's Crust

Continuous tilt and strain monitoring carried out

since 1976 at the Charlevoix Observatory, Quebec was concluded as planned, and the observatory site operation reduced to a minimum. The study of tidal and coseismic response of water wells near the Observatory revealed a drop in water levels of up to 6 cm in response to the larger local earthquakes. The earth tide response was found not to be characteristic of a homogeneous, isotropic medium, and that the major NE-trending faults of the Charlevoix region may attenuate stresses normal to their strike.

Section personnel aided in the successful coordination of the NASA Crustal Dynamics Project at Whitehorse, and in the horizontal levelling and gravity surveys carried out on Vancouver Island and Charlevoix using GPS receivers from the section. Analysis of the Vancouver Island survey data is nearing completion.

Calculation of the glacio-isostatic adjustment of Fennoscandia using a 3-layer, half-space model of the earth and knowledge of the deglaciation history of the region, indicates an upper limit of 80 km for the thickness of the Fennoscandian (elastic plate) lithosphere.

Special Talks and Lectures

J. Kouba

Seven lectures, five at the Research Institute of Surveying and Mapping, Beijing, two at the Wuhan Technical University of Surveying and Mapping, Wuhan, on all aspects of the Canadian Geodynamics program, November, 1986.

Membership on Committees

J. Popelar

International Astronomical Union Commissions 19 and 31
CNO/CCIR Study Group 7

A. Lambert

Canadian Committee on the Dynamics and Evolution of Lithosphere (CANDEL)
International Association of Geodesy, Special Study Groups 3.37 and 3.85

J. Kouba

IUGG/IA/COSPAR Commission VIII (International Coordination of Space Techniques for Geodesy and Geophysics), national representative
International Association of Geodesy, Special Study Groups 1.76, 2.82, 2.84 and 4.93

AEROMAGNETICS SUBDIVISION

P.J. Hood

The aeromagnetic mapping program provides aeromagnetic coverage of the Canadian landmass and continental shelves for both regional and detailed geological investigations. Approximately 80% of the landmass and 20% of the offshore have been surveyed at a normal line spacing of 0.8 kilometres for regional surveys and 0.3 kilometres for detailed surveys. A contract survey program currently operated under federal-provincial agreements provides detailed total field and gradiometer surveys to aid mineral exploration. Data are maintained in a national aeromagnetic database containing 10,000,000 kilometres of flight line data and are available on magnetic tape

or as line-contoured or solid-colour maps at various scales. Fields of research include aeromagnetic instrumentation and systems development; data representation for thematic magnetic maps; magnetic interpretation methods; interpretation of magnetic features in terms of crustal/lithospheric structure and evolution.

Experimental Airborne Operations

A record 55,017 line kilometres were flown by the Queenair aircraft in total field surveys conducted over Lake St. Clair and Lake Huron (including the U.S. portion) and the Camp Borden and Waterloo areas of Ontario.

Testing of the Internav Loran-C navigation system in the Convair 580 research aircraft proved it unsuitable, whereas a successful test was carried out of a combined ARNAV Loran, GNS-500A navigation system, and a GPS antenna borrowed from Geodynamics Section. On board data acquisition and display systems have been improved through installation of a Matrox video system and rewritten software.

Towards compilation of the Magnetic Map of North America, retrieval and reformatting of ocean magnetic data has been completed for the 1979-86 Convair Surveys, and for approximately 15% of the 1964-76 North Star operations. Whereas flying of control lines for this map was carried out in the Caribbean Sea and Gulf of Mexico, similar operations in the Arctic were delayed because of lengthy aircraft maintenance.

The continuing upgrading of data acquisition and treatment capabilities suitable for small aircraft is virtually complete, with the successful laboratory development and flight testing in the Queenair of a compact system lighter by 25kg than that previously employed. The successful use of a modified Loran-C navigation system over Lake Huron will prove valuable for positioning in the future surveys over the other Great Lakes and large enclosed bodies of water.

Geophysical Data Processing

Excellent progress was made in the compilation of total field magnetic data from Queenair surveys over eleven areas flown in 1986 and previous years, culminating in the open file release of 8 maps over Lake Erie, Lake Simcoe and Georgian Bay; 33 maps covering Lake Ontario, Lake of the Woods and Alberni are contracted for publication early in 1987-88.

Contract/Regional Aeromagnetic Surveys

The first maps from helicopter flown total field/vertical gradiometer surveys have been issued, and demonstrate the efficacy of this survey technique over rugged terrains. The 34 maps, covering the Monts Chic-Choc-Murdochville, Gaspé areas were produced through the Canada/Gaspé Lower St. Lawrence Economic Development Plan.

Gradiometer/VLF EM contracted surveys continued under Mineral Development Programs in the provinces of Newfoundland, Nova Scotia, New Brunswick, Ontario, Manitoba, Saskatchewan and British Columbia. Four contracts were awarded for 72,950 line km in Man., NB, NS and Nfld., and flying was completed in all but part of the Nova Scotia survey. A total of 154 total field contour and vertical gradient contour maps were issued from earlier surveys in Gaspé, New Brunswick, Nova Scotia and Newfoundland.

Regional surveys on the west coast are virtually complete. A total of 136 maps at 1:25,000 and 1:250,000 scales are being printed from surveys flown in 1985 over regions of the northern Yukon/Beaufort Sea and the Juan de Fuca Strait/Queen Charlotte Islands. Compilation has begun on 37,678 line km of data acquired in 1986 over parts of Vancouver Island and the coast of British Columbia.

Special Talks and Lectures

P.J. Hood and D.J. Teskey

"Helicopter-borne aeromagnetic gradiometer surveys: a progress report", 56th Annual Meeting, SEG, Houston, November 1986

"Aeromagnetic survey program of Canada, mineral applications and vertical gradiometry", USGS Workshop on Aeromagnetic Surveying, Denver, January 1987

Membership on Committees

P.J. Hood

Magnetic Anomaly Map of North America Committee, DNAG Project, Geological Society of America, Co-chairman

Working Group I-4 (Magnetic Anomalies - Land and Sea), Division 1, International Association of Geomagnetism and Aeronomy, Chairman

D.J. Teskey

Magnetic Anomaly Map of North American Committee, DNAG Project, Geological Society of America and Co-chairman of its Magnetic Data Exchange Format Subcommittee

W.W. Nassichuk

ISPG is responsible for establishing a sound geoscience base for the sedimentary basins of western and Arctic Canada, which occupy one-third the area of the country and contain most of Canada's oil, natural gas, and coal resources. In addition, units of the Division are responsible for the appraisal of the oil, gas and coal resource potential of the country.

The geological framework is being broadly outlined by current mapping and topical studies. These studies, together with paleontological investigations, support exploration for, and assessment of the non-renewable resources of western and northern Canada. Emphasis on energy resources has resulted in development of evaluation programs in both petroleum and coal, each supported by multidisciplinary basin studies. The geological evaluations contribute to the national inventories of oil, gas and coal resources.

The Institute is organized into six subdivisions: Regional Geology, Paleontology, Coal Geology, Petroleum Geology, Geological Publications and Administration, each comprising several sections. A seventh major administrative unit, the Petroleum Resource Appraisal Secretariat also has a number of subordinate sections.

Regional Geology is responsible for preparing geological maps and lithostratigraphic and sedimentological reports for the principal sedimentary basins of Western Canada, Northern Mainland, Arctic Islands and adjacent offshore areas. Paleontology ensures precise and consistent biostratigraphic correlation, by refinement, through detailed taxonomic and stratigraphic studies, of the biochronologic scale which serves as the basis for biostratigraphic correlation. The Coal Geology Subdivision is responsible for providing the estimates of Canada's coal resources, for development of the National Coal File by accumulation of data, and for the development of regional models of coal occurrence. The Petroleum Geology Subdivision objectives are to identify the oil and gas resource base of Canada and to determine the origin, probable distribution and potential abundance of oil and gas resources. The Geological Publication Subdivision is concerned with processing, publication and dissemination of information on Canada's sedimentary basins and resources. Activities in the four scientific subdivisions at ISPG, that is the Regional Geology, Paleontology, Coal Geology and Petroleum Geology in concert with the Petroleum Resource Appraisal Secretariat reflect the four Strategic Objectives of ISPG as follows:

1. To map, describe and explain the bedrock geology of sedimentary basins in western and northern Canada.
2. To develop and modify biochronologic standards essential to correlation and comprehension of bedrock geology in the sedimentary basins of western and northern Canada.
3. To assess the probable distribution and potential abundance of the oil and gas resources of Canada.
4. To investigate the geology of coal deposits in western and northern Canada; to determine extent, quality and quantity of selected coal deposits; to develop a National Coal Data File as an integral part of the National Coal Inventory.

The Administration Office provides financial services, central registry, stationery and supplies, and office services. A world class geological library, available to the public is under the jurisdiction of the Administration Subdivision. ISPG maintains and administers its building owned by the Department of Energy, Mines and Resources, and as a result building and engineering services are an important component within Administration.

The present establishment of the Institute is 168 person years including 82 scientific and professional positions, 8 operational, 41 technical, 4 administrative and foreign service, and 33 administrative support positions.

A repository is maintained for samples, core and other data resulting from both onshore and offshore exploration drilling by industry in the Yukon Territory, the Northwest Territories, including the Arctic Islands and for samples from all provinces and continental shelves of western Canada. Most of the material is available to the public for free examination and is used by the ISPG in research activities.

Attendance at Meetings Conferences and Courses

W.W. Nassichuk

Meeting with British Columbia Ministry of Energy, Mines and Petroleum Resources, Victoria, April 2-4, 1986.

Branch Management Committee Meeting, Ottawa, May 14-16, 1986.

Frontier Geoscience Program Meeting, Ottawa, May 21-22, 1986.

Meeting of Departmental Administrative Reform of Staffing Steering Committee, June 2-4, 1986.

Meeting before a Parliamentary Committee on Oil and Gas reserves, Ottawa, June 16-18, 1986.

Branch Management Committee Meeting, Ottawa, July 23-25, 1986.

Sector Information Seminar of Managers, Ottawa, October 7-10, 1986.

Meetings with Alberta Research Council and Alberta Geological Survey, Edmonton, January 9, 1987.

Branch Management Committee Meeting, Ottawa, January 13-16, 1987.

Canadian Reef Research Symposium, Banff, January 29-30, 1987.

Meeting with C.F. Minerals, Kelowna, March 21-22, 1987.

Branch Management Committee Meeting, Ottawa, March 17-20, 1986.

J.E. Brindle

Management Orientation Program for Senior Managers, Touraine, May 11-30, 1986.

Special Talks and Lectures

W.W. Nassichuk

The Geological Survey of Canada in Canada's coal geoscience community: Coal Geoscience Forum, November 17-19, 1986, Calgary.

Membership on Committees

W.W. Nassichuk

Vice-Chairman (Past) and Newsletter Editor, Subcommission on Permian Stratigraphy, International Union of Geological Sciences.

Corresponding Member, Subcommission on Carboniferous Stratigraphy, International Union of Geological Scientists.

Member, North American Working Group on Middle Pennsylvanian of North America (Subcommission on Carboniferous Stratigraphy).

Co-Chairman, Working Group on Permian Stratigraphy and Boreal Relations (Subcommission on Permian Stratigraphy).

J.E. Brindle

Co-Chairman, ISPG Joint Occupational Safety and Health Committee.

Member, ISPG Ad Hoc Committee on Space Allocation.

Member, Computer Service Committee.

Member, University Research Park Committee.

ADMINISTRATIVE SUBDIVISION

K.M. Cameron

The objectives of the Administrative Subdivision are directed toward providing efficient and timely administrative, financial, library, logistical, instrument development, electronics and building maintenance services to the Division.

During the fiscal year 1986/87, the Subdivision was manned by a full-time continuing staff of 21. During that fiscal year, the following staff changes occurred:

Transfers

Mrs. S.E.A. Dorward, an ST-SCY-2, was transferred from the Royal Canadian Mounted Police to join the Administrative staff on August 6, 1986.

Resignations

Mr. M. Novati, an STS-3, resigned on June 28, 1986 to enlist in the Canadian Forces.

Mr. C.R. Jermy, an EG-ESS-10, resigned on January 30, 1987 due to ill health.

Appointments

Mr. D. McInroy was appointed to the ISPG Stores staff as an STS-3 on September 8, 1986.

Attendances at Meetings Conferences and Courses

K.M. Cameron

Branch Administrative Officers' Committee Meeting, Ottawa, May 7-8, 1986.

Branch Administrative Officers' Committee Meeting, Dartmouth, October 16-17, 1986.

M. Kowalsky

Employee Benefit Benefit Course, Edmonton, Alberta, November 24 to December 3, 1986.

Dental Plan Payment Schedule Seminar, Edmonton, Alberta, February 6, 1987.

ISPG LIBRARY

In July we welcomed the return of Fontaine Hwang, Library Technician, from her maternity leave and bade farewell to Gail Kessler, her term replacement. The vacancy of Head Librarian remained unfilled. Some relief was available from temporary clerks.

There was no new activity of library automation with MINISIS. Progress was made, however, in debugging the system. Computer Services created a simple routine maintenance program to reindex the corporate author and call number fields to make them searchable. A Hewlett-Packard 150 microcomputer and a printer were acquired and were used in searching the library catalogue and text editing of the monthly accessions list.

Literature search capability was strengthened with the GEOSCAN training that Edward Hau, Assistant Librarian, received during his one-week visit to the Geological Survey of Canada library in Ottawa. With the assistance of summer

students and the maintenance staff, the circulation and reference areas were rearranged to create a more spacious environment to provide these services.

Our rare book collection received oiling of the leather bindings in February to prolong their lifespan. Rebinding was performed on two titles published in the 19th century – Systeine Silurien du Centre de la Boheme by Joachim Barrande (8-volume set in 29 bound volumes) and Transactions of the Geological Society (6 volumes).

This year, the library began keeping statistics on periodical issues received in order to provide an estimation of the growth of this collection.

Attendance at Meetings Conferences and Courses

E. Hau

Canadian Association for Information Science Annual Meeting, Vancouver, June 25-28, 1986.

In-house orientation/training (Geological Survey of Canada Library), Ottawa, August 18-22, 1986.

F. Hwang

CAN/OLE system update seminar, Calgary, October 6, 1986.

Career Advancement for Women Workshop, Calgary, March 19-20, 1987.

S. Webber

Career Advancement for Women Workshop, Calgary, March 16-17, 1987.

Library Statistics 1986/87

Acquisitions

Books, etc., acquired by purchase	529
Books, etc., acquired by gift or exchange	937
Maps added	357
Periodical issues added	2836

Circulation

Books and periodicals (to staff only)	7855
Inter-library loans:	
Borrowed	250
Loans and photocopies provided	269

Reference

Phone queries handled	900
On-line searches	37

REGIONAL GEOLOGY SUBDIVISION

D.G. Cook

The objectives of the Regional Geology Subdivision are directed toward the increased understanding of the depositional and deformational history of Proterozoic and Phanerozoic sedimentary rocks of Western and Arctic Canada. The investigations provide the data base essential for the appraisal of the economic potential of these sedimentary suites, both as reservoirs for, and sources of, oil and gas; and as host rocks for other economic deposits including coal, potash, lead, zinc, copper, precious metals and industrial minerals, and for the exploration and exploitation of these resources. Programs integrate field structural stratigraphic and sedimentologic studies, subsurface studies, analysis of industry-derived seismic data, and the acquisition and analysis of refraction seismic and deep reflection seismic data. Regional Geology's programs are co-ordinated with those of Paleontology, Petroleum Geology and Coal Geology Subdivisions.

The Regional Geology Subdivision is organized geographically, partly in response to similar geological problems and partly because of similar logistical problems. It comprises three sections. The Arctic Islands Section is responsible for the sedimentary areas of the Arctic Islands with geological investigations being concerned mainly with Proterozoic and Phanerozoic rocks of the Franklinian Geosyncline, Stable Platform, and Sverdrup Basin. Most of the Arctic Islands activities are funded through the Frontier Geoscience Program. Projects include surface and subsurface structural, stratigraphic and sedimentologic studies, and reflection and refraction seismic studies on the continental shelf, carried out from an ice island research station. The ice island projects are being carried out in co-operation with Terrain Sciences Division, Geophysics Division and Atlantic Geoscience Centre. The Northern Mainland section is concerned with sedimentary regions of the Yukon and Mainland Northwest Territories, including the Mackenzie Delta and Beaufort Sea. Most activities are funded under the Frontier Geoscience Program. Surface and subsurface structural, stratigraphic and sedimentologic studies are integrated with the study of deep structural geometry of sedimentary basins by the application of reflection and refraction seismic techniques. The Southern Mainland Section is responsible for sedimentary rocks of the Western Canada Sedimentary Basin lying within the prairie provinces and eastern British Columbia, the main focus of oil and gas exploration and exploitation. The Southern Mainland falls outside the Frontier Geoscience Program, and activities are essentially confined to surface and subsurface structural, stratigraphic and sedimentologic studies.

The Institute is the repository for cutting and core samples, and other data resulting from both onshore and offshore exploration drilling by industry in Yukon Territory, Northwest Territories (including the Arctic Islands), East Coast offshore, and for samples from all provinces of Western Canada. Some 12.5 million samples and 28 thousand boxes of core are stored at the Institute; the number of samples increases by about 400 thousand each year. With the exception of samples from wells in Alberta, all are available to the public for free examination. Alberta samples are provided to the public by the Alberta Government, for a

small fee. Files are maintained of all the logs and other data related to more than 70 thousand wells drilled in Western and Arctic Canada. The facility, including the core storage, sample storage, sample examinations, core examinations, log storage and administration areas, covers an area of 4866 square metres. The addition of a third person on term employment has permitted the provision of improved service to the public including remaining open over noon-hour, and giving a full library withdrawal and refiling service with respect to the well log library.

Arctic Islands

From the Ice Island research station a seismic refraction program was successfully completed on the Arctic Continental Shelf north of Axel Heiberg Island and Sverdrup Channel. Two lines parallel to the coast and two perpendicular lines were completed, thus extending the refraction grid for the shelf to the southwest. Interpretation of the 1985 data has revealed that up to 12 km of sedimentary strata occur under the outer shelf.

Seismic reflection data obtained in 1985 have been processed and a prominent reflector at 1.5 seconds (about 4 km depth) has been identified on the records. Recorded velocities (>5 km/sec) and scarcity of reflectors indicate that highly deformed, Lower Paleozoic strata occur near the sea floor on the inner shelf north of Axel Heiberg Island. The ice island moved very little during 1986; consequently the records obtained cover less of the continental shelf than expected.

A report on the subsurface upper Paleozoic geology of Sabine Peninsula, Melville Island by contractor G. Varney is nearing completion. Five time-structure and four isochron maps have been prepared utilizing the available seismic data. Major faults have been mapped and various episodes of faulting have been documented.

Contractors at the University of Alberta are reprocessing deep seismic reflection data from eastern Melville Island. Initial results are very encouraging with reflectors within the Proterozoic succession being distinguishable. A major angular unconformity has been recognized at the base of the Phanerozoic succession.

Extremely bad weather on northern Devon Island precluded completion of mapping of Grinnell Peninsula as planned. Nonetheless, substantial progress was made, utilizing the small number of good or moderate weather days available. The stratigraphic sequence present on southwestern Ellesmere and North Kent islands extends without major changes onto northern Devon Island at least as far as Arthur Fiord. Ellesmerian structures modified by late extension were traced from the Douro Range southeast as far as Viks Fiord. Similar compression and extension affected parts of Colin Archer Peninsula.

The original Rens Fiord Complex of northern Axel Heiberg Island has been divided into four mappable units with a probable age range from Late Hadrynian to Early Silurian.

The Svartevaeg Formation of northern Axel Heiberg Island, previously assumed to be Devonian in age, now is interpreted as a thrust slice of Silurian rocks. This implies that there are no known deep-water sediments and arc-type

rocks left in the (rather incomplete) Devonian record of northern Axel Heiberg and Ellesmere islands, the exposed strata consisting entirely of syntectonic clastic sediments of nonmarine and deltaic origin.

A hitherto unknown basaltic unit has been discovered in the basal Carboniferous succession of northern Axel Heiberg Island.

Steeply inclined to subhorizontal thrust faults in northern Axel Heiberg Island, directed both to the northeast and to the southwest, are attributed to orogenic events of Late Silurian - Early Devonian and post-Early Devonian pre-Visean ages.

Silurian flysch of northernmost Ellesmere Island is comparable to flysch in northeasternmost Greenland rather than to correlative flysch farther south in Ellesmere Island. This adds to mounting evidence that the Silurian (and older) rocks of northern Ellesmere Island have been affected by extensive sinistral strike slip.

Analysis of Devonian stratigraphic sections from Melville Island confirms that lower units of the Devonian clastic wedge are time-transgressive, becoming younger to the west.

Detailed description and study of Jurassic rocks of Melville Island have revealed that these strata were deposited during regressive and transgressive events coinciding with similar world-wide events.

Extrusive volcanic strata, which unconformably overlie Carboniferous carbonates on northwestern Ellesmere Island, have been dated as mid-Late Cretaceous on the basis of palynology of interbedded shales. These are the youngest volcanics of the Sverdrup Basin and appear to be an extension of the Alpha Ridge, a major oceanic, volcanic edifice which extends north from Ellesmere Island.

A regional unconformity of mid-Jurassic age has been identified in the Sverdrup Basin and it correlates with a widespread episode of tectonic activity previously recognized in Svalbard, Barents Sea, and North Sea.

Basin wide studies of Mesozoic sequences in the Sverdrup Basin indicate a primary structural control on their origin rather than a eustatic sea level change origin.

Northern Mainland

A Frontier Geoscience Program deep reflection seismic line across the Mackenzie Delta has been processed and interpreted. The Early Cretaceous extensional faults are listric and flatten northward into a decollement zone near 8 seconds. The sub-Paleozoic angular unconformity is visible in two places along the profile on the flanks of the Campbell Uplift. Beneath the uplift, south-dipping thrust faults offset seismic markers by several kilometres, while north-dipping reflections may be major crustal-scale shear zones. Crystalline basement is visible below 6 seconds under Campbell Uplift, but appears to thin northward. Base of the crust under the uplift is at 11-12 seconds but is invisible farther north. Three manuscripts are in preparation: two summaries for submission to Geology, and an Open File report which will contain the processed data in addition to an interpretation.

Under contracts to the University of Calgary, Dr. F. Cook is preparing a deep reflection seismic program across the Beaufort Continental shelf, to be run during the summer of 1987, provided a suitably equipped ship is available. Under another contract, F. Cook and K. Coflin are examining industry seismic data across the Tuktoyaktuk Peninsula to Banks Island to compare the sub-Mesozoic structures to that observed in the FGP seismic line.

A Mesozoic subcrop map, at 1:250 000 scale, has been compiled. Outcrop distribution of Lower Paleozoic facies, as published, constrains a northeastward shale-out north and south of the Kaltag-Yukon faults. This appears to negate previous interpretations of hundreds of kilometres of strike-slip motion on that system.

As part of the USSR/Canada Arctic Science Exchange Agreement, two Regional Geology Subdivision geologists joined a Soviet Field party on Wrangel Island, Chukchi Sea, U.S.S.R. With two weeks of traversing on the island they had a comprehensive first hand review of the geology. An important initial conclusion is that Wrangel Island geology is remarkably similar to parts of northern Alaska and the Yukon. Wrangel Island and the Doonerak "Window", Brooks Range, Alaska have very similar stratigraphic successions and similar pre-Mesozoic and post-Mesozoic structural and metamorphic histories. Comparisons with the Arctic Islands, however are equivocal and difficult to make. A joint publication comparing and contrasting the geology of Wrangel with other parts of the Polar rim is now in the planning stages.

Field work in the Ogilvie Mountains has resulted in a comprehensive documentation of the complex geometry of the platform-to-basin transition of lower Paleozoic rocks in this region. The position of this platform edge can be extrapolated into the subsurface of the Eagle Plains. Good potential reservoir facies rocks were identified in outcrop along the transition, enhancing the petroleum potential of the plains area.

Quantitative simulation of the development of some early Paleozoic arches in the Mackenzie Mountain region is consistent with the possibility that an uplift of thermal origin affected the Mackenzie Mountain region in Early Devonian time along a northwest trending axis parallel to the early Paleozoic shelf edge.

Data acquisition for the Geological Survey of Canada's Mackenzie Delta-Beaufort Sea-Northern Yukon seismic refraction survey was completed on March 28, 1987. This major crustal refraction project provided a successful field test of the new Lithoprobe refraction instrumentation designed by the Geological Survey of Canada. The survey was based at Inuvik and included personnel from the Institute of Sedimentary and Petroleum Geology, Lithosphere and Canadian Shield Division, Geophysics Division (all GSC), the Geodetic Survey of Canada, and the Universities of British Columbia and Calgary.

Approximately 870 km of reversed seismic profiling, 130 km of unreversed profiling, and 670 km of broadside profiling were completed, comprising twenty-two processed preliminary seismic sections. Analysis and modelling of these sections, which will begin almost immediately, will provide significant new information on the structure and geometry of the regional geological and tectonic elements of the southwestern Canadian Arctic and, in turn, new insights into the origins and evolutionary controls of the Canada Basin, Mackenzie Delta onshore and offshore, and Rapid Depression areas and environs.

Southern Mainland

The late Middle Devonian succession in the southern District of Mackenzie and northern Alberta were compared and some stratigraphic problems related to the sub-Watt Mountain unconformity resolved. The Tathlina Uplift in the District of Mackenzie remained emergent much longer than the northern Alberta part of the Elk Point Embayment.

Brecciation along the southwest margin of the Upper Devonian Ancient Wall reef complex suggests a temporary sea level drop of 40 to 70 m prior to the final 65 m thick phase of reef growth, which is dominated by tabular stromatoporoids.

During preparation of a regional synthesis of the Carboniferous of Western Canada Basin, it was concluded that the western margin of the Cordilleran Miogeocline (Prophet Trough) was an elevated rim. Parts of the rim were exposed during the Early Carboniferous and supplied western Prophet Trough with siliciclastics. The trough resulted from differential down-warping and local block faulting. It was predominantly an extensional element. During the earliest Carboniferous, however, the compressional Ellesmerian event caused subsidence in northern Prophet Trough, while the compressional Antler event probably influenced subsidence in its southern part.

Carbonates of the Upper Devonian Palliser Formation form a preferred zone for thrust faulting in the Front Ranges southwest of Calgary. Locally spectacular duplex structures up to 300 m thick, composed of individual fault bounded slices 20 to 40 m thick, are developed in the lower part of the Palliser. This type of duplex structure may be a surface analogue for some of the structurally thickened occurrences of the Palliser Formation found in the subsurface.

Decade of North American Geology

The volume "Sedimentary Cover of North American Craton: Canada", with the exception of the chapter on Petroleum Geology, was brought to a completion stage for submission to the series co-ordinator. This volume is part of the Geological Survey of Canada series on "The Geology of Canada" and is also part of the series by the Geological Society of America on "The Geology of North America". The volume deals principally with three tectono-stratigraphic provinces and their basins: Interior Platform, Hudson Platform, and St. Lawrence Platform. This volume, the first synthesis of the regions in 20 years, presents a concise though brief summary of the geology, including the mineral and fossil resources. It presents major new interpretations based on modern theories of plate tectonics. The volume will comprise approximately 600 pages and 450 text illustrations.

Nineteen out of 21 chapters of the volume "Inuitian Orogen and Arctic Platform: Canada and Greenland" (Geology of Canada, No. 3) were submitted to the series editor and two external referees. Prepared by some thirty Canadian and European authors, this is the first comprehensive geological and geophysical synthesis that includes both the Canadian Arctic Islands and North Greenland. A unified and partly revised tectonic framework is based on systematic summaries of the geophysical characteristics and stratigraphic and structural record of the region. The account is rounded off by chapters on history of exploration, landscapes and resources (petroleum, coal, metals).

Personnel Notes

Dr. H.H.J. Geldsetzer took an extended (4 month) working vacation and went with his family to Australia, where he studied Devonian reefs in the Canning Basin of Western Australia, and carbonate environments in Southern and Western Australia. He returned in November 1986.

Dr. Q. Goodbody has been a post-doctoral fellow at ISPG since October 1985 in the Arctic Islands Section. His fellowship is terminating in September 1987.

Mr. D.M. Jordan has been working as a term STS-3 in the Core and Sample Repository since July 28, 1986.

Dr. L.S. Lane joined the staff on May 20, 1986 as a structural geologist in the Northern Mainland Section. He came to us from Carleton University, where he was a post-doctoral fellow.

Mr. P. Lewis resigned in March 1987 after working for two years in the Core and Sample Repository. He and his family are moving to Ontario.

Karen McInnis, who is working as a term CR-3 with Elspeth Snow, and who ably filled in for Elspeth while she was seconded to Publications Subdivision, is leaving at the end of March 1987 - the end of her term.

Mr. N.C. Meijer Drees has taken leave for several months to go to the Netherlands and complete his Ph.D. at the University of Utrecht. He is expected to return in July, 1987.

Dr. D.W. Morrow was promoted to RES-3, effective April 1, 1987.

Elspeth Snow once again was seconded to the Publications Subdivision to act as Editorial Assistant for 5 months from October 1986 to March 1987, while the incumbent was on maternity leave.

Dr. H.P. Trettin was presented by the Canadian Society of Petroleum Geologists with the R.J.W. Douglas Medal at the society's Awards Dinner and Dance in February, 1987. This award is presented in recognition of career accomplishments, and for outstanding scientific contributions to the understanding of sedimentary geology in Canada, with emphasis on regional tectonics and petroleum and structural geology.

Attendance at Meetings Conferences and Courses

J.D. Aitken

CSPG Annual Convention "Reserves Canada 21", Calgary, June 1986.

AAPG Annual Convention, Atlanta, Georgia, June 1986.

CSPG - Canadian Reef Research Symposium, Banff, January 1987.

M.P. Cecile

GAC Annual Meeting, Ottawa, May, 1986.

CSPG Annual Convention "Reserves Canada 21", Calgary, June 1986.

CSPG Canadian Reef Research Symposium, Banff, January 1987.

R.L. Christie

Agrogeology in Eastern and Southern Africa, Malawi, Africa, June 1986, International Development Research Centre (Canada) sponsorship.

Arctic Initiatives Task Force Meetings, Yellowknife, October 1986.

D.G. Cook

GAC Annual Meeting, Ottawa, May 1986.

CSPG Annual Convention "Reserves Canada 21", Calgary, June 1986.

GSA Annual Convention, San Antonio, Texas, November 1986.

J. Dixon

CSPG Annual Convention "Reserves Canada 21", Calgary, June 1986.

A.F. Embry

CSPG Annual Convention "Reserves Canada 21", Calgary, June 1986.

GSA Annual Convention, San Antonio, Texas, November 1986.

H.H.J. Geldsetzer

International Association of Sedimentologists Congress, Canberra, Australia, August 1986.

CSPG Canadian Reef Research Symposium, Banff, January 1987.

J.C. Harrison

CSPG Annual Convention "Reserves Canada 21", Calgary, June 1986.

L.S. Lane

CSPG Annual Convention "Reserves Canada 21", Calgary, June 1986.

M.E. McMechan

GAC Annual Meeting, Ottawa, May 1986.

CSPG Annual Convention "Reserves Canada 21",
Calgary, June 1986.

N.C. Meijer Drees

CSPG Core Conference, Calgary, October 1986.

D.W. Morrow

CSPG Annual Convention "Reserves Canada 21",
Calgary, June 1986.

SEPM Annual Mid-Year Meeting, Raleigh, North
Carolina, September 1986.

B.C. Richards

CSPG Annual Convention "Reserves Canada 21",
Calgary, June 1986.

CSPG - Canadian Reef Research Symposium, Banff,
January 1987.

D.F. Stott

Organizational Meeting for the International Geological
Correlation Program Project 245, Nonmarine
Cretaceous Correlations (in conjunction with Annual
Meeting of Geological Society of America), San
Antonio, Texas, November 1986.

Special Talks and Lectures

J.D. Aitken

"Precambrian of Northwestern Canada - Facts, Myths
and Prejudices", CSPG Structural Geology Division,
Calgary, April, 1986.

"Giant Cryptalgal Reefs of the Upper Proterozoic
Little Dal Group, Mackenzie Mountains", CSPG
Canadian Reef Research Symposium, Banff,
January 1987.

M.P. Cecile

"The Niddery Thrust Sheet - A Selwyn Basin Structural
Feature", GAC Annual Meeting, Ottawa, May 1986.

"Geology of Wrangel Island, U.S.S.R., Comparison with
Alaska and Arctic Canada", CSPG Petroleum Geologists
International Division, Calgary, November 1986; GSC
Branch Management, Calgary, September 1986.

"Shoaling Stromatolite Reef Complex, Proterozoic
Goulburn Group, N.W.T." and a poster display "Late
Ordovician and Early Silurian Mounds, Edge of the
Misty Creek Embayment, Mackenzie Mountains,
N.W.T.", CSPG Canadian Reef Research Symposium,
Banff, January 1987.

J. Dixon

"Geology of the Beaufort Sea Continental Margin near
the Canada-USA border" (presented by J.R. Dietrich)
CSPG Annual Convention, Calgary, June 1986.

"Geology and Petroleum Potential of Beaufort Sea",
presented to Unocal geologists, Los Angeles, California,
February 1987 (J.R. Dietrich, D.H. McNeil also
attended).

A.F. Embry

"Petroleum Geology of the Schei Point and Blaa
Mountain Groups (Middle-Upper Triassic) Canadian
Arctic Archipelago", and poster display, CSPG Annual
Convention, Calgary, June 1986.

"Mesozoic Depositional Sequences, Arctic Islands:
Anatomy and Origin", GSA Annual Convention, San
Antonio, Texas, November 1986.

H.H.J. Geldsetzer

"Upper Devonian Reef Development in Alberta",
International Association of Sedimentologists Congress,
Canberra, Australia, August 1986.

"Upper Devonian Reefs in Alberta" and "Frasnian-
Famennian Boundary Beds in Alberta", Petroleum Club,
Perth, Australia, September 1986.

"Upper Devonian Ancient Wall reef complex", poster
display, CSPG Canadian Reef Research Symposium,
Banff, January 1987.

J.C. Harrison

"Devonian to Permian Tectonics on the Southern Margin
of the Sverdrup Basin, Melville Island, Canadian Arctic
Islands", (J.S. Oldow, H.E. Avé Lallemont co-authors),
CSPG Annual Convention, Calgary, June 1986.

U. Mayr

"Pridolian-Gedinnian Downslope Buildups in the Vicinity
of Cardigan Strait, Arctic Canada" (J. Packard, co-
author), poster display, CSPG Canadian Reef Research
Symposium, Banff, January 1987.

M.E. McMechan

"Structure of the Central Rocky Mountain Foothills,
Athabasca to Peace Rivers", University of Calgary,
Department of Geology and Geophysics Graduate
seminar class, Calgary, April 1986.

"Thermal Maturation and Burial History, Rocky
Mountain Foothills and Plains, East-central British
Columbia", GAC Annual Meeting, Ottawa, May 1986.

D.W. Morrow

"Silurian-Devonian Facies and Paleotectonics of
Mackenzie Shelf versus Ogilvie Platform", CSPG
Annual Convention, Calgary, June 1986.

"Chemical Controls on the Precipitation of Dolomite, the Sulfate Enigma", Annual mid-year Meeting of Society of Economic Paleontologists and Mineralogists, Raleigh, North Carolina, September 1986; ISPG McConnell Club, Calgary, November 1986; CSPG Petrology Division, Calgary, March 1987.

B.C. Richards

"Carboniferous of Western Canada Basin", Chevron Lunchbox Lecture Series, Calgary, November 1986.

"The Carboniferous of Western Canada Sedimentary Basin", poster display, CSPG Annual Convention, Calgary, June 1986.

Membership on Committees

J.D. Aitken

Corresponding Member, Precambrian-Cambrian Boundary Working Group, International Union of Geological Sciences.

Co-editor, "Sedimentary Cover of the North American Craton: Canada", Geological Survey of Canada, The Geology of Canada, Vol. 6 (also Geological Society of America, The Geology of North America, Vol. D-1).

Member, ISPG Committee on Guided Tours.

Member, Geological Society of America Membership Committee.

Co-ordinator, CSPG 1987 Canadian Reef Inventory Project (Cambrian System).

M.P. Cecile

Chairman, CSPG International Liaison Committee.

Co-chairman, Lithoprobe Dempster Highway Transect (transferred to L.S. Lane, November 1986).

Co-ordinator, Associate Editor, CSPG 1987 Canadian Reef Inventory (Ordovician System).

Associate Editor, Geoscience Canada.

Member, CSPG Technical Committee for the 2nd International Symposium on the Devonian System (Western Canada and Alaska).

Member, CSPG National Conference on Earth Science Advisory Committee.

R.L. Christie

Canadian Geological Correlations Program Project 156 (phosphorites).
Corresponding Member, International Program Project 156 (phosphorites).

Member, ISPG Exhibits Committee.

Member, CSPG Committee for Guidebook to Stone in Calgary Buildings.

D.G. Cook

President, CSPG.

Chairman, CSPG President's Award Committee.

Member, CSPG Management Task Force.

J. Dixon

Senior Editor, CSPG.

CSPG Editor for "Oil and Gas Pools of Canada".

CSPG Representative, CSPG-GAC Paleontological Monograph Committee.

Member, ISPG Stratigraphic Nomenclature Committee.

Member, ISPG Library Committee.

Member, CSPG-CSEG Steering Committee "Geophysical Reservoir Atlas of Western Canada".

A.F. Embry

Chairman, North American Commission on Stratigraphic Nomenclature.

Chairman, ISPG Stratigraphic Nomenclature Committee.

Chairman, CSPG Technical Program Committee, 2nd International Devonian Symposium.

Co-editor, CSPG Proceedings of the 2nd International Devonian Symposium.

Member, CSPG International Subcommittee on Stratigraphic Classification.

Member, CSPG Stratigraphic Nomenclature Committee.

H.H.J. Geldsetzer

Chief Editor, CSPG Memoir on "Reefs Case Histories".

Member, Organizing Committee, CSPG 1987 Canadian Reef Inventory Project.

L.S. Lane

Co-chairman, Lithoprobe Dempster Highway Transect (took over from M.P. Cecile, November 1986).

M.E. McMechan

Chairman, CSPG Medal of Merit Committee.

Councillor, GAC.

Member, CSPG National Conference on Earth Science Advisory Committee.

Member, ISPG Library Committee.

Member, ISPG Joint Occupational Safety Committee.

N.C. Meijer Drees

Chairman, CSPG 1986 Core Conference.
Chairman, CSPG Sedimentology Division.

D.W. Morrow

Associate Editor, CSPG Bulletin of Canadian Petroleum Geology.
Member, Technical Program Committee, 2nd International Devonian Symposium (Western Canada and Alaska).
Member, Ph.D. Thesis Committee, University of Calgary.

B.C. Richards

Co-ordinator, CSPG 1987 Canadian Reef Inventory Project (Carboniferous and Permian systems).
Member, ISPG Stratigraphic Nomenclature Committee.

E.G. Snow

Chairman, CSPG Awards Dinner and Dance Committee.
Chairman, ISPG Support Staff Field Trip Committee.
Assistant Registrar, CSPG 2nd International Devonian Symposium.
Member, CSPG Logan Day Committee.

D.F. Stott

Co-editor, "Sedimentary Cover of the North American Craton: Canada", Geological Survey of Canada, The Geology of Canada, Vol. 6 (also Geological Society of America, The Geology of North America, Vol. D-1).
Regional co-ordinator, Canada, International Geological Correlation Program Project 245, Nonmarine Cretaceous Correlations.

H.P. Trettin

Editor, "Innuitian Orogen and Arctic Platform: Canada and Greenland", Geological Survey of Canada, The Geology of Canada, Vol. 3 (also Geological Society of America, the Geology of North America, Vol. E).

Lapidary

Thin sections, standard	746
Thin sections, stained	67
Polished slabs	10

Core and Sample Repository

Well Samples received:

Alberta	278 376
British Columbia	27 331
Saskatchewan	41 317
Manitoba	12 934
Off-shore	3 600
Territories	19 250

382 808

Mechanical logs received (Alberta, British Columbia, Saskatchewan, Manitoba and the Territories) 8600

Territories Core Received (boxes) 536

Visitors requiring core, samples, or related information 1450

9500 boxes of core were made available for examination and samples from some 1026 wells were requested.

Cuttings or core from about 75 wells were sampled for various scientific purposes by 10 to 15 oil companies (estimate only) and our own scientific staff.

PALEONTOLOGY SUBDIVISION

B.S. Norford

The Paleontology Subdivision is responsible for interpretation of the fossil record in Canada through studies in biostratigraphy, paleoecology and systematic paleontology. These investigations provide data that support regional mapping and stratigraphic studies, and exploration for hydrocarbons, metals and other non-renewable resources and assessment of these resources. Most of the Subdivision's activities are in northern and western Canada, but a significant number of projects deal with basinal areas in central and eastern Canada (onshore). In all these areas, paleontology plays an important role in GSC basin analysis programs.

The Subdivision develops and maintains biostratigraphic standards for regional and international correlation and carries out a continuing program for improvement of zonal schemes and refining interpretation of paleo-environments. Most projects are directed toward fossil groups that display rapid evolutionary changes and are therefore particularly useful for biostratigraphy, but less well known fossil groups are being tested for biostratigraphic potential and application. A large part of the program involves dating and correlation by means of detailed studies of fossils recovered from cuttings and cores from northern and offshore wells.

The Subdivision consists of the Micropaleontology Section, the Macropaleontology Section, the Ottawa Paleontology Section (including both micropaleontology and macropaleontology), and the ISPG Curation Unit.

Micropaleontological studies, mainly on palynomorphs, foraminifers, conodonts, and ostracodes, involve material from both surface and subsurface with emphasis on subsurface well material from frontier and offshore areas. Macropaleontological studies, on a wide variety of groups, deal mainly with surface material, but include some material from subsurface cores. In addition to paleontological studies, members of the Subdivision conduct stratigraphic studies in cooperation with other units of the Geological Survey of Canada. The Curation Unit is responsible for receipt, documentation, cataloguing, storage, retrieval and loans of GSC field and subsurface samples from the Calgary and Vancouver offices.

Research and service programs within the Subdivision are closely coordinated with those of other Subdivisions of the ISPG, with similar programs in other divisions of GSC, and with programs of outside government agencies, universities, and industry in Canada and other countries. The function of the Subdivision is conducted, in part, through contracts with consulting companies and university scientists, supervised by scientists within the Subdivision. In addition, a number of EMR Research Agreements, arranged with scientists outside the Survey, are administered by the Subdivision.

Paleotemperature studies, both as an aid to hydrocarbon and mineral exploration and as a contribution to the burial and uplift history of sedimentary basins, are increasingly being pursued in the Subdivision. The principal fossil geothermometers include conodonts, graptolites and palynomorphs. Fossil interpretations and colour assessments, are carried out by paleontologists in both Calgary and Ottawa, but quantification of maturity assessments is being developed in cooperation with scientists of the Coal Subdivision.

Subdivision scientists and associated outside specialists completed 190 paleontological reports on 2479 collections of fossils from outcrop and subsurface. These reports were prepared for direct quotation in publications and provided dating, correlations and hydrocarbon maturity data of rock units throughout Canada for use by the GSC, other EMR agencies, the Department of Indian and Northern Affairs, industry, and Provincial Government agencies, such as the Alberta Geological Survey.

International collaboration included formal interchange with the All-Union Research Institute for Geology and Mineral Resources of the World Ocean (Leningrad), visits to Calgary by specialists from Belgium, England, Germany, Norway and the United States, and visits by Subdivision scientists to Poland and the United States. Several members of the Subdivision participated in IUGS Stratigraphic Subcommissions and Working Groups as Canadian representatives. These included leadership of an inspection of a potential Cambrian-Ordovician Boundary stratotype in China and preliminary organization of a 1987 inspection of a potential Precambrian-Cambrian Boundary stratotype in Newfoundland.

Personnel Notes

The Subdivision includes 30 permanent positions (18 scientists, 7 technicians, 2 secretaries, 2 curators) as well as 18 contract workers and a varying number of temporary and summer assistants.

In Calgary: Dr. A.C. Higgins left the Survey to join British Petroleum, London as a Senior Research Scientist.

Dr. B.S. Norford has been filling the 'chair' as Acting Subdivision Head, along with his other duties and responsibilities, while recruitment of a permanent Head proceeds.

Dr. R. Kalgutkar (Palynology Lab Senior Technician) was successful in being promoted to a Research Scientist position. Production in the Micropaleontology Lab has hit an all-time high this year, due to the dedication, determination and exceptional talent of our two micro lab technicians Denise Then and Jean Dougherty. These two went beyond our expectations to increase the efficiency and scheduling of their production methods and programs. This has resulted in requests from both Denise and Jean for Maternity Leave to culminate in mid-November.

In the Ottawa Paleontology Section Mr. Art Whitehead retired in December 1986 after 35 years of service in the lapidary. Two Visiting Fellows, Dr. J. Haggart and Dr. A.J. McCracken, were attached to the Ottawa Paleontology Section, working on Cretaceous microfossils and Ordovician-Silurian conodonts.

Visiting Scientists During 1986/87

Dr. W. Brochwicz-Lewinski, Instytut Geologiczny Warsaw, Dr. A.C. Higgins, British Petroleum Research London, Dr. R.M. Konieczny, Continental Shelf and Petroleum Technology Research Institute Ltd. (I.K.U.) Norway, Dr. P. Bultynck, Institute Royal Des Sciences Naturelles Des Belgique, Brussels, Dr. P. Bender, Marburg University West Germany, Dr. F. Lutke, Darmstadt, West Germany, Dr. D.E. Jackson, Amoco International, England, Dr. William Oliver, USGS, Washington, U.S.A..

Attendance at Meetings Conferences and Courses

M.J. Copeland

Geological Association of Canada Annual Meeting, Ottawa.

Northeastern Section, Geological Society of America, Annual Meeting, Kent, Ohio.

Pre-retirement Course, Hull.

G.S. Nowlan

Geological Association of Canada Annual Meeting, Ottawa, May 1986.

Canadian Paleontology and Biostratigraphy Seminar Albany, New York - September 1986.

W.H. Fritz

Geological Association of Canada Annual Meeting, Ottawa, May 1986.

D.C. McGregor

International Palynological Workshop, London, England, October 1986.

Combined Annual Meeting of the American Association of Stratigraphic Palynologists and the Commission Internationale de Microflore du Paleozoique, New York City, October 1986.

Council of the International Federation of Palynological Societies, New York City, October 1986.

Geological Survey of Canada/U.S. Geological Survey Palynologist's combined meeting, Reston, Virginia, November 1986.

D.J. McIntyre

Geological Survey of Canada/U.S. Geological Survey Palynologist's combined meeting, Reston, Virginia, November 1986.

American Association of Stratigraphic Palynologists Annual Meeting, New York City, October 1986.

A.R. Sweet

Geological Survey of Canada/U.S. Geological Survey Palynologist's combined meeting, Reston, Virginia, November 1986.

CSPG Reserves Canada 21 Conference, Calgary, June 1986.

Western Canada Coal Geoscience Forum, Calgary, November 1986.

J. White

Geological Survey of Canada/U.S. Geological Survey Palynologist's combined meeting, Reston, Virginia, November 1986.

E.T. Tozer

Conference on Permian and Permian-Triassic Boundary in the Western Tethys, Brescia, Italy, July 1986.

Field Conference on Permian-Triassic Boundary, Turkey, July 1986.

D.H. McNeil

CSPG Reserves Canada 21 Conference, Calgary, June 1986.

Second International Workshop on Agglutinated Foraminifera, Vienna, Austria, June 1986.

J.H. Wall

CSPG Reserves Canada 21 Conference, Calgary, June 1986.

Western Canada Coal Geoscience Forum, Calgary, November 1986.

A.E.H. Pedder

Meeting of the Subcommittee on Devonian Stratigraphy, Prague, August 1986.

Special Talks and Lectures

G.S. Nowlan

Conodont colour alteration data from the St. Lawrence Platform and Appalachian orogen in eastern Canada: Canadian Paleontology and Biostratigraphy Seminar, Albany, N.Y., September 1986 (Poster).

Correlation of Upper Ordovician strata on the basis of conodonts: Canadian Paleontology and Biostratigraphy Seminar, Albany, N.Y., September, 1986 (co-author with A.D. McCracken).

E.T. Tozer

"Definition of the Permian-Triassic Boundary: the question of the age of the Otoceras Beds", delivered at Brescia, Italy, July 12, 1986 (IGCP Project 203).

A.R. Sweet

The Cretaceous-Tertiary boundary in Alberta. Invited talk jointly given with T. Jerzykiewicz at the University of Windsor and at the University of Toronto.

Geology and Coal resource potential, Summit Creek Formation, Fort Norman area, N.W.T. (Jointly with A.R. Cameron, D.K. Norris and B.D. Ricketts) Geological Society of America, 99th Anniversary Meeting, San Antonio, Texas, October 1986.

Coal-bearing versus barren floodplains in Late-Maastrichtian to Early-Paleocene of Alberta. (Jointly with T. Jerzykiewicz) Western Canada Coal Geoscience Forum, Calgary, November 1986.

J.M. White

An Overview of Pollen and Spores - function, morphology, ecology and biostratigraphic value. Presented to Vancouver Cordilleran Division and Pacific Geoscience Centre, Sydney.

Membership on Committees

B.A. Acker

EMR-ISPG Joint Occupational Safety and Health Committee - Secretary.

E.W. Bamber

Dinantian Working Group, International Subcommittee on Carboniferous Stratigraphy.

North American Study Group, International Subcommittee on Permian Stratigraphy.

M.J. Copeland

Subcommission on Silurian Stratigraphy, International Union of Geological Sciences, Corresponding Member.

International Research Group on Paleozoic Ostracods, International Paleontological Association, President.

National Inventory Programme, Paleontology data base, National Museums of Canada.

Cultural Property Export and Import, Department of Communications, Expert Examiner, Paleontology.

B.J. Dougherty

Chairperson, ISPG Tour Committee.

EMR-ISPG Joint Occupational Safety and Health Committee, Member.

W.H. Fritz

Head of Canadian Precambrian-Cambrian Boundary Working Group, International Union of Geological Sciences, International Geological Correlation Program.

D.C. McGregor

International Federation of Palynological Societies, President.

IUGS Subcommission on Devonian Stratigraphy, voting member; member of working group on "Correlation of marine and non-marine facies".

North American Devonian Study Group, organizing member.

IUGS Commission on Stratigraphy, Working Group on the Devonian-Carboniferous Boundary, member.

Canadian Geoscience Council Standing Committee on International Geological Relations (SCIGR), member.

Cleveland Museum of Natural History, Research Associate.

D.H. McNeil

Canadian Paleontological Monograph Series (GAC-CSPG), Associate Editor, Secretary of committee for Palaeontographica Canadiana.

ISPG Exhibits Committee.

Member on Ph.D. committee for B. Nicholls, Department of Biology, University of Calgary.

B.S. Norford

Working Group on Cambrian-Ordovician Boundary, International Commission on Stratigraphy, Chairman.

International Commission on Stratigraphy, Corresponding Member.

Palaeontographica Canadiana, Associate Editor.

Board of Directors Canadian Energy Research Institute
Honorary Professor, University of Calgary.

Foreign Secretary of the Canadian Geoscience Council and a member of its Board of Directors.

University Research Park Liaison Committee, Chairman.

A.W. Norris

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

North American Devonian Study Group, Organizing Member.

Working Group on Devonian Marine - Non-marine Correlation Problems, Member.

G.S. Nowlan

Member, Joint Committee on Paleontological Monographs representing GAC.

Titular Member, IUGS Subcommission on Silurian Stratigraphy.

Corresponding Member, IUGS Ordovician-Silurian Boundary Bioevents Working Group.

Chairman, Publications Committee, Geological Association of Canada, (Editor, GEOLOG).

Member, Executive Committee of Geological Association of Canada.

Advisory Committee for Ms. I. Munro, Ph.D. candidate, Ottawa University.

Member, North American Ordovician Chronostratigraphy Working Group, IUGS Subcommission on Ordovician Stratigraphy.

Special Series Editor, Geoscience Canada.

Adjunct Professor, University of Ottawa School of Graduate Studies, University of Ottawa.

Member, Ottawa-Carleton Centre of Geoscience Studies.

Group Leader, IGCP Project 233, Terranes in the Circum-Atlantic Paleozoic Orogens.

Supervisor, M. Hitch M.Sc. candidate, University of Ottawa.

Chairman, Billings Medal Committee, Paleontology Division GAC.

A.E.H. Pedder

Subcommission on Devonian Stratigraphy, Titular Member.

North American Devonian Study Group.

Technical Program and Scientific Exhibits Committees
of the CSPG Second International Symposium on the
Devonian System.

T.P. Poulton

ISPG Nomenclature Committee, Member.

ISPG Library Committee, Chairman.

Alberta Paleontological Advisory Committee.

IUGS Jurassic Subcommittee; Subcommittee; full
member; Member of 2 working groups.

Canadian representative to IGCP Project 171 (Circum-
Pacific Jurassic) and on 4 working groups.

D.R. Then

ISPG 'Club Fed' Social Organizing Committee.

E.T. Tozer

IUGS Subcommittee on Triassic Stratigraphy, Vice
Chairman.

IUGS Commission on Stratigraphy, Working Group on
Permian-Triassic Boundary, Chairman.

IUGS Commission on Stratigraphy Working Group on
Triassic-Jurassic Boundary, Member.

J. Utting

International Commission for Palynology, Councillor
representing Canadian Association of Palynologists.

IUGS Working Group on the Permian-Triassic Boundary.

IUGS Subcommittee on Carboniferous Stratigraphy,
Corresponding Member.

IUGS Subcommittee on Carboniferous Stratigraphy,
Corresponding Member.

T.T. Uyeno

North American Working Group on the Devonian
System.

J.H. Wall

ISPG Library Committee, Chairman.

International Working Group on the Jurassic-Cretaceous
Boundary, Corresponding Member.

D.J. McIntyre

American Association of Stratigraphic Palynologists,
Director.

Foraminifer Laboratory

A total of 966 samples were disintegrated during the
fiscal year. (For J.H. Wall: core 23 and 238 from outcrop; for
D.H. McNeil: core 41, cuttings 339 and 116 from outcrops).
A total of 440 of these samples were picked internally and
526 were contracted out.

Conodont Laboratory

388 samples processed and picked
40 samples processed only
84 samples picked only
170 samples viewed (check picking and estimate grain
percentage).

Of the above 168 were well samples while the remainder
were outcrop samples. Material processed for T.T. Uyeno
and A.C. Higgins.

Outside Contracts

392 samples contracted out for processing
198 samples under separate picking contracts

Palynology Laboratory

1615 samples from surface and subsurface were
processed for miospores for studies by D.J. McIntyre,
A.R. Sweet, J. Utting and J.M. White. 22 megaspores
preparations were made for the Canada-Poland exchange
program. The laboratory provided training in palynological
techniques as part of a post-graduate course in Organic
Petrology and Geochemistry, operated at ISPG.

Macropaleontology Laboratory

The major output consisted of 1215 coral and
foraminiferal thin sections for study by A.E.H. Pedder,
E.W. Bamber and B.S. Norford and paleontologists outside
ISPG. Casts and moulds of the fossils numbered 24, fossils
were picked from 4 acid residues.

Curation Statistics - Calgary

"C" Numbers Issued	9,300
Transferred from Ottawa	72
Transferred to Ottawa (Ottawa & Calgary nos.)	348
Samples circulated within ISPG	3,276
Samples shipped out for processing, study loans, gifts:	1,486
GSC Ottawa	260
GSC Vancouver	104
Contract processing	400
Other institutions	722

The above institutions include 2 foreign government agencies,
1 foreign museum, 8 Canadian, 6 foreign universities,
5 Canadian companies, 3 foreign companies.

Reports entered in to Internal Report Computer Listing 796

Laboratory Statistics - Ottawa

Lapidary Laboratory

Rock thin sections:

Standard, produced by laboratory	3,305
Large, produced by laboratory	265
Standard, produced on overtime	2,890
Large, produced on overtime	117
Standard, purchased by contract	1,887
Large, purchased by contract	111
Polished, produced by laboratory	21
Polished, purchased by contract	2,083
Polished rock surfaces	117
Fluid inclusion, purchased by contract	78

Paleontology Laboratory

Preparation:

Thin sections	256
Plaster casts	549
Latex rubber moulds	8
Silicone rubber moulds	7
Epoxy casts	27
Presentation pieces	40
Polished surfaces	24

Curation:

Parcels received	82
(plus crates from Whittington)	10
Parcels shipped	125
Fossil localities catalogued (GSC Localities 101658 to 102201)	544
Collections received with Calgary numbers	190

Palynology Laboratory

In the Ottawa palynology laboratory, supervised by D.C. McGregor, G. Buckler processed 211 surface and subsurface samples were processed, and 789 slides were prepared containing marine and non-marine palynofossils and 72 specimens for study with the scanning electron microscope.

Conodont Laboratory

In the Ottawa conodont laboratory, supervised by G.S. Nowlan, 307 samples were acidized and 433 samples were prepared for picking on outside contract.

TYPE SPECIMENS CATALOGUED IN 1986 (Thomas E. Bolton, Curator)

Publications	PC	Camb.	Ord.	Sil.	Dev.	Carb.- Perm.	Jur.	Cret.	Tert.- Recnt.	Total	Nfid	NS	NB	Que	Ont	Man	Alt	BC	Yuk	NWT	Other
<u>GSC Bulletins</u>																					
340 (Palynomorphs)									322	322											X
353 (Forams, algae)						165				165								X			
364 (Spores)					26					26		X		X				X	X	X	X
<u>GSC Papers</u>																					
84-15 (Palynomorphs)								49		49							X	X			
85-22 (Forams, ostracodes)									63	63				X							
86-1A (Arthropods, corals)	1				4					5							X				X
86-1B (Corals, ostracodes, algae, palynomorphs, bryozoans)	4	3	28	26	3	38	1	14	117	X			X	X	X	X	X	X		X	
Subtotals (GSC)	5	3	28	56	168	38	50	399	747												
<u>Outside GSC</u>																					
Can. J. Earth Sciences (Microflora, trilobites, graptolites, corals)	36	28	77	5	17				163	X			X	X	X	X					X
J. of Palynology (Corals, trilobites, plants)	8	23	29		22				82	X	X		X	X							X
Other (Palyn., corals, brachiopods, sponges, ostracodes, plants)	4	106	1	135	5				251	X	X	X	X	X	X	X	X	X			X
Subtotals (Outside)	36	40	206	35	152	27			496												
TOTAL	36	45	209	63	208	195	38	50	399	1243											

PETROLEUM GEOLOGY SUBDIVISION

R.W. Macqueen

Petroleum Geology Subdivision personnel conduct research centred around the habitat of hydrocarbons in basins of Western and Arctic Canada. This involves studies mainly on a regional scale and mainly based on subsurface information, but outcrop studies and local subsurface studies on the scale of individual reservoirs are an important and continuing part of some projects. A particular strength of projects based in the Subdivision is the ability of personnel to draw on other expertise in the Institute as required or appropriate, including regional geology, paleontology, organic petrology and coal geology, as well as approaches developed in the Petroleum Resource Appraisal Secretariat (P.R.A.S.). Petroleum Geology Subdivision personnel are active contributors to the continuing resource appraisals of P.R.A.S.

Funding of the work of the Subdivision is obtained from A-base, Petroleum Energy Research and Development (P.E.R.D.), and Frontier Geoscience Program (F.G.P.), reflecting the emphasis on energy-related studies. New approaches in Subdivision projects include an increased emphasis on cooperative projects such that geological, geochemical, paleontological, geophysical and other aspects of areally-based research work are fully addressed, using personnel of other subdivisions and contract work and industry and university cooperation as desirable. Examples include Beaufort-Mackenzie studies (mainly FGP-funded), and the Peace River Arch project (mainly PERD-funded). The Peace River Arch project is a program of collaborative research with personnel of the Alberta Research Council/Alberta Geological Survey, which begins formally in April, 1987.

In March of 1987 the Subdivision was reorganized the more accurately to reflect our objectives and the work of our scientists. Two new sections were established: Resource Geology under D.A. Leckie, and Geophysics under R.A. Stephenson. Geochemistry Section under L.R. Snowdon remains as previously. Work of Resource Geology and Geophysics personnel consists of geological and geophysical studies at several levels: from that required to understand individual stratigraphic units and hydrocarbon plays, up to the level of the behaviour of an entire sedimentary basin through time. Some of the work of these individuals is coordinated, through PRAS, with related activities within ISPG and with requirements of the Canada Oil and Gas Lands Administration (COGLA). The major activity of all personnel of the Subdivision is to participate in research projects that are aimed at understanding the origin, migration and occurrence of hydrocarbons in Canada, within the context of evolving sedimentary basins. In-house, cooperative, and contractual work has this goal.

Geochemistry Section personnel provide organic and inorganic geochemical services to a broad spectrum of workers and projects at ISPG: the organic geochemical facility is identified as GSC's National Organic Geochemical Laboratory. Organic geochemistry personnel will be playing a leading role in the new Queen Charlotte Basin project, Pacific Continental Margin, and are continuing to play an important role in geochemical studies of Atlantic Continental Margin basins. The organic geochemical laboratories utilize a range of sophisticated analytical tools and approaches, including kerogen isolation and classification, solvent extraction, and gas chromatography of certain hydrocarbon fractions. Exciting new approaches carried out in the section involve the study of geochemical fossils or biomarkers, of

great value in oil-oil and oil-source correlations, and in recognizing important changes undergone by extractable organic material as a result of such processes as maturation, migration and biodegradation. During the year the section took delivery of a hybrid triple sector mass spectrometer, which provides a superb capability for the isolation and identification of individual biomarkers from complex mixtures such as are found in certain Canadian basins (e.g. Jeanne d'Arc Basin, Atlantic Continental Margin).

Most recent organic geochemical studies have been carried out on material from frontier areas, including the Arctic Islands, Mackenzie Delta - Beaufort Sea, and Atlantic Continental Margin. There is an increasing need to examine oils, oil-source correlations and related aspects of the Western Canada Basin. This work is developing, especially through P.E.R.D. funding of Williston Basin (Saskatchewan) work, and with renewed study of tar sands/heavy oils.

Inorganic geochemical work involves x-ray diffraction, x-ray fluorescence, analytical chemistry and scanning electron microscopy, as well as a number of other less commonly used approaches (e.g. infra-red spectroscopy). These facilities are used to carry out research in the field of diagenesis related to the hydrocarbon-generating potential of source rocks and the development of authigenic minerals in reservoirs, in addition to providing analytical services for ISPG.

The Petroleum Geology Subdivision also has responsibility for maintaining geological and geophysical reports obtained from COGLA, and pertaining to seismic surveys conducted in frontier areas including the Arctic Islands, Beaufort-Mackenzie, and Lower Mackenzie river areas.

Highlights Petroleum Geology Subdivision

Personnel of the Subdivision are engaged in a very wide range of geological, geochemical and geophysical, petroleum-related studies. In March of 1987, following discussion among all Subdivision members, we decided to establish the two new sections noted above: Resource Geology under Dr. Dale Leckie, and Geophysics under Dr. Randell Stephenson. Geochemistry Section, headed by Dr. Lloyd Snowdon, continues. These new sections reflect the fact that many personnel are involved in studies within several geographic/geological regions, and give greater visibility to certain activities such as geophysical studies.

Resource Geology

In the Western Canada Basin, a regional petroleum geology study of the Cretaceous Peace River Formation integrating outcrop and subsurface data is underway, and involves subsurface mapping, facies analyses, geochemistry, source-rock analysis and paleontology. Results of the outcrop study indicate that regional sea level fluctuations played a major role in sedimentary distribution patterns. A 1.3 km long diamond drill core penetrating most of the Lower Cretaceous of the Monkman Pass area of northeastern British Columbia was obtained from Petro-Canada and is under study: a manuscript on the source-rock potential (TOC) and maturity (coal reflectance) of these sediments has been submitted. This core includes a thick sequence of paleosols,

related to regional sea level fluctuations. Other features of the core study include micropaleontology of the Peace River Formation of the Monkman core, and trace element analyses of marine shales in the Peace River Formation of the Monkman core (Ph.D. study, University of Calgary). A new study has begun on the reservoir geology of the Basal Colorado Sandstone of the Cessford pool of southeastern Alberta. Preliminary work indicates that the Basal Colorado Sandstone is a tidal sheet sandstone deposited on a transgressive surface. A second reservoir-related regional study has begun, on the Upper Cretaceous Doe Creek member of the Kaskapau Formation, central Alberta.

A new project on the nature and timing of deformation associated with the Sweetgrass Arch in southern Alberta is underway. Significant emphasis is being placed on utilizing existing data (geophysical and geochemical) that is available in oil companies that can tie into the petroleum geology of the Arch, and on a comparison of the Sweetgrass Arch with the Peace River Arch. These two features, although superficially similar, vary significantly in detail and have a very different history and origin.

Several planning meetings and much discussion took place in preparation for the initiation of a new research project to begin in 1987 on the nature and origin of the Peace River Arch, a collaborative project with personnel of the Alberta Geological Survey. Meanwhile, a regional petroleum geology study of the Mississippian Stoddart Group on the Peace River Arch is in progress involving stratigraphy, sedimentology, geochemistry, palynology and organic petrology. A paper and poster display at the CSPG Core Conference documented the presence of paleosols in the Stoddart Group and is the first paper on this interval since the early 1960's.

Collaboration continues with University of Alberta investigators on the relationship of geothermal gradients, patterns of thermal maturity and hydrocarbon pools in southern Alberta. The results will be published in the Bulletin of Canadian Petroleum Geology, and as a series of 1:1 million scale maps with abbreviated text.

Good progress continues to be made on the Williston Basin (Saskatchewan portion) OERD-funded oil-source study. Three compositionally distinctive oil families have been identified from a suite of 34 samples from representative oil pools. This work is in press with members of the geochemistry section, and involves both conventional and biomarker organic geochemical approaches.

Analysis of the Cambrian sedimentary history within the Mackenzie Corridor (mainland Canada, north of 60°N) continued, revealing the probable existence of a broad Proterozoic zone of structural weakness that extends from the Colville Hills in the north to the southern Mackenzie Plains. Adjustments of basement blocks within this zone may have influenced subsidence and structure, hence thickness and facies, of sediments from Early Cambrian time to the present. Related work in the Mackenzie Corridor demonstrates the close correspondence between two regional Devonian drowning events in the Northern Mainland and the Alberta basin. These drowning events are separated by a regional regression and are evident in spite of the quite different sedimentary packages in the two areas. In terms of Western Canada Basin geology, these events were the Keg River transgression, the Watt Mountain transgression and the Swan Hills (Kee Scarp) transgression. Details appear in GSC open file reports.

Microfiche of geophysical logs covering all wells in Canada was purchased to assist in subsurface mapping. Computer data base systems of wells in Alberta, British Columbia and Saskatchewan are up and running using a retrieval program prepared in-house. The data base system currently is being used to generate regional structure and isopach maps of the Cretaceous system of the Western Canada Basin. These maps will be a valuable resource to assist in understanding the evolution of the Western Canada Sedimentary Basin.

Several members of the Subdivision have contributed to the Petroleum Resources Appraisal Secretariat (P.R.A.S.) volume on a conventional oil resources of western Canada, and one member will be leading a new project designed to appraise gas resources of the western Canada Basin for P.R.A.S.

Geophysics

Continued interpretation of industry seismic data and integration of new well information from the western part of the Beaufort-Mackenzie basin has led to some important revisions to the intra-Tertiary stratigraphy of that area, including assignment of new ages to two prominent Eocene unconformities. Other industry seismic reflection data in the Mackenzie Delta area - some 120 km of 6 second data - have been reprocessed under contract to enhance deeper reflecting horizons. Preliminary interpretations of these data provide support for the analysis of components of the FGP deep seismic transect (see Regional Geology Subdivision), including the geometries and decollement levels of the Eskimo Lakes and other fault systems in the area. Also complementary to the FGP seismic transection, a major crustal seismic refraction survey, with participation of the Geophysics and Lithosphere and Canadian Shield Divisions and the Universities of British Columbia and Calgary, was carried out onshore and offshore in the Mackenzie Delta - northern Yukon area in March 1987 (see Regional Geology Subdivision).

In the field of geodynamic basin modelling, the first phase of a tectonic subsidence and basin evolution model was completed for the Sverdrup Basin, with colleagues of the Regional Geology Subdivision and the University of Calgary. A new quantitative subsidence model was developed, one which fully couples the thermal evolution of the lithosphere and overlying sedimentary wedge and which incorporates regional isostatic compensation of thermal in-plane as well as thermal body forces. The model was applied to the Sverdrup Basin and it was shown that the Viséan to Berriasian geological development of the Sverdrup Basin can be explained by the geodynamic effects of a moderate, uniaxial, Viséan-Artinskian continental rifting event. With colleagues from the Atlantic Geoscience Centre, several poster sessions were presented on the thermal evolution of the Jeanne d'Arc Basin, offshore Newfoundland. Measurements of organic maturity such as vitrinite reflectance observations were combined with computed subsidence and thermal evolution histories to provide maps of hydrocarbon maturity for the Kimmeridgian source rock in this basin. These maps indicate the importance of vertical migration of hydrocarbons from source to reservoir in the Jeanne d'Arc Basin.

With the merger of the former Earth Physics Branch with GSC, ISPG acquired the services of Dr. Alan Jessop, a heat flow specialist remaining in Ottawa presently but working on aspects of heat flow in sedimentary basins, and completing, with colleagues, final publications on the Geothermal Energy Program.

Geochemistry

As members of the national centre for organic geochemistry within the Geological Survey of Canada, Geochemistry Section personnel continued to be active on a wide range of projects in many sedimentary basins in Canada. Source rock evaluations, oil-oil and oil-source correlations are in progress on materials from the Arctic Islands, Beaufort-Mackenzie Basin, Norman Wells area, Pine Point region, Jeanne d'Arc Basin of the Atlantic Continental Margin, and Queen Charlotte Basin of the Pacific Continental Margin, as well as Williston Basin, Saskatchewan. In addition a major project has begun on the characterization of the organic geochemistry of the tar sands and heavy oils of the Western Canada Basin.

The addition of a new organic geochemist Dr. M.G. Fowler, provides the section with expertise in the area of hydrous pyrolysis, and with further expertise in biological marker geochemistry, a major aspect of organic geochemistry at ISPG.

In January, Dr. Shimon Feinstein arrived from Ben Gurion University, Beer Sheva, Israel, to begin a post-doctorate fellowship at ISPG. Dr. Feinstein is working on aspects of organic maturation and burial history of the Lower Mackenzie River area.

A research program on the east coast offshore basins in cooperation with AGC geologists and geophysicists has been reinitiated. Hydrous pyrolysis equipment was also acquired and several test runs have been made to establish optimum operating conditions. A hybrid triple sector mass spectrometer was purchased and delivered, with installation to proceed early in the new fiscal year. This hardware will be used to provide an important, and in some cases vital, extra dimension of chemical separation of compounds in crude oils and extracts so that quantitative determination of single compounds can be made in mixtures containing literally millions of components.

With the retirement of A.E. Foscolos during the fiscal year, the Geochemistry Section lacks expertise in inorganic geochemistry. It will be essential to any further program of inorganic geochemical research to obtain a skilled and experienced scientist at an early date.

Personnel Notes

Currently the Petroleum Geology Subdivision employs a permanent staff of 15 scientists, 8 technicians and one secretary. During the year Dr. A.E. Foscolos retired (October, 1986) from GSC to accept a position at the Technical University of Crete in Greece. Arthur Densmore retired in January, 1987. Tony Hamblin began Ph.D. studies at the University of Ottawa in September, 1986, on educational leave.

Dr. Alan Jessop joined ISPG/Petroleum Geology as a sedimentary basin heat flow specialist, following the merger between Earth Physics and GSC on April 1, 1986.

Dr. Shimon Feinstein began post-doctorate studies with the Petroleum Geology Subdivision in January, 1987, from Ben Gurion University, Beer Sheva, Israel.

As of April 1, 1987, Dr. Randell Stephenson was promoted to RES-2.

Mrs. Claudia Thompson was promoted to SCY-3 effective July, 1986.

Ms. Colleen Boyle, a former assistant in a casual CR-3 position, left Petroleum Geology to join ISPG's Cartography unit.

Ms. Erin Wolter, also formerly in a casual position, has left ISPG to become a dental hygienist.

Karen Wallace-Dudley returned from maternity leave in July, 1986.

During the year Dr. Sebastian Bell of AGC, Dartmouth, and Dr. Terry Gordon of LCSD, Ottawa transferred to ISPG. Although each of these individuals is still assigned to the divisions noted, each is contributing to Petroleum Geology research programs.

Many subdivision scientists are serving as Scientific Authorities and/or advisors on a large number of research and support contracts made possible through the Frontier Geoscience Program and the Petroleum Energy Research and Development Program

Attendance at Meetings Conferences and Courses

I. Banerjee

CSPG Core Conference, Calgary, Alberta, October 16, 17, 1986. Core Display "Basal Colorado Sandstone in Cessford Field".

J.E. Barclay

Society of Economic Paleontologists and Mineralogists Conference on Shelf Stratification, Bandon, Oregon, May 26 - June 2, 1986.

CSPG Annual Convention, Calgary, Alberta, June, 1986.

CSPG Core Conference, Calgary, Alberta, October 16, 17, 1986. Poster "Triassic Halfway Play Types and Reservoir Characteristics".

P.W. Brooks

American Chemical Society Meeting, Anaheim, California, September 7-17, 1986.

Gordon Conference on Organic Geochemistry, Plymouth, New Hampshire, August 17-22, 1986.

A.A. Densmore

CSEG Annual Meeting, Calgary, Alberta May, 1986.

J.R. Dietrich

- CSEG Annual Meeting, Calgary, Alberta May, 1986.
CSPG Annual Convention, Calgary, Alberta, June, 1986.

M.G. Fowler

- Basins of Eastern Canada and Worldwide Analogues Symposium, Halifax, Nova Scotia, August 13-15, 1986.
American Chemical Society Meeting, Anaheim, California, September 7-17, 1986.

D.A. Leckie

- Society of Economic Paleontologists and Mineralogists Conference on Shelf Stratification, Bandon, Oregon, May 26 - June 2, 1986.
International Sedimentological Congress, Canberra, Australia, August 14 - September 13, 1986.
CSPG Core Conference, Calgary, Alberta, October 16, 17, 1986.

R.W. Macqueen

- GEOEXPO'86, Vancouver, British Columbia, May, 1986.
Sixth International Conference on Geochronology, Cosmochronology and Isotope Geology, Co-Convenor "Genesis of Low Temperature Ore-deposits", Cambridge, England, June 28 - July 10, 1986.
CSPG Annual Convention, Calgary, Alberta, June, 1986.
Gordon Conference on Organic Geochemistry, Plymouth, New Hampshire, August 17-22, 1986.
Canadian Reef Inventory Project, Banff, Alberta, January 27-30, 1987.

K.G. Osadetz

- GAC Annual Meeting, Ottawa, Ontario, May, 1986.
CSPG Annual Convention, Calgary, Alberta, June, 1986.

J.A. Podruski

- CSPG Annual Convention, Calgary, Alberta, June, 1986.

D.N. Skibo

- CSEG Annual Meeting, Calgary, Alberta May, 1986.
CSPG Annual Convention, Calgary, Alberta, June, 1986.
Basins of Eastern Canada and Worldwide Analogues Symposium, Halifax, Nova Scotia, August 13-15, 1986. Poster "Level of organic maturity measurements and computed geothermal history models for the Jeanne d'Arc Basin, Offshore Newfoundland".

L.R. Snowdon

- AAPG Annual Meeting, Atlanta, Georgia, June 14-19, 1986.
CSPG Annual Convention, Calgary, Alberta, June, 1986.
Gordon Conference on Organic Geochemistry, Plymouth, New Hampshire, August 17-22, 1986.

R.A. Stephenson

- Basins of Eastern Canada and Worldwide Analogues Symposium, Halifax, Nova Scotia, August 13-15, 1986.

Special Talks and Lectures

I. Banerjee

- "Subsurface facies analysis - an example from the Lower Cretaceous Mannville Group, Alberta, Canada". Department of Geology, University of Calcutta, India, December 29, 1986.
"Distinguishing tide-generated and storm-generated facies of shelf sandstones in the subsurface", K.D.M. Institute of Petroleum Exploration, Oil and Natural Gas Commission, Dehra Dun, India, January 19, 1987.

D.A. Leckie

- "Evidence for tides in a Cretaceous epeiric seaway: a case study from the Milk River Formation, southern Alberta", Chevron Canada Resources Ltd.
"Is there paleocurrent evidence for geostrophic flows in ancient shelf deposits?". Society of Economic Paleontologists and Mineralogists Field Research Conference on Shelf Sedimentation, Bandon, Oregon, May, 1986.
"Evidence for tides in a Cretaceous epeiric seaway, a case study", Department of Geology, University of Canterbury, Christchurch, New Zealand.
"The Gates Formation, northeastern British Columbia; a wave-dominated strandplain system: outcrop and subsurface", Department of Geology, Brandon University, Brandon, Manitoba.

"Paleosols and late Albian sea level fluctuations, or why coals are scarce in the Boulder Creek Formation, northeastern British Columbia", Canadian Society of Petroleum Geologists, Coal Division.

"Rates, controls and sandbody geometries of transgressive-regressive cycles: The Cretaceous Falher Member, one of Canada's major gas producers", Rocky Mountain Association of Geologists, Denver, Colorado.

R.W. Macqueen

"Applications of Organic Geochemistry in Base Metal Exploration", GEOEXPO, Vancouver, British Columbia, May 14, 1986.

"Estimating Canada's Undiscovered Petroleum Resources", Space Update 86, Pacific Methods Conference on Space and Earth Sciences, Burnaby, British Columbia, 1986

"Origin of Pine Point Lead-Zinc Deposits, N.W.T., Canada: Organic Geochemical and Isotopic Evidence, Sixth International Conference on Geochronology, Cosmochronology and Isotope Geology, Cambridge, England, July 4, 1986, Session organizer, with H. Ohmoto of Penn State, of Genesis of Low Temperature Ore Deposits session.

By invitation: "Organic geochemistry of Pine Point Pb/Zn deposits, Northwest Territories, Canada", Gordon Conference on Organic Geochemistry, New Hampshire, August 21, 1986.

Seminars: a) McGill University, Montreal (January 23, 1987); b) McMaster University, Hamilton (January 27, 1987): "Origin of the Pine Point Lead-Zinc Deposits".

L.R. Snowdon

"Hydrocarbon Migration in the Tertiary of Mackenzie Delta, AAPG, June 14-19, 1986.

"Overpressures and Migration", University of Waterloo, Waterloo, Ontario, February, 1987.

Short Course "Thermal maturation", Fredericton, New Brunswick, February, 1987.

Short Course "Interpretation of Organic Geochemical Data", ISPG.

R.A. Stephenson

"Rift-initiated subsidence and thermal evolution of the Sverdrup Basin", Basins of Eastern Canada and Worldwide Analogues, Halifax, August 13-15, 1986.

Membership on Committees

D.A. Leckie

Co-Chairman for 1988 CSPG Core and Field Conference.

Organized Core Display for Western Canada Coal Geoscience Forum, November, 1986.

Treasurer for Canadian Sedimentology Research Group (CSRG).

Organizing CSPG Field Trip "Cretaceous Depositional Facies in the Western Interior: The Southern Alberta Transect", August, 1987.

Co-Editor, Foreland Basins and Foldbelts Volume, AAPG Petroleum Basin Series (from March, 1986).

R.W. Macqueen

Associate Editor, Bulletin of Canadian Petroleum Geology (to December, 1986).

Member, Organizing Committee, Continental Scientific Drilling in Canada.

Adjunct Professor, Department of Earth Sciences, University of Waterloo (to 1988).

Member of Liaison Committee, ISPG/University of Calgary Geology and Geophysics Department.

Symposium Co-convenor, "Genesis of Low Temperature Ore Deposits", Sixth International Conference on Geochronology, Cosmochronology and Isotope Geology, Cambridge, England, July, 1986.

Co-Editor, Foreland Basins and Foldbelts Volume, AAPG Petroleum Basin Series (from March, 1986).

Co-Convenor, Special Session on Metallic Mineral Potential, Western Interior Platform and Underlying Precambrian; GAC Annual Meeting, May, 1987.

Member ISPG Computer Committee.

K.G. Osadetz

ISPG Computer Committee.

L.R. Snowdon

ISPG Computer Committee.

Member CSPG Geochemistry Division.

Adjunct Professor, Department of Earth Sciences, University of Waterloo.

K. Wallace-Dudley

Member ISPG Library Committee.

Member ISPG Exhibits Committee.

Organic Geochemistry Laboratories

Extraction and Separation of hydrocarbon fractions:

	<u>1985/1986</u>	<u>1986/1987</u>
Extractions	97	232
Distillations	78	170
Separations	175	422
Gas Chromatographic Analysis	215	633
High Pressure Experiments		20

	<u>1985/1986</u>	<u>1986/1987</u>
Source Oil Correlation Studies:		
Gasoline Range	476	349
Mass Spectrometry (Faman)	0	0
Capillary GC/MS Analysis	600	520

	<u>1985/1986</u>	<u>1986/1987</u>
Pyrolysis:		
Rock-Eval/TOC	8,780	16,511
Pyrolysis Gas chromatography	46	120

SEM Lab Statistics

	<u>1985/1986</u>	<u>1986/1987</u>
Exposures:		
Paleontology Subdivision	550	150
Petroleum	100	150
Regional	50	40
Coal	50	50
Others (Machine Shop, NEB, etc.)	30	750

Inorganic Geochemistry

	<u>1985/1986</u>	<u>1986/1987</u>
XRD Mineral Determinations	6,000	13,756
XRF Analysis	4,100	13,490
Infra-red Analysis	50	50
TGA/DTA	500	1,000
Atomic Absorption Analysis	12(24)*	78(700)
Low Temperature Ash	18(77)*	2(16)
High Temperature Ash	364(364)*	150(152)
CHN	42(95)*	325(1,111)
Proximate Analysis	218	150

Miscellaneous (C, P, S, Moisture, pH, digestions, kerogens, extractions)	1879(2718)*	1,800
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*No. of Samples (No. of Analyses)

COAL GEOLOGY SUBDIVISION

G. Grant Smith

The role of the Coal Geology Subdivision is to provide comprehensive geological knowledge, technology and expertise pertaining to Canada's coal deposits, to determine their geologic distribution, origin and potential abundance to facilitate exploration, land-use planning and policy formation, and to provide understanding of quality characteristics for commercial use in their national and international context.

To fulfill this role, the Subdivision is organized into three sections which, although often working on fully integrated projects, have distinct responsibilities. The Geology of Coal Section conducts stratigraphic, sedimentologic and structural studies that focus on the

fundamental geological context of Canadian coal measures. These result in an understanding of paleoenvironments that favoured coal formation, and tectonic elements that affected coalification histories in various sedimentary basins.

The Organic Petrology Section directs its research toward studies of coal origin with respect to various plant-forming communities relative to syndepositional paleoenvironments, and to studies of organic maturation within Canadian sedimentary basins. Research is conducted regarding concentrations of mineral matter and trace elements associated with coal beds, providing an additional dimension to the understanding of coal-forming paleoenvironments. Regional rank distribution studies furnish a framework for considering broader aspects of basin evolution histories. The petrological techniques are also applied to researching hydrocarbon generation and occurrence.

The Resource Evaluation Section works toward the establishment of an inventory of Canada's coal resources on a consistently-defined basis and in a manner whereby resource estimates can be subdivided using a number of criteria, such as environmental land classification, land tenure, coal quality and other factors which have profound socioeconomic implications. A National Inventory of Coal Exploration Data currently contains lithologic, coal thickness and analytical data from about 20,000 boreholes having an aggregate depth of more than 1,000,000 m. These data reside in 23 computer-processable databases established according to separate coalfields; including 14 in Alberta, 4 coalfields in British Columbia, 3 in Saskatchewan and 2 in Nova Scotia. Computer-based assessments of the geology, resource quantities, quality distributions and potential mineabilities of these coal deposits, for the National Coal Inventory, are based on these data.

Current coal research involves the support of the specialists in geoscience subdisciplines in all subdivisions at ISPG. Regional geologists, paleontologists, petroleum geologists, geochemists and computer specialists, among others, actively collaborate with scientists of the Coal Geology Subdivision.

Highlights

Subdivision personnel were principal organizers of the highly successful Western Canada Coal Geoscience Forum that was held in Calgary in November 1986. The Forum, which was hosted by the GSC, in conjunction with the Alberta Geological Survey and British Columbia Geological Survey, was attended by about 150 geoscientists from across Canada. It helped to promote the transfer of GSC-developed coal geoscience technologies to an audience comprising a good balance of representation between federal and provincial government agencies, coal companies, consulting firms and universities. The Forum also provided an excellent opportunity for the exchange of recently acquired geoscientific information relevant to the exploration, evaluation, development and utilization of western Canadian coals. A total of 9 talks and 10 poster sessions involved GSC personnel.

Significant discoveries and advances pertaining to the geology and resource potential of Canada's coal deposits have been made during the past year. Highlights of these discoveries and advancements are as follows:

1. Studies of rank and composition of anthracitic coals of the Kayak Formation, northern Yukon Territory, indicate a prospective source for high quality thermal coal. The high rank of Kayak coals, however, suggests that Mississippian and older rocks are not good oil prospects, though some may still be within the gas window.
2. Studies of coal potential in the Summit Creek Formation of the Brackett Basin, Fort Norman area, N.W.T., indicate a prospective source of high quality lignitic to subbituminous thermal coal having less than 25% ash and 0.4% sulphur contents, within a cumulative total coal thickness of up to 30 m.
3. Interpreted depositional environments for the Boulder Creek and Hulcross formations, which overlie the important coal-bearing Gates Formation in northeastern British Columbia, help to explain the absence of commercially important coal deposits in these formations.
4. The importance and use of trace fossils and syneresis cracks to identify marine and marginal marine environments in the commercially important coal-bearing Gething Formation of northeastern British Columbia has been demonstrated. This will assist interpretations of other similar clastic successions.
5. The discovery of several paleosol horizons in the Boulder Creek Formation has led to new paleoenvironmental interpretations useful in assessing coal potential in this and other similar clastic successions. These paleosols indicate a significant lowering of regional ground-water levels, which would have resulted in the disappearance of peat swamps and marsh environments within which coal beds originate.
6. Paleoclimatic and paleoecologic research in the central and southern Foothills of Alberta indicate a significant change in paleoenvironments between the two regions that has important ramifications on coal distributions, and hence an impact on coal exploration strategies. Semi-arid alluvial plain depositional environments, which existed in the southern part of the basin, limited the extent of coal formation at the same time that favourable coal-forming humid conditions prevailed further north to allow formation of commercially significant deposits such as those being mined near Coalspur.
7. A new stratigraphic framework was established for the Eureka Sound Group of the eastern Arctic Islands which provides a fundamental context for continuing studies of the potentially vast coal resources of these strata.
8. A major organic maturation study that was completed for a 70,000 square kilometre area in the Rocky Mountain Foothills and foreland area of northeastern British Columbia and adjacent parts of Alberta, shows that coal rank is related to maximum depth of burial and to timing of the Laramide deformation. Major zones of hydrocarbon occurrences that were determined from the derived maturation models were consistent with known oil and gas pools of the study area, demonstrating that results of the study can be used to predict hydrocarbon occurrences reliably.
9. Coals are severely degraded by weathering. Volatile elements such as chlorine and bromine have been found to be depleted in weathered coals, and their concentrations can assist to distinguish zones of coal zones of coal which have been unfavourably oxidized relative to the corresponding unaltered coal. Additionally, results of organic geochemical studies have shown that parameters such as "total organic carbon" (TOC), amounts of aromatics, and polar compounds can be used to accurately determine the degree of natural weathering of coals.
10. Vacuum-pyrolysis of some eastern Canadian high volatile bituminous coals indicates that they can be successfully converted to liquid products with a resulting residue having better combustion potential than the feed coal.
11. A set of Canadian, European, Chinese and South African coals was tested for hydrogenation suitability. Best liquid and gaseous yields were obtained from reactive-rich low rank Canadian coals obtained from the Highvale and Luscar Sterco mines of west-central Alberta.
12. Studies of the composition and properties of coals from the Hat Creek No. 2 Deposit of south-central British Columbia indicate a potentially excellent feedstock for gasification and liquefaction processes, and high vanadium concentrations of potential commercial significance.
13. New techniques for determining organic maturation levels using reflectance of scolecodont and infrared spectroscopy are proving successful and will expand the geoscience tools available for assessing coal and hydrocarbon potential in Canadian sedimentary basins.
14. Continued work on reflectance data of coals in deformed terrains has allowed the development of composite depth-reflectance profiles in the commercially significant Kootenay Group at localities with similar geological settings. This allows prediction of coal ranks up- and down-section even if as few as one or two samples are available.
15. Studies of Saskatchewan lignites from the Cypress and Estevan areas indicate regional rank patterns to be related to present-day geothermal regimes.
16. Several computer-processable databases were developed, upgraded and/or expanded, which allow efficient management and processing of coal-related geological information. Some advancements included the following:
 - An ORGANIC PETROLOGY DATABASE was developed; 10 per cent of the backlogged 12,000 analyses, which are currently in hardcopy form, have been entered, and all new analyses are being entered upon receipt.
 - About 200,000 metres of primary exploration data from several major coalfields in British Columbia, Alberta and Nova Scotia were compiled in computer-processable form in the COAL EXPLORATION DATABASE.
 - a computer-based data storage and analysis system was developed to analyse coal rank data from structurally deformed regions.
17. New computer-based methods were established to display and model geological variables, adding to the increasingly powerful and flexible tools available to

examine Canada's coal resources in support of effective resource management. Two major advancements included the following:

- A new computer program (LITHLOG) was developed and is in general use for displaying lithological, sedimentological and structural geology data that result from coal exploration in deformed terrains.
- A computer program was developed which couples output from a borehole analysis system for stratified sequences to the grid-interpolation process. This program allows the automatic definition of horizon subcrops and pinchouts and surface geology, the representation of gridded coal-deposit models with stratigraphic or structural datums, and the development of models suitable for grid-based resource volume calculations, resulting in a 20-30 per cent reduction in the computer-interaction required of a geologist in the modelling process.
- A computer program was developed which evaluates a gridded geological model to detect any logical flaws it may contain, reports the magnitude and location of the flaws, and generates a corrected model based on certain assumptions.

Personnel Notes

The Coal Geology Subdivision has a permanent staff of 11 scientists, 2 technicians and 1 secretary. Although a Resource Evaluation position (PC03) remained vacant until December, M. Lewis worked as a term employee in support of activities associated with that position. Visiting Associate Professor Li Baofang from the Peoples Republic of China began a study of the Judy Creek coal deposit of central Alberta in May 1986, which is scheduled for completion in October 1987. The Subdivision was given approval to staff a new Senior Organic Petrology Technologist position, to assist handling a growing backlog of organic petrology sample analyses.

A.R. Cameron spent 3 months (September to December) in visiting scientist status at the Northern Carbon Research Laboratory, University of Newcastle, England. While there, Dr. Cameron presented 16 lectures on basic organic petrology to students in the laboratory and also carried out combustion research on a selected suite of Canadian coals.

F. Goodarzi became adjunct professor of Geology, University of Regina. He acted as thesis advisor for M.Sc. thesis by L.D. Statiuk, University of Regina, on "Organic petrology and thermal maturation of Mesozoic sediments southern Saskatchewan", M.Sc. thesis by K. Cole, University of Regina on "Source Evaluation of the Middle Jurassic Vanguard Formation, Saskatchewan", M.Sc. thesis by D. Kirste, University of Waterloo on "Organic petrology and geochemistry of bitumen associated with Pb-Zn deposit at Pine Point, N.W.T.", and Ph.D. thesis by T. Gentzis, University of Newcastle-Upon-Tyne, on "Source rock potential and maturity of sediments from Melville Island, Arctic Canada". He also advised on thesis research for students at the universities of Regina, British Columbia and Calgary and at the Southern Alberta Institute of Technology, Calgary. He organized a 32-hour course entitled "Organic petrology and organic geochemistry - their application in

hydrocarbon exploration". This course was attended by post-graduate students from Universities of Calgary, Regina and British Columbia, and by industry and I.S.P.G. personnel.

A poster entitled "Petrographic characteristics, technological properties and regional rank patterns of Cretaceous coals from Peace River Coalfield, British Columbia, Canada" by W. Kalkreuth and M. McMechan was awarded honorable mention in the GSA Coal Division Best Paper competition.

B.D. Ricketts was on Leave of Absence until June 30, 1986. While in New Zealand, he conducted research with members of Geology Department, Auckland University, and gave a series of lectures.

Attendance at Meetings Conferences and Courses

A.R. Cameron

Organized and chaired workshop of Canadian Coal Petrographers Group, Ottawa, May, 1986.

CSPG Annual Meeting, Calgary, June, 1986.

One-day meeting on geology of North Sea oilfields, University of Newcastle, November, 1986.

F.M. Dawson

Western Canada Coal Geoscience Forum, November, 1986.

D.W. Gibson

Western Canada Coal Geoscience Forum, November, 1986.

F. Goodarzi

Tenth Annual Meeting of CIM District 6, Victoria, B.C., October 2-4, 1986.

Western Canada Coal Geoscience Forum, November, 1986.

J.D. Hughes

Western Canada Coal Geoscience Forum, November, 1986.

The Coal Association of Canada's Working Group on Coal Resources and Reserves, Calgary, November, 1986.

T. Jerzykiewicz

CSPG Core Conference, Calgary, October, 1986.

Western Canada Coal Geoscience Forum, November, 1986.

W.D. Kalkreuth

GAC/MAC Meeting, Ottawa, May, 1986.

Canadian Coal Petrographers Group Workshop, Ottawa, May, 1986.

GSA Annual Meeting, San Antonio, Texas, November, 1986.

Western Canada Coal Geoscience Forum, November, 1986.

B.D. Ricketts

Western Canada Coal Geoscience Forum, November, 1986.

CSPG Reef Research Symposium, Banff, Alberta, January 27-30, 1987.

G.G. Smith

Western Canada Coal Geoscience Forum, November, 1986.

The Coal Association of Canada's Working Group on Coal Resources and Reserves, Calgary, November, 1986.

Special Talks or Lectures

A.R. Cameron

"Geology and coal resource potential Summit Creek Formation, Fort Norman area, N.W.T.". CSPG Meeting, June 1986, (with D.K. Norris, B.D. Ricketts and A.R. Sweet).

"Modelling maturation regimes in the Kootenay Group, Alberta and British Columbia". Western Canada Coal Geoscience Forum, November, 1986, (with J.D. Hughes; Hughes presented talk).

"Energy-related research at the Geological Survey of Canada". Lecture given to Chemistry Department, University of Newcastle, England, December, 1986.

Two lectures on coal composition for organic petrology course (organized by F. Goodarzi), ISPG, March, 1987.

F.M. Dawson

Exploration Techniques for the Horseshoe Canyon Formation; Western Canada Coal Geoscience Forum, Calgary, November, 1986.

CSPG Coal Group Field Trip Leader, "Geology of the Coalspur Formation", September, 1986.

GSC Field Trip - "Structural Geology of the West-Central Alberta Foothills", August, 1986.

F. Goodarzi

"Organic petrology and paleoenvironment of deposition of Hat Creek coal deposits, British Columbia". Tenth annual meeting of CIM District 6, Victoria, B.C., October 2-4, 1986.

"The relationship between geological factors and elemental concentrations in some western Canadian coals". Western Canada Coal Geoscience Forum, November 17-19, 1986, Calgary.

Ten lectures on organic petrology; organic petrology and geochemistry course (organized by F. Goodarzi), ISPG, February-March, 1987.

Two seminars entitled "Fluorescence microscopy, its use and application in organic petrology and coal technology" and "Trace elements in some western Canadian coals", University of Regina, Saskatchewan, March 25-26, 1987.

J.D. Hughes

"Computer-based methods for coal basin analysis and resource assessment used in Canada's National Coal Inventory"

presented to:

- a. Cape Breton Development Corp. engineering and geological staff in June, 1986, in Sydney, Nova Scotia.
- b. Annual Meeting of Urban Resource Information Systems Association in October, 1986, in Edmonton.
- c. N.E.D.O. Mission on coal exploration from Japan in March, 1987, at the Coal Mining Research Centre in Devon, Alberta.

"Perspectives on a coal reserve/resource classification system for Canada" presented at Coal Association of Canada symposium on resources and reserves in November, 1986.

"Modelling maturation regimes in the Kootenay Group, Alberta and British Columbia" presented at the Western Canada Coal Geoscience Forum in November, 1986.

"Coal, rank distribution in the Jura-Cretaceous Kootenay Group and its implications on the geological evolution of the southern Canadian Rocky Mountains" seminar presented to class on organic maturation in March, 1987.

T. Jerzykiewicz

"The Cretaceous-Tertiary boundary in Alberta" (co-speaker with A.R. Sweet) at Department of Geology, University of Windsor, Windsor, Ontario, April 8, 1986.

"The Cretaceous-Tertiary boundary in Alberta: Stratigraphic, Sedimentologic and Floristic overview" (co-speaker with A.R. Sweet) at Department of Geology, University of Toronto, Toronto, Ontario, April 9, 1986.

Led CSPG Coal Division Field Trip No. 2 on Geology of the Coalspur Formation to Nordegg and Hinton on September 4-6, 1986.

"Coal-bearing versus barren floodplains in late-Maastrichtian to early-Paleocene of Alberta" (co-speaker and co-author with A.R. Sweet), at Western Canada Coal Geoscience Forum, November 17-19, 1986.

"Polish-Mongolian Palaeontological Expedition to Gobi Desert" at Tyrrell Museum in Drumheller, March 1987.

W.D. Kalkreuth

"Effects of maturation on hydrocarbon recoveries from Canadian oil shale deposits". 19th Oil Shale Symposium, Colorado School of Mines, Golden, Co., April 21-23, with G. Macauley and L. Snowdon.

"Organic petrology and geochemical (Rock Eval) studies on oil shales and coals from the Pictou and Antigonish areas, Nova Scotia". GAC-MAC Joint Annual Meeting, May 19-21, Ottawa, with G. Macauley.

"Thermal maturation and burial history, Rocky Mountain Foothills and Plains, East-Central British Columbia". GAC-MAC Joint Annual Meeting, May 19-21, Ottawa, with M. McMechan.

"Petrology of oil shales and associated coals, Pictou and Antigonish areas, Nova Scotia". Annual Meeting of Canadian Coal Petrographers Group, May 22-23, Ottawa.

"Petrographic characterization of oil shales and associated coals from Pictou and Antigonish areas, Nova Scotia". Nova Scotia Department of Mines and Energy, Halifax, N.S., May 28.

"Basic principles of coal petrology and its application in conversion of coals". Institute of Geology and Mineral Exploration, Athens, Greece, June 20.

"The petrology of Greek brown coals". Institute of Geology and Mineral Exploration, Athens, Greece, June 24, A.R. Cameron and C. Koukouzas.

"Olschiefer und Kohlen in Nova Scotia, Kanada - Geologie und Petrographie". Geologisch - Lagerstättenkundliches Kolloquium, Technical University Aachen, Germany, July 10.

"Grundzüge der Kohlenpetrographie und ihre Anwendung in der Geologie anhand von Beispielen aus Kanada: 1. Inkohlungs-Untersuchungen in den Rocky Mountain Foothills. 2. Organische Petrologie von Olschiefern". Geowissenschaftliches Colloquium, Universität Mainz, Institut für Geowissenschaften, October 28.

"Regional rank studies in Canadian Rocky Mountain Foothills - Its role in assessment of coal quality and its implication for hydrocarbon generation". Guest lecture at Institute de Géologie, Université de Neuchâtel, Switzerland, October 30.

"Die organische Petrologie und Geochemie von kanadischen Olschiefern". Sondercolloquium, Geologisches Institut der Universität Köln, Germany, November 3.

"Structurally thickened coal of the Smoky River Coalfield near Grande Cache, Alberta". Western Canada Coal Geoscience Forum, Calgary, Alberta, November 17-19, with W. Langenberg and R. Dawson.

B.D. Ricketts

"Geology of Late Cretaceous and Tertiary basins in the Canadian Arctic Archipelago". New Zealand Geological Survey, Lower Hutt, April, 1986.

"Precambrian rocks and fossils of Hudson Bay". Department of Geology, Auckland University, April, 1986.

"Cretaceous and Tertiary geology of the Canadian Arctic Archipelago". Department of Geology, Auckland University, May, 1986.

Two lectures to graduate students of Auckland University of Precambrian sedimentation, and alluvial fan sedimentation.

"Chemical controls on the precipitation of mineral analogues of dolomite: The sulphate enigma". ISPG McConnell Club, presented with D.W. Morrow.

"The chemistry of dolomite precipitation: The sulphate enigma". CSPG Petrology Division, March, 1987. Presented with D.W. Morrow.

G.G. Smith

"Coal potential of Niger (French West Africa); planning, execution and results of a study conducted for the Canadian International Development Agency". McConnell Club, Calgary, April, 1986.

"Possible solution to the energy crisis of French West Africa's Republic of Niger - a CIDA project". CSPG International Division, Calgary, May, 1986.

"Coal geoscience activities of the Geological Survey of Canada". Western Canada Coal Geoscience Forum, Calgary, November, 1986.

Membership on Committees

A.R. Cameron

International Committee for coal petrology.

Society of Organic Petrology.

Member of editorial board - International Journal of Coal Geology.

Chairman, Canadian Coal Petrographers Group.

Member ISPG Safety Committee.

F.M. Dawson

Coal Group Canadian Society of Petroleum Geologists.

ISPG McConnell Club Chairman.

ISPG Library Committee, member.

CSPG Devonian Symposium Organizing Committee, member.

D.W. Gibson

IGCP Correlation of Coal-Bearing Formations Project 166, national representative.
(Project completed in 1986)

J.D. Hughes

Technical Committee - Joint Federal-Provincial B.C.

Coal Data Collection Project, member.

ISPG Computer Committee, member.

CSPG Devonian Symposium Organizing Committee, member.

Coal Association of Canada Resources and Reserves Committee, member.

T. Jerzykiewicz

International Geological Correlation Program, Project 245: Nonmarine Cretaceous Correlations.

W.D. Kalkreuth

Member of International Committee for Coal Petrology.

Elected to council of Society for Organic Petrology.

Member of Canadian Coal Petrographers Group.

B.D. Ricketts

Editor, Joint CSPG/Open University of London project to produce an undergraduate level textbook on the Western Canada Basin.

ISPG Exhibits Committee, member.

G.G. Smith

OERD Task 2.2 Program Committee

General Chairman, Organizing Committee for Western Canada Coal Geoscience Forum.

Chairman, ISPG Management's Computer Subcommittee.

Technical Committee - Joint Federal-Provincial B.C.

Coal Data Collection Project, member.

Organic Petrology Laboratory

The workload in terms of samples processed increased significantly in 1986-87 compared to previous years. Samples processed for various uses are grouped as follows: 1710 pellets of coal and kerogen-bearing rock for inhouse determination of reflectance, fluorescence and/or maceral content; 40 specimens of oriented coal blocks for reflectance measurements; 350 samples of coal and rock for trace element analyses; 1800 samples of coal and rock partially prepared for petrographic analyses by outside contract. A number of the samples prepared for inhouse analyses required special treatment because the subject materials were oil shales, fossils (graptolites, chitinozoa) and coaly matter carbonized to various degrees as a result of heat treatment.

PETROLEUM RESOURCE APPRAISAL SECRETARIAT

R.M. Procter

The Secretariat, which is a small staff group within ISPG, was created early in 1980. The Secretariat's major responsibility is for the preparation of estimates of Canada's potential oil and gas resources, including the provision and testing of methodology, convening of evaluation meetings, final responsibility for estimates and preparation of reports. The Secretariat provides functional direction to the GSC petroleum resource evaluation activities at ISPG and AGC and liaison with geologists and geophysicists in Canada Oil and Gas Lands Administration (COGLA).

The results of resource evaluation work done by GSC is communicated to a Petroleum Resource Appraisal Panel, chaired by the ADM Petroleum and consisting of ADM's in Energy, Science and Technology plus representatives from INA and NEB. Panel meetings are held periodically to review specific resource base topics, identify priorities in evaluations, and to discuss oil and gas resource activity in general.

The Secretariat has a liaison role with petroleum exploration companies, other Federal Agencies, Provincial Government Agencies, and Universities as well as duties of a consultative nature when assigned to external (outside Canada) petroleum assessment matters.

Sedimentary Basin Syntheses and Regional Geological Syntheses as they relate to petroleum geology and assessment are done by the Secretariat for the GSC.

An additional role of the Secretariat is the curation of all resource estimate data and files and provision of data to downstream cost and supply analysis groups.

Highlights

- 1) A workshop on Petroleum Resource Assessment was presented, April 21-26, 1986 at Kuala Lumpur, Malaysia by Drs. Procter and Taylor in cooperation with two members of the U.S. Geological Survey, on behalf of International Union of Geological Sciences. Thirty-three participants from eleven East Asian countries attended the lectures where the GSC methodology was described using the geology of the Circum-Borneo region as the data-base. The instruction was supported by a workshop manual prepared by the GSC.
- 2) In June Dr. Procter with Drs. Nassichuk and Fyles, gave a presentation to the House of Commons Standing Committee on EMR in which the GSC approach to resource evaluation was described. The petroleum resources of various regions of Canada were also described in terms of reserves and potential.
- 3) In September, Drs. Taylor and Procter participated in a review of an economic analysis of remaining conventional oil resources of western Canada. The resource-base studies undertaken by GSC were the basis for economic studies conducted largely within the Energy Commodities Sector of EMR.
- 4) Drs. Taylor and Procter completed petroleum resource estimates and reports related to three disputed boundary areas. These were the Canada/Alaska boundary; the Dixon Entrance/USA boundary and the Canada/USA boundary in Juan de Fuca Strait.
- 5) Dr. Procter participated with Dr. Hea (EMR) and Mr. Campbell (COGLA) in a review of petroleum resource estimates prepared by the U.S. Department of Interior. The estimates of oil and gas potential of a part of the Alaska National Wildlife Refuge are contained in a draft report to U.S. Congress, recommending opening an environmentally sensitive area to petroleum exploration. The request for an evaluation of the estimates originated in External Affairs.
- 6) In December, Dr. Taylor participated with Dr. Hea and Mr. Christie (Energy Commodities Sector) in a review of remaining conventional oil resource potential of Canada, including an analysis of marginal economics, to a combined meeting of the Canadian Petroleum Association and the Independent Petroleum Association of Canada.

Personnel

The Secretariat currently consists of an Executive Director, three scientists, an engineer and a secretary:

Foo, A.G.	Secretary
Lee, P.J.	Senior Geologist - Resource Evaluation Methodology
McMillan, N.J.	Senior Petroleum Scientist - Basin Studies
Procter, R.M.	Executive Director
Raicar, M.	Senior Heavy Oil and Enhanced Recovery Engineer
Taylor, G.C.	Senior Petroleum Geologist

Attendance at Meetings Conferences and Courses

Lee, P.J.

15th Geochautauqua Conference, Calgary, October 1986.

Reserves 21, Canadian Society of Petroleum Geologists, Calgary, June 1986.

McMillan, N.J.

Exploration Overview, N.W.T., Yellowknife, December 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Taylor, G.C.

Reserves 21, Canadian Society of Petroleum Geologists, Calgary, June 1986.

Special Talks or Lectures

Lee, P.J.

"Hydrocarbon Resources in the Beaverhill Lake Group - An Example of Resource Assessment" Reserves 21, C.S.P.G., June 1986.

"Conventional Oil Resources of Western Canada - Predicting Remaining Potential" Reserves 21, C.S.P.G., June 1986.

"Resource Potential - Estimating Methodology" C.S.P.G. Computer Application Section, June 1986.

McMillan, N.J.

"Fossil Forests in the far North, Arctic Islands, N.W.T." Exploration Overview, Yellowknife, December 1986.

Charles Camsell Annual Lecture - Exploration Overview, Yellowknife, December 1986.

"The Early Tertiary Fossil Forests, Axel Heiberg Island - Ellesmere Island" Current Activities Forum, Ottawa, December 1986.

Procter, R.M.

"Petroleum Resource Assessment East Asia Workshop" CCOP-IUGS-ASCOPE Sponsored Six Day Workshop, Kuala Lumpur, April 1986.

"Resource Assessment" Parliamentary Standing Committee on EMR, Ottawa, June 1986.

"Conventional Oil Resources Western Canada" U.S. Department of Energy, Washington, D.C., November 1986.

Taylor, G.C.

"Petroleum Resource Assessment East Asia Workshop" CCOP-IUGS-ASCOPE Sponsored Six Day Workshop, Kuala Lumpur, April 1986.

"Conventional Oil Resources of Western Canada" Reserves 21, C.S.P.G., Calgary, June 1986.

"Economic Analysis, Western Canada Conventional Oil Resources" Presentation to PANEL, Ottawa, September 1986.

"Western Canada Oil Resources" Ottawa Section CIMM, September 1986.

"Convention Oil Resources Western Canada" Special Meeting CPA-IPAC, Calgary, December 1986.

Membership on Committees

Procter, R.M.

ISPG Management Committee to Review Computer Services at ISPG.

International Union of Geological Sciences Committee on Basin Analysis for Resource Evaluation.

Taylor, G.C.

Chairman, Canadian Hydrocarbon Potential Committee.

Lee, P.J.

Canadian Hydrocarbon Potential Committee.

Computer Management Committee.

McMillan, N.J.

NSERC - Oceans Panel. Elected for 3 years.

Canadian Society of Petroleum Geologists:

- a) Geolog
- b) Publication and Sales
- c) Honorary Membership Committee
- d) Editor of Proceedings, Second International Symposium on the Devonian System, Calgary, August, 1987

Ph.D. Committee of University of British Columbia.

Staff - Petroleum Resource Appraisal Secretariat

Mini workshops and briefings to ASEAN Council, China, Japan, Korea, Brazil, Columbia, Ghana; Esso, Shell, Arco, Tennaco, Conoco, Elf-Aquitaine.

GEOLOGICAL PUBLICATIONS SUBDIVISION

N.C. Ollerenshaw

This subdivision is responsible for ensuring that publications resulting from the Institute's scientific programs meet accepted high standards. This is achieved mainly through the screening and processing of manuscripts for publication in the Geological Survey's own series of papers, bulletins and memoirs, and in established national and international scientific and technical journals. Items of immediate interest, requiring rapid publication, are made available through an Open File system. In support of this objective, the Subdivision maintains capabilities and facilities in scientific editing, cartography, technical photography, word processing and phototypesetting. In addition, the Subdivision maintains a large inventory of, and operates as a retail outlet for, all Geological Survey papers, bulletins, memoirs and geological maps, and departmental topographic maps for Western Canada and the Canadian Arctic. The Subdivision communicates with the scientific community and the public by responding to direct requests for information, by preparing semi-popular articles and displays, by sending news reports to technical and scientific journals and newsletters, by lectures, and by participating in the work of committees and associations.

During the past year, the editorial staff processed 38 reports, 71 outside papers, 44 abstracts, and 11 open file reports. Processing of manuscripts involves the selection of critical readers and the evaluation of their reports, scientific editing, copy editing, proofreading and, in the case of GSC reports, the layout of the publication.

Most maps and illustrations produced by Institute scientists for publication are prepared in the Cartography Section. To expedite publication, some are now prepared by the scientists themselves with the advice and guidance of Cartography Section staff. The work of the Section includes both black-and-white and multicoloured illustrations in addition to photomechanical and reproduction work. The Section also prepares slides for oral presentations and large graphic displays for workshops, meetings, and for information exchanges with universities. Good contacts are maintained with the local university and technical institute, lectures are given and students receive guided tours through our cartographic facilities as part of their course work.

The Photographic Section provides general and specialized photographic services for the Institute staff. Preparation of paleontological plates is possibly its most demanding and unique function. This entails photographing fossils from various key angles and, together with microphotography, involves about 40 per cent of the Section's effort. Copy work accounts for close to 50 per cent of staff time. Miscellaneous activities include I.D. and passport photography, specialized photographic work for some other Government departments, and an increasing amount of publicity work illustrating personnel and equipment in action.

The Word Processing Centre produces all the Institute's manuscript copy for scientific papers, ranging from initial drafts to the the final, camera-ready copy for the printer. This year, some 40,000 pages were processed. In addition, some 456 letters and memoranda were typed as a special service. ISPG uses a network of 13 Xerox workstations and two microcomputers to process and transfer both copy and data. A phototypesetter, acquired in 1985, has been used extensively in the preparation of cartographic type.

The Institute's Publications and Air Photo Section, the largest, retail operation of its kind in Western Canada, reported a decrease in sales during the fiscal year (as the graph at the conclusion of this report illustrates). Sales trends are normally seasonal and also reflect the decrease in exploration activity experienced in the Western Canadian oil production sector owing to the decline in world market prices. Sales of publications and maps, however, did increase slightly in the fourth quarter. In May of 1986, a systems audit of the Publications and Air Photo Section was undertaken by representatives of the Canada Map Office. This resulted in several procedural changes that have proved of benefit to both groups.

Personnel Notes

Dr. N.C. Ollerenshaw was elected to a three year term as a Director of the Association of Earth Science Editors.

J. Stevenson joined the Word Processing Centre as an operator on September 15th, 1986.

On November 17th, 1986, C. Boyle was appointed to a drafting position in the Cartography Unit.

In March of 1987, L. Machan-Gorham returned to the editorial unit after an absence of 5 months (maternity leave).

E. Snow was seconded from Regional Geology to act as Editorial Assistant during L. Machan-Gorham's absence.

Attendance at Meetings Conferences and Courses

N.C. Ollerenshaw

Visit to GID/GSC Ottawa, April 2-4th, 1986.

Western Canada Coal Geoscience Forum, November 17-19, 1986, Calgary, Alberta.

J. MacGillivray

Visit to GID/GSC Ottawa, April 3-4th, 1986.

Association of Earth Science Editors, Annual Meeting, Duluth, Minnesota, October 5-8th, 1986.

Career Advancement Seminar for Women, Calgary, March 16-20, 1987.

B.C. Rutley

Trade show sponsored by the Alberta Professional Photographers' Association, Calgary, June 7-8, 1986.

W.B. Sharman

Trade show sponsored by the Alberta Professional Photographers' Association, Calgary, June 7-8, 1986.

P.L. Greener

Compugraphic System Course, "Advanced MCS 100 and Power Page", Calgary, April 21-25th, 1986.

Career Advancement Seminar for Women, Calgary, March 16-20th, 1987.

H. King

Compugraphic System Course, "Advanced MCS 100 and Power Page", Calgary, April 21-25th, 1986.

Career Advancement Seminar for Women, Calgary, March 16-20th, 1987.

M.L. Jacobs

Career Advancement Seminar for Women, Calgary, March 16-20th, 1987.

J. Stevenson

Career Advancement Seminar for Women, Calgary, March 16-20th, 1987.

S. Young

Career Advancement Seminar for Women, Calgary, March 16-20th, 1987.

J. Spirritts

Career Advancement Seminar for Women, Calgary, March 16-20th, 1987.

Special Talks or Lectures

N.C. Ollerenshaw

"Stratigraphy of the Elk Formation (Kootenay Group) in the Fernie Basin, southeastern British Columbia"; (with D.A. Grieve); Western Canada Coal Geoscience Forum, Calgary, November 17-19th, 1986.

Membership on Committees

N.C. Ollerenshaw

Director, 1987-1989, Association of Earth Science Editors.

Liaison between the Association of Earth Science Editors' Organizing Committee and Board for planning of 1989 meeting in Ottawa.

ISPG Stratigraphic Nomenclature Committee, member.

B.C. Rutley

ISPG Support Staff Field Trip Committee, member.

ISPG Support Staff Field Trip Committee, member.

G.N. Edwards

Safety Committee, member.

L. Wardle

Safety Committee, member.

S.D. Orzeck

Safety Committee, member.

STATISTICS ON SUBDIVISION ACTIVITIES
(April 1, 1986 — March 31, 1987)

Scientific Editor's Office

Format	Received	Edited/ Approved	To Ottawa or Publisher	Printed
Memoirs	0	2	2	1
Bulletins	14	4	4	2
Papers	6	1	2	2
86-1B	2	22	22	22
87-1A	12	9	9	9
Maps	0	0	0	1
Open Files	14	11	11	13
<u>Outside</u>				
Papers	83	71	71	52
Abstracts	44	44	44	24
Total	175	164	168	125

Word Processing Centre

Letters	300
Memos	156
Tables	677
Blue-line pages	10,802
8 1/2 x 11 pages	23,884
8 1/2 x 14 pages	3698
Miscellaneous items	2105

Compugraphic (Typesetting)

Paper (8 1/2" x 11")	200
Film (8 1/2" x 11")	98

Maps and figures completed by the Cartography Section between April 1, 1986 and March 31, 1987.

	1985-1986	1986-1987
Multicolour maps and section sheets	9	7
Figure illustrations (page)	354	346
Figure illustrations (pocket)	7	0

Manuscripts received	1985-1986	1986-1987
Multicolour geological maps	13	1
Figure illustrations (page)	380	438
Figure illustrations (pocket)	4	1

Maps and illustrations in progress on March 31

	1985-1986	1986-1987
Multicolour geological maps	3	3
Figure illustrations (page)	199	209
Figure illustrations (pocket)	0	1

Miscellaneous drafting which averaged approximately 20% of the total drafting time comprised 2483 separate items of which 321 were slides.

Reproduction services	1985-1986	1986-1987
Diazo prints	5922	4441
Diazo prints (frame shots)	285	272
Di-chrome	243	482

Photomechanical services

Film (sheets, negatives and positives)	3359	4242
Drafting keys on scribe-coat	51	168
Blue-line on Cronaflex	-	11
Colour proofs	18	23
Peelcoats	125	112
KC-5 prints	1962	2748
Autopositives (multiple exposure)	541	713
Sepia (dry erasable film)	126	112

Camera services

Film shots (line)	3821	2890
Film shots (halftone)	159	232
Paper	80	206
Ektaflex	-	32

Photography Section

Production during the review years
1985-86 and 1986-87

	1985-1986	1986-1987
Total number of black and white, continuous tone 4" x 5" negatives	1517	1245

Total number of black and white prints	11 970	10 015
Total number of contact proof sheets	1184	1288
Total number of 35 mm films (black and white and colour) submitted for processing by staff members	244	239
Total number of black and white 35 mm negative films	187	226
Total number of 35 mm colour slide films	197	276
Total number of colour negatives on file	1960	2138
Total number of colour prints	4065	3881

Publications and Airphoto Section

Breakdown of Sales

	<u>1985-1986</u>	<u>1986-1987</u>
Surveys and Mapping	\$ 118,524.40	\$ 87,356.00
National Air Photo Library	8,714.53	15,829.18
GSC Maps	15,005.55	17,172.12
Rock and Mineral Kits	1,516.00	2,144.00
Miscellaneous GSC Material	1,730.50	1,022.60
GSC Publications	18,070.30	14,010.30
Mineral Policy Sector	198.20	322.45
TOTAL SALES	\$163,759.48	\$137,856.65

Breakdown of Accounts

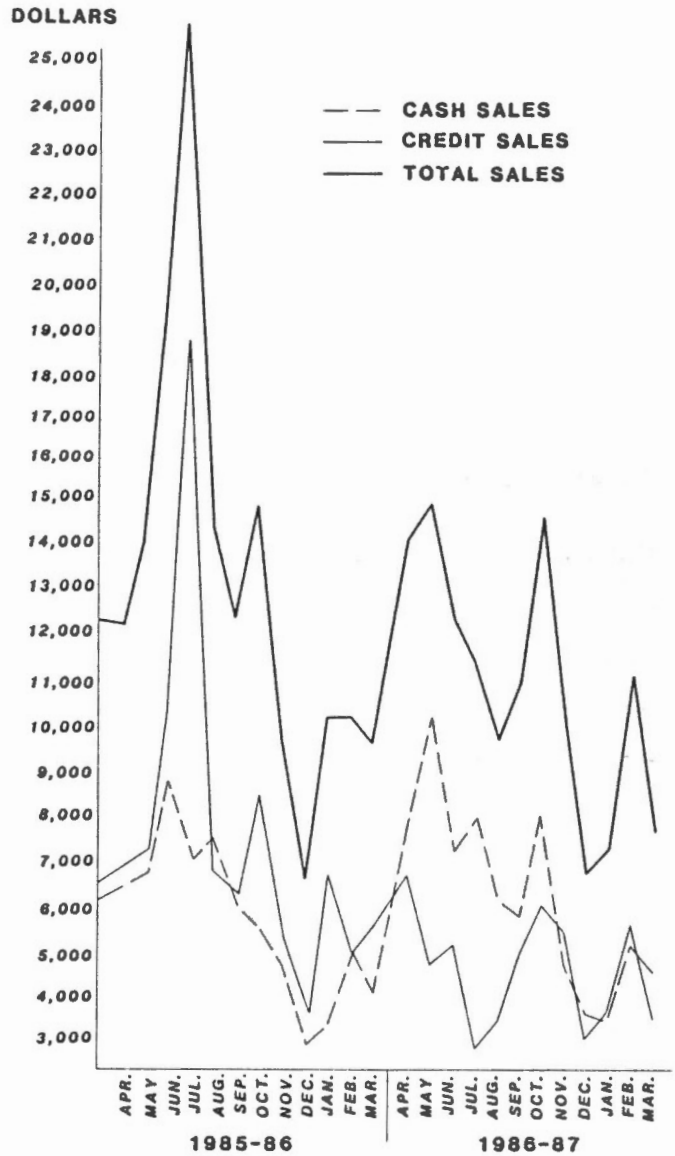
	<u>1985-1986</u>	<u>1986-1987</u>
Credit Sales	\$ 92,749.25	\$ 56,259.00
Cash Sales	\$ 68,575.33	\$ 77,815.85
Received On Account	\$ 95,184.15	\$ 60,040.80

Air Photos

A total of 191 orders (147 prepaid) were forwarded to Ottawa during the year. These consisted of:

- 4852 Black and white contact prints
- 2 ITEK prints
- 6 Colour contact prints
- 71 Flight line index maps
- 27 Black and white diapositives
- 2 Landsat mosaics
- 2 Landsat slide sets
- 1 20" x 20" transparency enlargements
- 9 10" x 10" black and white enlargements
- 38 15" x 15" black and white enlargements
- 135 20" x 20" black and white enlargements
- 15 30" x 30" black and white enlargements
- 38 40" x 40" black and white enlargements

A graph illustrating sales trends follows:



DATA MANAGEMENT SECTION

Ken N. Nairn

The Data Management Section provides computer facilities and support to all subdivisions within the Institute with a permanent staff of 3 analysts and 1 additional analyst seconded to the group. There are over 50 personal computers and terminals connected to the central facility (based on a Hewlett-Packard system) which provides laser printing, plotting, processing and file storage services.

The Well database system has undergone 2 major revisions in capability in response to requests for enhancement by the Institute's Petroleum Geologists. Alberta, Saskatchewan and Canada Land's well data have been made available and are being used to prepare analytical and structure maps in several Institute projects. As well, the retrieval system is being made available to COGLA personnel by telephone/terminal facilities.

Data Management has cooperated with the Petroleum Subdivision to produce a paper and program on the analysis and synthesis of Burial History and Thermal Maturity of a stratigraphic section.

Further work in Statistical Methodology has been undertaken cooperatively with the Coal Technology Section to apply Canonical Correlation, Fuzzy Analysis and related statistical concepts to the analysis of petrographic data. The results of this analysis was presented in the form of papers and posters to the Coal Forum in mid-November.

The Coal Resource database system has been defined and programmed. This system provides for an inventory of all assessments undertaken by the Coal Resource Assessment group in a form that provides for reports and summations of Canada-wide totals.

An effort is underway to convert FORTRAN/3000 programs to industry standard FORTRAN 77 in preparation for the installation of an upgraded computer facility scheduled for September, 1987. Some 250 programs are being inventoried prior to the main conversion effort.

The Data Management section defined and requisitioned upgrades to both the XEROX Word Processing System and the Hewlett-Packard 3000 Computer System. In both instances, the economy of maintenance of newer technology equipment completely offset the increment of lease costs for the newer, more capable equipment.

The Division Management Committee struck a Computer review committee to investigate the state of computing services in the Institute and to recommend ways of prioritizing the section's services to correspond to geo-scientific priorities within the Institute's project system. Their recommendations are currently under study and implementation.

Attendance at Meetings Conferences and Courses

K.N. Nairn

HP3000 User Symposia, Detroit.

M. Labonte

M.B. Foster Communications Symposia, Ottawa.
MINISIS Conference, Ottawa.

Personnel Notes

K. Mottershead left for maternity leave, successfully delivering a new system programmer.

D. Lepard was promoted to CS-3, rewarding his prodigious output as a system designer and implementer.

M. Labonte has been seconded to the Coal Subdivision to permit fuller liaison with F. Goodarzi and D. Hughes in the development of Coal Assessment Statistics methodology.

LITHOSPHERE AND CANADIAN SHIELD DIVISION

J.C. McGlynn, Director

INTRODUCTION

The Division is responsible for all aspects of the bedrock geological framework of the Canadian Shield as well as serving as a national centre for studies of the Canadian lithosphere.

The objectives of the Division are: To ensure the availability of comprehensive knowledge, technology and expertise concerning the deep geology and geophysics of the Canadian lithosphere; concerning the bedrock geology of the Canadian Shield, particularly with reference to mineral deposits; and concerning geochronology and paleomagnetism in Canada. Specifically, the division is responsible for the bedrock geology, tectonics, gravity, magnetics and seismic studies within the Canadian Shield and within the Appalachians in New Brunswick, Nova Scotia and Newfoundland.

The division serves as a national centre for non-Quaternary geochronology, for petrological studies, for paleomagnetic studies and for studies of the Canadian lithosphere, using a multi-disciplinary approach with emphasis on the integration of geological and geophysical (seismic, electromagnetic, gravity and aeromagnetic) data.

The Division is organized into seven sections and a special projects group. Three of the sections are responsible for the regional geology of the Canadian Shield and are named after the structural provinces in which they work; Bear-Slave, Northern Churchill and Superior-Grenville. These sections report their bedrock studies on geological maps at various scales and in reports and scientific papers. The Geochronology, Petrology and Paleomagnetic sections provide isotopic, petrologic and paleomagnetic studies by which age relations and processes of formation of rock assemblages are established. The Lithospheric Geophysics Section provides seismic, electromagnetic, gravity and aeromagnetic studies to define the deep crustal structure of the Canadian lithosphere. Special studies in the Division undertake bedrock studies in volcanology, Precambrian stratigraphy and Lower Paleozoic geology of Eastern Canada.

The mix of disciplines in the Division makes possible multidisciplinary studies and increasingly groups of scientists with a variety of expertise will focus on important national problems or on critical regional tectonic zones as well as on deep crustal studies. Priorities include application and testing of plate tectonic theory to Precambrian and deep crustal studies.

The establishment consists of 89 person-years for indeterminate staff, 11 person-years for employment of term research assistants and students for summer field work and 7.50 person-years for research scientists and assistants employed on the federal-provincial mineral development agreements, the Asbestos Initiatives Program and the Frontier Geoscience Program.

Personnel Notes

E. Stevens joined the Division in April as Division Administrative Officer.

B. Cox retired from her secretarial position after 23 years of service with the GSC.

C. Bencik retired from his position as cartographic draftsman for the regional geology sections after 25 years of service.

D. Wereley accepted a lateral transfer in November to the Department of Supply and Services.

G. Allen accepted a CR-4 position in the Division Administrative Office effective January.

Mrs. He Shuyan, a visiting scientist from the Geological University of China, Beijing, spent the year working with division scientists.

T. West accepted a term draftsman position with the Division effective November.

ADMINISTRATION

Membership on Committees

J.C. McGlynn

Northwest Territories Co-ordinating Committee on Work in the North.

International Union of Geological Sciences, corresponding member

Canada Safety Code Committee, Member.

BEAR-SLAVE SECTION

M.B. Lambert (Head)

Highlights

Ongoing investigations across the transition from the Archean Slave Province to the Proterozoic Thelon Tectonic Zone (TTZ) of the western Churchill Province resulted in completion of a 1:250 000 scale geological map of the Artillery Lake area. Detailed gravity profiles across the central part of the TTZ between the Bathurst and MacDonald faults outlines a major composite paired gravity anomaly that suggest a large scale deep crustal structure in contrast to the Thelon magnetic anomaly which reflects a near surface effect.

Structural investigations in the northern Tinney Hills-Overby Lake areas suggest a major synmetamorphic Archean thrusting event west of the Thelon Tectonic Zone and Proterozoic structures related to oblique continental convergence in the TTZ. Zircon geochronology confirms the Archean age (2650-2560 Ma) for the main metamorphic and plutonic events west of the TTZ and the continuity of Archean rocks across the western boundary of the zone, and demonstrates the presence of major Proterozoic magmatic, metamorphic and deformation events (2000-1900 Ma) in the TTZ.

A synthesis of stratigraphic, structural, metamorphic and geochronological data from Wopmay Orogen shows that regional metamorphism is the result of three overlapping, thermally additive, thermotectonic regimes: (1) onset of metamorphism during crustal thinning, (2) plutonic heat advection during crustal shortening, and (3) thermal relaxation, concurrent with uplift, as a consequence of crustal thickening.

Structural studies in the metamorphic-internal zone of the Wopmay Orogen outlined contrasting processes by which autochthonous and allochthonous basement were deformed. The Archean Kapvik granite cores a hanging-wall anticline within a thin-skinned fault system at high structural levels of the orogen. The probably allochthonous Kaiser Gneiss Complex is, together with part of its cover units, infolded with allochthonous rift-facies units. Autochthonous Archean units that core the Exmouth Antiform at low structural levels accommodated Proterozoic deformation by tight folding, and moderately developed cleavage and hinge-parallel extension. Basement-cored structural culminations in the Emile River area are part of a Type 1 interference pattern that is superposed on an earlier set of recumbent isoclinal folds. All phases of the deformation in the Emile River area are correlative with deformation defined in the northern part of the Orogen. Significant strike-parallel displacement and extension were recognized within the metamorphic-internal zone of the orogen. Kinematic studies of shear zones documented transpressional deformation during Calderian deformation.

Continued compilation of map data for Asiatic Thrust-Fold belt led to the recognition that at least some ramps nucleate within the accretionary wedge, as opposed to propagation up from the decollement. In addition, a partial explanation for the large slip and wide spacing of frontal ramps in collision zones has been developed, based on the mechanics of subareal (and therefore eroding) accretionary wedges compared to their subaqueous counterparts.

In the Calder River map-area mylonites, of unknown age that developed from Archean granitoids, occur over a 10 km width straddling the Wopmay shear zone. Kinematic indicators suggest movement to the north orthogonal to Calderian shortening and therefore probably pre-Calderian in age. The eastern margin of the Great Slave Magmatic zone is an unconformity and the oldest rocks of the belt (Dumas Group) lie above Archean granitoids and mylonites. Archean basement, mylonites, Coronation Supergroup and the Dumas Group were tightly folded about north-south axes just prior to, or during, development of the regional transcurrent faults, which bend, splay and die out as they approach the folded zone.

In the southern Slave Province ultramafic bodies were discovered within structurally complex tectonic margins between the Cameron River and Beaulieu River volcanic belts and the Sleepy Dragon basement terrain. Locally slivers of basement gneisses are tectonically interleaved within the Beaulieu volcanic belt which hosts four periods of deformation. East of Sunset Lake a major mafic dyke swarm comprises densely packed multiple intrusions separated by screens of mylonitic granite. A shear zone marks the boundary between the dyke swarm and the volcanic belt.

In the Fort Smith, Fort Resolution and Taltson Lake areas, zircon and monazite geochronology permit correlation of major plutonic events with plutonism in the Thelon Tectonic Zone. The plutons and related metamorphism support the interpretation that the Taltson Magmatic Zone reflects subduction along a plate margin to the west, now hidden by the Paleozoic overlap, that is related to Thelon Tectonic Zone by a major transcurrent shear, The Great Slave Shear Zone. Tourmaline-bearing pegmatites discovered in the southern part of the Taltson Lake map-area are potentially related to magmatism in the Taltson Magmatic Zone and are younger than allanite-bearing pegmatites which occur in the gneisses east of the zone.

Continuation of work in the Himalayas (NW Pakistan) recognized the composite nature of the Karakorum Batholith and the complex structure of its host rock. New data consists of K-Ar dates on plutonic rocks (208-142 Ma), the documentation of associated low pressure metamorphic assemblages, and the recognition of additional ultramafic lenses not associated with established sutures. U-Pb and K-Ar geochronology established that the batholith comprises at least two major plutonic units - a deformed Late Cretaceous suite, and a volumetrically more important Miocene granite. This work shows that subalkaline batholiths may be emplaced in collisional settings 30 m.y. after final subduction of oceanic crust. The "Karakorum Plate", into which these plutons intruded, is a large-scale tectonic melange including a belt of ultramafic lenses. It formed prior to the intrusion of the main phase batholith, and may correlate with a late Jurassic-early Cretaceous (Banggong-Nujiang) suture in Tibet.

Personnel Notes

J.P. Grotzinger accepted a 3-month term position to continue work in the Bathurst Inlet area, NWT.

K. Manser and W.J. Davis were employed as term research assistants for the Section.

Attendance at Meetings, Conferences and Courses

J.B. Henderson

Geological Association of Canada, Annual Meeting, Ottawa, May.

GSC Current Activities Forum, Ottawa, January.

R.S. Hildebrand

Geological Association of Canada, Annual Meeting, Ottawa, May.

Hawaii Symposium on How Volcanoes Work, Hilo, Hawaii, U.S.A., January.

J. King

Geological Association of Canada, Annual Meeting, Ottawa, May.

Canadian Tectonics Group, Annual Meeting, Sudbury, Ontario, September.

Western Roundup, GSC, Vancouver, B.C., January.

M.B. Lambert

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting and short course, "Silicate Melts", Ottawa, May.

Hawaii Symposium on How Volcanoes Work, Hilo, Hawaii, U.S.A., January.

P.H. Thompson

Geological Association of Canada, Annual Meeting, Ottawa, May.

R. Tirrul

Canadian Tectonics Working Group Meeting, Sudbury, Ontario, October.

Geological Society of America, Annual Meeting, San Antonio, Texas, U.S.A., November.

GSC Current Activities Forum, Ottawa, January.

Membership on Committees

A. Frith

TFSS Field Equipment Committee, National Liaison Officer.

R.S. Hildebrand

Geological Association of Canada, Precambrian Division, secretary-treasurer.

GSC Logan Club, chairman.

I.C.L. Task Group on Variations in the Nature and Evolution of Mobile Belts, member.

International Geological Correlation Project, Working Group 217, Proterozoic Geochemistry, Canadian group leader.

International Association of Volcanology and Chemistry of the Earth's Interior, Working Group on Explosive Volcanism, member.

M.B. Lambert

International Association of Volcanology and Chemistry of the Earth's Interior, vice-secretary.

P.H. Thompson

Member of Review Board: Journal of Metamorphic Geology.

Subcommission on the Systematics of Metamorphic Rocks, working group member.

International Geological Correlation Project 235, Evolution of Metamorphic Belts, Canadian contact person.

Special Talks and Lectures

H.H. Bostock

"The Talston Magmatic Zone", Precambrian High, Ottawa, January.

R.S. Hildebrand

"Evolving magmatism and tectonism in an early Proterozoic Cordilleran-type plate margin: Wopmay Orogen", University of Hawaii at Manoa, Hawaii, U.S.A., January.

"Great Bear magmatic zone: An early Proterozoic magmatic arc", University of Hawaii at Manoa, Hawaii, U.S.A., February.

J. King

"Structure of the metamorphic-internal zone, Wopmay Orogen, Northwest Territories", Virginia Polytechnical Institute, Blacksburg, Va., U.S.A., April.

"Tectonic history of the metamorphic-internal zone of Wopmay Orogen, NWT, Canada", Brown University, Providence, R.I., U.S.A., May.

"Structure of the metamorphic-internal zone of Wopmay Orogen, NWT: thin-and thick-skinned deformation", University of Toronto, Erindale Campus, Toronto, Ontario, November.

"The structural evolution of the metamorphic-internal zone of Wopmay Orogen, NWT", University of British Columbia, Vancouver, B.C., January.

"The tectonic history of Wopmay Orogen", Queen's University, Kingston, Ontario, March.

P.H. Thompson

"The Thelon Tectonic Zone - an Archean ensialic mobile belt? and "Regional Metamorphism in Time and Space", University of Iowa, Iowa, U.S.A., October.

R. Tirrul

"Himalaya Tectonics", Carleton University, Ottawa, March.

Manuscripts submitted

2 open file maps, 2 'A' Series maps, 2 GSC papers, 6 Current Research papers, 5 external publications, 5 abstracts.

NORTHERN CHURCHILL SECTION

A.N. LeCheminant (Head)

Highlights

1:250 000 scale mapping continues to be the major focus of research in the northwest Churchill Province. A new project was initiated to map northern Boothia Peninsula and southern Somerset Island. Mapping continued in northern Melville Peninsula, in the vicinity of Wager Bay and in the Chesterfield Inlet area. Petrologic and isotopic studies in previously mapped areas have provided new understanding of the complex Archean and Proterozoic history of the northwest Churchill Province.

The Precambrian core of Boothia Uplift is a medium-pressure granulite terrane made up of a central north-trending granitoid gneiss belt flanked by supracrustal sequences containing aluminous paragneiss and marble. Three phases of folding are recognized. Predominant third phase folds control the steep N-S regional structural grain. Pre- or syntectonic intrusive rocks include two-pyroxene amphibolite, ultramafite and syenite. Field work included hosting a 10-day visit by two Soviet geologists studying granulite gneiss terranes under terms of the Canada-USSR Arctic Science Exchange Protocol.

Zircon chronology has identified a major early Proterozoic tectonothermal event in Ellesmere Island. Granitoid plutons dated at about 1.95 Ga were emplaced shortly before or during granulite facies metamorphism and deformation. In southern Devon Island granulite facies orthogneisses have late Archean U-Pb zircon ages and the extent of Proterozoic deformation and metamorphism has not yet been determined.

The Encampment Bay area of northwestern Melville Peninsula is underlain by strongly sheared granulite-grade tonalitic-granodioritic plutonic rocks cut by granite and mafic dykes. Mapping in the 1986 field season identified steep northeast-trending shear zones that retrograde the metaplutonic suite and contain slivers of metasedimentary rocks and metagabbros provisionally correlated with the Archean Prince Albert Group. These shear zones contain extensive pyritic gossans. Geochemistry of low-grade volcanic rocks of the Prince Albert Group previously mapped around Richards Bay to the northeast of the granulite complex shows the flows range in composition from dacite to komatiite. Differences in the composition of ultramafic and basaltic lavas may be due to variable contamination of mantle-derived ultramafic melts by melting of lower crustal rocks during ascent in a tensional tectonic setting. Oxide facies iron formation is closely associated with the lavas but no significant sulphide occurrences are known.

The Wager Bay Shear Zone is a major east-west striking ductile dextral transcurrent shear. Mapping near Wager Bay indicates shear strain across the zone is very inhomogeneous. A high strain amphibolite-grade mylonite at least 2 km wide occurs along the northern boundary of the zone but dextral mylonite fabrics persist up to 30 km to the south. Dextral shear-related fabrics mapped in northeastern Southampton Island indicate that the shear zone extends at least 170 km east of Wager Bay. Aeromagnetic anomalies suggest the zone continues about 135 km to the west where it may be related to the Amer Mylonite Zone as one element in a crustal-scale right-stepping dextral transtensional shear system with a minimum strike length of 700 km. A northeast-trending belt of I-type calc-alkaline plutons exposed northwest of Wager Bay comprises large intrusions of megacrystic granite/granodiorite (U-Pb zircon; 1823-1826 Ma) with smaller bodies of monzodiorite, diorite and gabbro. The plutonic belt is truncated to the south by the Wager Bay Shear Zone. A small pluton of biotite granite dated at 1811 Ma and sheared along its southern contact establishes the maximum age for late movement on the shear zone.

In the Chesterfield Inlet region metamorphic grade increases from south to north. In the south low-grade volcanic and sedimentary rocks of the (?)Archean Rankin Inlet Group comprise two major mafic volcanic cycles with intervening turbidite deposition. Ultramafic and layered gabbro sills occur within the volcanic sequences. Chemically the mafic lavas and gabbros are Fe-Mg-rich tholeiites similar to Archean tholeiites in the Slave and Superior provinces.

The ultramafic sills are chemically distinct and probably not genetically related to the tholeiitic suite. The greenschist to lower amphibolite grade Rankin Inlet Group overlies higher grade gneissic rocks to the north with apparent conformity. Regional metamorphism and migmatization of the polydeformed northern gneiss terrane was contemporaneous with syntectonic emplacement of granitoid plutons. Metamorphic conditions increase from amphibolite- to granulite-grade north of Chesterfield Inlet. The age of deformation and metamorphism is considered to be Archean but definitive geochronology is required.

In the Baker Lake region zircon chronology has defined two periods of Archean magmatism followed by Archean and Proterozoic orogenesis and 1.75-1.9 Ga anorogenic magmatism. The older Archean volcanic suite (2.66-2.8 Ga) is bimodal and dominated by rhyolite, basalt and komatiite. A younger episode of Archean felsic magmatism at 2.58-2.61 Ga is characterized by emplacement of large granite plutons associated with dacitic and rhyolitic flows. Extensive Proterozoic anorogenic magmatism accompanied the uplift and extension of the variably reworked Archean terrane. Plutons of fluorite granite emplaced at about 1.88 Ga were intruded by potassic lamprophyre dykes and pyroxenite-syenite stocks at 1.84-1.85 Ga. The upper mantle source region for the potassic alkaline magmas was strongly enriched in most incompatible elements. Nd model ages (T_{DM}) of 2.7-2.9 Ga point to long-term LREE enrichment in the magma source and suggests that the minimum age for craton stabilization in the region is about 2.9 Ga. Widespread felsic magmatism at 1.75-1.78 Ga, indicated by high-silica fluorine-rich rhyolites and epizonal granites, implies melting of a lower crustal source. Inheritance of an older, typically Archean, Pb component is invariably detected in U-Pb zircon data. This is probably a consequence of the low solubility of residual zircon from the Archean source region in the granitic melts.

Middle Proterozoic reefs in the Borden Rift Basin of northwestern Baffin Island have been more fully described. Extensive carbonate platforms of the middle and upper Bylot Supergroup contain bioherm-reef complexes that developed in a stable shelf environment on a passive continental margin. The stable environment ended abruptly with regional reactivation of rifting and the reef complexes were buried by submarine fan deposits. Nanisivik Mines' lead-zinc ore body occurs in the Society Cliffs Formation. This formation, especially the biohermal buildups, may have been the main lead-zinc source; traces of sphalerite and galena are common throughout much of the formation.

Personnel Notes

A. Fraser retired from his research scientist position after 31 years of service with the GSC.

I. Annesley and L. Adamitz were employed as term research assistants for the Section.

Attendance at Meetings, Conferences and Courses

T. Frisch

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

International Symposium on Granites and Associated Mineralizations, Salvador, Brazil, January.

J.R. Henderson

Geological Association of Canada, Annual Meeting, Ottawa, May.

Field Trip: A new look at the Grenville Front in Ontario; Killarney River Valley, Ontario, May.

Gold '86, Toronto, Ontario, September.

Field Trip: Friends of the Grenville: Precambrian Stratigraphy of the Northwest Adirondacks, Gouverneur, New York, U.S.A., October.

Conference/Field Trip: Canadian Tectonics Group, Sudbury, Ontario, October.

A.N. LeCheminant

IGCP/Geological Society of London Symposium on Geochemistry and Mineralization of Proterozoic Volcanic Suites, Keyworth, U.K., April.

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

Gold '86, Toronto, Ontario, September.

Geological Society of America, Annual Meeting, San Antonio, Texas, U.S.A., November.

GSC Current Activities Forum, Ottawa, January

S. Tella

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

Canadian Tectonics Group Meeting, Sudbury, Ontario, October.

14th Annual Geoscience Forum, Yellowknife, NWT, December.

Membership on Committees

J.R. Henderson

Geological Association of Canada, Structural Geology and Tectonics Division, secretary.

A.N. LeCheminant

Joint Occupational Safety and Health Committee, member.

S. Tella

Building Fire Emergency Organization, member.

Special Talks and Lectures

T. Frisch

"Geochemistry of granulite facies metabasalts and quartzo-feldspathic gneisses from the northernmost Churchill Province, Arctic Canada", (poster presentation), Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

"Granulite-facies analogues of I- and S-type granitoids in the northernmost Canadian Shield, Arctic Canada", International Symposium on Granites and Associated Mineralizations, Salvador, Brazil, January.

J.R. Henderson

"Sense of movement across the Wager Bay shear zone", Geological Association of Canada, Ottawa, May.

"Are asymmetrical folds reliable shear criteria in mylonite zones?", Canadian Tectonics Group meeting, Sudbury, Ontario, October.

"Timing of gold mineralization in the Meguma Zone, Nova Scotia", Ecole Polytechnique, Montreal, Quebec, December.

G.D. Jackson

"Borden Rift Basin", Precambrian High, GSC, Ottawa, October.

A.N. LeCheminant

"Early Proterozoic alkaline igneous rocks, Keewatin, Canada: petrogenesis and mineralization", IGCP/Geological Society of London Symposium, Keyworth, U.K., April.

"Isotopic evidence for multiple enrichment events from mica-lamprophyre dykes in the District of Keewatin, Canada", Geological Society of America, Annual Meeting, San Antonio, Texas, U.S.A., November.

S. Tella

"On Rankin Inlet Homocline", Precambrian High, GSC, Ottawa, May.

"The geology and structure of the Rankin Inlet region, District of Keewatin, NWT", Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

"Structural studies in Rankin Inlet Region", Canadian Tectonics Group Meeting, Sudbury, Ontario, October.

"Structure and geochemistry of the Rankin Inlet Group, Rankin Inlet, NWT", 14th Annual Geoscience Forum, Yellowknife, NWT, December.

Manuscripts submitted

3 Current Research papers, 1 memoir, 5 abstracts, 2 'A' series maps, 2 GSC papers, 1 open file report with maps, 4 outside publications.

A. Davidson (Head)

Highlights

A project to map and study a granulite facies terrane in the Superior Province, the Ashuanipi complex, was initiated in the western half of the Schefferville map area (NTS 23J). Mapping at 1:250 000 scale showed that this Archean complex is composed mainly of units of sedimentary origin, both gneisses and anatectically derived granodiorite (diatexite). Both early and late tonalites are widespread, as are minor amounts of granite, diorite, syenite, mafic gneiss and pyroxenite. Ubiquitous garnet-orthopyroxene-biotite-plagioclase-K feldspar-quartz assemblages permit estimation of metamorphic pressure and temperature at 5-6.5 kbar and 700-775°C respectively. Preliminary results of U-Pb zircon geochronology on units from lac Clairambault indicate major metamorphic and igneous events in the range 2690-2640 Ma. This part of the granulite complex shows striking lithologic, metamorphic and age similarities to along-strike metasedimentary gneiss belts of western Superior Province.

In central Cape Smith Belt, northern Ungava, continuing mapping has documented that 1), a dismembered, potentially ophiolitic, mafic-ultramafic suite is preserved at the highest structural levels of this thrust-fold belt, 2), regular stacking sequence thrusts can be distinguished from out-of-sequence thrusts, 3), imbricates of Archean basement are interleaved with Proterozoic units in a basal shear zone and 4), the structural geometry of the thrust-fold belt provides a first-order constraint on PGE potential to 20 km depth. Thermal modelling of the Cape Smith Belt metamorphic culmination indicates that regional metamorphism is the result of initial tectonic thickening followed by thermal relaxation during uplift and its accompanying erosion.

Structural studies were begun in the Tantato domain, northern Saskatchewan, and identified this northeast-tapering, wedge-shaped region as being composed predominantly of mylonite derived from both mafic and felsic rocks. The mylonites developed under granulite facies metamorphic conditions. Dextral shear sense is indicated by rock fabrics in the northwest part of this domain, but shear sense along its southeast side is at present equivocal. Structural studies in the Grenville Province of Ontario and western Quebec have 1), shown the the northwest boundary of the Central Metasedimentary Belt in the Haliburton region is a zone of stacked lenticular sheets with metaplutonic cores, emplaced during Grenvillian orogeny (1070-1030 Ma) and followed closely by relaxation that produced extensional mylonites in the southeast part of this zone, 2), identified highly deformed metagabbroic rocks at and southeast of the Grenville Front near Sudbury as equivalents of the Sudbury diabase dyke swarm (1250 Ma) located northwest of the front, thus indicating considerable uplift of Grenvillian age along the front, and 3), demonstrated once again that rocks of Archean age are present in the Grenville Province adjacent to the front in the Chibougamau region, although problems of the changing nature of the front along its length are not yet resolved in the relationship of the parautochthon to granulite facies rocks farther east as a nappe front is questioned.

Preparatory work for geological mapping in the Kapuskasing zone (Groundhog River and Chapleau blocks) and in the southwest Grenville Province (transect exposed along the coast of Georgian Bay) under the terms of the Canada-Ontario Mineral Development Agreement was undertaken. Four-person teams will commence mapping in each area in May 1987.

K.D. Card and A. Davidson were heavily involved again this year in the preparation of maps and manuscripts for the 'Decade of North American Geology' volume on the Canadian Precambrian Shield.

A. Davidson and J.A. Percival led field excursions associated with the Annual Meeting of the Geological Association of Canada in Ottawa, May.

A. Davidson received the Geological Association's Howard S. Robinson Lectureship for 1986-1987.

M.R. St-Onge was transferred to this Section effective 1 April 1986.

S. Black, Q. Gall, S. Marincak and S. Neufeld were employed as term research assistants for the Section.

Attendance at Meetings, Conferences and CoursesK.D. Card

Institute on Lake Superior Geology, Annual Meeting, Wisconsin Rapids, Wisconsin, U.S.A., April.

Geological Association of Canada, Annual Meeting, Ottawa, May.

A. Ciesielski

Memorial University, St. John's, Newfoundland, April.

A. Davidson

New York Geological Survey, 150th Anniversary Meeting and Adirondack Caucus, Albany, New York, U.S.A., April.

Institute on Lake Superior Geology, Annual Meeting, Wisconsin Rapids, Wisconsin, U.S.A., April.

Geological Association of Canada, Annual Meeting, Ottawa, May.

Friends of the Grenville, Annual Meeting, Gouverneur, New York, U.S.A., October.

Geological Society of America, Annual Meeting, San Antonio, Texas, U.S.A., November.

Geoscience Research Seminar, Ontario Geological Survey, Toronto, Ontario, December.

GSC Current Activities Forum, Ottawa, January.

I.F. Ermanovics

Review of Activities, Mines Branch, Department of Mines and Energy, St. John's, Newfoundland, November.

S. Hanmer

Shear criteria meeting, London, U.K., May.

Canadian Tectonics Group, Sudbury, Ontario, October.

J. Percival

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

Newfoundland Department of Mines and Energy, Open House, St. John's, Newfoundland, November.

Ministère de l'Energie et des Ressources du Québec Forum, Québec, December.

Course: French language training (on-going).

Membership on Committees

K.D. Card

International Union of Geological Sciences, Subcommission on Precambrian Stratigraphy, corresponding member.

Penrose Conference on crustal cross-sections organizing committee.

Research Grant Review Committee - NSERC, University - Industry Co-op, Inco.

A. Davidson

North American Commission on Stratigraphic Nomenclature, commissioner.

Canadian National Committee on the Dynamics and Evolution of the Lithosphere (CANDEL), member.

GLIMPCE, Geochemistry/Geology Subcommittee, member.

S. Hanmer

Saskatchewan - Manitoba Roundtable.

Thelon Roundtable.

J. Percival

Canadian Continental Drilling Program, Steering Committee, member.

Kapuskasing LITHOPROBE Transect co-ordinator.

Special Talks and Lectures

K.D. Card

Lectures, guidebook preparation and field trip to N. Ontario for Drs. Glebovitskiy and Kitsul, USSR - part of Canada - USSR scientific exchange.

Lectures, guidebook and field trip to N. Ontario for Drs. Lehtonen and Honkamo, Finland - part of Canada-Finland scientific exchange.

A. Ciesielski

"Problématique des gneiss dans l'Archean", Université du Québec à Montréal, Montréal, Québec, March.

A. Davidson

"Advances in the Grenville in Canada", invited speaker, Adirondack Caucus, Albany, New York, U.S.A., April.

"Granulites and Granulites, S.E. Ontario" and "A New Look at the Grenville Front, central Ontario", Geological Association of Canada, field trip leader, May.

"A new look at the Grenville Front" and "Ductile Tectonics in the S.W. Grenville", Geological Association of Canada Robinson Lectureship across Canada, March.

S. Hanmer

"Natural examples of the role of strain regime in the rotational behavior of stiff inclusions", Shear Criteria Meeting, London, U.K., May.

"Great Slave Lake Shear Zone, variations on a theme", Sudbury, Ontario, October; Chicoutimi and Montreal, Quebec, November.

J. Percival

"Crustal structure of the northern Kapuskasing uplift from geobarometry and gravity-aeromagnetic modelling" and "The Kapuskasing uplift: Archean greenstones and granulites" speaker and field trip leader, Geological Association of Canada, Ottawa and parts of Ontario, May.

"Geology of the Kapuskasing uplift", University of Massachusetts at Amherst, Amherst, Va., U.S.A., October.

"Geology of the Ashuanipi granulite complex" and "The Kapuskasing uplift", State University of New York at Stony Brook, New York, U.S.A., October.

"Geology of the Ashuanipi complex in the Schefferville area", GSC Current Activities Forum, Ottawa, January.

"L'origine des granulites", Université de Montréal, Montréal, Québec, March.

Manuscripts submitted

1 'A' series map, 4 abstracts, 1 GSC paper, 6 Current Research papers, 4 external publications.

SPECIAL PROJECTS SECTION

Highlights

As a by-product of the new 1:1 million scale geological compilation map of the Bear, Slave and Churchill provinces prepared for the DNAG synthesis, a predictive model for accretion of continental crust of "granite-greenstone" type was developed, consistent with the operation of plate tectonics in the Archean. In addition, the 1200-km-long Great Slave Lake shear zone was defined on the basis of magnetic anomalies from the Western Canada platform and geology of the adjacent shield, and interpreted as a continental transform structure linked to the previously recognized early Proterozoic Thelon-Queen Maud collision zone, analogous to the great active continental transform zones of Pakistan and Burma that link the Himalaya-Tibetan collision zone to the Makran and Java subduction zones.

Cyprus Project

Metamorphism in the sheeted dyke member of the Troodos ophiolite has the attributes of the "actinolite facies" of Elthon and Stern (1978) which is interpretable as the low water/rock ratio equivalent of the greenschist facies. Its effects diminish downward within the sheeted dyke zone and all but disappear in the plutonic complex about 200 m below the lower contact of the sheeted dyke zone. The pillow lava sequence above the dyke zone has variable but generally low-temperature alteration related to sea water circulation. Accordingly the source of metamorphic energy would appear to be the plutonic complex and the degree and type of metamorphism which is imposed on the overlying rocks is a function of both upward declining geothermal gradient and penetrability of sea water into the successive lithologies of the ocean crust.

Studies on petrochemical variations across individual pillows at successive levels within the lava sequence of the Troodos ophiolite provides some insights into the type and extent of alteration that is presumably attributable to variation of water/rock ratios. Principal among these are the following changes in compositions in the higher water/rock environment of the pillow rims relative to interiors: 1) enrichment in, and greater oxidation of, iron; 2) enrichment of Ni, Cu, and Zn; 3) depletion of K, Cr, Sr and Ba. The significance of the variations is not fully understood but the enrichment of pillow rims of the chalcophile elements Ni, Cu, and Zn is of particular interest in its possible relationship to the formation of ores.

Circum-Superior Belt

The lithic content of the northern part of the Circum-Superior Belt comprises principally an earlier tholeiitic and later komatiitic succession. Geochemical characteristics of at least parts of the tholeiitic succession are indicative of sialic contamination and, therefore, of supracontinental emplacement. The evidence is less certain in the case of the komatiitic rocks but dykes of this composition in the Archean foreland provide an indirect linkage of these rocks with the craton. Variation in major element composition of the komatiitic suite is wholly attributable to fractional crystallization in surface conduits and in crustal magma reservoirs.

Aphebian deformation seems to be manifested in the Archean craton immediately south of the Ungava Trough, segment of the Circum-Superior Belt as sparse, isolated, ENE-trending shear zones. This is evidence that within the present setting of the Ungava Trough deformation was not entirely thin-skinned and that the belt itself may not be greatly out of its original setting. The north boundary of the Ungava Trough is shaped by domes of granitoid gneiss, presumed to be basement, that appear to protrude into it. Farther north these are flattened and overturned to the south and, in part, seem to be overridden by thrust sheets from the north composed largely of metasupracrustal rocks and migmatites.

Personnel Notes

P.F. Hoffman was transferred to this section effective 1st April 1986.

Attendance at Meetings, Conferences and Courses

W.R.A. Baragar

Geochemistry and mineralization of Proterozoic volcanic suites, IGCP 217, sponsored by Geological Society of London, Nottingham, U.K., April.

Management Panel Meeting and Progress Review, International Research Drilling Group, Cyprus Study Project, London, U.K., January.

Magmatism in the Ocean Basins Conference sponsored by Geological Society of London and Mineralogical Society of Great Britain, Leicester, U.K. January.

P.F. Hoffman

Trans-Hudson orogen LITHOPROBE workshop, Winnipeg, Manitoba, April.

Geological Society of America, Rocky Mountain Section, Annual Meeting, Flagstaff, Arizona, U.S.A., April.

Global Sedimentary Geology Program (GSCP) Workshop, Bloomington, Illinois, U.S.A., May.

New Perspectives in Basin Analysis Symposium, Minneapolis, Minnesota, U.S.A., May.

Geological Association of Canada, Annual Meeting, Ottawa, May.

Global Sedimentary Geology Program, International Workshop, Miami, Florida, U.S.A., June.

Circum-Pacific Energy and Mineral Resources Conference, Singapore, August.

European Geotraverse Study Centre, Espoo, Finland, November.

B.V. Sanford

Basins of Eastern Canada and Worldwide Analogues, Halifax, Nova Scotia, August.

Membership on Committees

W.R.A. Baragar

International Crustal Research Drilling Group, management panel.

Editorial Committee: Canadian Journal of Earth Sciences.

Ph.D. thesis committee, University of Ottawa.

P.F. Hoffman

International Lithosphere Program, Task Group 2A (Variation in Nature and Evolution of Mobile Belts), chairman.

International Union of Geological Sciences, Subcommission on Precambrian Stratigraphy, titular member.

Geological Society of America, Path to the year 2000 committee.

Associate editor: Geology.

Associate editor: Tectonics

Associate editor: Precambrian Research.

B.V. Sanford

Member of Advisory Committee on Names for Undersea and Maritime Features for Canadian Permanent Committee on Geographic Names.

Special Talks and Lectures

W.R.A. Baragar

"Proterozoic komatiitic and tholeiitic lavas and related intrusions of the Circum-Superior Belt, Canadian Shield", Geological Society of London, sponsored meeting, Nottingham, U.K., April.

"Structural character and plutonic setting at the western end of the Ungava Trough, Quebec City, Quebec, December.

"Some observations on alteration in the pillow lavas and sheeted dyke complex of the Troodos ophiolite", Geological Society of London and Mineralogical Society of Great Britain sponsored meeting, London, U.K., January.

P.F. Hoffman

"Transect of two sutures of the Himalaya-Karakorum, Pakistan", University of Ottawa, Ottawa, April.

"Comparative tectonics of the Pakistan Himalaya and Trans-Hudson orogen"; Lithoprobe Workshop, Winnipeg, Manitoba, April.

"Precambrian sediments: challenges and opportunities for a global program", GSCP Workshop, Bloomington, Illinois, U.S.A., May.

"Is the Thelon Front (NWT) a suture?" and "Crustal accretion in a 2.7-2.5 Ga 'Granite-greenstone' terrane, Slave Province, NWT: a prograded arc-trench system?", Geological Association of Canada, Annual Meeting, Ottawa, May.

"Arc-trench progradation and Precambrian granite-greenstone terranes", Circum-Pacific Energy and Mineral Resources Conference, Singapore, August.

"Styles of tectonic accretion of the Laurentian craton", European Geotraverse Study Centre, Espoo, Finland, November.

"Tectonic subdivision of the Churchill Province, Canadian Shield", GSC Current Activities Forum, Ottawa, January.

"Granite-greenstone terranes and arc-trench progradation", Concordia University, Montreal, Quebec, February.

B.V. Sanford

"Paleozoic geology of the Hudson Platform", Basins of Eastern Canada Symposium, Halifax, Nova Scotia, August.

Manuscripts submitted

6 external publications, 8 abstracts, 1 book review, 5 maps for Canada Atlas Series.

GEOCHRONOLOGY SECTION

O. van Breemen (Head)

Highlights

A second Finnigan MAT 261 solid source mass spectrometer was installed in the fall of 1986 and now provides greater flexibility in the operation of the section. With this new instrument, a number of Sm-Nd isotopic analyses have run on granitoids from Newfoundland. Extensive K-feldspar common Pb data have also been obtained from granitoids in New Brunswick and these demonstrate that a Precambrian basement component, possibly Avalonian in age is much more widespread than had been previously recognized.

With the implementation of various improvements in U-Pb zircon analysis production has doubled since last year. With the ability to analyze very small samples, selectivity in the choice of zircon has greatly improved the success rate of achieving accurate age determinations. Aspects of these techniques which represent new advances have been presented at the Sixth International Conference on Geochronology, Cosmochronology and Isotope Geology in July, Cambridge, England. Since then, a new error treatment for U-Pb isotope dilution calculations which realistically includes all sources of error and assesses error correlation has been developed and programmed for routine use.

While K-Ar and Rb-Sr analyses continue, the most significant results have been U-Pb ages on zircon and other accessory minerals. Mapping projects closely integrated with geochronology have been pursued in the Yukon-Tanana terrane (SW Dawson map-sheet, Yukon) and the southern Ominica Belt (B.C.). Eocene ages of mylonitic granite within the Monashee mountains prove an Eocene, normal fault, interpretation for part of the mylonitic rocks. The presence of widespread metamorphic zircons in a number of rocks of the Ominica Belt of ca. 60 Ma will require a major revision to ideas of the age of Ominica Belt metamorphism. Very precise ages of Cordilleran rift margin volcanism in the MacKenzie Mountains have been determined at 780 +/- 3 Ma. Alkaline magmatism in the Cordillera is grouping at about 750 Ma, 350 Ma, and 180-170 Ma. Zircon dates of ca. 280 Ma on plutons restricted to the Quesnel terrane represent a widespread igneous event. In the Yukon-Tanana terrane widespread and previously unrecognized Permian volcanism and plutonism has been documented as well as regionally developed Permo-Triassic metamorphism and deformation. A widespread mafic sill complex emplaced into strata of the North American continental margin further east yield preliminary mid-Triassic U-Pb zircon ages.

In the Central Metasedimentary Belt, Grenville Province (Ontario), the late tectonic Deloro pluton has yielded a surprisingly old age of 1245 Ma while a similar age was obtained from the deformed Addington granite. U-Pb age determinations from four other syenitic and granitic intrusions suggest groupings at ca. 1165 Ma and 1080 Ma. Metamorphic ages of ca. 1050 Ma have been obtained in the Algonquin Domain of the Central Gneiss Belt. In the Killarney area, near the Grenville Front, two distinct ages of granites are found, ca. 1740 Ma and 1470 Ma.

In the Churchill Province (Manitoba), ages from the Flin Flon Volcanic Belt and the Kisseynew Sedimentary Gneiss Belt along with those obtained previously from the Lynn Lake Belt, Rusty Lake Belt, and the Wathaman Batholith, indicate that formation of the juvenile crust now preserved in the southern Churchill Province took place over approximately 75 million years. The earliest magmatism occurred in two episodes at approximately 1900 Ma and 1875 Ma. This was followed by emplacement of the Wathaman Batholith at about 1850 Ma. Volcanic and plutonic activity in the Flin Flon Belt outlasted that in the Rusty Lake and Lynn Lake belts to the north. Metamorphism and anatexis of sediments began during the waning stages of magmatism and continued to approximately 1800 Ma. Northwest of Wager Bay (District of Keewatin), two plutons from a calc-alkaline batholith intruded as part of magma production within a continental arc provide precise ages of 1823 Ma and 1826 Ma. In the northern Thelon Tectonic Zone (District of Mackenzie), conditions of high grade metamorphism associated with tectonism have been shown to extend over the period of 1990-1910 Ma while plutonism has been dated from 1960-1910 Ma.

In the northern Slave Province near Bathurst Inlet (District of Mackenzie), deformation coeval with I and S type plutonism has been dated in the range 2600-2580 Ma. In both the eastern and western Slave Province, volcanism predates plutonism by 50-100 Ma. In the eastern Abitibi Subprovince (Quebec), U-Pb zircon ages indicate that volcanism and synvolcanic plutonism in the northern part of the belt ranges in age from 2729-2720 Ma, whereas in the southern part of the belt, volcanism occurred in two discrete episodes, one at about 2730-2728 Ma and one at 2703-2697 Ma. Late- and post-Kenoran plutonism throughout the Abitibi, range from 2697-2684 Ma. There is an indication of an older volcanic event in the Chibougamau area at about 2802 Ma. In the Bienville Subprovince, James Bay region, the oldest gneisses yield an age of 2813 Ma while post-tectonic granodiorites are 2711 Ma old. Extensive sampling for U-Pb zircon and monazite geochronology was carried out in the Ashuanipi Subprovince in the Schefferville map area. U-Pb age data from high grade gneisses slightly to the west of this area suggest a protracted period of metamorphic zircon growth from 2668 Ma to 2642 Ma, and protolith ages of at least 2786 Ma.

Personnel Notes

R. Theriault accepted a permanent position with the section as an isotope analyst.

Visiting Fellowship for J. Mortensen was renewed for a second year.

Visiting Fellowship funded by New Brunswick Mineral Development Agreement commenced for M.L. Bevier.

D. Corrigan was employed as a term research assistant.

Field Activities

Sample collecting trips by members of the Geochronology Section have been made to the following areas:

Artillery Lake area, District of Mackenzie, NWT.
Talston Lake area, District of Mackenzie, NWT.
Schefferville map area, northern Quebec.
Eastern Abitibi Belt, eastern Ontario and western Quebec.
Dawson map area, western Yukon.
Baker Lake area, District of Keewatin, NWT.
Hope map area, near Harrison Lake, British Columbia.
Monashee Complex, south of Revelstoke, British Columbia.
Western Valhalla Complex, near Lower Arrow Lake, British Columbia.
Central and Southern Plutonic Belts, New Brunswick.

Attendance at Meetings, Conferences and Courses

R.R. Parrish

Geological Association of Canada, Annual Meeting, Ottawa, May.

5th International Conference on Geochronology, Cosmochronology and Isotope Geology, Cambridge, U.K., July.

Cordilleran Tectonics Workshop, Montreal, Quebec, February.

Geological Association of Canada, Cordilleran Section Forum, Vancouver, British Columbia, January.

F.B. Quigg

Radiation Protection Training, Chalk River, Ontario, June.

J.C. Roddick

5th International Conference on Geochronology, Cosmochronology and Isotope Geology, Cambridge, U.K., July.

R.W. Sullivan

Institute of Environmental Sciences (I.E.S.) seminar, Gananoque, Ontario, October.

R.J. Theriault

Course in Radioisotope Geochemistry (Graduate Level), Carleton University, Ottawa, January-April.

O. van Breemen

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

Membership on Committees

R.R. Parrish

Lithoprobe: Cordilleran transect planning committee and transect co-leader.

R.W. Sullivan

Joint Occupational Health and Safety Committee (J.O.S.H.) for 601 Booth Street, Ottawa.

Special Talks and Lectures

R.R. Parrish

"Fission Track Dating", short course presented at University of Calgary, Alberta, September.

"Extensional tectonics, Southern Cordillera", Lithoprobe planning workshop, Sidney, British Columbia, September.

"Extensional tectonics in Canadian Cordillera", Geological Association of Washington, D.C., U.S.A., October.

"U-Pb zircon geochronology-interpretation and techniques", United States Geological Survey, Reston, Virginia, U.S.A., October.

Two tectonics seminars at Carleton University, Ottawa, March.

J.C. Roddick

"Precise U/Pb dating of sub-milligram quantities of zircon", 5th International Conference on Geochronology, Cosmochronology and Isotope Geology, Cambridge, U.K., July.

Manuscripts submitted

9 external publications, 4 Current Research papers, 1 note, 6 abstracts

Laboratory Statistics

U-Pb zircon age projects 249; mineral fractions analyzed 759

Trace lead analyses 105

Rb-Sr projects 11; samples analyzed 123

K-Ar age determinations 89

PALEOMAGNETIC SECTION

W.F. Fahrig (Head)

Highlights

An "A series" map showing the distribution and age classification of diabase dyke swarms of the Canadian Shield was published. This complements the first international symposium volume on mafic dykes which has gone to the printers. Members of the Division were involved in editing, and in preparation of four papers of the volume.

A paleomagnetic pole from the Sept Isles layered intrusion indicates that most of North America was a coherent tectonic unit in the Cambrian. The pole position agrees with many other poles of the same age from localities throughout the continent. A mid-Cambrian emplacement of the intrusion is indicated by field geology, radiometric dating, and a positive paleomagnetic contact test with a younger dyke swarm.

Paleomagnetic study of Precambrian diabase dykes and sills in the Mackenzie Arc from Northeastern British Columbia to the Yukon/Alaska boundary confirms that the arc is primary as suggested by earlier structural studies. The geometry was largely inherited from the shape of the ancient cratonic margin.

Personnel Notes

P. Lapointe was seconded to the A.D.M.'s Office.

T. West and T. Pilgrim were employed as term research assistants for the Section.

Visiting Fellowship for A. Latham continued.

Attendance at Meetings, Conferences and Courses

K. Buchan

17th Nordic Geology Meeting (Special Paleomagnetic Session), Helsinki, Finland, May.

Geological Association of Canada, Annual Meeting, Ottawa, May.

P. Lapointe

Geological Association of Canada, Annual Meeting, Ottawa, May.

J.K. Park

Geological Association of Canada, Annual Meeting, Ottawa, May.

American Geophysical Union, Fall Meeting, San Francisco, California, U.S.A., December.

E.I. Tanczyk

Geological Association of Canada/Mineralogical Association of Canada/Canadian Geophysical Union, Joint Annual Meeting, Ottawa, May.

Basins of Eastern Canada and Worldwide Analogues, Halifax, Nova Scotia, August.

Nova Scotia Department of Mines and Energy Open House, Halifax, Nova Scotia, November.

Mineral Investment in Atlantic Canada, Canadian Institute of Mining District 1 Meeting, Halifax, Nova Scotia, November.

GSC Current Activities Forum, Ottawa, May.

Membership on Committees

W.F. Fahrig

International Geological Correlation Program, Project 257, Precambrian Diabase Dyke Swarms, member.

P. Lapointe

Société Québécoise de Géophysique, Board of Directors.

International Geological Correlation Program, Project 233, Paleomagnetism, national committee leader.

Special Talks and Lectures

K. Buchan

"Estimating vertical movement of Precambrian Shields from remanent magnetization in dyke contact zones", 17th Nordic Geology Meeting, Helsinki, Finland, May.

"The Nipissing Diabase: Two decades of paleomagnetic research", Geological Association of Canada, Annual Meeting, Ottawa, May.

P. Lapointe

"Geophysical prediction of fracture systems in three dimensions in the Eye-Dashwa Lakes Archean pluton, Ontario", "Subsurface lithological mapping by regional geophysics at the east Bull Lake pluton" and "A Cambrian pole from the layered mafic intrusion at Sept-Iles, Québec", Geological Association of Canada, Annual Meeting, Ottawa, May.

Manuscripts submitted

1 abstract, 6 external publications, 1 Bulletin, 1 Current Research paper.

PETROLOGY SECTION

K.L. Currie (Head)

The Petrology Section analyses rock and mineral assemblages with the goal of understanding and quantifying processes of rock formation and deformation. Detailed field studies supply material for analysis and provide opportunities to apply models worked out theoretically and in the laboratory. The section includes laboratories for the study of rock-forming processes at high temperatures and pressure. The section has also taken responsibility for the bedrock mapping component of most federal-provincial mineral development agreements.

Highlights

A new model of origin for quartz-rich sandstones suggests that assembly of super continents on a cyclic basis at about 300 Ma intervals produces low sea levels, arid climates and glaciation, producing eolian sandstones with associated evaporites and sedimentary copper deposits. Breakup of the land masses causes widespread warm-wet climates and major marine transgressions producing marine sandstones rich in weathered granitic debris. Such rocks contain ironstone, petroleum, phosphate, bauxite, manganese and lead-zinc deposits.

Regional mapping of northwestern Cape Breton Island was completed by S.M. Barr and R.P. Raeside (MDA contract). This work has shown that the Highlands are composed of several distinct terranes separated by major faults with long and complex movement histories. Remapping of the Cobequid highlands was commenced by Brendan Murphy and Georgia Pe-Piper (MDA contract). Preliminary results suggest that basement is widespread but complexly deformed and reworked.

Metasedimentary gneisses thought to be Grenvillian from a continuous strip along the Long Range fault in southwestern Newfoundland. This fault is therefore not a divider between "American" and "European" lithologies as previously thought. East of the fault a stack of metasedimentary thrust slices are interleaved with thin ophiolites, and intruded by syn-tectonic to late tectonic granite. West of the fault the rocks contain Late Precambrian peralkaline granites which may be correlative to Avalonian plutons to the east.

Mapping of the Northern Long Range of Newfoundland was completed. The rocks consist of Middle to Late Precambrian granulite-grade gneisses intruded by large late Precambrian plutons. Deformation and retrogression become more intense to the southeast. This retrogression is probably of Paleozoic age since it overprints the latest Precambrian Long Range dyke swarm. Devonian plutons have been identified, and may be associated with gold mineralization found in shear zones along their flanks.

Mapping of the Late Precambrian terrane west of Saint John, N.B. showed that the prominent ductile deformation is of Late Precambrian age, approximately coeval with mafic dyke emplacement, and hence indicates major transtension. The dykes are slightly younger than mafic volcanics known to have arc type characteristics. The history of this region therefore probably involved oblique subduction. Ductile deformation terminates abruptly against a NNW trending fault with a major gravity contrast. The Avalonian terrane in this region is clearly composite.

Deformed granites of central New Brunswick appear to be all of mid-Ordovician age, hence correlative in general to the Tetagouche Group. Younger (Silurian) plutons contain fayalite-hedenbergite, and clearly are A-type, with striking similarities to the Topsails terrane of Newfoundland. All the plutons contain leads which strongly suggest underlying Precambrian crust of Avalonian affinities. Such crust extends along tectonic strike south into Maine.

The Grenville and adjacent Churchill provinces of central Labrador exhibit distinct differences in isotopic composition. Crustal components older than about 1700 Ma do not constitute part of the northeastern Grenville provinces, but substantially older (Archean) components can be recognized in the Churchill province.

Igneous zircons associated with charnockitic intrusions associated with anorthosite massifs in the Grenville province imply that much of this type of magmatism was associated with a Grenvillian magmatic event (1050-1150 Ma).

Reconstruction of the cooling history of the Mistastin batholith shows that K-Ar closure ages on hornblende cluster around 1385 Ma, or about 25-30 Ma younger than zircon, implying that unusually high heat flow persisted in the aftermath of Elsonian igneous activity.

The contact between the main bodies of silicic and mafic volcanics in the Bathurst district of New Brunswick is a thrust, which has been folded producing the characteristic large-scale late structure. This thrust is a major control of ore deposition. The Thompson nickel belt of Manitoba has a structure much more complex than previously recognized. The structure is thought to be due to a deep-crustal reversed transpression zone. The boundary zone between an Archean greenstone belt and its granitic basement in the Slave province proved to be a high strain zone, probably a thrust.

Aluminous and ferromagnesian alteration accompanies sulphide mineralization in the Wolverton Lake district, Manitoba. Detailed studies of drill core from Cook Lake permit reconstruction of the physical conditions of alteration, and a prediction of mineral assemblages useful for prospecting. Two thesis studies of similar problems have just been completed as the Lynda deposit (Snow Lake area) and the New Fox zone (Lynn Lake).

Geochronological investigations established that the Lynn Lake - Rusty Lake - Kiseynew - Flin Flon belts in northern Manitoba formed over a time span of 75 million years. These rocks are the remnants of an active continental margin and represent the only known Early Proterozoic juvenile crust in the southern Churchill Province. Numerical modelling of the thermal history of this region is constrained by metamorphic isograds, pressure-temperature determinations, and closure temperatures of various mineral-isotope systems. The results indicate that deformation has had a pronounced effect on the present isograd configuration.

A geochemical study of subaerial volcanic rocks in the Flin Flon belt has demonstrated that igneous processes can be deduced from the chemistry of metamorphosed volcanic rocks and that carefully designed sampling schemes are necessary in order to use geochemistry as a stratigraphic tool.

K.E. Ashton (contract under MDA) was able to divide the transition from the Flin Flon volcanic belt to the Kiseynew gneiss belt into stratigraphic units which are equivalent, and demonstrated that mineralization similar to that in the Flin Flon belt is present in the high-grade equivalents. This work has greatly encouraged exploration activity.

The Daly Bay Complex in northern District of Keewatin represents Archean supracrustal rocks that have been buried to deep crustal levels, intruded by mafic magmas, and then emplaced into the upper crust along a ductile shear zone during the Early Proterozoic. This shear zone is a long lived major crustal break that can be correlated to the west and south with the Chesterfield, Tulemalu, and Black Lake - Virgin River shear zones. It may be one of the controls on the sub-Phanerozoic Sweetgrass Arch in southern Alberta.

Personnel Notes

Visiting Fellowship continued for V. Owen.

C. van Staal accepted a permanent research scientist position with the section.

J. Langton, D. Lemkow, F. Kiss, J. Walhroth, B. Blair and S. Barham joined the section as term support geologists.

T.M. Gordon continued his work at the Institute of Sedimentary and Petroleum Geology, Calgary.

Attendance at Meetings, Conferences and Courses

F.W. Chandler

Symposium on sedimentary copper deposits, Geological Association of Canada, Annual Meeting, Ottawa, May.

Nova Scotia Department of Mines and Energy, Halifax, Nova Scotia, November.

K.L. Currie

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

E. Froese

Manitoba Mineral Resources Division, Annual Meeting with Industry, Winnipeg, Manitoba, November.

T.M. Gordon

Trans-Hudson Orogen Lithoprobe Organizational Meeting, Winnipeg, Manitoba, April.

Manitoba Mineral Resources Division, Annual Meeting with Industry, Winnipeg, Manitoba, November.

Manitoba-Saskatchewan Regional Review, Ottawa, November.

J.T. van Berkel

Canadian Tectonics Group Meeting, Sudbury, Ontario, October.

Newfoundland Department of Mines and Energy, Review of Activities, St. John's, Newfoundland, November.

Interpretation of gravity and magnetic anomalies for non-specialists, GSC, Ottawa, November.

GSC Current Activities Forum, Ottawa, January.

C. van Staal

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

Friends of the Nickel Belt, Annual Meeting, Thompson, Manitoba, June.

Friends of the Grenville, Annual Meeting, Balmat-Edwards, New York, U.S.A., September.

Canadian Tectonics Group, Sudbury, Ontario, October.

Mineral Resources Division, New Brunswick Department of Natural Resources and Energy, Review of Activities, Fredericton, New Brunswick, November.

Atlantic Geoscience Society, Annual General Meeting, Fredericton, New Brunswick, February.

J.B. Whalen

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting and short course on Silicate Melts, Ottawa, May.

Mineral Resources Division, New Brunswick Department of Natural Resources and Energy, Review of Activities, Fredericton, New Brunswick, November.

Membership on Committees

F.W. Chandler

Ph.D. examiner, University of Western Ontario.

Interdisciplinary Earth Science Research Workshop for Atlantic Canada, member.

Geological Association of Canada Annual Meeting, exhibits committee co-organizer and sedimentology session co-chairman.

K.L. Currie

Mineralogical Association of Canada, Hawley award committee.

T.M. Gordon

Manitoba-Saskatchewan regional review committee, chairman.

C. van Staal

Heath Steele Federal-Provincial project in northern New Brunswick committee, member.

Special Talks and Lectures

F.W. Chandler

"Stratabound copper mineralization in Early Proterozoic marine-transgression-related quartz arenite, Cobalt Group, Ontario", Geological Association of Canada, Annual Meeting, Ottawa, May.

K.L. Currie

"A Silurian magmatic event in Atlantic Canada and its tectonic significance", Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

"Sapphirine-bearing granulites from Wilson Lake, Labrador", Precambrian High, Ottawa, March.

E. Froese

"Metamorphism of sulphide-bearing rocks", McGill University, Montreal, Quebec, March.

J. van Berkel

"Geology of the Dashwoods Pond, St. Fintan's and Main Gut map areas, S.W. Newfoundland" (poster) Newfoundland Department of Mines and Energy, St. John's, Newfoundland, November.

"Geology and geophysics of south-central Newfoundland", GSC Current Activities Forum, Ottawa, January.

C. van Staal

A discussion of the use of so called primary features as evidence for a syngenetic exhalative origin for deformed and metamorphosed orebodies, using the Brunswick No. 12 and No. 6 orebodies as an example, Precambrian High, Ottawa, April.

"Problems in structural analysis in the Bathurst Camp, northern New Brunswick", Canadian Tectonic Group, Sudbury, Ontario, October.

"The importance of macro, meso and micro structures in the study of deformed massive sulfide orebodies", University of Toronto, Toronto, Ontario, December.

"The Tetagouche Group: Record of a Cambrian-Early Ordovician passive margin and Middle Ordovician back-arc basin", Atlantic Geoscience Society, Fredericton, New Brunswick, February.

J. Whalen

"A-type granites: geochemical characteristics and discrimination", Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

Manuscripts submitted

3 internal reports, 16 external publications, 15 open file maps, 27 Current Research papers, 2 open file reports, 5 'A' series maps, 1 GSC paper, 1 Memoir, 10 abstracts

LITHOSPHERIC GEOPHYSICS SECTION

A. Green (Head)

Highlights

LITHOPROBE

Southeastern Cordillera

A preliminary interpretation has been completed of the seismic reflection profiles collected across the southeastern Cordillera. The 270 km of seismic reflection data, obtained during the Fall of 1985, extend from the Rocky Mountain thrust and fold belt, across the Rocky Mountain Trench, Purcell anticlinorium, Kootenay Arc, Nelson batholith and Valhalla gneiss complex. North American basement and its overlying foreshortened miogeoclinal rocks can be traced westward to the Kootenay Arc. The Purcell anticlinorium is carried by a series of west dipping thrust faults which emerge east of the anticlinorium and converge downward and merge with a detachment surface above autochthonous North American basement. Proterozoic supracrustal rocks, thickened by folding and thrusting, occupy the core of the anticlinorium. Steeply dipping surface structures of the western Purcell anticlinorium and Kootenay Arc appear to be truncated at 3-4s (9-12 km) by a gently east-dipping reflection that may delineate the upper boundary of an allochthonous wedge inserted between the near surface rocks and autochthonous basement below. Beneath the Kootenay Arc, at a travel time of 9-10 s (27-30 km), the North American basement seems to be truncated by the major east-dipping Slocan Lake fault zone, which can be traced from its surface exposure at the east edge of the Valhalla gneiss complex eastward to near the base of the crust. A very high amplitude and continuous west-dipping reflection underlies the Valhalla complex and may be related to a major compressional shear zone.

Kapusking Structural Zone

A major magnetotelluric (electrical induction) survey was conducted across the Kapuskasing Structural Zone (KSZ) west of Timmins, Ontario. The KSZ is located in the ancient Superior Province, the source of much of Canada's mineral wealth. It represents an upthrust section of the Archean crust, providing an opportunity to examine crustal growth and crustal structure, essential for understanding not only the processes that produced these rocks but also their contained ore deposits. The magnetotelluric study suggests that the increased electrical conductivity observed in the lower crust (20 to 40 km depth range) in many regions of the world, including most regions of the Canadian Shield, is dependent on environment (depth, pressure, temperature, fluid content) rather than lithology. A contract survey carried out by Lamontagne Geophysics confirmed these results and also mapped a weakly conducting zone that probably coincides with a major thrust fault on the eastern boundary of the KSZ. The fault has been identified previously by geological and seismic reflection studies.

Preliminary results of the 1984 LITHOPROBE refraction survey of the Kapuskasing region became available in 1986. Five lines, each 300 km long, have yielded the interpretation that mantle velocity is relatively constant, at $8.1 \pm .05$ km/s. Crustal thickness varies significantly and systematically with respect to major surface geological features, from approximately 49 km beneath the Chapleau block of the Kapuskasing structure, through a sharp gradient to the southeast, to approximately 31 km. Crust thicker than 44 km is also present northwest of the Lepage crustal-scale normal fault. The results suggest a crustal root beneath the Chapleau block, probably isostatic compensation for the dense granulitic rocks thrust into the upper crust in the early Proterozoic.

Isotopic analyses of various minerals (zircon, sphene, hornblende, biotite) have provided the basis for an interpretation of the cooling and uplift history of the Kapuskasing zone. The deep crustal terrane cooled extremely slowly from the 800°C metamorphic peak at about 2.7 Ga, to approximately 350°C at 2.0 Ga ago, suggesting some 700 Ma of lower crustal residence. Uplift probably occurred between 2.0 and 1.9 Ga ago, based on the presence of 1.9 Ga alkalic-rock plutons which cut Kapuskasing-related faults.

Great Lakes International Multidisciplinary Program on Crustal Evolution (GLIMPCE)

In September 1986, GLIMPCE collected, through a contract to Geophoto Services Ltd. of Calgary, approximately 1350 km of deep seismic reflection data in the Great Lakes of Canada and the United States. This survey, which was jointly funded by the Geological Survey of Canada (through its LITHOPROBE contribution) and the United States Geological Survey, was run with a huge 130 litre tuned airgun array and a 120-channel data acquisition system. Complementary seismic refraction data were recorded by five ocean bottom seismographs in Lake Superior and numerous land-based stations. The survey was designed to resolve the deep structure of the Keweenaw Rift and the Hemlo and Michipicoten Granite/Greenstone Belts in Lake Superior, the Grenville Front and Huronian continental margin in Lake Huron and the Penokean Orogen and Niagara Fault in Lake Michigan. Data from Lake Superior reveal a remarkable image of the asymmetric Keweenaw Rift basin with strong reflections from the intercalated rift volcanics and sediments extending to two-way travel times (T) of up to 9s. In places the bounding Keweenaw and Isle Royale faults seem to have evolved first as normal growth faults influencing basin subsidence, and then as reverse faults thrusting blocks of rift volcanics and sediments over younger strata. Beneath the western end of Lake Superior the crust-mantle transition is represented by the base of a prominent band of reflections that appears to dip to the south from about approximately 40 km to approximately 47 km, and beneath the central and eastern parts of the lake it could be as deep as approximately 53 to 60 km. The crustal section underlying some parts of the rift basin may be as thin as 18 km, which is about half the thickness of crust beneath adjacent regions of unrifted Archean and Early Proterozoic terranes.

The Grenville Front at the western end of Georgian Bay is imaged as the westernmost event of a spectacular series of southeast dipping reflections that clearly truncates the terrane to the northwest, characterized by a laterally extensive zone of flat reflections at approximately 20 km depth. The southeast dipping reflectors, which extend from the surface to near the base of the crust, are best interpreted as zones of intense ductile shear with probably northwest thrust sense, similar to those that are exposed within the Grenville Front Tectonic Zone a short distance to the north along the coast of Georgian Bay. A weak band of subhorizontal reflections at about 33 to 40 km depth may delineate the base of the crust beneath the Grenville Province.

ARCTIC PROJECTS

Preliminary analysis of the 1985 Ice Island seismic refraction data collected along the inner Arctic continental shelf, indicates a thin veneer of 2.0 to 2.5 km/s sediments overlying material with velocity of 5.2 to 5.3 km/s. At a depth of about 3 to 4 km the velocity increases to 5.8 km/s. The 5 km/s velocities may be associated with volcanic rocks of the nearby Rens Fjord section. In marked contrast to the inner shelf profiles, data recorded on the outer shelf reveal a 5 km thick upper crustal section with velocities ranging from 3.8 to 4.2 km/s. This upper region of the crust is interpreted as a major sedimentary basin. The mid to lower crustal velocities range from 5.4 to 6.4 km/s and these are underlain by upper mantle material with velocity near 8.2 km/s at a depth of 22 to 55 km.

The seismic refraction program using the Ice Island as a base station continued in 1986. One of the 1985 lines was reversed and five further lines of seismic refraction data were collected. Each of these lines was 120 km long, with effective receiver spacing of 2.5 km. Data from this survey has been processed and is currently being modelled.

In March of 1987, LCSD personnel were involved in the Richardson Mountains - Mackenzie Delta seismic refraction survey. During this survey more than 1300 seismograms were recorded along seven 110 km long spreads using a 2 to 3 km receiver spacing. This survey constituted the first full-scale experiment using the new generation of single channel recorders (or 'lunchboxes') and the newly developed in-field processing software. Within two days of the completion of the survey all of the refraction data were available in modified SEGY-format computer tapes ready for plotting - this represents a 6 to 12 months reduction in time required for preparing/processing land-based seismic refraction data.

LCSD PROJECTS

Central Plains

Interpretation of the eight COCRUST seismic refraction profiles collected across the Williston Basin/Trans-Hudson orogen in 1977, 1979 and 1981 is now complete. Within the southern extension of the Superior craton margin (Thompson belt) a high velocity lid overlies a zone of westerly dipping reflections that is nearly coincident with a weak velocity discontinuity that seems to delineate the western edge (Thompson fault) of the craton margin. The model implies that part of the Trans-Hudson orogen overrides the margin of the Superior craton. Complex zones of low-velocity material and the North American Central Plains (NACP) electrical conductivity anomaly, the largest electrical conductivity anomaly on earth, are concluded to lie

within the southern extension of the Reindeer-South Indian Lakes terrain, a component of the Trans-Hudson orogen. To the west, our modelling implies that the Wyoming craton may override the terrains of the Trans-Hudson orogen. A high velocity lower crustal layer, which represents a zone of complexity separating 'normal' crust from the upper mantle, extends throughout the region. The crust is relatively thick, with depths to Moho varying smoothly between 41 and 48 km. There is no evidence in the relatively low resolution seismic refraction data for abrupt changes in the level of the Moho, but there may be a minor thinning of the crust near the center of the Williston basin.

Using a 35 station magnetotelluric (MT) data set from southern Manitoba and Saskatchewan, donated to the GSC by PanCanadian Oil Co., a special study has been made of the NACP electrical conductivity anomaly. Results show the anomaly is about 75 km further east than previously estimated and suggest the source of the anomaly lies at a depth of about 10 km, with the structure dipping down to the west. The magnetotelluric profile also traverses another electrical structure to the east which is an expression of the southern extension of the Thompson belt. The MT data were corrected for near-surface distortions using a new technique and the corrected responses agree well with the known variation of the conductivity in the Williston Basin sediments of southern Saskatchewan. It demonstrates that the MT method may be a useful tool in the exploration for hydrocarbons.

A new method of illustrating Bouguer gravity anomalies has been successfully applied to studies of North America, with emphasis on the Central Plains. This method, which uses the horizontal gradient of the Bouguer anomaly field, has been applied to a composite North American data base using information from both U.S. and Canadian sources. Structures on the exposed Canadian Shield can be traced with confidence beneath adjacent Phanerozoic platform deposits that cover approximately 40% of the continent. In conjunction with other geological/geophysical data the pattern of North American structures revealed in the gravity gradient maps suggest that growth of the continent, from the end of the Archean, has to a large extent been outward from the Superior and Wyoming Provinces; the Slave Province is another, smaller nucleus for growth that is not as obvious on the gradient map. Several good correlations between Phanerozoic sedimentary basins and discrete sets of gravity trends suggest that crustal structure and crustal processes have controlled the development of the basins. On the other hand an orthogonal system of Phanerozoic basement arches, believed to have influenced intra-arch (i.e. basin) deposition, bears little relationship to structural trends.

TECHNOLOGY DEVELOPMENT

Seismic Studies

In order to enhance and highlight structural features observed in seismic reflection data, an interactive processing package has been developed. This package enables scientists to scan the vast amounts of data collected along deep seismic profiles for relevant single- and multi-trace seismic attributes and to plot in colour various parameters such as instantaneous frequency, instantaneous phase, apparent velocity, semblance and amplitude.

Significant progress has also been made in resolving problems associated with the migration of deep seismic reflection data. A new noise-rejection migration algorithm has been developed. The algorithm is applicable to post- and pre-stack migration problems. In particular, the problem in conventional reflection seismic processing of imaging near-surface steeply dipping faults or migrating converted phases has been successfully resolved by this new technique.

Magnetotelluric Studies

Work has progressed on a fast approximation scheme for modelling the anomalous electromagnetic fields produced by a buried conductive anomaly. These new developments will permit rapid modelling by inversion programs, reducing computing costs and at the same time producing more realistic interpretations of the structure of the earth.

Four applied geophysics projects were carried out in the Eastern Townships of Quebec for the Asbestos Initiatives Program. One final report was submitted by MERI under contract entitled "Interprétation des levés magnétiques et gradiomagnétiques aéroportés dans la région de Weedon, Quebec". It was subsequently open filed. The possibility of detecting buried (gold) placer deposits was studied by carrying out detailed magnetic surveys in the Chaudière River Valley. The results have yielded a method to select the areas of a river terrace which are probably the most interesting in the exploration of these deposits. Several mining companies are to try out the method. Thirdly, the rotary wing airborne magnetic gradiometer/VLF/EM survey, Mont Stoke, a pioneering survey yielding detailed information on bedrock magnetic and electric properties in an area on strike and geologically similar to adjacent areas which contained proven ore deposits. The survey is carried out under contract by Aerodat Ltd. The total magnetic field data obtained as part of this survey is being used by Le Groupe ACS1 under contract by GSC for the preparation of a calculated gradient map for comparison with the flown map also obtained in the survey.

Personnel Notes

L. Mayrand completed the Scientibank assignment.

J. Craven and C. Smith were employed as term research and computer programming assistants.

G. Parry accepted a term secretarial position with the section.

Attendance at Meetings, Conferences and Courses

J. Broome

Society of Exploration Geologists, Houston, Texas, U.S.A., November.

M.Sc. courses, Carleton University, Ottawa.

M.J. Drury

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

T. Feininger

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May.

Pan-American Institute of Geography and History (PAIGH), Washington, D.C., U.S.A., October.

D.A. Forsyth

European Seismological Commission Meeting - Polar Research Symposium and International Committee on the Lithosphere-Arctic Subcommittee meeting, Kiel, FRG, August.

Atlantic Geoscience Centre, Program Review, Halifax, Nova Scotia, August.

A. Green

LITHOPROBE meeting on the Trans-Hudson transect proposal, Winnipeg, Manitoba, April.

GLIMPCE organizational meeting, Reston, Virginia, U.S.A., May.

GLIMPCE organizational meeting, Wisconsin Rapids, Wisconsin, U.S.A., June.

Deep Seismic Reflection Profiling Conference, Cambridge, U.K., July.

LITHOPROBE seismic sub-committee on the Processing Centre, Calgary, Alberta, November and February.

LITHOPROBE seismic committee meeting, Calgary, Alberta, November.

GLIMPCE executive meeting, Madison, Wisconsin, U.S.A., December.

GLIMPCE interpretation meeting, Reston, Virginia, January.

J.C. Gupta

Space time structure of geomagnetic field, International Symposium, Wittenberg, G.D.R., September.

C.C.M. Michaud

Administrative writing course, PSC, Hull, Quebec, April-June.

ACFAS, Montreal, Quebec, May.

B. Milkereit

The Continental Lithosphere-Structure, Composition and Processes Symposium, Karlsruhe University, Karlsruhe, F.R.G., April.

EAEG/SEG Research Workshop on Deconvolution and Inversion, Rome, Italy, September.

P. Morel

Assemblée générale de la Société Québécoise de Géophysique, Montreal, Quebec, May.

Transport of dangerous goods, EMR course, Ottawa, October.

Geological Society of America, Annual Meeting, San Antonio, Texas, U.S.A., November.

Interpretation of gravity and magnetic anomalies for non-specialists, GSC, Ottawa, November.

Meeting on GLIMPCE, Madison, Wisconsin, U.S.A., December.

Réunion avec la direction de l'Université du Québec et des représentants des différents campus, Québec, February.

Prospectors and Developers Annual Meeting, Toronto, Ontario, March.

L.W. Sobczak

GSC Current Activities Forum, Ottawa, January.

M.D. Thomas

Geological Association of Canada, Annual Meeting, Ottawa, May.

American Geophysical Union, Annual Fall Meeting, San Francisco, California, U.S.A., December.

GSC Current Activities Forum, Ottawa, January.

Membership on Committees

J. Broome

GSC Data Integration Committee, member.

GSC Geophysical Data Base Working Group, member.

M.J. Drury

Canadian Continental Drilling Program, steering committee member.

Interdepartmental Geothermal Technical Advisory Committee, member.

Canadian Geothermal Energy Association, executive committee member.

Observatory Campus Library Committee, member.

T. Feininger

Canadian Mineralogist: Associate Editor.

Pan-American Institute of Geography and History (PAIGH), Geophysics Commission, vice-president.

D.A. Forsyth

Arctic Solid Earth Geosciences Research, United States National Research Council Committee member.

The '88 Chukchi Borderlands Program, Advisory Committee, member.

Neotectonics of Eastern Canada, Atomic Energy Control Board Project Review Committee, member.

EMR Earth Science Sector Committee to implement cabinet approved expenditures to update and refurbish Polar Continental Shelf facilities at Resolute Bay and Tuktoyaktuk.

EMR Committee to monitor revisions to the manual for field parties, member.

A. Green

LITHOPROBE Seismic Committee, member.

LITHOPROBE Seismic Sub-committee on the Processing Centre, member.

GLIMPCE Executive Committee, member.

GLIMPCE Seismic Sub-committee, member.

Subgroup on "Structure", Working Group-6 of the International Lithosphere Program, corresponding member.

R.D. Kurtz

Geophysics Library Committee, member.

Geophysics Seminar Committee, member.

Instrumentation Working Group Committee, member.

P. McGrath

GLIMPCE Potential Fields Sub-committee, member.

E.J. Schwarz

Proposal for an Abitibi-Grenville Front Lithoprobe Transect with Quebec and Ontario Universities and Industry Personnel, co-investigator.

DNAG - Geology of Canada Advisory Committee, French Edition, member.

External examiner, Ph.D. thesis, University of Toronto.

L.W. Sobczak

DNAG - Arctic Volume, Inuitian Volume and Transect, committee member.

Canadian Ice Island (FGP)

Fire and Health Committee for Building 3, Observatory Crescent.

Special Talks and Lectures

J. Broome

"An IBM-compatible microcomputer work station for geophysical interpretation" and "Gravity and magnetic interpretation for non-specialists", Geological Association of Canada, microcomputer seminar and short course, Ottawa, May and November.

"Microcomputer based interpretation of potential field data", Queen's University, Kingston, Ontario, March.

M.J. Drury

"Whither geothermics?", G.S.C. Geophysics Seminar Series, Ottawa, January.

T. Feininger

"The layered mafic intrusion at Sept-Iles, Quebec" and "Allochthonous terranes in the Andes of Ecuador and N.W. Peru", Cornell University, Ithaca, New York, U.S.A., February.

L'intrusif statiform mafique de Sept-Iles", Université de Montréal, Montreal, Quebec, March.

D.A. Forsyth

"Role of the Lithospheric Geophysics Section, Ottawa", Geological Association/Mineralogical Association of Canada, Meeting Tour, Ottawa, May.

"Alpha Ridge and Iceland - Products of the same Plume?" and "Proposed geophysical program for the Lincoln Sea", European Seismological Commission Meeting, Kiel, FRG., August.

A. Green

"LITHOPROBE seismic reflection profiling across Vancouver Island", Cambridge University, Cambridge, U.K., July.

"LITHOPROBE seismic reflection profiling across Vancouver Island and the southeastern Cordillera", Concordia University, Montreal, Quebec, February.

"LITHOPROBE: Concept and early results" and "GLIMPCE: Results of seismic reflection profiling in the Great Lakes", University of Waterloo, Waterloo, Ontario, March.

J.C. Gupta

"Electromagnetic induction and applications", Indian Institute of Geomagnetism, Bombay, India, August.

"Geomagnetic induction studies in the region of Wopmay Orogen, Northwest Territories", Wittenberg, G.D.R., September.

P. McGrath

"Interpretation of gravity and magnetic anomalies for non-specialists" participant in short course, Canadian Geophysical Union and GSC, Ottawa, May and November.

C.C. Michaud

"Des nouveaux appareils d'enregistrement de sismique réfraction dans la région de Charlevoix", ACFAS Congress, Montreal, May.

B. Milkereit

"Migration of deep seismic data", University of British Columbia, Vancouver, B.C., April.

"Results of reprocessing of Vancouver Island Lithoprobe reflection lines", Pacific Geoscience Centre, Sydney, B.C., April.

"Seismic reflection mapping across accreted terrains on Vancouver Island", Karlsruhe University, Karlsruhe, F.R.G., April.

"Inversion of P-S conversion data sets", EAEG/SEG Research Workshop, Rome, Italy, September.

"Migration of seismic data", Department of Mineral Engineering, Ecole Polytechnique, Montreal, Quebec, November.

"Seismic migration: theory and practice of the Kirchhoff method", Queen's University, Kingston, Ontario, March.

P. Morel

"Les programmes de géophysiques à la Commission géologique du Canada", Quebec, February.

E.J. Schwarz

"Detecting buried placers by magnetic survey, Chaudière River, Quebec", Gold '86, Toronto, Ontario.

"Detection des placers enfouis", Colloque de géophysique appliquée, Ecole Polytechnique, Montreal, Quebec.

"The detection of buried placers by ground magnetic survey", GSC Geophysical Series, Ottawa.

L.W. Sobczak

"Ice Island - Frontier Geoscience Program", Ottawa, October.

M.D. Thomas

"Paired gravity anomalies and orogenic belts in North America", University of Quebec at Montreal, Quebec, March.

"Gravity trends and domains of the North American continent" Ecole Polytechnique, Montreal, Quebec, March.

Manuscripts submitted

1 GSC paper, 1 open file map, 1 open file report, 4 Current Research papers, 2 maps, 31 external publications, 2 obituaries, 13 abstracts, 1 T.B. submission, 1 DNAG contribution.

Mineral Resources Division

D.C. Findlay, Director

The Division was formed April 1, 1986 as a result of merging the former Economic Geology and Mineralogy Division with the Resource Geochemistry and part of the Resource Geophysics components of the previous Resource Geophysics and Geochemistry Division.

The Division is responsible for: providing a comprehensive knowledge base on the nature and distribution of Canada's mineral resources; developing concepts and technologies to aid Canadian industry in the search for new resources; providing scientific and technical support for resource management and land use policies; providing compositional analyses of geological materials; and developing methodologies and establishing standards relevant to the above.

To carry out these responsibilities, the Division is organized into an Administrative Unit and four Subdivisions: Mineral Deposits; Mineralogy and Chemistry; Exploration Geophysics; and Exploration Geochemistry. The objectives and roles of individual units and highlights of their activities are presented under the relevant headings on the following pages.

The Division has a continuing staff strength of 151 person years with an additional 15.5 person years in term positions that are assigned to activities in Federal Initiative programs in Quebec and various Mineral Development Agreements.

In 1986-87, the Division supported 15 EMR Research Agreements and 46 outside research contracts.

Highlights

In mineral deposits research the Division continued its focus on gold and platinum group metals, both of continuing topical exploration interest. In gold investigations, major industry exploration interest in the Baie Verte region of north-central Newfoundland is in part linked to Division scientists' recognition that hydrothermal processes related to obduction/subduction in ophiolite terranes could provide favourable target areas for gold (Newfoundland Ophiolite Project). A project underway, in part under the Ontario MDA to investigate direct-dating (geochronology) of mineral deposits has provided evidence that the rare earth element content of scheelite from Archean gold deposits can indicate the source of mineralizing fluids - a finding that has significant implications for gold metallogeny. Discussion and reconnaissance field investigations began with staff of the B.C. Ministry of Energy, Mines and Petroleum Resources concerning the introduction of gold metallogeny studies in the Cordilleran. A field program in this area will begin in 1987/88.

The Division's platinum group elements research program has now completed preliminary field investigations of some 50 mafic/ultramafic intrusions in Manitoba, Saskatchewan, Ontario, New Brunswick and

Newfoundland and laboratory studies are progressing on these potential environments. This work has yielded important new information on PGE potential in Canada and a significant part of current industry platinum exploration programs was catalyzed by GSC work. One of the most significant findings to date is the previously unrecognized relationship between selenium and sulphur ratios in magmatic sulphides that can be used as a discriminant in identifying target intrusions favourable for PGE concentrations. In view of the current intense interest in PGE exploration, the Division is producing a summary report on platinum in Canada which is scheduled for publication during the summer of 1987.

Mineral deposit investigations continued on a variety of other fronts. A project that is of considerable scientific and practical interest is the continuing investigation of seafloor massive sulphide deposits in the Juan de Fuca spreading ridge system. Work continued on the major (about 100 million tonnes) "Middle Valley" deposit discovered by GSC scientists in 1985 and further investigations of the Axial Seamount area resulted in the location of high temperature venting and zinc and gold-enriched sulphides. A major internal report on the scientific and economic assessment of Juan de Fuca seafloor sulphides was completed for the Department's Boundary Program final report. This report (sulphides) will be modified for public release as a GSC paper later in the year.

In northern mineral resource assessment (MERA) work, the Division has now completed most of the currently scheduled (proposed) northern park assessments. Field work in the last remaining area (Nahanni Park Extensions) will be completed during the 1987 season. With the exception of the Nahanni, Wager Bay-Southampton Island, and Banks Island projects, all of the terrestrial park assessment reports are now published or in final pre-publication stage (Bylot-Borden-North Baffin).

In exploration geochemistry, Division activities resulted in a number of major findings and new products. Under the various federal-provincial Mineral Development Agreements and the Yukon Economic Development Agreement, a total of about 152,000 km² was covered by regional geochemical (lake and stream sediment) surveys, involving the collection of 13,100 samples. A new index map to National Geochemical Reconnaissance Surveys, covering the period 1973-1986 was completed. The map provides summary geochemical information for lake and stream sediments, waters and heavy mineral concentrates for surveys with cumulative coverage of about 1,800,000 km² across Canada. In connection with federal initiatives in Quebec, the results of heavy mineral geochemistry surveys conducted by the Division under the Gaspé Lower St. Lawrence Geoscience Program have resulted in extensive staking activity by industry in the region.

In geochemical research directed at precious metals, biogeochemical test surveys in the LaRonge belt, Saskatchewan successfully outlined anomalous gold zones, leading to the discovery by industry drilling of new gold mineralization (as yet sub-economic) in the belt. In the Cordillera, geochemical investigations of the Bennet Lake Caldera Complex (BC-Yukon) and the Whitehorse Trough indicate the potential for additional epithermal precious metal mineralization in these environments. In the Atlin District, B.C. geochemical

investigations of mesothermal gold-quartz veins suggest the potential for a "motherlode" (California) environment. Investigations (isotopic and geochemical) of certain Archean gold deposits, including those of the Hemlo camp, suggest an association of gold mineralization with oxidized fluids that may have been derived from magmas that generated felsic plutons in the gold camps.

The investigation of groundwaters as a mechanism of geochemical dispersion in surficial environments continued. A piezometer system for sampling uncontaminated groundwaters in rotasonic overburden drill holes was developed and successfully tested. Similar technology has been developed for use in reverse circulation overburden drilling.

In data processing technology a new computerized system called "IDEAS" (Interactive Data Exploration and Analysis System) was brought to production status and is being used to assist in the graphical presentation and interpretation of geochemical data. The production of geochemical maps was improved significantly through new techniques developed for use on the Optronics Laser Plotter at Canada Lands Directorate, Environment Canada.

Increasingly the Division is making use of LANDSAT (Thematic Mapper) and other remote sensing imagery to investigate correlations with geochemical (e.g. biogeochemistry - stressed vegetation) and geological (linear features, mineral deposits distribution) data and several projects in this field were continued in New Brunswick, Nova Scotia, Ontario and Yukon. Image processing and analysis methods were used to successfully integrate LANDSAT data, digitized geological information, catchment basin geochemistry and other parameters to predict the presence of tungsten skarn mineralization associated with buried intrusions in the Nahanni area, Yukon. These techniques have attracted industry attention and at least one major mining company has installed GSC-derived software for treatment of geochemical data. Preparations are being made in the Division for the installation of a new "Geoscience Image Analysis Facility" which will allow more sophisticated and rapid data integration and analysis.

In geophysics, the Division proceeded with research and demonstration projects directed at improving applications in exploration technology.

Contract airborne radiometric/VLF surveys to extend regional coverage, and in-house experimental surveys, totalling 42,000 line km, were flown in six (6) provinces. New products during the year included the 1:5,000,000 scale Radioactivity Map of Canada (Map 1600A) and completion of GSC Paper 87-14, a ternary radioelement compilation map of southern Newfoundland at 1:500,000 scale. The Newfoundland map, displayed at Current Activities Fora in Ottawa and St. John's, attracted considerable attention and comment.

A major joint venture demonstration project in borehole geophysics was conducted in British Columbia with the collaboration of seven mining companies and the application of a new spectral gamma-gamma (SGG) logging tool to semi-quantitative assay logging was demonstrated. A milestone in borehole logging was the publication of GSC Paper 85-27 - "Borehole Geophysics

for Mining and Geotechnical Applications", the proceedings of a GSC/KEGS (Canadian Exploration Geophysical Society)-sponsored symposium held in 1983.

Much of the work in electrical methods was applied to establishing of a test site in the Matheson, Ontario area, conducting ground and contract helicopter EM surveys at the test site and along transects in the Timmins-Kapuskasing area for overburden thickness/Quaternary mapping applications. Proceedings of a GSC-sponsored symposium in 1985 were published in GSC Paper 86-22 - "Airborne Resistivity Mapping".

In the mineralogical and chemical laboratories of the Division, federal-provincial Mineral Development Agreement projects have added a considerable workload to the operations. In the chemistry and geochemical laboratories, in-house sample throughput increased by about 20% over 1986/87 and management and contract supervision for MDA samples increased by about 200%. The laboratories have kept pace with the added workload through internal reallocation of staff and through the bringing on-line of new technology, including the new X-ray fluorescence spectrometer and new automated equipment for rapid determination of sulphur and water. Contracting-out is now a significant component in the analytical chemistry operations with about \$184 000 worth of contract analyses being processed during the year.

Research on methods development in the laboratories continued in a number of areas, including new methods of sample vaporization in inductively-coupled mass spectrometry, evaluation of microwave digestion of samples, and techniques for the determination of gold and platinum-group elements in dry and ashed vegetation.

Progress was made in the establishment of an in-house Light Stable Isotope Facility (O and H in silicate materials) at 601 Booth Street and it is anticipated that the laboratory will be in operation in the summer/fall. The Joint GSC-Ottawa-Carleton Stable Isotope Facility (S, C and O in carbonate materials at Ottawa University (managed by Division staff) had a successful year of operations and all sample backlogs were eliminated by year-end.

Administration

This unit, comprising the Director, Assistant, Secretary, Staff Scientist, Administrative Officer and three Financial Clerks, manages the Division's activities and resources and provides general administrative, financial and personnel support for the Division.

Personnel Notes

After seven years of dedicated service to the Division and its predecessors as Administrative Officer, R.A. Gaudreau left in December for new challenges at headquarters with Human Resources Sector. His replacement, Bonnie L. Rankin, joined the Division in January from Surveys and Mapping Branch.

Dr. L.M. (Bud) Cumming was appointed Staff Scientist; his responsibilities include, amongst other things, co-ordination of student employment for the

Division, management of the Branch contract for lapidary services, and coordination of Division reports to the weekly DM briefing letter.

A. Gil provided term support for Administrative Services for part of the year.

Attendance at Conferences, Meetings & Courses

L.M. Cumming

Geological Association of Canada/Mineralogical Association of Canada/Canadian Geophysical Union Annual Meeting, Ottawa, May 1986.

Canadian Mineral Outlook Conference, Ottawa, May 1986.

Canadian Geotechnical Conference - Advances in Peatland Engineering, Ottawa, August 1986.

Federal-Provincial Industrial Minerals Workshop, Ottawa, October 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Prospectors and Developers Association, Toronto, March 1987.

D.C. Findlay

Canadian Institute of Mining and Metallurgy, Annual General Meeting, Montreal, May 1986.

Geological Association of Canada/Mineralogical Association of Canada/Canadian Geophysical Union Annual Meeting, Ottawa, May 1986.

The Canadian Mineral Industry: Emerging Challenges and Opportunities, Banff, September 1986.

Newfoundland Annual Review of Activities, St. John's, November 1986.

Ontario Geological Survey Geoscience Research Seminar and Open House, Toronto, December 1986.

Prospectors and Developers Association, Toronto, March 1987.

C.R. McLeod

Geological Association of Canada/Mineralogical Association of Canada/Canadian Geophysical Union Annual Meeting, Ottawa, May 1986.

New Brunswick Department of Natural Resources and Energy Annual Review of Activities, Fredericton, November 1986.

Nova Scotia Department of Mines and Energy Review of Activities and Annual Open House, Halifax, November 1986.

Staffing for Managers, Ottawa, February 1987.

B.L. Rankin

Staffing for Managers, Ottawa, February 1987.

M.M. Redden

Advanced Professional Secretaries and Administrative Assistants Seminar, Humber College, Toronto, March 1987.

Special Talks, Lectures

L.M. Cumming

"Geology of Brucite Occurrences, Wakefield, Quebec"; Geological Association of Canada Field Trip, May 1986.

Memberships on Committees

D.C. Findlay

Working Committee on Northern Mineral Resource Assessment, Co-chairman.

Geological Survey of Canada representative on Energy, Mines and Resources ISMI (International Strategic Minerals Inventory) Committee.

International Union of Geological Sciences UNESCO Mineral Deposit Modelling Program; Member Steering Committee.

Canada/Ontario Mineral Development Agreement, member of Geoscience Technical Committee, and Management Committee.

C.R. McLeod

Energy, Mines and Resources Committee for Ocean Mining, Working Group for Deep Ocean Mining, Member.

MINERAL DEPOSITS SUBDIVISION

J.M. Duke, Head

The mission of the Mineral Deposits Subdivision is to provide comprehensive geological knowledge concerning the nature, distribution and origin of Canada's nonhydrocarbon mineral resources. This knowledge is intended to assist the private sector in mineral exploration and government in policy formulation. To meet this responsibility, the subdivision has designed a program which includes three main elements:

1. Mineral Deposits Studies: Both mineral exploration and resource assessment endeavour to predict the location, size and quality of undiscovered mineral deposits. This presupposes an understanding of (a) the attributes of various types of mineral deposits, and (b) the reasons why deposits occur where they do. To contribute to such an understanding, the subdivision carries out comprehensive field and laboratory studies of selected deposits, characterizes the essential attributes of related deposits, and investigates ore-forming processes using such techniques as thermodynamic analysis, radiogenic and stable isotope geochemistry, structural analysis and so on.
2. Regional Metallogenic Studies: Different

geological terranes are characterized by different assemblages of mineral deposit types. An understanding of the relationship between mineral deposits and their geological setting is fundamental to the prediction of what types of deposits are likely to occur in a given region. Consequently, the subdivision undertakes regional metallogenic studies which integrate the broad range of geological, tectonic and metallogenic data in selected regions of Canada. These studies provide guidelines for mineral exploration as well as for mineral resource appraisal.

3. Mineral Resource Assessment: The department is required to provide annual assessments of Canadian reserves and resources of uranium and thorium. The subdivision contributes data on resources, exploration activity, geological deposit models, and exploration technology to the annual URAG (Uranium Resource Appraisal Group) process which are released as the biennial reports of the Department (Uranium in Canada; Assessment of Supply and Requirements). The subdivision is also required to evaluate resources of specified regions or commodities in Canada on an 'on demand' basis. These evaluations are carried out at the request of other government agencies such as the Department of Indian and Northern Affairs, Parks Canada, and the Department of External Affairs and are used as the basis for land use planning, the delineation of national parks, aboriginal land claims negotiations, international boundary disputes negotiations, and the like.

The subdivision includes five research sections which are Mineral Deposits Geology, Geochemistry of Mineral Deposits, Northern Minerals, Southern Minerals, and Mineral Resource Appraisal Secretariat. In addition, the subdivision operates two service units in support of its research and other activities. The Mineral Resource Information Services Unit ensures the availability of mineral deposits data in both electronic and traditional form. This unit maintains the GSC-developed CANMINDEX system and acquires and makes accessible electronic data bases from provincial and other agencies. The Laboratory and Scientific Support Unit is responsible for processing rock specimens, preparation of polished sections, mineral separations, maintenance of the research microscopy laboratory, and certain drafting requirements.

Highlights

Mineral Deposits Research

Gold and platinum group elements (PGE) have been major foci for mineral deposits studies in line with current priorities of the exploration industry.

Investigations of a diverse range of gold deposits continued in virtually all major terranes in Canada. Mesothermal vein deposits emerge as the most important class regardless of age. Among the examples under investigation are several deposits at Val d'Or, P.Q., Salmeta, N.W.T., Star Lake and Falcon Lake,

Manitoba, Timmins, Ontario, Meguma, N.S., and Baie Verte, Newfoundland. The most important structural controls of these vein systems are shear zones and extensional arrays. A second important class being studied is auriferous sulphide deposits such as Lupin, Hemlo and Chetwynd. The discovery that the rare earth element content of scheelites from Archean gold deposits is indicative of the source of mineralizing fluids has exciting implications for gold metallogeny.

This was the third year of a program to investigate magmatic PGE environments in Canada. Field work and data collection have been completed for the majority of the nearly 50 intrusions that have been examined to date in Manitoba, Saskatchewan, Ontario and New Brunswick, including bodies at Rottenstone Lake, Peter Lake, Lynn Lake, Reed Lake, Namew Lake, St. Stephen and the Logan sills. Field and laboratory studies are continuing at Bird River and Fox River sills in Manitoba where factor analysis of PGE and related analytical data is providing new insight into the relative roles of sulphides and chromite in concentration of PGE. Discovery of a previously unrecognized positive correlation between PGE and selenium abundances in a variety of magmatic sulphide deposits has important implications for exploration. Research at Peter Lake and Nicholson Bay, Saskatchewan, and Bay of Islands, Newfoundland is providing important clues to the hydrothermal behaviour of PGE, and thereby suggesting new exploration targets.

Investigation of PGE in intrusions of the Brito-Arctic Tertiary flood basalt province is yielding interesting results. Laboratory follow-up to field work on Disko Island, West Greenland has shown the strong preference of PGE for the metallic as compared with the sulphide phase in the strongly reduced basalts. A collaborative project undertaken with the British Geological Survey to investigate ore element variation in the Rhum Igneous Complex resulted in the discovery of a PGE enriched horizon in which the sulphur appears to have been derived locally from Jurassic sediments.

Detailed mapping of the chromite deposits in the Bird River Sill continued for the second year, and served as a basis for contract economic assessment and pre-feasibility studies commissioned by CANMET.

Detailed mapping, petrography and chemical studies were initiated on the Methuen ilmenite deposit, Peterborough County, Ontario. The deposit is unmetamorphosed and is associated with the most primitive rock compositions in a lopolithic intrusion. A new occurrence of iron-titanium-vanadium oxides and, possibly, phosphates was discovered at Tow Lake, Manitoba.

More emphasis is being placed on investigation of mineral deposits associated with felsic magmatism due in part to the increasing importance of associated rare and precious metals. Image analysis and integration of LANDSAT, geological, geochemical and mineral occurrence data identified new areas of high tungsten skarn potential in the Nahanni River area, Yukon Territory. Also in Yukon, it was found that quartz-tourmaline orbicules in the Seagull batholith formed from boron-rich aqueous magmatic fluids and contain anomalous levels of tin: this has implications for the origin of tin deposits associated with the batholith. Investigation of fluorine-rich granitic rocks and topaz rhyolites in southern Yukon and northern B.C.

indicate that they are related to Late Cretaceous-Early Tertiary extensional tectonism. Preliminary work in the Mitchell-Sulphurets area, B.C. suggests that gold-silver occurrences are more widespread than previously thought and may be part of a large porphyry system. Similarly, base and precious metal veins in the Woodstock, N.B. area are peripheral to a porphyry system centred on Connell Mountain. Documentation of thermal and mineral zoning in base metal deposits peripheral to granitic intrusions in the Gaspé Peninsula, Quebec suggest similarities to classical mining districts in the U.S.A. and Mexico.

Detailed mapping of volcanogenic massive sulphide environments in the Sturgeon Lake area, Ontario has shown that the ore horizon is shifted considerably from its previously determined position. Subsequent exploration drilling by the property owners based on these findings resulted in a significant discovery of massive sulphides.

Sediment-hosted mineral deposits also continued as a focus of important research. Stratiform exhalative lead-zinc deposits in the Selwyn Basin, Yukon Territory were shown to have formed by the mixing of metalliferous sulphur poor hydrothermal fluids with sulphidic bottom waters during periods when the water column was stratified with anoxic waters. Studies of conodont colour indices in the carbonate host rocks of Mississippi Valley Type lead-zinc deposits in Canada suggests that the deposits do not represent thermal anomalies relative to host rocks, a conclusion with important implications regarding timing of ore emplacement. Cathodoluminescence studies of lead-zinc veins in the western Newfoundland carbonate platform resulted in the discovery of K-feldspar, albite and apatite as gangue minerals. The age of these minerals, which are at least partly contemporaneous with mineralization, has been determined by the $^{40}\text{Ar}/^{39}\text{Ar}$ method: this is the first direct dating of carbonate hosted base metal mineralization in the Canadian Appalachians. Detailed vitrinite reflectance and other studies at the sandstone-hosted Yava lead deposit, Cape Breton, Nova Scotia revealed that features heretofore attributed to elevated temperatures in fact resulted from chemical processes. A publication on the geochemistry of iron-formation in Canada compares compositional variation among 25 stratigraphic units from 10 major depositional/metamorphic environments. A reconnaissance investigation of the trace element content of coals from the Sydney Basin, Nova Scotia revealed potentially economic concentrations of gallium and germanium.

Lead isotopic studies have shown that volcanogenic massive sulphide deposits in western and southern Slave Province incorporate lead from an ancient felsic crustal source whereas those from northern and eastern Slave do not. Similarly, lead in mineral occurrences in the oldest volcanic cycle at Wawa, Ontario was derived from a long-lived felsic crustal source.

Seafloor Minerals Program

A major massive sulphide deposit (about 100 million tonnes) in the Middle Valley area of the Juan de Fuca Ridge was photographed and sampled by dredging and diamond drilling. Work in the Axial Seamount area revealed the presence of high temperature vents with

zinc and gold rich sulphides, and unusual radium-rich barite. Petrographic and geochemical studies of a pristine alteration zone associated with sulphides on the Galapagos Rift have improved our understanding of ancient massive sulphide deposits.

A major report entitled "Assessment of Mineral Resource Potential, Juan de Fuca and Explorer Ridges" was completed as part of the Branch commitment to the Boundary Studies Program.

A report entitled "Metallic Minerals on the Deep Seabed" (GSC Paper 86-21 and Map 11-1986), which provides a world survey of the geological environment and types of metalliferous sedimentary deposits on the seabed, has been completed.

Regional Metallogenic Studies

A high potential for structurally controlled gold-quartz veins has been suggested for the Ferguson River Greenstone belt in west-central Keewatin District, N.W.T. Gold is associated with pyrite and arsenopyrite in highly strained iron formation in a turbidite sequence. Also in west-central Keewatin, high uranium potential has been related to regionally extensive thrusts in Archean greenstone belts close to the basal Helikian unconformity. A study of U-Au mineralization in the sub-Thelon unconformity at Boomerang Lake revealed the presence of nickel-cobalt selenides and contemporaneity with deposits associated with the sub-Athabasca unconformity.

A unique zone of supermature platform metasedimentary rocks, mainly quartzite and quartz pebble conglomerate, was mapped 150 km northeast of Yellowknife, N.W.T. This is a possible analogue of the Witwatersrand Supergroup of southern Africa and therefore has possible implications for gold exploration.

In the central Mineral Belt of Labrador, granite-related polymetallic mineralization was recognized near Makkovik, and in the Burnt Lake area molybdenum-base metal mineralization was found to be superimposed upon earlier volcanogenic uranium mineralization. Geological mapping and age determinations in the Buchans-Roberts Arm belt of Newfoundland has demonstrated that stratigraphic control of massive sulphide deposits is more important than previously appreciated. In the western Newfoundland carbonate platform, improved understanding of groundwater flow in karstic terranes has enhanced water management in the Daniels Harbour Mine.

Regional metallogenic studies in the Cape Breton Highlands, Nova Scotia have led to a new understanding of the stratigraphy which in turn will aid in the reinterpretation of the mineral potential of the Jumping Brook Formation. Sulphur and lead isotope analyses of samples from Lime Hill and Meat Cove confirm the interpretation of these occurrences as "Grenville type". Mapping and sampling has allowed recognition of two distinct types of Cape Breton marbles which may have different ages and mineral potentials.

Remote sensing studies in the Chaleur Bay belt of northeast New Brunswick have clearly demonstrated a structural control of base and precious metal mineralization.

In the Bralorne district, southern B.C., lead isotopic studies of mesothermal gold-quartz veins and adjacent epithermal gold-silver-antimony veins demonstrate that a single mixing model, if not age, applies to most deposits in the district. A common source of gold in the predominantly oceanic volcanic host rocks is indicated.

Mineral Resource Appraisal and Information Services

A report entitled "Interim Assessment of Geology of Areas under Exploration for Uranium in Canada, 1985, and of Estimated Additional Resources I as of 31.12.1985" was submitted on schedule to the Uranium Resource Appraisal Group (URAG). As well as the reviews of resources and exploration activity, the report includes an updated genetic model for unconformity associated deposits and an analytical review of the geological features of significant uranium deposits including Cigar Lake, Eagle Point, Dominique-Peter, Dominique-Janine, Key Lake, Lone Gull and Elliot Lake.

Work continued on regional mineral resource appraisals of four proposed national park sites: East Arm-Artillery Lake, Wager Bay-Southampton Island, South Nahanni River, and Banks Island. The East Arm (Great Slave Lake) and Artillery Lake assessment was completed and published as GSC Open File 1434. Among the potential resources identified are uraniumiferous alkalic intrusions in the Reliance area believed to have potential for rare metals. Field work was completed for the Wager Bay-Southampton Island assessment, and led to recognition of similarities between a highly deformed Archean supracrustal belt at Wager Bay and the possible contiguous Prince Albert Group. The stratigraphy of three oil shales on Southampton Island was clarified, and the stratigraphic and tectonic evolution of the Bell Arch was compared to that of the Boothia Arch. Field studies in the South Nahanni River area led to recognition of (i) high potential for zinc-lead "SEDEX" deposits in the Prairie Creek Embayment, (ii) zinc-bearing spring waters near the linear structure associated with the Prairie Creek silver-lead-zinc vein deposit, and similar veins carrying significant germanium and gallium, (iii) anomalous levels of molybdenum and tungsten in spring waters in the Ragged Ranges, and (iv) a belt of tungsten-copper skarn and silver-lead-zinc skarn and replacement deposits extending from Tungsten southeastward to the central Flat River map area. Finally, the resource assessment of the proposed park site on Banks Island has led to the recognition of high potential for placer alluvial uranium deposits.

The GSC CANMINDEX database was expanded by addition of new data from Nova Scotia, and a computerized mineral inventory project for New Brunswick was initiated. The Ontario Geological Survey computerized mineral inventory file was obtained and made available to Branch personnel. Oral and written presentations were made to the United Nations inter-regional seminar on "Applications of Electronic Data Processing in Mineral Exploration and Development" which was attended by delegates from 31 countries.

Laboratory and Scientific Support

During the report year, 6106 rock and ore specimens were slabbed, 913 specimens were slabbed

and polished, 781 polished sections were prepared, 697 samples were ground, and 820 mineral separations were performed.

Ottawa-Carleton Centre for Geoscience Studies -GSC Stable Isotope Facility

A total of 3120 samples and 1167 standards were analyzed by the laboratory during the year. The backlog of samples was completely eliminated by year-end and the quality of results is superior to that accepted in many other laboratories.

Personnel Highlights

The Mineral Deposits Subdivision consisted of 27 Research Scientists, 18 Physical Scientists, 3 Clerical Staff and 2 Technical Staff. Of this staff, three Research and seven Physical Scientists were associated with Federal - Provincial Mineral Development Agreements. During the year Inglis, Silver and Pasitchniak completed their terms of employment with the Subdivision.

Attendance at Conferences, Meetings & Courses

D.E. Ames

Gold '86: An International Symposium on the Geology of Gold Deposits in Toronto, September 1986. 3 POSTERS: a) "Structural geology of the San Antonio Gold Mine Southeastern Manitoba", b) "Structural geology of gold deposits in the Star Lake Pluton, LaRonge Domain", Saskatchewan, c) "Gold in the Snow Lake area, Churchill Province Manitoba".

Saskatchewan Geological Survey Open House, November 1986, Regina, Saskatchewan. POSTER: "Geology and gold deposits, Star Lake Pluton, LaRonge Domain".

Manitoba Mines Branch, Industry Meeting, Winnipeg, Manitoba, November 1986. POSTER: "Carbonatization of a metamorphosed layered mafic intrusion, San Antonio Mine, Bissett, Manitoba".

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. POSTER: "Gold metallogeny of the Southern Churchill Province".

C.D. Anglin

Gold '86: An International Symposium on the Geology of Gold Deposits, Toronto, September 1986. POSTER: "Geochemistry and gold mineralization, Geraldton, Ontario" (with J.M. Franklin).

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Recent Hydrothermal Mineralization at Seafloor Spreading Centres, Montreal, Quebec, February 1987.

R.T. Bell

International Sedimentological Congress, Canberra, Australia, August 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987: POSTER: "Olympic Dam - geology and significance to Canadian exploration".

T.C. Birkett

Current Activities Forum, Geological Survey of Canada, Ottawa, January, 1987: POSTER: "Canada-Newfoundland Mineral Development Agreement."

Geological Association of Canada/Mineralogical Association of Canada, Annual General Meeting, Ottawa, May 1986.

J.J. Carrière

Symposium on Sediment-Hosted Stratiform Cu Deposits May 1986 Ottawa. POSTER (with R.V. Kirkham): "World Distribution of sedimentary copper deposits".

Geological Association of Canada/Mineralogical Association of Canada Carleton University, Ottawa, May 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. POSTER: (same as above).

G. Darcy

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

K.M. Dawson

GEOEXPO '86, Vancouver, British Columbia, May 1986.

Canadian Institute of Mining and Metallurgy, District 6 Annual Meeting, Victoria, British Columbia, October 1986.

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May 1986.

A. Douma

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

J.M. Duke

Geological Association of Canada/Mineralogical Association of Canada, Joint Annual Meeting, Ottawa, May 1986. POSTER: "Layer Disruption in the Ultramafic Series of the Bird River Sill".

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

PSC Course: "Leadership and Change", Touraine, Quebec, March 1987.

H.E. Dunsmore

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

O.R. Eckstrand

Geological Association of Canada/Mineralogical

Association of Canada, Annual Meeting, May, 1986 in Ottawa. TALK: a) "Se/S evidence relating to genesis of sulphides in the Crystal Lake gabbro", b) "Nickel-copper deposits of the St. Stephen Intrusion: Sulphur isotope and Se/S relations".

Ontario Geological Survey Open House, December 1986, in Toronto.

Platinum '87 Conference, University of Western Ontario, London, February 1987.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. TALK: "Selenium and the source of sulphur in magmatic nickel and platinum deposits".

Prospectors and Developers Association Annual Convention, Toronto, Ontario, March 1987. POSTER: "GSC Research into Processes of Platinum Group Element Concentration".

J.M. Franklin

Gold '86: An International Symposium on the Geology of Gold Deposits, Toronto, September 1986. POSTER: "Geochemistry and gold mineralization, Geraldton, Ontario" (with C.D. Anglin).

American Geophysical Union, Fall Meeting, San Francisco, California, December 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. POSTER: "Studies of hydrothermal systems on Galapagos, Juan de Fuca and Explorer Ridges".

Recent Hydrothermal Mineralization at Seafloor Spreading Centres, Montreal, Quebec, February 1987.

A.G. Galley

Gold '86: An International Symposium on the Geology of Gold Deposits, Toronto, Ontario, September 1986. POSTER: "Gold in the Snow Lake area, Churchill Province, Manitoba".

Saskatchewan Geological Survey, Open House, Regina, November 1986. POSTER: "Structural geology of gold deposits in the Star Lake Pluton, LaRonge Domain, Saskatchewan".

Manitoba Geological Services Branch, Meeting with Industry Winnipeg, November 1986. POSTER: "Gold in the Snow Lake area, Manitoba".

Current Activities, Forum, Geological Survey of Canada, Ottawa, January 1987. POSTER: "Gold metallogeny of the southern Churchill Province".

S.S. Gandhi

Newfoundland Department of Mines and Energy Open House and CIM Branch Meeting in St. John's, Newfoundland. November 5-9, 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

D.F. Garson

United Nations Interregional Seminar on the

Applications of Electronic Data Processing Methods in Mineral Exploration and Development, Sudbury, Ontario, October 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

In-house French Tutorial (continuing).

W.D. Goodfellow

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. POSTERS: "Integration of Landsat, geology, surficial geochemistry and mineral deposit data for locating tungsten skarn deposits, Nahanni River area, N.W.T." (with Aronof et al.); "Data integration and its application to tungsten exploration in the Nahanni map area, N.W.T."

S.B. Green

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting Ottawa, May 1986.

Ontario Geological Survey Open House and Geoscience Research Seminar, Toronto, December 1986.

Current Activities Forum, Geological Survey of Canada, January 1987.

Prospectors and Developers Association Annual Convention in Toronto, March 1987.

G.A. Gross

17th Underwater Mining Institute, Biloxi, Mississippi, USA, November 1986.

United States Congress Office of Technology Assessment Workshop on Hard Mineral Resources of the United States Pacific Northwest and Hawaiian Exclusive Economic Zones, Newport, Oregon, USA, November 1986.

M.N. Henderson

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986.

Gold '86, Toronto, Ontario September-October 1986. POSTER: "Timing and origin of auriferous quartz veins, Meguma Terrane, Nova Scotia".

"Friends of the Grenville", field trip to Gouverneur, New York, October 1986.

Canadian Tectonics Group Meeting, Sudbury, October 1986.

L.J. Hulbert

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986.

Economic Minerals of Saskatchewan Symposium. TALK: "PGE Environments: A Brief Overview", Regina, Saskatchewan, November 1986.

Saskatchewan Geological Survey Annual Report of Activities; 1986, Regina, Saskatchewan, November 1986.

Quebec Ministry of Mines Annual Report of Activities; 1986. TALK: "PGE Environments: A Brief Overview", Quebec City, December 4, 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. TALK: "PGE Environments in the Churchill Province of Northern Saskatchewan and Manitoba".

B.C.-Yukon Chamber of Mines Round-up in Vancouver, B.C., January 1987. TALK: "PGE Environments: A Brief Overview".

Prospectors and Developers Association Annual Convention, Toronto, Ontario, March 1987. TALK: "PGE Environments in Canada".

C.W. Jefferson

Symposium on Sediment-Hosted Stratiform Cu Deposits May 1986, Ottawa '86, Annual Meeting, May 1986. TALK: "Stratigraphic, tectonic and sedimentologic setting of deposits in the Redstone Copper Belt, Mackenzie Mountains, Northwest Canada"; TALK: (with Winston et al.): "Middle to Late Proterozoic (1.8-0.6 Ga) sedimentation, North America".

Yellowknife Geoscience Forum, December 1-3, 1986. TALK: "Non-renewable resource assessments in Wager Bay-Southampton Island and South Nahanni River areas-a progress report."

Canadian Society of Petroleum Geologists, Research Symposium on Reefs, Banff, Alberta, January 1987. POSTER: "Late Proterozoic orange-weathering stromatolite biostrome, Mackenzie Mountains and western Arctic Canada."

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

I.R. Jonasson

American Geophysical Union in San Francisco, December 1986. TALK: Nature of alteration zone beneath Galapagos Ridge Sulfide Mounds (and contributions to 4 other presentations.)

Recent Hydrothermal Mineralization at Seafloor Spreading centres, Montreal, February 1987.

Prospectors and Developers Annual Meeting, Toronto, Ontario, March 1987. POSTER: "Ocean Floor Sulphide Studies".

J.A. Kerswill

Gold '86 International Symposium on the Geology of Gold Deposits, Toronto, Ontario, September 1986. POSTER: "Gold deposits hosted by iron formation in the Contwoyto Lake area, N.W.T."

IUGS/UNESCO Workshop on Mineral Deposit Modelling, Belo Horizonte, Brazil, December 1986. TALK: "Iron Formation hosted gold deposits with emphasis on Canadian examples".

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

R.V. Kirkham

Geological Association of Canada/Mineralogical Association of Canada/Canadian Geophysical Union Joint Annual Meeting in Ottawa, May 1986. TALK: "Distribution of sediment-hosted stratiform copper: an introduction". Also contributed to two other talks "Middle to Late Proterozoic (18-0.6 Ga) sedimentation, North America" and "Diagenesis, sulfides and metal zoning in the Redstone copper deposit, Northwest Territories" presented by others.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. POSTER: (with J.J. Carrière) "Global distribution of sediment-hosted stratiform copper deposits".

The Third Annual V.E. McKelvey Forum on Mineral and Energy Resources, Denver, Colorado, March 1987.

R.D. Lancaster

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

R.M. Laramée

United Nations Interregional Seminar on the Applications of Electronic Data Processing Methods in Mineral Exploration and Development, Sudbury, Ontario, October 1986. TALK: "The Canadian mineral occurrence index: CANMINDEX".

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. POSTER: "Computer generated overlays for mineral deposits data, using popular geographic projections".

"IDMS/R: Database Concepts and Facilities Course", Ottawa, Summer 1986.

"IDMS/R: End-User Applications Development Course", Ottawa, December 1986.

J.W. Lydon

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986. TALK: "The role of hydrothermal eruption in the formation of a volcanogenic massive sulphide deposit of Cyprus".

IGCP 1987 "Metallogeny of Ophiolites", Athens, June 1986. TALK: "Geology, geochemistry and genesis of the Mathiati volcanogenic sulphide deposit".

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. TALK: The potential for hydrothermal platinum deposits"; POSTER: "PGE distribution in sulphide occurrences of magmatic affinity in the Bay of Islands ophiolite complex".

Recent Hydrothermal Mineralization at Seafloor Spreading Centres, Montreal, February 1987. TALK: "Comparison of ancient basalt-hosted sulphide deposits with those found on the modern ocean floor".

A.R. Miller

Gold '86: An International Symposium on The Geology of Gold Deposits, Toronto, Ontario, September 1986

K.K. Nguyen

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

K.H. Poulsen

Gold '86, an international symposium on the geology of gold deposits, Toronto, Ontario, October 1986. TALK: "The Cameron Lake gold deposit, northwestern Ontario: geological setting, structure, and alteration" (with Melling et al.); POSTERS: "Structural geology of gold deposits in the Star Lake Pluton, LaRonge Domain, Saskatchewan" (with Ames and Galley); "Structural geology of the San Antonio mine, southeastern Manitoba" (with Lau et al.).

Ontario Geoscience Forum, Toronto, December 1986.

Symposium on the Metallogeny of gold deposits, Northwest Mining Association, Spokane, Washington, December 1986. TALK: Metallogenic Significance of the Structure of Precambrian gold deposits.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Institute on Lake Superior Geology, Wisconsin Rapids, WI, May 1986. TALK: "Geochronology of the southern Rainy Lake area, northwest Ontario" (with D.W. Davis).

N. Prasad

International CODATA '86 conference Ottawa, July 1986.

Information Management Forum, EMR Ottawa, October 1986.

French language Course (training) September 1986 to the present.

F. Robert

Gold '86, an international symposium on the geology of gold deposits, Toronto, Ontario, October 1986. POSTER: "Structural setting of gold-bearing veins in the Val d'Or area, SE Abitibi subprovince".

Seminaire D'Information 1986, Ministère de L'Energie et des Ressources du Québec, Québec City, December 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Cordilleran Roundup, Cordilleran Section, Geological Survey of Canada, BC-Yukon Chamber of Mines, BCEM&PR joint meeting, Vancouver, B.C., January 1987.

Prospectors and Developers Association Annual Meeting, Toronto, Ontario, March 1987. TALK: "Structural control of gold mineralization in the Val d'Or district".

S.M. Roscoe

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Prospectors and Developers Association of Canada Annual Meeting, Toronto, March 1987.

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986.

V. Ruzicka

International Atomic Energy Agency, Vienna, Austria (IAEA): Technical Committee Meeting on Uranium Resources, October, 1986.

IAEA: Consultants' Meeting on "Undiscovered Resource Manual", Vienna, Austria, October, 1986.

New Brunswick Department of Natural Resources and Energy: 1986 Annual Review of Activities, coauthor of a 'Poster Session'; Fredericton, N.B., November 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

A.L. Sangster

Nova Scotia Department of Mines and Energy, Review of Activities. Halifax, N.S., November 1986. TALK: "A Review of GSC Activities Under the Canada-Nova Scotia Mineral Development Agreement"; POSTER.

Canadian Institute of Mining and Metallurgy, Eastern Regional Meeting, Halifax, November, 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January, 1987. POSTER: "Aspects of the geology and geochemistry of the Lime Hill zinc occurrence, Nova Scotia."

D.F. Sangster

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May 1986.

Society of Economic Geology Annual Meeting, San Antonio, Texas, November 1986.

Society of Economic Geology Winter Meeting, Denver, Colorado, February 1987.

R.F.J. Scoates

Canadian Institute of Mining and Metallurgy, District 6 Annual Meeting, Victoria, B.C., October, 1986. TALK: "Contrasting modes of platinum-group element mineralization in two Manitoba layered intrusions".

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986. 3 POSTERS: "Petrochemical variations in a successive sequence of cyclic units, Upper Central Layered Zone, Fox River Sill, Manitoba" (Scoates, R.F.J., Randsepp, M., and Turnock, A.C.); "Layer disruption in the Ultramafic Series of the Bird River Sill" (Duke J.M., Scoates, R.F.J., and Williamson, B.); "The

internal fabric of the Falcon Lake Igneous Complex, Southeastern Manitoba" (Mandziuk, W., Brisbin, W.C., and Scoates, R.F.J.).

Current Activities Forum, Geological Survey of Canada, Ottawa, January, 1987. TALK: "Stratigraphic distribution and interelement correlation of platinum-group elements in the Bird River Sill, Manitoba".

Manitoba Department of Energy and Mines Annual Meeting with Industry, Winnipeg, November 1986. POSTER: "The Bird River Sill Project-Geology of the Chromiferous Zone, Eastern Chrome Property".

S. Scully

Current Activities Forum, Geological Survey of Canada, Ottawa, January, 1987.

W.D. Sinclair

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986. TALK: "Early Tertiary topaz rhyolites and associated deposits in the northern Canadian Cordillera: products of anorogenic magmatism".

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Cordilleran Geology and Exploration Roundup, Vancouver, January 1987. POSTER: "Topaz rhyolites and associated deposits in the northern Canadian Cordillera".

The Third Annual V.E. McKelvey Forum on Mineral and Energy Resources, Denver, Colorado, March 1987.

H.S. Swinden

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May 1986.

Newfoundland Department of Mines and Energy, Open House, November 1986. St. John's. POSTER: "Geology and metallogeny of the northern part of the Roberts Arm Group, central Newfoundland".

Canadian Institute of Mining and Metallurgy, Newfoundland Branch Annual Meeting, St. John's, November 1986.

Geological Association of Canada, Newfoundland Section, Fall Field Trip and Semi-Annual Meeting, Springdale, Newfoundland, October, 1986.

Geological Association of Canada, Newfoundland Section, Annual Spring Meeting, St. John's, March 1987.

B.E. Taylor

Geological Association of Canada/Mineralogical Association of Canada, Ottawa, Annual Meeting May, 1986. Short course on Silicate Melts.

Fifth International Conference, Water/Rock Interaction, Reykjavik, Iceland, August 1986.

TALK: "Hydrogen isotope variations in magmas and magmatic fluids."

Gold '86: An International Symposium on the Geology of Gold Deposits, Toronto, September 1986. POSTER: "Origins and isotopic characteristics of motherlode hydrothermal fluids and gold deposits with comparison to Archean analogues."

Geological Society of America Annual Meeting San Antonio, Texas, August 1986. MSA Short Course "Stable Isotope Geochemistry of High Temperature Processes"; Short Course lecture "Magmatic Volatiles: Isotopic Composition of C, H, and S."

Recent hydrothermal Mineralization at Seafloor Spreading Centres, Montreal, February 1987.

R.I. Thorpe

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Ottawa, May 19-21, 1986. TALK: "Lead isotope data for gold deposits at Hemlo, Ontario".

Sixth International Conference on Geochronology, Cosmochronology and Isotope Geology; Cambridge, England, July 1986. TALK: Modelling lead isotope evolution from data for Archean massive sulphide deposits".

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

G.P. Watson

New Brunswick Annual Review of Activities, Fredericton, N.B., November 1986. POSTER: "Remote sensing applications to metallogeny, northern New Brunswick" (with A.N. Rencz).

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. POSTER: As above.

B. Williamson

Geological Association of Canada/Mineralogical Association of Canada Annual Joint Meeting, Ottawa, Ontario, May 1986. POSTER: "Layer disruption in the Ultramatic Series of the Bird River Sill". FIELDTRIP: "Fieldtrip No. 13 (Layered Igneous Intrusions of S.E. Manitoba and N.W. Ontario).

Manitoba Energy & Mines-Geological Services Meeting with Industry; Winnipeg, Manitoba, November 1986.

Platinum '87, University of Western Ontario, London, Ontario, February 1987.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Special Talks and Lectures

R.T. Bell

"Wernecke megabreccias, with emphasis on comparison with Adelaidean geology", South Australia Department of Mines Discussion

Group; Adelaide, Australia, September 1986.

"Circum Ungava geosyncline", South Australian Department Mines Discussion Group; Adelaide, Australia, September 1986.

"Wernecke megabreccias, with emphasis on metallogeny", Roxby-Olympic Dam Discussion Group; Olympic Dam, Australia, September 1986.

"Comparison South Australia-Canadian Cordilleran geology", South Australia Department Mines Discussion Group; Adelaide, Australia, September 1986.

"Olympic Dam", Mineral Deposits Group, Brown Bagger, GSC.; Ottawa, 1986.

"Adelaidean geology, recent advances", Precambrian High, Ottawa, January 1987.

T.C. Birkett

"Applications of cathodoluminescence in igneous petrology", McGill University, Montreal, November, 1986.

H.E. Dunsmore

"Evaporitic differentiation and sedimentary metallogeny" Ottawa University-Carleton Postgraduate Class, Ottawa.

G.A. Gross

"Types and Distribution of Offshore Metallic Mineral Deposits", Department Committee on Ocean Mining (DCOM) Forum at University of British Columbia, December 1986.

L.J. Hulbert

"The Bushveld Complex and its mineral resources", Department of Geological Sciences, University of Regina, Saskatchewan, November 1986.

"PGE environments: an extended overview." University of British Columbia, Vancouver, B.C., January 1987.

"Precambrian High: PGE environments globally and in Canada", Geological Survey of Canada, Ottawa, March 1987.

C.W. Jefferson

Ottawa-Carleton Centre for Geoscience Studies, March 1987 (with R. Parrish): "Upper Mackenzie Mountains Supergroup, northwestern Canada-Late Proterozoic stratigraphy, U-Pb zircon ages and tectonic implications".

R.V. Kirkham

Precambrian High, GSC, Ottawa, "Comb quartz layers in felsic intrusions", Ottawa, March 1987.

N. Prasad

"Development of geological data bases in Canada and the impact of new technology", Indian CODATA Seminar, Bangalore, India, December 1986.

K.H. Poulsen

"Structure and gold deposits of the Superior Province"; Canadian Institute of Mining and Metallurgy, University Visiting Lecturers Program; February 1987; University of Montreal, Laval University, University of Quebec at Chicoutimi.

"Metallogenic Significance of the structure of Precambrian gold deposits"; March 1987, Departmental Seminars, University of Toronto.

F. Robert

"The metallogenic significance of the structure of precambrian gold deposits"; Northwest Mining Association Annual Meeting, Spokane, WA., December 1986.

"Structural and fluid evolution at the Sigma gold mine, Val d'Or, Quebec"; Carleton University, Ottawa, February 1987.

"Stratigraphie deformation, et minéralization aurifère le long de la faille de Cadillac au sud de Val d'Or"; University of Montreal, March 1987.

"Stratigraphie, deformation et minéralization aurifère le long de la faille de Cadillac au sud de Val d'Or"; University of Montreal, March 1987.

"Structural setting of vein gold mineralization in the Val d'Or district"; Queen's University, Kingston, Ontario, March 1987.

A. L. Sangster

Atlantic Geoscience Society, POSTER
Fredericton, January 1986.

R.F.J. Scoates

"Layer disruption, PGE mineralization and the role of supercooling in the crystallization of the Bird River Sill, Manitoba"; Cambridge University graduate students, Isle of Rhum, Inner Hebrides, April, 1986.

"Contrasting modes of platinum-group element mineralization in two Manitoba layered intrusions"; GSC Cordilleran Division Visiting Speakers lecture, Vancouver, October, 1986.

"Contrasting modes of platinum-group element mineralization in two Manitoba layered intrusions"; Discussion group seminar, "What Canadian exploration geologists should know about Platinum" Toronto, Ontario, November, 1986.

"Contrasting modes of platinum-group element mineralization in two Manitoba layered intrusions"; GAC Winnipeg Section lecture, November, 1986.

W.D. Sinclair

"Granite-related deposits in southeast China", Toronto Geological Discussion Group, Toronto, Ontario, April 1986.

"China"; Century Public School, Nepean, Ontario, April 1986.

"Selected Canadian deposits of gallium, indium, niobium, tantalum, zirconium, hafnium, rare

earth elements, tungsten and molybdenum", Japanese Mission on Rare Metals Technology, Ottawa, November 1986.

H.S. Swinden

"Precious metals in volcanogenic sulphide deposits in Central Newfoundland." Newfoundland Department of Mines, Mineral Development Division Colloquium Series, St. John's, Newfoundland, March 1987.

B.E. Taylor

"Hydrogen isotope systematics of magmatic degassing" at Department of Geology, U. of McGill, Montreal, Quebec, April 1986.

"Magmatic volatiles: Isotopic variations of C, H and S." at Precambrian High (GSC) in February 1987.

"Magmatic volatiles: chemical and isotopic systematics" at Concordia U., Montreal, March 1987.

R.I. Thorpe

"Superior province Pb isotope models based on data for massive sulphide deposits and zircon ages for their host rocks", May 1986, Internal GSC talk.

"Massive sulphide and gold deposits in the Canadian Shield and their lead isotope compositions", February 1987, USGS, Menlo Park, California.

"Actualistic models for the evolution of Archean ore leads", February 1987, USGS, Denver, Colorado, and at Lunar and Planetary Institute, Houston, Texas.

"Application of lead isotopes in the study of mineral deposits in the Canadian Shield", February 1987, Rice University, Houston, Texas.

Memberships on Committees

R.T. Bell

EMR Uranium Resource Appraisal Group (URAG); Subcommittee on Estimated Resources (EAR): Member.

T.C. Birkett

Councillor, Geology Division of CIM.

Represent CIM on Canadian Geoscience Council.

J.M. Duke

Vice President, Mineralogical Association of Canada.

Co-Chairman, GAC-MAC Joint Program Committee.

Chairman, Program Committee Mineralogical Association of Canada.

Member, Editorial Board, Economic Geology.

Member, Finance Committee, Mineralogical Association of Canada

Co-organizer, "Symposium on Layered Igneous Rocks", Geological Association of Canada/Mineralogical Association of Canada Joint Annual Meeting, Ottawa, Ont., May 1986.

O.R. Eckstrand

Society of Economic Geologists Research Committee.

Secretary for "Friends of the Nickel Belt" (Manitoba).

Mineral Deposits Research Committee, Member.

A.G. Galley

Co-chairman, Geoscience Sector, Canada-Manitoba MDA.

Federal Representative, Manitoba Industry Liaison Committee.

Federal Representative, Saskatchewan Industry Liaison Committee.

Co-ordinator-MDA Federal Geoscience Programs, Manitoba and Saskatchewan.

S.S. Gandhi

EMR, Uranium Resource Appraisal Group (URAG); subcommittee on Estimated Additional Resources (EAR): Member.

S.B. Green

Chairman, Technical Services Committee Geological Association of Canada/Mineralogical Association of Canada Annual Meeting.

Member, Organizing Committee, Geological Survey of Canada Current Activities Forum.

Canada-Ontario Mineral Development Agreement Co-ordinator for Geoscience Programs.

G.A. Gross

Member, EMR Department Committee on Ocean Mining.

Canadian Co-chairman of the Canada-USSR Working Group in Geology. Canada-USSR Mixed Commission on Economic, Industrial, Scientific and Technical Cooperation.

Chairman, GSC research group on the Metallogeny of Sedimentary Mineral Deposits.

Member of GSC editorial committee for preparation of DNAG volume on Mineral Deposits of Canada.

Member, Editorial Board, Precambrian Research.

Member, Editorial Committee, Theophrastus Publications, Athens, Greece.

Charter Member and Canadian Representative for the International Marine Minerals Society.

M.N. Henderson

Treasurer of Structural and Tectonic Division of GAC.

C.W. Jefferson

Mineral Exploration Liaison Committee, Yellowknife. Member.

Ottawa-86 Local Organizing Committee (Field Trips Chairman).

Planning committee for Special MDD-GAC-MAC Symposium on "Sediment-hosted stratiform copper deposits".

Secretary, Mineral and Energy Resource Assessment (MERA) working group.

I.R. Jonasson

Canadian Liaison: IGCP 254 "Mineralization in 'black shales'".

Coorganizer 1990 IAGOD Symposium, Ottawa, Ontario; Association Secretary General IAGOD.

Adjunct Professor, Carleton University in Geology.

Associate Member: Derry Laboratory, Ottawa University.

MRD Research Committee.

R.V. Kirkham

Publications Committee, Society of Economic Geologists.

K.H. Poulsen

Canada-Ontario Mineral Development Agreement; Co-ordinator Mineral Deposits Subdivision programs.

Canada-Manitoba Mineral Development Agreement; Co-ordinator, Mineral Deposits Subdivision programs.

Canada-Saskatchewan Mineral Development Agreement; Co-ordinator Mineral Deposits Subdivision programs.

V. Ruzicka

Uranium Resource Appraisal Group (URAG) of EMR: Member and Chairman of the Subcommittee on Estimated Additional Resources (EAR).

Editorial Board of Elsevier's Journal "URANIUM": Member.

International Atomic Energy Agency, Vienna: Consultant.

A.L. Sangster

Nova Scotia Mineral Development Agreement (ERDA) Co-ordinator For Mineral Resource Division Projects. Mineral Deposits Subdivision.

D.F. Sangster

Society of Economic Geology, Vice-President.

Society of Economic Geology, Program Policy Committee, Member.

Society of Economic Geology Thayer Lindsley Visiting Lecturer Committee, Member.

Geological Survey of Canada Mineral Deposit Research Committee, Chairman.

Member of University Thesis Committees at the following universities: University of Ottawa; Carleton University; M.U.N., McGill University, University of Toronto, University of Melbourne.

Ottawa-86 Local Organizing Committee, Vice Chairman.

R.F.J. Scoates

Thompson Nickel Belt Working Group, Member.

Friends of Forsterite, Member.

Logan Club President 1985/86.

Associate Editor, The Canadian Mineralogist.

Member of the Board of Directors, Centre for Precambrian Studies, University of Manitoba.

Member of the Lancaster Sound Marine Park Working Group.

Co-organizer, "Symposium on Layered Igneous Rocks", Geological Association of Canada/Mineralogical Association of Canada, Ottawa, May 1986.

W.D. Sinclair

Special Volumes Committee, Geology Division, The Canadian Institute of Mining and Metallurgy.

H.S. Swinden

Program Chairman for Geological Association of Canada, Mineral Deposits Division for 1988 Annual Meeting in St. John's.

1986-87-Vice President Newfoundland Section Geological Association of Canada.

1987-88-President Geological Association of Canada, Newfoundland Section.

B.E. Taylor

Mineral Deposits Research Committee (member).

Logan Club, Geological Survey of Canada, Secretary.

B. Williamson

Geological consultant to CANMET re: CANMET projects on mineral processing and mining potential of Bird River Sill chromite deposits.

EXPLORATION GEOPHYSICS SUBDIVISION

K.A. Richardson

The objectives of the Subdivision are to develop and demonstrate new geophysical measurement techniques and their applications to mapping, mineral deposit research, mineral exploration, engineering geology, and environmental concerns; to provide standards and calibration facilities for geophysical measurements; to provide a comprehensive, systematic geophysical database for use by government and industry; to provide a nuclear emergency response team, having the expertise and equipment to monitor radiation released due to nuclear accidents; and to provide to the Branch mechanical services for instrument development.

To better accomplish these objectives, the Subdivision was reorganized in April, 1986, into 5 sections: Airborne Geophysics, Borehole Geophysics, Electrical Methods, Instrumentation R&D, and Technical Services.

Goals for the Airborne Geophysics Section include: the improvement of the GSC Skyvan system; conducting surveys for geologic mapping purposes and for determination of geophysical signatures of mineral deposit types; development of data presentation and interpretation, publication of radioelement maps; and carrying out follow-up investigations. The Borehole Geophysics Section maintains and develops calibration facilities for borehole measurements and tests and develops applications of multiparameter logging to geological problems. The Electrical Methods Section work involves the investigation of applications of ground and airborne electrical and electromagnetic methods to geologic mapping and mineral exploration, and includes operation of the physical rock properties laboratory. The Instrument R&D Section is involved in the design, development and evaluation of instrumentation primarily for airborne and borehole geophysical applications. The Technical Services Section provides service to the Branch in design, fabrication and testing of prototype equipment for laboratory and field applications, and in maintenance and servicing of scientific equipment.

Highlights

The Airborne Geophysics Section conducted surveys in Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, and New Brunswick. A planned survey in Newfoundland was delayed to 1987 due to bad weather late in the season. These surveys included 31,000 line km flown with the GSC Skyvan, for a variety of experimental/demonstration purposes, and 11,000 line km flown under contract by Sander Geophysics Ltd. as a contribution to Mineral Development Agreements (MDAs), in northern Cape Breton Island, N.S., and Campbellton-Bathurst, N.B.

Surveys were flown with the Skyvan to acquire a VLF-EM data set to be used for developing data presentation/analysis methods; to determine geophysical "signatures" of mineral deposit types (Laronge Gold Belt, Winnipeg River Pegmatite area); as detailed follow-up surveys under the N.S. MDA aimed at mapping zonation in several granites; to fill in regional (1 km) coverage in N.S. and N.B.; and to extend reconnaissance (5 km) coverage in the Quebec-Sherbrooke area.

In addition to the 1:5,000,000 scale Radioactivity Map of Canada published in 1986/87 (compilation from all

reconnaissance radiometric surveys flown from 1970 to 1985); and the new ternary radioelement map of southern Newfoundland which combines K, U and Th concentrations into a pseudo-geologic colour map, an additional 278 radioelement and VLF-EM maps were published in the GSC Geophysical Map Series.

Towards the end of the year, work began on modification of the Skyvan geophysical equipment to utilize upward-looking detectors for measurement of atmospheric radon (to improve background corrections, based on new theoretical developments completed earlier in the year) and to improve the magnetometer installation for increased sensitivity.

A definitive description of the design and construction of calibration facilities for airborne radiometric systems was published as a GSC paper which will also serve as the basis of an International Atomic Energy Agency report on the subject, and be used by China and Turkey as a guide in their construction of calibration pads in 1986 and 1987. Technical assistance in radiometrics provided by Division staff was in part instrumental in the sale by Canadian suppliers of an airborne system to China and ground equipment to Turkey.

A major field activity of the Borehole Geophysics group was the multiparameter logging research carried out in B.C. in collaboration with seven major mining companies. The project's prime objectives were to characterize physical rock properties at a number of Cordilleran mineral deposit types, to acquire useful information for the design of geophysical surveys in this part of the country, and to develop methods for interpretation of results. Borehole results have changed the ideas regarding structure and lithology at one property, and have demonstrated the application of a new spectral gamma-gamma (SGG) logging tool to heavy metal assay logging. Tests have shown correlation of the SGG log data with antimony (associated with silver) in B.C., with barite (associated with gold) at Hemlo, with lead at Yava Mine, N.S.; and with zinc mineralization in Nfld.

One member of the Borehole Geophysics Section joined the Ocean Drilling Program in March 1987, to serve as borehole logging expert on the Leg 114 cruise from Falklands to Mauritius.

The Electrical Methods Section carried out ground EM surveys which defined several previously unknown geological features at the Val Gagné test site, Ontario. A helicopter electromagnetic/VLF/magnetic survey was carried out by Aerodat Ltd. in January-February 1987. The most useful products are maps of apparent conductivity and several airborne anomalies agree well with conductors identified by ground surveys; other features will be investigated in summer 1987. A new application for airborne electromagnetic measurements to Quaternary geology mapping is being developed by the Electrical Methods Section. A helicopter EM survey was carried out by Aerodat Ltd. along selected roads (in the vicinity of Kapuskasing, Smoky Falls, Smooth Rock Falls, and Timmins).

An assessment of deep transient and multifrequency EM systems for detection of deep sulphide deposits in resistive host rocks and under conductive overburden was completed by analyzing and interpreting field data over the Winston Lake deposit and a deep sulphide body near Matagami, Quebec. An analysis of

magnetic wavelit measurements near Atikokan, Ontario, indicated the usefulness of this new technique for detecting weak conductors (e.g. fractures) with confidence. The data from this technique can also be interpreted quantitatively. The technique may have applications in gold exploration.

Physical Properties Group continued to carry out diffusion measurements. Fifty granitic and gabbroic rock samples were studied. The group also prepared one of the Level II Concept Assessment Documents entitled "Geotechnical Studies at Whiteshell Research Area: Rock Properties" for the Canadian Nuclear Fuel Waste Management Committee.

At the leading edge of technology, the Instrumentation R&D Section is now able to produce custom integrated circuits, using an IBM-PC based logic system. This enables the design and fabrication of borehole probes, for example, containing sophisticated circuitry that would not be possible with conventional components.

International activities of the Subdivision included two lecture tours to China in co-operation with the Canadian Geophysical industry, a CIDA-supported visit to Thailand to provide advice on airborne EM surveys to be flown under the Thai Mineral Resource Development Project, and IAEA-supported travel to Portugal and Turkey to assess their capabilities and assist in planning airborne radiometric survey programs in those countries.

The Instrument Development Shop, Technical Services Section, completed 197 work orders during the year, with the work distributed among the Divisions as follows:

MRD	51.1%
TSD	20.1%
LCSD	13.6%
GID	4.5%
ISPG	1.8%
Admin & Other	0.8%
Emergency Repair & Maintenance	8.1%

Major efforts were directed at the development of a borehole groundwater sampling system, development and fabrication of a winching system for the borehole logging truck, work on a high pressure vessel for experimental petrology, and on electrothermal vaporizers for the ICP mass spectrometer.

Personnel Notes

T.C. Cannon resigned in July 1986 after working 4 years on airborne geophysics data compilation in order to relocate to Halifax.

R.B.K. Shives was appointed to an indeterminate position in the Airborne Geophysics Section in the fall of the year.

J.R. Hetu joined the Airborne Geophysics Section in December 1986 to provide support for New Brunswick MDA work.

B.E. Elliott joined the Borehole Geophysics Section to work on processing of logging data in February 1987.

A.V. Dyck resigned in July 1986 to accept an appointment to the faculty of Queen's University.

Attendance at Conferences, Meetings & Courses

G.R. Bernius

Current Activities Forum, Geological Survey of Canada, January 1987.

Q. Bristow

Current Activities Forum, Geological Survey of Canada, January 1987.

J.M. Carson

Current Activities Forum, Geological Survey of Canada, January 1987.

B.W. Charbonneau

Northwest Territories Geoscience Forum, Yellowknife, NWT, December 1986. TALK: "Radioactive granitic rocks of the Nueltin Lake area, NWT; geophysical signature and mineralization potential".

Current Activities Forum, Geological Survey of Canada, January 1987.

K.L. Ford

Nova Scotia Dept. of Mines & Energy Open House, Halifax, November 1986.

Newfoundland Dept. of Mines & Energy Open House, St. John's, November 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

R.L. Grasty

Current Activities Forum, Geological Survey of Canada, January 1987.

Prospectors & Developers Association Annual Meeting, Toronto, March 1987.

International Atomic Energy Agency Consultants Meeting on the Chernobyl Nuclear Accident, Vienna, November 1986.

P.B. Holman

Current Activities Forum, Geological Survey of Canada, January 1987.

T.J. Katsube

Joint Annual Meeting, Geological Association of Canada - Mineralogical Association of Canada - Canadian Geophysical Union, Ottawa, May 1986.

Geoscience Research Seminar and Open House '86, Ontario Geological Survey, Toronto, December 1986.

Current Activities Forum, Geological Survey of Canada, January 1987.

P.G. Killeen

Society of Professional Well Log Analysts Annual Meeting, Houston, TX, June 1986. TALK: "New coal logging facilities in Canada: a progress report".

Western Canada Coal Geoscience Forum, Calgary, November 1986. TALK: "Borehole calibration facilities for quantitative coal logging".

B.C. Geophysical Society Meeting, Vancouver, January 1987. TALK: "Progress in borehole Geophysics at the GSC from downhole assaying to a new IP system".

Current Activities Forum, Geological Survey of Canada, January 1987.

Prospectors & Developers Association Annual Meeting, Toronto, March 1987. TALK: "Borehole geophysics: application of new techniques to exploration".

C.J. Mwenifumbo

Society of Professional Well Log Analysts Annual Meeting, Houston, TX, June 1986. TALK: "Mise-à-la-masse mapping of fracture zones".

B.C. Geophysical Society Meeting, Vancouver, January 1987. TALK: "Progress in borehole geophysics at the GSC from downhole assaying to a new IP system".

Current Activities Forum, Geological Survey of Canada, January 1987.

G.J. Palacky

48th Annual Meeting of the European Association of Exploration Geophysicists, Ostend, Belgium, June 1986. TALK: "Clay mapping using electromagnetic methods".

Canadian Airborne Geophysical Industry Meeting, Ottawa, July 1986.

2nd Symposium on Exploration Geophysics, Xian, China, October 1986. TALK: "Geological mapping with airborne electromagnetic systems".

Geoscience Research Seminar and Open House '86, Ontario Geological Survey, Toronto, December 1986.

Thailand Mineral Resources Development Project, Technical Meeting, Department of Mineral Resources, Bangkok, Thailand, January 1987.

Current Activities Forum, Geological Survey of Canada, January 1987.

K.A. Richardson

Newfoundland Dept. of Mines and Energy Open House, St. John's, November 1986.

Current Activities Forum, Geological Survey of Canada, January 1987.

L.D. Schock

Western Canada Coal Geoscience Forum, Calgary, November 1986.

Current Activities Forum, Geological Survey of Canada, January 1987.

Exploration Geophysics Course, Ottawa University, January-April 1987.

R.B.K. Shives

New Brunswick Dept. of Forest, Mines & Energy Open House, Fredericton, November 1986.

Nova Scotia Dept. of Mines & Energy Open House, Halifax, November 1986.

Current Activities Forum, Geological Survey of Canada, January 1987.

Gold '86, Toronto, September 1986.

A.K. Sinha

56th Annual International Meeting of the Society of Exploration Geophysicists, Houston, TX, November 1986. TALK: "Case histories on the application of transient EM techniques for detection of deep sulphide conductors in Canada".

Current Activities Forum, Geological Survey of Canada, January 1987. TALK: "Exploration and mapping of deep targets with surface EM techniques".

Special Talks and Lectures

C. Gauvreau

Series of lectures on Microprocessor Architecture & Applications, CEGEP, Hull.

R.L. Grasty

Series of lectures on Airborne Gamma Ray Spectrometry, Chinese Ministries of Geology, Nuclear Industry and Mining and Metallurgy, China, July 1986.

P.G. Killeen

Series of lectures on Exploration Geophysics, Ottawa University, January-April 1987.

G.J. Palacky

"Weathered layer identification by electromagnetic methods"; International Institute for Aerospace Survey and Earth Sciences, Delft, The Netherlands, June 1986.

"Tonkartierung mit elektromagnetischen Methoden"; Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, Germany, June 1986.

"Use of modern airborne electromagnetic systems in geological mapping"; Institute of Geophysical and Geochemical Exploration, Ministry of Geology and Mineral Resources, Beijing, China, October 1986.

"Electromagnetic techniques in geological mapping and uranium exploration"; Beijing Uranium Geology Research Institute, Ministry of Nuclear Industry, Beijing, China, October 1986.

"Use of modern airborne electromagnetic systems in geological mapping and mineral exploration"; China National Nonferrous Metals Industry Corporation (CNNC), Beijing, China, October 1986 and Guilin, China, October 1986.

"Use of airborne electromagnetic surveys in prospecting for volcanic-associated massive sulphides"; Department of Mineral Resources, Bangkok, Thailand, January 1987.

"L'utilisation des méthodes électromagnétiques pour la cartographie géologique"; Ecole Polytechnique, Montréal, March 1987.

Memberships on Committees

Q. Bristow

Member, IAEA Consultants Group on Nuclear Methods in Borehole Geophysics.

J.M. Carson

Sir Sandford Fleming College Minerals Technology Advisory Committee.

J.A. Grant

Contributing Editor to "FOCUS", magazine of North American Data General User's Group.

P.G. Killeen

Member, Expert Review Panel on Downhole Geophysics Research in Alberta, Coal Mining Research Company, Edmonton.

President, Minerals & Geotechnical Logging Society.

Member, Editorial Board, Journal of Nuclear Geophysics (Pergamon Press).

Principal Investigator, International Atomic Energy Agency, for worldwide borehole gamma ray intercalibration experiment.

C.J. Mwenifumbo

Member, Expert Review Panel on Downhole Geophysics Research in Alberta, Coal Mining Research Company, Edmonton.

G.J. Palacky

Associate Editor for International Scientific Advances, for "Geophysics".

K.A. Richardson

Member, Geophysics Working Group, Newfoundland Mineral Development Agreement.

A.K. Sinha

Member, Reviews Committee, Society of Exploration Geophysicists.

V.R. Slaney

Principal Experiment Coordinator, Radarsat ERS-1 Geology Experiment Proposal.

EMR representative to the GEOSAT Committee.

R.J. Thibedeau

Member, EMR Technical Services Working Committee.

Subdivision Productivity

279	Maps (55 G Series Releases)
1	GSC Report
11	Outside Publications
10	Abstracts (Formal Talks)
11	Posters

MINERALOGY AND CHEMISTRY SUBDIVISION

A.G. Plant

The principal responsibilities of the Subdivision are as follows:

1. To provide mineralogical data and professional expertise to support Branch projects by maintaining and developing mineralogy laboratories to include X-ray diffraction and crystallography, electron microprobe analysis, scanning electron microscopy and image analysis.
2. To undertake research studies on selected mineral deposits, on problems of mineralogical terminology and on mineral assemblages to contribute to petrological research.
3. To provide chemical analyses of geological materials in support of Branch projects by maintaining and developing analytical chemistry laboratories, including general chemical laboratory, atomic absorption, ion chromatography, X-ray fluorescence and inductively coupled plasma emission and mass spectrometry laboratories, and by managing contracts with commercial laboratories.
4. To develop analytical procedures to improve the quality and quantity of analytical data reported in the Subdivision laboratories, to develop methodology for new matrices and for elements not currently determined, and to undertake research in new analytical methodology in cooperation with instrument manufacturers and commercial laboratories.
5. To operate sample preparation laboratories for the preparation of geological samples prior to chemical analysis and to prepare mineral separates and rock samples for geochronological determinations and research studies.
6. To curate and develop the Geological Survey of Canada Rock Collection, the Reference Series of the National Mineral Collection and the National Meteorite Collection.
7. To provide geological information to the Canadian public through the preparation and sale of rock and mineral sets, the free examination of specimens submitted by the public, and the preparation of guidebooks to Canadian mineral areas as an aid to collectors and tourism.

At the end of the report period the Subdivision comprised 3 research scientists, 12 physical scientists, 5 chemists and 27 scientific and technical support staff.

Mineralogy

X-ray Diffraction, Electron Microbeam Analysis and General Mineralogy

Four hundred and eighty-four (484) requisitions for X-ray diffraction, electron microprobe analysis, scanning electron microscopy, image analysis, petrographic studies and general mineralogy were completed during the year in support of 104 projects. This work included 814 mineral identifications by Debye-Scherrer powder camera and 31

new standard reference patterns, 2607 X-ray diffractometer scans, 125 autoradiographs and 4491 hours of instrument time in the electron microprobe, scanning electron microscopy and image analysis laboratories. The studies encompassed a very broad range of geological topics and included studies in mineral deposits (including seafloor sulphides), petrology, geochemistry, sedimentology, mineralogy and paleontology.

The scanning electron microscope-image analysis system was upgraded in October with the installation of a Cambridge S-200 SEM. This instrument has a number of technical advantages which will provide improved analytical and imaging capabilities. In addition, new software has also been acquired and there is now comprehensive multi-directional communication between the three instruments that comprise the image/particle analysis system. New software has also been purchased for the Cameca electron microprobe for improved processing of X-ray data, particularly for those of low energy. Additionally, improvements in processing energy dispersive X-ray data have been incorporated into programs developed in-house to provide quantitative data for a broader range of compositional matrices.

Sample Preparation and Mineral Separation

Numbers of samples prepared for chemical analysis are shown in the following table, together with subtotals for each Division. This work resulted from 187 requisitions in support of 52 projects, and showed a 42% increase over 1985-86.

	MR	LCS	CG	TS	Other	Total
Forwarded from 85-86	60	81	0	72	0	213
Received from 86-87	3985	702	173	198	12	5070
Completed 86-87	3973	765	173	170	12	5093
Carried forward 87-88	72	18	0	100	0	190

Sample preparation and mineral separation for geochronology included the following: 5 potassium-argon and 89 rubidium-strontium whole rock samples; 128 zircon, 128 monazite, 55 biotite, 38 amphibole, 31 muscovite and 15 other mineral concentrates. In addition, separations were completed for 177 miscellaneous concentrates for other projects.

Assistance to the Public

Information provided to the public by the Curatorial Services Unit required the identification of 231 rocks, minerals and other objects, with results being communicated in 41 reports. Miscellaneous information related to minerals and rocks was given in person or by telephone on numerous occasions.

Enquiries on minerals and mineral occurrences were received by Mrs. Stenson as follows: 27 office visits, 44 telephone enquiries and 23 letters. Identifications were provided for 68 specimens.

Preparation of Rock and Mineral Sets

Nine thousand, five hundred and eighty-one (9,581) sets of rocks and minerals were prepared and shipped during the year, compared to 9573 in 1985-86. The distribution of these was as follows:

	1985-86	1986-87
Alberta	578	1224
British Columbia	351	156
Manitoba	263	584
New Brunswick	138	216
Newfoundland	10	18
Nova Scotia	457	191
Northwest Territories	20	42
Ontario	1320	810
Prince Edward Island	18	32
Quebec	3405	2746
Saskatchewan	109	202
Yukon	354	300
GSC Offices	1600	1625
EMR Offices	850	1370
Others	100	65

Revenue from the sale of all sets was \$38,324, payable to the Receiver General. Special requests for specimens and collections were filled for: Minister's Office, EMR; CANMET; Information EMR; National Museum Mobile Exhibits; National Museum of Canada; and the Government Exhibition Centre.

Fieldwork was undertaken at 59 localities in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario and Quebec. The work involved more than 29,000 km of travel and the collection of 21 tonnes of minerals, rocks, ores and fossils.

Curation of Collections

Curation of the National Mineral Collection, Systematic Reference Series, resulted in the addition of 306 specimens, including 30 specimens new to the collection, 4 of the latter being type material contained in 7 type specimens. Notable among the 80 bulk accessions were suites of material from: Mont St-Hilaire, Québec; East Kemptville Mine, Nova Scotia; Mount Pleasant Mine, New Brunswick; Polaris Mine, NWT; Geco Mine, Manitowadge, Ontario; Page-Williams and Golden Giant Mines, Hemlo, Ontario; Devon Island NWT; Somerset Island, NWT; and West Greenland. The National Mineral Collection computer database was improved by the addition of 361 specimen records, and by updated locality data for hundreds of Canadian occurrences. New fields were added to streamline search and retrieval procedures of the more than 14600 specimen records available. In response to 46 separate requests for material, approximately 200 individual samples of mineral specimens were selected and provided in support of earth science research and education. A similar number of requests for mineralogical information were received and answered. Fieldwork in support of the mineral collection was carried out in Nova Scotia, New Brunswick, Québec, Ontario, and the NWT. Significant finds included well-crystallized specimens of wolframite, fluorite and galena, and the first Canadian occurrence of jeanbandyite/natanite (Fe-Sn hydroxides) from a kaolinized zone at the Mount Pleasant Mine, New Brunswick, and crystals of sapphirine in association with gemmy pyrope garnet from Mount Walker, Somerset Island, NWT. Support was given to the National Museums' initiatives to purchase the Pinch Mineral Collection for the National Mineral Collection of Canada.

Curation of the National Meteorite Collection of Canada resulted in the addition of 13 samples, all new to the collection, including a very recent fall at KIDAIRAT, Sudan. Loans from the collection totalled 5, and two exchanges were completed. A private meteorite collection was evaluated for the University of Ottawa.

Work on a compilation of Canadian meteorites and Canadian meteorite collections continued. A suite of soils from Meteor Crater, Arizona, was received from Dr. P. Millman. Dr. Herd participated in fieldwork on Devon Island, NWT, in connection with the Canadian Arctic Meteorite Project (CAMP).

Curation and development of the GSC Rock Collections and their auxiliary files housed in the Reference Collection Facility, Tunney's Pasture, resulted in the receipt and addition of 1150 pails, boxes and bags of current project materials. The Facility provides services to the GSC at the rate of 100 individuals or groups served per month. There were 72 loans of specimens from current, reference and archival rock collections. A relatively complete collection of GSC Publications and maps is now available at Tunney's Pasture to assist those consulting collections, and suites of auxiliary project material and air photos are being organized.

The Ad Hoc Committee to consider the Baillie Report on Sample Repository Services at GSC submitted a revised report to Management, following discussions with Divisions.

Personnel Notes

Sandra Thompson, a term employee since January 1985 resigned at the end of March 1987 to pursue a career in the business world. During the year Gina LeCheminant, Gerry Gagnon and Alan McRae were appointed to indeterminate positions. Mark Epp and Kirn Dhaliwal provided term support for part of the year.

Attendance at Conferences, Meetings and Courses

H.G. Ansell

Thirteenth Annual Rochester Academy of Sciences Mineralogical Symposium, Rochester, New York, April 1986.

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986. POSTER: "The National Mineral Collection database."

Canadian Heritage Information Network PARIS (Pictorial and Artifact Retrieval and Information System) User Representatives Training Seminar, Ottawa, September 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Cordilleran Geology and Exploration Roundup, Vancouver, British Columbia, January 1987.

Tucson Gem and Mineral Show, Tucson, Arizona, February 1987.

M. Bonardi

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986.

Cameca Instruments Inc. 1986 CAMEBAX School, Stony Brook, N.Y., June 1986.

Microbeam Analysis Society-Electron Microscopy Society of America Joint Meeting, Albuquerque, N.M., August 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

R.N. Delabio

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

S.A. Frewen

St. John Ambulance Safety Oriented First Aid Course, April 1986.

D.C. Harris

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986. TALK: "Mineralogy of the main Hemlo gold deposit, Hemlo, Ontario." FIELD TRIP AND GUIDEBOOK: "The Hemlo gold deposits, Ontario."

14th General Meeting of the International Mineralogical Association, Stanford, California, July 1986. POSTER: "The diverse mineralogy of the Hemlo gold deposit, Hemlo, Ontario."

Gold '86, An International Symposium on the Geology of Gold Deposits, September 1986. TALK: "Mineralogy and geochemistry of the main Hemlo gold deposit, Hemlo, Ontario."

R.K. Herd

Thirteenth Annual Rochester Academy of Sciences Mineralogical Symposium, Rochester, New York, April 1986. DISPLAY: "National Meteorite Collection of Canada."

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986. FIELD TRIP AND GUIDEBOOK: "Mineralogy and petrology of Mont St-Hilaire, Québec"; DISPLAY: "Some rare minerals from granulites"; POSTER: "Oxygen fugacity variations and mineral reactions in sapphirine-bearing paragneisses, eastern Grenville Province, Canada"; WORKSHOP: "Earth Science Curation."

Canadian Heritage Information Network, PARIS Users' Meeting Forum, Ottawa, September 1986.

National Research Council of Canada Associate Committee on Meteorites Annual Meeting, Ottawa, October 1986.

NRCC/ACOM/Research Subcommittee Meeting on Canadian Arctic Meteorite Project, Ottawa, October 1986.

Information Management Forum, EMR, Ottawa, October 1986.

Ottawa Lapsmith Show, Nepean Sportsplex, October 1986. DISPLAY: "National Meteorite Collection of Canada."

Polar Continental Shelf Project, General Planning Meeting, Ottawa, November 1986.

Annual Hallimond Lecture Meeting, Mineralogical Society, London, England, January 1987. TALK: "The correlation and calibration of experimental data in the MASH and FMASH systems with natural sapphirine-bearing assemblages."

Magmatism in Ocean Basins, Leicester, England, January 1987.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. POSTER: "P-T time paths and metamorphic reactions in sapphirine-bearing assemblages."

J.M. Larose

Long Range Financial Planning, EMR, Ottawa, March 1987.

G.M. LeCheminant

CAMECA School on the CAMEBAX electron microprobe, SUNY, N.Y., June 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

A.G. Plant

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986.

Inductively coupled plasma - mass spectrometry users group meeting, Toronto, June 1986.

14th General Meeting of the International Mineralogical Association, Stanford, California, July 1986.

Meetings of the Board of Directors, Isotrace Laboratory, University of Toronto, September and October 1986, and March 1987.

Information Management Forum, EMR, Ottawa, October 1986.

National Research Council of Canada Associate Committee on Meteorites Annual Meeting, Ottawa, October 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Staffing for Managers, EMR, Ottawa, February 1987.

Pittsburgh Conference and Exposition on Analytical Chemistry and Applied Spectroscopy, Atlantic City, N.J., March 1987.

Long Range Financial Planning, EMR, Ottawa, March 1987.

A.C. Roberts

14th General Meeting of the International Mineralogical Association, Stanford, California, July 1986. POSTER: "Montroyalite, a new hydrated Sr-Al carbonate from the Francon Quarry, Montreal, Quebec."

Joint Committee for the Powder Diffraction Standards, International Centre for Diffraction Data, Biannual Meeting, Philadelphia, PA, October 1986 and March 1987.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

A.P. Stenson

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986 and Annual Joint GAC/MAC Executive Meeting.

Mineralogical Association of Canada Executive

Council Meetings: Ottawa, May 1986 and Saskatoon, October 1986.

14th General Meeting of the International Mineralogical Association, Stanford, California, July 1986.

International Centre for Diffraction Data, Essington, Pennsylvania, October 1986 and March 1987.

Long Range Financial Planning, EMR, Ottawa, March 1987.

D.A. Walker

11th International Congress on X-ray Optics and Microanalysis, London, Ontario, August 1986. POSTER: "Image/particle analysis: applications in the geosciences." TALK: "Applications of image and particle analysis in mineralogy and palaeontology."

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. TALK: "Image and particle analysis: applications in the characterization of precious metals."

Course on "Advanced applications of analytical X-ray and imaging software", at Link Systems, High Wycombe, England, December, 1986.

Course on "Advanced image analysis", at Cambridge Instruments, Cambridge, England, December 1986."

Special Talks and Lectures

R.K. Herd

"Identification of rocks and minerals for children", General Vanier Public School, May, 1986.

L'identification des roches et des minéraux pour les jeunes gens", Fielding Drive Public School, June, 1986.

A.P. Stenson

"Some classic mineral localities in Ontario", Central Canadian Federation of Mineralogical Societies (CCFMS), Waterloo University, Waterloo, June 1986.

D.A. Walker

"Applications of scanning electron microscopy in the geosciences", Geological Survey of Canada, Vancouver, September 1986.

"The present status of the GSC image/particle analysis system", Geological Survey of Canada, Ottawa, October 1986.

"Applications of scanning electron microscopy and image/particle analysis", Geology Department, Carleton University, Ottawa, October 1986.

Membership on Committees

H.G. Ansell

Ad Hoc Committee on Baillie Report on GSC Sample Repository Services.

National Capital Region PARIS User Group (Natural Sciences Database, Canadian Heritage Information Network).

R.W. Christie

Branch Christmas Party Committee, member.

D.C. Harris

Commission on New Minerals and Mineral Names, International Mineralogical Association, Canadian representative.

Mineralogical Association of Canada, Membership Committee, Chairman.

Commission on Ore Mineralogy, International Mineralogical Association, Vice-Chairman.

R.K. Herd

B.Sc. Thesis Committee, D. Aiken, Geology Department, Carleton University, Ottawa.

Ad Hoc Committee to consider the Baillie Report on Geological Survey of Canada Sample Repository Services, Chairman.

National Research Council of Canada, Associate Committee on Meteorites (also Education Subcommittee, Canadian Arctic Meteorite Project, and Research Subcommittee), member.

Canadian Arctic Meteorite Project expedition to Devon Island, N.W.T., 1986, member.

Mineralogical Museums Advisory Council, Director.

Economic Geology and Ore Deposits, Mineralogical Abstracts, Sub-editor.

National Capital Region PARIS User Group (Natural Sciences Database, Canadian Heritage Information Network), member.

Cultural Property Export and Import Act, Expert Examiner for Minerals and Meteorites.

Field trip to St-Hilaire, Quebec: Mineralogical Association of Canada/Geological Association of Canada/Canadian Geophysical Union, Ottawa meeting, 1986, Co-ordinator (with R. Gault); Earth Science Curation Workshop, Organizer.

NATO grant 289.81: The petrology of sapphirine-bearing rocks, Recipient (with B.F. Windley and D. Ackermann).

A.G. Plant

Board of Directors, Isotrace Laboratory, University of Toronto.

National Research Council of Canada Associate Committee on Meteorites, member and chairman, Education subcommittee.

Cultural Property Export and Import Act, Expert Examiner for Minerals and Meteorites.

Treasury Board Management Team, Physical Sciences Contract Negotiations.

Co-chairman, 601 Booth Street Joint Occupational Safety and Health Committee (J.O.S.H.).

A.C. Roberts

Joint Committee for Powder Diffraction Standards, International Centre for Diffraction Data, member: Minerals and Ceramics Subcommittee, task group within Minerals and Alloys Subcommittee; member and secretary for the Electron Diffraction Subcommittee.

Abstractor for the New Minerals section of the American Mineralogist.

A.P. Stenson

Mineralogical Association of Canada, Treasurer.

Joint Committee for Powder Diffraction Standards, International Centre for Diffraction Data, Secretary, Minerals and Ceramics Subcommittee.

Consulting Editor, Rocks and Minerals Magazine.

W.U. ter Haar Romeny

Branch Safety Committee, member.

D.A. Walker

Short course on Image Analysis, concurrent with Geological Association of Canada/Mineralogical Association of Canada, Montreal, 1989.

Chemistry Laboratories

G.R. Lachance and G.E.M. Hall

The April 1 reorganization of GSC that grouped the Analytical Chemistry and Geochemistry Laboratory Sections has led to a more integrated operation of Branch and analytical facilities and capabilities. The ongoing objective of the Laboratories is to provide compositional data on a wide variety of geological materials submitted by GSC scientists. Currently, the short term objectives are to continue to upgrade instrumentation and methods to provide on the one hand, the higher level of accuracy necessary for some research studies, and on the other to provide data on broad suites of elemental concentrates on much larger numbers of samples required for some projects.

The various analytical techniques used to provide compositional data for rock, ore, mineral and water samples include atomic absorption (flame and graphite furnace), infra-red analysis, ion chromatography, X-ray fluorescence spectrometry, inductively coupled plasma emission and mass spectrometry, and classical methods for unusual samples. Method development is a necessary prerequisite for the Laboratories and is undertaken, often concurrently, with requests for analyses for which established methods are not available. The Laboratories also take a leading role in the study and certification of international standard reference materials for chemical analyses.

A computerized database has been established to record requisitions, numbers of samples, elements required, distribution of work to various laboratories, data of completion and other pertinent information. The status of samples processed is as follows:

	Brought forward	Received	Completed	Carried forward
C&PG	63	325	285	103
MR	1629	9592	10022	1199
LCS	207	1349	1285	271
TS	41	648	662	27
Other	5	71	55	21
Total	1945	11985	12309	1621

Sub-totals

A-Base	1448	8548	8409	1587
MDA	497	3437	3900	34

The 12309 completed samples for 278 requisitions include 6855 A-Base samples analyzed in-house and contract analyses for 1554 A-Base samples and 3900 MDA samples at a cost of \$31300 and \$152779 respectively. Because of the reorganization, precise comparison with 1985-86 is difficult; however, in-house analyses have increased by 20% and supervision of MDA requirements increased by 200%. The improvement in laboratory operations has been possible through internal reallocation of staff and the installation of new instrumentation, including an automated sequential X-ray fluorescence spectrometer and equipment for the determination of sulphur and water.

Methods development to improve the capability of the laboratories and in response to requests from clients has included: (1) the application of electrothermal vapourization (ETV) as a sample introduction technique in inductively coupled plasma - mass spectrometry (ICP-MS) for the determination of Mo, Tl and W in various geological media with improved efficiency and detection levels of 0.1 ppm. A spray chamber has been designed, built and successfully used, which allows undisturbed ICP operation while switching from ETV to nebulization sample introduction. Studies have been initiated into the application of ICP-MS to the analysis of waters and the determination of platinum group elements in various geological samples; (2) evaluation of matrix interferences in ICP-MS to improve quantitative determinations; (3) determination of gold and platinum group elements in dry and ashed vegetation; (4) evaluation of microwave digestion for the dissolution of samples; (5) development of methods for the determination of carbonate carbon; (6) extensive design changes to hydride-AAS instrumentation to increase sample throughput and reduce reagent consumption; this work may lead to patent applications; (7) development of a comprehensive data reduction program for the new automated sequential X-ray fluorescence spectrometer; (8) improved detection limits for the determination of Tl, Ga and In in various geological media using graphite furnace atomic absorption spectroscopy after solvent extraction; and (9) development of a preconcentration procedure for improved detection levels of Ag, Cd and Pb by extracting the metals as their iodide complexes into an organic medium, followed by determination using atomic absorption spectrometry. Methods developed in-house to separate and recover various sulphur species for isotopic analysis are being transferred to a commercial laboratory; industry has not been able to fulfill such requests in the past. Publication of the work developed at the GSC to determine Au in waters has led to IRAP funding of a proposal by Hydrochem, Toronto to extract and recover gold in industrial applications; GSC is to collaborate on this project in 1987-88.

Personnel Notes

Richard Faulkner resigned from the Public Service in September 1986 after three and half years working in the Chemistry Laboratories to resume his academic studies for qualification as a school teacher. Richard Pittuck, Isabelle Girard and Rob Phillips provided term support during the year.

Attendance at Conferences, Meetings, and Courses

K.N. De Silva

Congress on Advances in Spectroscopy and Laboratory Science (CASALS), Toronto, October 1986. TALK: "Application of internal standard methods for analysis of geological materials by ICP/AES."

D.C. Gregoire

Inductively coupled plasma - mass spectrometry users group meeting, Toronto, June 1986. TALK: "Non-spectroscopic interferences in ICP-MS."

Federation of Analytical Chemistry and Spectroscopy Societies (FACSS), St. Louis, U.S.A., September 1986. TALK: "Ion sampling effects in inductively coupled plasma - mass spectrometry."

Congress on Advances in Spectroscopy and Laboratory Science (CASALS), Toronto, October, 1986. TALK: "Ion sampling effects in inductively coupled plasma - mass spectrometry."

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. POSTER: "Research activities in the analytical laboratories."

G.E.M. Hall

Inductively coupled plasma - mass spectrometry users group meeting, Toronto, June 1986. TALK: "Determination of Mo and W at low levels in geological materials by ICP-MS."

The Third Biennial National Atomic Spectroscopy Symposium, Bristol, England, July 1986. TALK: "The determination of tungsten and molybdenum at low levels in geological materials by ICP-mass spectrometry."

Congress on Advances in Spectroscopy and Laboratory Science (CASALS), Toronto, October 1986. TALK: "Determination of boron, molybdenum and tungsten at low levels in geological materials by ICP-AES."

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. POSTER: "Research activities in the analytical laboratories."

G.R. Lachance

35th Annual Denver Conference on Applications of X-ray Analysis, Denver, Colorado, August 1986. Chaired and lectured a one-day workshop on Quantitative methods in X-ray fluorescence analysis.

C.J. Park

Inductively coupled plasma - mass spectrometry users group meeting, Toronto, June 1986. TALK: "Application of electrothermal vaporisation as a means of sample introduction in ICP-MS."

Federation of Analytical Chemistry and Spectroscopy Societies (FACSS), St. Louis, U.S.A., September 1986. TALK: "Determination of tungsten and molybdenum in geological materials by electrothermal vapourisation ICP-mass-spectrometry."

Congress on Advances in Spectroscopy and Laboratory Science (CASALS), Toronto, October 1986. TALK: "Determination of thallium in geological materials by ICP/MS with sample

introduction by electrothermal vapourisation."

J.G. Sen Gupta

Congress on Advances in Spectroscopy and Laboratory Science, Toronto, Ontario, October 1986. TALKS: "Analysis of Oka-2 Britholite, a new Canadian rare-earth reference material" and "Determination of rubidium, strontium and barium in barite by AAS after dissolution in disodium ethylenediaminetetra - acetate."

Varian Canada Inc., workshop on Atomic Absorption Spectroscopy, Ottawa, May 1986.

J.E. Vaive

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987. POSTER: "Research activities in the analytical laboratories."

St. John Ambulance First Aid Course, February 1987.

Career Advancement Seminar for Women, March 1987.

Special Talks and Lectures

G.R. Lachance

23rd Annual X-ray Clinic, State University of New York at Albany, Albany, N.Y., U.S.A., June 1986.

Principal Lecturer, Special one-week session on Advanced Methods in XRF, State University of New York at Albany, Albany, N.Y., U.S.A., August 1986.

Twenty lectures/seminars on "Application of XRF to geological materials, theory and practice" during a three-week tour (cities of Chengdu and Shanghai), People's Republic of China, October 1986.

Membership on Committees

D.C. Gregoire

Co-chairman, 601 Booth Street Joint Occupational Safety and Health Committee (J.O.S.H.)

G.E.M. Hall

GSC representative on the Management Committee for the Stable Isotope Laboratory, University of Ottawa.

J.E. Vaive

Secretary-Treasurer of the Ottawa Section, Spectroscopy Society of Canada.

EXPLORATION GEOCHEMISTRY SUBDIVISION

The mission of this Subdivision is to provide comprehensive knowledge of geochemical processes, geochemical exploration techniques and statistical methods of data interpretation and integration for use in mineral exploration, resource assessment and environmental monitoring.

The Subdivision is organized into three Sections, Geochemical Methodology and Research, Regional Geochemical Studies and Mathematical Applications in Geology. These sections were formed as a result of reorganization of the former Resource Geochemistry Subdivision following its merger with Economic Geology and Mineralogy Division on April 1, 1986.

Geochemical Methodology and Research Section

This Section comprises eight specialists who are responsible for research and methodology development in surficial geochemistry, litho-geochemistry, hydrogeochemistry, biogeochemistry and isotopic geochemistry. This research, including the development of geochemical exploration methods and the generation reference geochemical data bases, is used by the mineral industry as well as by other agencies requiring geochemical information.

Highlights

A new, more sensitive, radon measuring device has been developed and tested in offshore surveys applications. An extensive radon plume was outlined over the hydrothermal vents of the Endeavour Ridge in the North Pacific. The oval-shaped plume measured approximately 8 by 5 km, and reached a maximum thickness of 250 m above the sea-floor directly over the vents.

To better understand the role of groundwaters in dispersing elements into the secondary environment, a multi-level piezometer system, designed to obtain uncontaminated groundwaters, has been developed for use in rotasonic overburden drill holes. A similar system has been developed, in cooperation with the Explosives Research Branch, for use with reverse circulation overburden drilling applied to mineral exploration. It is anticipated that both systems will be sufficiently advanced for the technology to be transferred to the mining industry late in 1987.

Preliminary investigations of the geochemistry of thick Quaternary deposits in the Timmins areas of Ontario have provided clearer insight into the stratigraphic framework and ice movement directions of the sediments, thereby helping to improve the usefulness of overburden drilling operations in this environment. Similar studies in Nova Scotia are assisting in evaluation of the gold potential of the Beaver Dam area.

The Interactive Data Exploration and Analysis System (IDEAS) is a "user-friendly" data analysis system which has been brought into production mode. It is now being used successfully by staff members to prepare colour graphics and statistical displays to assist in the interpretation of geochemical data. Monitoring the fieldwork of a CIDA Phase I Metallic Mineral Survey in Jamaica has been completed and advice on data compilation and interpretation is being given.

Contributions were made to the development of the Gaspé and Lower St. Lawrence Geoscience Program, for which an additional \$1 million funding and a one year extension has been announced. Results of a heavy metal geochemical survey in the Eastern Townships were released as Open File 1332 in November 1986. Subsequently over 22000 hectares have been staked, mainly for gold exploration.

An "Index to National Geochemical Reconnaissance Surveys (1973-1986)" was compiled which brings together summary information involving the extensive lake and stream sediment and well water geochemical surveys undertaken by, and on behalf of, the Exploration Geochemistry Subdivision.

Biogeochemical methods of exploration for precious metals have been investigated in the Casa Berardi area of Quebec; in the coastal range of British Columbia; and in

the La Ronge gold belt of Saskatchewan. Preliminary biogeochemical data have outlined relatively auriferous zones, and drilling of anomalies by industry has resulted in the discovery of several zones of gold mineralization. Research continued on the natural uptake of mercury by plants, particularly in areas of known gold mineralization.

Petrographic and geochemical investigations of talus, soil and bedrock exposures of volcanics and related high level intrusions in the Bennet Lake Caldera Complex and Whitehorse trough suggested Nevadan-style epithermal precious metal potential for the region. In the Atlin British Columbia district, mesothermal, structurally-controlled gold-quartz veins and the associated carbonate alteration zone indicate similarities to a "California Motherlode" type of mineralization. Multi-media and multi-element geochemical studies have shown that Au-Ag and pathfinder element concentrations of As, Sb and Hg yield significant anomalies for either above styles of gold mineralization.

Personnel Notes

After spending several years working for industry, Dr. W.B. Coker, re-joined the Survey in June to specialize in geochemical studies of Quaternary deposits, particularly in the clay-belt areas of Canada. His experience from the industry perspective will be a valuable addition to the Subdivision.

Attendance at Conferences, Meetings and Courses

S.B. Ballantyne

GEOEXPO '86, Vancouver, May 1986. TALK: "Heavy Mineral Techniques in Geochemical Prospecting."

GOLD '86 Symposium, Toronto, September 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Cordilleran Geology and Exploration Roundup, Vancouver, January 1987.

D.R. Boyle

Courses on Groundwater Modelling Without Advanced Mathematics, Boston, Mass., April 1986 and Columbus, Ohio, July and November 1986.

Sediment-Hosted Stratiform Copper Deposits Symposium, Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986.

W.B. Coker

Ontario Geological Survey Geoscience Research Seminar and Open House '86, Toronto, December 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Prospectors and Developers Association Annual Convention, Toronto, March 1987. TALKS: "Treatment of overburden technology", In Seminar on Modern Drilling Technology; "Geochemistry of surficial media as used for mineral exploration in Canada", In Seminar on Modern Geochemical Exploration.

Gold Dispersion in Surficial Media Conference, Mineral Exploration Research Institute, Ecole Polytechnique, Montreal, March 1987. TALK: "Lake

sediment geochemistry."

C.E. Dunn

GEOEXPO '86, Vancouver, May 1986. TALK: "Practical application of biogeochemical methods of exploration in Canada's forests."

Saskatchewan Geological Society Symposium Economic Minerals of Saskatchewan, Regina, November 1986.

Saskatchewan Geoscience Forum, Saskatchewan Dept. of Energy and Mines, Regina, November 1986.

Manitoba Geoscience Forum, Manitoba Dept. of Energy and Mines, Winnipeg, November 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Prospectors and Developers Association Annual Convention, Toronto, March 1987. TALK: "Geochemical exploration in clay-covered terrain" (co-authored with W.B. Coker).

Gold Dispersion in Surficial Media Conference, Mineral Exploration Research Institute, Ecole Polytechnique, Montreal, March 1987. TALK: "Biogeochemical prospecting for gold."

R.G. Garrett

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Y.T. Maurice

Canadian Institute of Mining and Metallurgy, Annual General Meeting, Montreal, May 1986. TALK: "On the origin of placer gold in the Quebec Appalachians and exploration guidelines."

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986.

Séminaire d'information sur les activités de la direction générale de l'exploration géologique et minérale du Ministère de l'énergie et des ressources, Quebec City, December 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Prospectors and Developers Association Annual Convention, Toronto, March 1987.

Gold Dispersion in Surficial Media Conference, Mineral Exploration Research, Institute, Ecole Polytechnique, Montreal, March 1987. TALK: "Minéraux lourds alluvionnaires dans d'exploration pour l'or."

Special Talks and Lectures

W.B. Coker

"Overburden drilling and overburden geochemistry in mineral exploration"; Queen's University, Kingston, October 1986.

"The application of overburden geochemistry to mineral exploration in areas of deep overburden"; Ottawa Mineral Exploration Discussion Group, Ottawa, November 1986.

C.E. Dunn

"Biogeochemistry applied to prospecting for gold and platinum"; Exploration seminar organized by Chamber of Commerce, Rouyn-Noranda, September 1986.

"The use of plants in helping to identify mineralized zones concealed by Quaternary deposits"; GSC Terrain Sciences Division seminar; Ottawa, March 1987.

Membership on Committees

S.B. Ballantyne

GSC/MRD Member, EMR Field Equipment Committee

D.R. Boyle

Exploration Geochemistry Member, MRD EMR Research Agreement Committee.

W.B. Coker

Member, Editorial Board, Journal of Exploration Geochemistry.

Member, Ontario Geoscience Research Grant Program Review/Awards Committee.

C.E. Dunn

Councillor and symposium chairman to the Association of Exploration Geochemists.

Member of Editorial Review Boards for Applied Geochemistry, Journal of Geochemical Exploration and Science Magazine.

Member of Canadian Geobotanical Working Group.

R.G. Garrett

Co-Chairman (Programme) and Symposium Proceedings Editor, 11th International Geochemical Exploration Symposium.

Councillor, Association of Exploration Geochemists.

Member Editorial Board, Journal of Geochemical Exploration.

Member of Organizing Committee, Exploration '87.

Y.T. Maurice

Member of the Advisory Committee, Geology of Canada Series, French Edition.

Member of the Executive Committee and Coordinator of the Geoscience Program for Gaspé and Lower St. Lawrence Program.

Member of the Board of Directors for Mineral Exploration Research Institute.

Regional Geochemical Studies Section

The objectives of this Section are to carry out geochemical reconnaissance surveys and related orientation/follow-up studies to: (1) provide a national geochemical data base and (2) to develop and improve the methodology and methods of interpretation and data integration. The regional survey data are used by industry in mineral exploration and to provide a data base for use in resource assessment by government. The data are further applied to aid in geological mapping in thick overburden and to provide relevant information for the investigation of environmental and public health

concerns.

During the report year, the Section was involved in Mineral Development Agreements with Newfoundland, New Brunswick, Ontario, Manitoba, Saskatchewan and the Yukon Territory. Regional geochemical surveys were carried out in all provinces and the Yukon resulting in the collection of 13,100 samples covering 151,900 km². Joint regional surveys were also carried out in British Columbia under "Joint Letters of Agreement" involving the collection of 2200 samples over 29000 km². All the 1986 regional geochemical data will be published as Open File releases early in fiscal 1987/88.

Early in 1986 the results of the 1985 regional geochemical surveys were released as 12 Open Files comprising 275 geochemical maps. In addition 4 Open Files consisting of 27 maps were produced and released based on the reanalysis of archived samples from Manitoba and the Yukon for Au and associated elements. Based on data obtained from the various mining recording offices post-release activity in the release areas (up to mid-September) included the staking of 203,000 acres (excluding British Columbia). Most of the activity focussed on areas of anomalous gold responses and/or associated pathfinder elements such as Sb and As.

In New Brunswick, a multi-media stream sediment orientation study was completed by P.W.B. Friske in the Cape Spencer area. It was found that heavy mineral concentrates were not significantly more effective than standard stream silts for detecting Au, Sn and W bearing mineralization in this area of New Brunswick. As a result, a standard stream sediment-silt survey was successfully carried out in 1986 over the Avalon Belt in southeast New Brunswick in lieu of a more difficult and expensive heavy mineral survey.

In Saskatchewan, follow-up survey results indicated that Au dispersion patterns in organic-poor lakes may be significantly influenced by the presence of micron sized particulate gold and possible Au inclusions in well-preserved sulphide grains. Work in Manitoba based on a limited number of W analyses in lake sediments, indicates the potential for W in lake sediment as a pathfinder for intrusive hosted Au-W mineralization.

A method was developed for producing open file geochemical maps with values, symbols and marginal information on the Optronics Laser plotter at CLDS, Environment Canada. Values over the 70th percentile are highlighted by grey shaded symbols. This method is more efficient and produces higher quality maps than the previous procedure.

Characterization studies are being carried out on four lake and four stream sediment international reference standards on which analytical data have been received from 35 participating laboratories prior to their release for public distribution. Four remaining soil/till standards have been prepared for analysis. Under contracts, 15,000 samples were prepared and 63,000 samples were analysed for a total of 386,000 single element determinations.

Personnel Notes

Barbara Elliott left the Section in late January joining P.G. Killeen's Borehole Geophysics Section.

Attendance at Conferences, Meetings and Courses

D.J. Ellwood

Current Activities Forum, Geological Survey of Canada, January 1987.

Prospectors and Developers Annual Convention, Toronto, March 1987.

P.W.B. Friske

Review of Activities, 1986, New Brunswick Department of Natural Resources and Energy, Fredericton, November 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Prospectors and Developers Annual Convention, Toronto, March 1987.

E.H.W. Hornbrook

IV International Congress of Ecology, Syracuse, New York, August 1986. TALK: "Geochemical surveys: Precambrian Shield of southeastern Ontario, Canada".

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

H.R. Schmitt

Gold Exploration '86 Conference/Workshop, Queen's University, Kingston, April 1986.

Economic Minerals of Saskatchewan, Saskatchewan Geological Society Symposium, Regina, November 1986. TALK: "Regional geochemical surveys and gold in lake sediment investigations in Saskatchewan" (Co-authored with P.W.B. Friske).

Saskatchewan Geoscience Forum, Saskatchewan Department of Energy and Mines, Regina, November 1986.

Manitoba Geoscience Forum, Manitoba Department of Energy and Mines, Winnipeg, Manitoba, November 1986.

Gold Dispersion in Surficial Media Conference, Mineral Exploration Research Institute, Ecole Polytechnique, Montreal, March 1987.

Special Talks and Lectures

E.H.W. Hornbrook

"Design of aquatic surveys" Aquatic Surveys Workshop, International Congress of Ecology, Syracuse, August 1986.

Membership on Committees

D.J. Ellwood

Computer Users Committee, Geological Survey of Canada.

P.W.B. Friske

Organizing Committee for Prospecting in Areas of Glaciated Terrain CIMM Conference, Halifax, October/November 1988.

E.H. Hornbrook

Member, Canada-Ontario MDA Committee.

Member, Ad Hoc Committee to consider the Baillie Report.

Mathematical Applications in Geology

The objectives of the Section are: (i) to develop and apply probabilistic methods of mineral resource estimation for land-use planning purposes; (ii) to develop and apply new methods for the integration and interpretation of various geoscience data sets, including LANDSAT and other remotely sensed data; (iii) to develop statistical methods for exploration geochemical and other related geoscience data; and (iv) to provide statistical expertise and services to projects throughout the Geological survey.

These objectives are met by maintaining a long-range research effort on mathematics and statistics with applications to solve current geological problems. Geostatistical techniques and systems of computer programs are prepared for use in projects carried out in collaboration with other Geological Survey staff. Documented computer programs may be transferred to other Sections or to outside organizations. The acquisition of an image analysis facility will greatly enhance efforts on the interpretation and integration of remotely sensed data with other geoscience data.

Specific topics on which consultation is provided include: (1) fitting of frequency distribution models; (2) trend-surface analysis and geostatistical contouring techniques including "Kriging"; (3) multivariate statistics applied to geological data; (4) image analysis of remote sensing data, map patterns and photomicrographs; (5) artificial intelligence and expert systems in geology; (6) statistical analysis of directional features; (7) quantitative stratigraphic correlation techniques; (8) cluster analysis; (9) computer simulation of geological processes; (10) geostatistical crustal abundance models; (11) truncated or censored data analysis.

Highlights

Methods of multivariate analysis for estimating probabilities of occurrence of mineral deposits were further developed. Generalized logistic, Poisson and negative binomial models for estimating frequencies of occurrences of deposits in larger unit areas were applied to data sets for polymetallic massive sulphide deposits in the Abitibi Volcanic Belt of the Canadian Shield.

New spatial multivariate statistical methods are being tested in collaboration with staff of the Ontario Geological survey to delineate from litho-geochemical data, zones of carbonate alteration and sulphur enrichment, and other anomalous zones in the Ben Nevis area, east-central Ontario.

Software newly developed in Fortran for IBM personal computers (AT and XT) includes the LOGDIA programme for logistic regression diagnostics and SPLIN for spline-curve fitting with cross-validation and confidence bands. SIMSAG, an integrated system for resource evaluation, has been successfully implemented on an IBM PC microcomputer and a user's guide has been prepared. Several plotting programs for microcomputers have been developed for statistical analysis of geoscience data.

Software for the VAX computer has been written to detect spectral shifts in multichannel airborne remote

sensing data (MEIS) that may be due to vegetation stress induced by toxic levels of chemical elements in underlying soils or bedrock. Application of this technique to a carbonate-related anomaly in Algonquin Park was reported at the Canadian Remote Sensing Symposium in Edmonton, at the International Remote Sensing Symposium in Edmonton and at the International Remote Sensing Conference in Reno, Nevada. LANDSAT imagery was processed to enhance geologic structure in northern New Brunswick. The images were interpreted, and major lineaments were identified and digitized. There was strong correlation of the processed data with geology and with the location of known mineral occurrences. The results were presented at several forums including New Brunswick Review of Activities, 1986, GSC Current Activities Forum and at the Prospectors and Developers Association Annual Convention in Toronto. In order to condense multi-channel imagery from the LANDSAT Thematic Mapper, principal components analysis has been generalized. The generalized method enables the user to consider not only variation among different channels but also variation between neighbouring pixels. This new technique has been applied to data in the Bathurst area, New Brunswick.

Image processing methods were successfully employed to integrate LANDSAT, geological, catchment basin geochemical, and mineral occurrence data, and predict the presence of tungsten skarn deposits associated with shallowly-buried intrusives in the Nahanni River map area. Newmont Explorations Canada Limited has developed image processing software for analysing digitized geological maps and catchment basin geochemistry maps produced in the Geochemistry Subdivision.

Statistical techniques have been developed to handle truncated data such as geochemical data with relatively high detection limits. These new techniques can be applied for the statistical analysis of lake sediment geochemical data including determinations of silver and gold.

Previous methods developed for the ranking and scaling of biostratigraphic events (RASC computer programme) were based on the assumption of equal variances for the frequency distributions of these events. As a result of the development of weighted spline-curve methodology, it has become possible to test this assumption in practice and to allow for unequal variances.

Personnel Notes

M. Steneker, and C. van der Grient provided term support during part of the year.

Yuan Ding from the Wuhan College of Geology, Peoples Republic of China joined the Section in September 1986 for a one-year period as Visiting Chinese Research Scholar.

Attendance at Conferences, Meetings and Courses

F.P. Agterberg

Fifth International Quantitative Stratigraphy short Course, University of Aberdeen, Scotland, April 1986. TALKS: "Ranking and scaling methods with demonstration of RASC"; and "Automated well correlation with error analysis and demonstration of spline fitting."

NATO Advanced Study Institute on "Statistical Treatments for Estimation of Mineral and Energy

Resources, Il Ciocco, Italy, June 1986. TWO TALKS: "Application of recent developments of regression analysis in regional mineral resource evaluation"; and "Spatial analysis of patterns of land-based and ocean-floor ore deposits."

Second International Conference on Paleocyanography, Woods Hole, Massachusetts, September 1986. TALK: "Use of splines, for construction of geologic time scales" (contribution to Geochronology Workshop).

Sixth International Quantitative Stratigraphy Short Course, Comprehensive Institute of Petroleum Geology, Jiangling County, Hubei Province, China, October 1986. TALK: "Ranking and scaling methods in biostratigraphy with computer programme demonstrations."

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

G.F. Bonham-Carter

Tenth International CODATA Conference, Ottawa, July 1986.

Fifth Thematic Conference, Remote Sensing for Exploration Geology, International Symposium on Remote Sensing of Environment, Reno, Nevada, September/October 1986.

Fifteenth Geochatauqua,, Computers in the Petroleum Industry, Calgary, October 1986.

Nova Scotia Tenth Annual Open House and Review of Activities, Halifax, November 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

C.F. Chung

The 1986 Annual Meeting of Statistical Society of Canada, Banff, May 1986. TALK: "Confidence bands for Quantile Function with Applications in the Earth Sciences."

NATO Advanced Study Institute on "Statistical Treatments for Estimation of Mineral and Energy Resources", June/July 1986, Italy. TALKS: "Quantile processes and their applications in earth sciences" and "Poisson regression and its Applications."

The 15th Geochautauqua, Computers in the Petroleum Industry Calgary, October 1986. TALK: "Poisson regression and its applications."

A.N. Rencz

Review of Activities 1986, New Brunswick Department of Natural Resources and Energy, Fredericton, November 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1987.

Special Talks and Lectures

F.P. Agterberg

"Correlation and scaling in time", Xian Institute of Geology and Mineral Resources, Xian, China, October 1986.

"Geological data analysis", Course GEO3123,

Department of Geology, University of Ottawa, January-March 1987.

"Use of spline curves in stratigraphic correlation", Syracuse University, Syracuse, New York, March 1987.

G.F. Bonham-Carter

"Modelling spectral shifts using MEIS data: a progress report" at Canadian Advisory Committee on Remote Sensing (CACRS), Geoscience Working Group, Toronto, January 1986.

"Digital cartographic activities carried out in Mineral Resources Division" at Workshop on automated mapping, AGC, Dartmouth, February 1986.

C.F. Chung

"Confidence bands for percentile residual lifetime function under random censorship model", Departmental Colloquium of Department of Statistics in University of Alberta, Edmonton, September 1986 and at University of Calgary, Calgary, October 1986.

"Percentile residual lifetime function under random censorship model and bootstrapping confidence bands", Departmental Colloquium of Department of Statistics in Carleton University, Ottawa, December 1986.

"An extension of principal component analysis for LANDSAT TM data", Canada Centre for Remote Sensing, Ottawa, March, 1987.

A.N. Rencz

"Role of remote sensing in geographic information Systems", Carleton University, Ottawa, 1987.

Membership on Committees

F.P. Agterberg

Voting Member, International Commission on Stratigraphy, Committee on Quantitative Stratigraphy..

Member, International Working Group, International Geological Correlation Programme Project 148, Quantitative Stratigraphic Correlation Techniques, Leader.

Adjunct Professor, Carleton University, Department of Mathematics and Statistics.

Adjunct Professor and Graduate School member, University of Ottawa, Department of Geology.

Chairman, 1986 President's Prize Selection Committee, International Association for Mathematical Geology,

Member, Program Committee APCOM 89 Conference, Society of Mining Engineers of AIM.

Chairman, Commission on Tectonics of Ore Deposits Working Group No. 3.

Member, Editorial Advisory Board, Computers and Geosciences.

Member, Geo-Processing, Editorial Board.

Member, Editorial Board, Canadian Mining and Metallurgical Bulletin, Geology Division.

Associate Editor, Geologie en Mijnbouw.

Advisory Editorial Council, Global Tectonics and Metallogeny.

G.F. Bonham-Carter

Editorial Advisory Board, Computers and Geosciences.

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

Member, Data Integration Committee, Geological Survey of Canada.

C.F. Chung

Co-Director of NATO Advanced Study Institute on "Statistical Treatments for Estimation of Mineral and Energy Resources", June/July 1986, Italy

Co-Editor of the Proceedings of the NATO ASI to be published in August, 1987.

A.N. Rencz

Member, Geobotany Working Group, Canadian Advisory Committee on Remote Sensing.

Advisory Committee, CIM Conferences in 1988.

Member, Data Integration Committee, Geological Survey of Canada.

Coordinator for Eastern Ontario Projects in MRD, Canada-Ontario MDA Program.

Special Projects

The study of Archean gold mineralization is the main responsibility of the senior staff geochemist in Special Projects.

Highlights

Starting with the earlier work at the Hemlo deposit, it has become increasingly apparent that a number of large gold deposits of Archean age were formed from oxidized fluids. There are very limited options for the source of such fluids in Archean time, with the only general source being oxidized felsic magmas. This hypothesis receives support from the observation that those felsic intrusions that are spatially and temporally related to major gold mineralization were derived from oxidized magmas.

Attendance at Conferences, Meetings and Courses

E.M. Cameron

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Ottawa, May 1986.

Gold '86, Symposium, Toronto, September 1986.

Membership on Committees

E.M. Cameron

Editor-in-Chief, Journal of Geochemical Exploration.

Member, Mineral Resources Division, Mineral Deposits Research Committee.

TERRAIN SCIENCES DIVISION

J.S. Scott, Director

Introduction

The primary responsibilities of the Division are to ensure the availability of comprehensive knowledge, technology and expertise on the surficial and Quaternary geology, glaciology, geomorphic processes and natural terrain hazards of the Canadian landmass and on the practical applications of terrain science. The Division is also responsible for management and administration within the Department for a co-operative program with Atomic Energy of Canada Limited on geoscience research for disposal of high-level nuclear fuel wastes.

Divisional objectives arising from these responsibilities are: to provide a systematic coverage of modern standard surficial geology maps throughout Canada, provide information on paleoecological, paleoenvironmental and glaciological conditions as a means for establishing rates and directions of climatic and environmental change, document geological and geomorphological conditions and natural terrain hazards that influence environmental and resource development issues, develop and evaluate geophysical methods and techniques for delineation of bedrock, surficial geological and permafrost conditions affecting land use, develop sedimentological and geochemical methods for mineral prospecting in drift-covered regions and for evaluation of the impact upon terrain and the environment of phenomena such as acid rain. The Division also provides standards, controls and reference materials to ensure consistency of correlation between geological events of the Pleistocene and Holocene Epochs and to develop and maintain standards of mapping of surficial geology appropriate to national needs.

The Divisional organization comprises three Subdivisions and a Sedimentology Research Unit. Quaternary Geology Subdivision has responsibility for systematic Quaternary geological mapping of the Canadian landmass exclusive of offshore areas, development of mineral exploration methodology based upon characteristics of glacial sediments and operation of the radiocarbon laboratory. Quaternary Environments Subdivision is responsible for paleontological and paleoecological investigations of Quaternary fossil materials as an aid to stratigraphic correlation and determination of paleoenvironments, studies of arctic glaciers also as an aid to paleoenvironmental and paleoclimatic interpretations, and operation of Divisional sedimentology laboratories. Responsibilities for studies of active geomorphic processes, including landslides, permafrost, erosion and related terrain hazards and development of geophysical methods, particularly shallow seismic reflection and refraction techniques and ground profiling radar systems are centered within Terrain Dynamics Subdivision. Scientific activities of the Subdivisions are complemented by a Sedimentology Research Unit which maintains and develops expertise and techniques in Quaternary sedimentology and geochemistry pertinent to terrain and related environmental problems.

During the year the scientific program of the Division continued to be strongly influenced by involvement in federal/provincial mineral development agreements in Labrador, Nova Scotia, New Brunswick, Ontario and Manitoba, federal programs to encourage mineral exploration in Gaspé and Eastern Townships of Quebec, northern research funded through the Office of Energy Research and Development and through participation in geophysical investigations from the Ice Island off the northwest coast of Ellesmere Island supported by the Frontier Geoscience Program. These special programs provided an aggregate of 78 per cent of the total O&M funding allocated to the Division.

The Canadian Geoscience Council Review Committee on Outputs in Quaternary and Engineering Geology, chaired by Professor M. Church, U.B.C. completed its study and submitted its final report entitled "Mapping the Landscape". The report was reviewed within the Branch and commentary prepared to accompany publication of the report by the Geological Survey on behalf of the Canadian Geoscience Council.

At the end of the report-period the staff comprised 1 Research Manager, 39 Research Scientists, (4 terms) 22 Physical Scientists (7 terms), 21 technical support (4 terms), and 6 administrative support. Staff of the Division are based primarily in Ottawa with small operational units in Calgary at the Institute of Sedimentary and Petroleum Geology and in the Vancouver Office of the Geological Survey.

During the year the Division approved the following for publication: 5 GSC Reports; 17 Maps; 13 Open Files; and 22 contributions to Current Research. In addition 65 papers and 31 abstracts were approved for Outside Publication.

REPORTS ON SECTIONS

DIVISION HEADQUARTERS

Division Headquarters, in addition to the Director's office, comprises the Scientific and Technical Services Unit, which provides editorial and cartographic services, the Administrative and Financial Services Unit, and the Secretarial and Clerical Services Unit. Also included in Division Headquarters are two Staff Scientists. One carries out studies of Quaternary geochronology in the high arctic while the other has responsibility for the Nuclear Fuel Waste Management Program.

Personnel Notes

Division Headquarters consists of a permanent staff of 1 Research Manager, 2 Research Scientists (1 term), 2 Physical Scientists, 1 technical support and 6 support staff.

Attendance at Meetings, Conferences and Courses

W. Blake, Jr.

Presented a poster session at the 15th Annual Arctic Workshop, INSTAAR, Boulder, Colorado, April 1986.

Fiftieth Anniversary Symposium, International Glaciological Society, Cambridge, England, September 1986.

P.A. Brown

Presented a paper at the Geological Association of Canada Annual Meeting, Ottawa, May 1986.

Canadian Nuclear Society, Winnipeg, Manitoba, September 1986.

Isotope Geochemistry of Groundwater and Fracture Material in Plutonic Rock, Mont Ste. Marie, Quebec, September-October 1986.

J.S. Scott

Geological Association of Canada Annual Meeting, Ottawa, May 1986.

Geological Society of America Annual Meeting, San Antonio, Texas, November 1986.

Membership on Committees

W. Blake, Jr.

Fellows Committee, Arctic Institute of North America, Calgary; Chairman

Editorial Advisory Committee, Royal Canadian Geographical Society, Ottawa; Member

Ph.D. Thesis Committee for M. Krawetz, Department of Geography, McMaster University, Hamilton; Member

J.S. Scott

Department Committee for Research Manager Classification; Member

NRC Associate Committee on Geotechnical Research; Member

Geological Society of America, Committee on Geology and Public Policy; Chairman (86-87)

Geological Society of America; Councillor

Special Talks or Lectures

P.A. Brown

'Progress and results from the Geological Activity 1986/87' to staff at Atomic Energy of Canada Limited, Pinawa, Manitoba, February 1987.

J.S. Scott

'Canada's mineral, forest and fisheries resources' to Course XL at the National Defence College, Kingston, Ontario, October 1986.

Quaternary Discussion Group

Under the Chairmanship of S.G. Evans the following papers were presented during April 1986 to March 1987.

Dr. Heikki Ignatius, Geological Survey of Finland, Finland -- Activities of the Geological Survey of Finland.

Dr. A.S. Dyke, Terrain Sciences Division, GSC, Ottawa -- Quaternary geology of Prince of Wales Island: Implications for the Wisconsin northwest Laurentide Ice Sheet.

Prof. G.H. Denton, University of Maine, Maine -- Glacial history of Antarctica with emphasis on Late Wisconsinan and Stage 6.

Dr. D.I. Godfrey-Smith, Simon Fraser University, Burnaby, B.C. -- Optical dating of Quaternary sediments using argon-laser light.

Dr. R.A. Price, Geological Survey of Canada, Ottawa -- Geological perspectives on the proposed International Geosphere-Biosphere Program on Global Change.

Dr. Niels Reeh, Polar Continental Shelf Project, Ottawa -- The effect of deformable beds on ice-sheet flow patterns.

Mr. H. Thorleifson, Mrs. P. Henderson, Mr. M. Nixon, Terrain Sciences Division, GSC, Ottawa -- A report on the cruise of the CSS HUDSON in Hudson Bay, 4-21 October 1986 - Quaternary geology of the Hudson Bay seafloor.

Dr. F. Gasse, CNRS, Paris, France -- Diatoms and geochemistry data for reconstructing Late Quaternary hydrologic and climatic variations.

Dr. S. Pullan, Terrain Sciences Division, GSC, Ottawa -- The application of shallow seismic reflection methods to Quaternary geology.

Dr. D.A. St-Onge, Terrain Sciences Division, GSC, Ottawa -- Morphosedimentary zones in the Bluenose Lake region, N.W.T.

Dr. J.R. Bélanger, Terrain Sciences Division, GSC, Ottawa -- The use of LANDSAT imagery in Quaternary geology.

Dr. W.W. Shilts, Terrain Sciences Division, GSC, Ottawa -- Quaternary stratigraphy and gold placers in the Beauceville area, Quebec.

Dr. G. Prichonnet, Université du Québec à Montréal -- Glacio-marine facies of the Late Wisconsinan Champlain Sea, southern Québec.

Ms. C. Causse and Dr. C. Hillaire-Marcel, Université du Québec à Montréal -- Uranium-thorium dating in continental basins.

Dr. M. Fenton, Alberta Geological Survey -- Glacial tectonism on the Plains with special reference to slope stability in open pit coal mines.

QUATERNARY GEOLOGY SUBDIVISION

D.A. St-Onge (Chief)

Dr. D.G. Harry, Ms. M.M. Burgess, Terrain Sciences Division, GSC, Ottawa -- Permafrost and terrain research, Norman Wells Pipeline, northwestern Canada.

Dr. Matti Seppala, University of Helsinki, Finland -- Geomorphic mapping of cold environments.

Mr. D.R. Sharpe, Terrain Sciences Division, GSC, Ottawa -- Glacial geology of Wollaston Peninsula, Victoria Island, N.W.T.

Dr. C. Dunn, Mineral Resources Division, GSC, Ottawa -- The use of plants in helping identify mineralized zones concealed by Quaternary deposits.

Dr. J.J. Clague, Terrain Sciences Division, GSC, Calgary -- Catastrophic outburst floods - recent examples from western North America.

Mr. B. Spark, Geophysics Division, Ottawa -- A re-assessment of the 1965 Hope Slide: Implications for other sites in the Cordillera.

Mr. D.A. Hodgson, Terrain Sciences Division, GSC, Ottawa -- Episodic retreat of the Late Wisconsinan Laurentide Ice Sheet over northeast Victoria Island (Storkerson Peninsula and Stefansson Island).

Dr. J-S. Vincent, Terrain Sciences Division, GSC, Ottawa -- The Quaternary of the Northern Interior Plains and western Canadian Arctic Archipelago.

Dr. M. Lamothe, Terrain Sciences Division, GSC, Ottawa -- A new concept for the Pleistocene stratigraphy of the St. Lawrence lowland.

The Quaternary Geology Subdivision includes most of what was formerly the Regional Projects Section, some former parts of the Sedimentology and Mineral Tracing Section, and the Radiocarbon Laboratory.

The prime objectives of the Quaternary Geology Subdivision are to provide a Canada-wide inventory of surficial materials and landforms, to establish the stratigraphy and environmental history of Quaternary deposits, and to provide basic data on drift composition and provenance.

Projects are designed to provide information on the nature and distribution of surficial materials and on terrain conditions, to determine the geologic history of the Quaternary period, to furnish an understanding of the genesis of deposits and landforms and, to develop models which will aid in prospecting for minerals.

Terrain and surficial geology information is required to elaborate policies for all landuse activities in order to ensure that land resources are used economically, and that development will proceed without unacceptable deterioration of the environment. Important adjuncts of this work are preparation of regional syntheses, which explain the general nature and environmental history of Canada, and the development of expertise in terrain and environmental matters that can be tapped by other agencies. Results also provide significant input into international scientific projects such as Global Change and the International Geosphere-Biosphere Program. The ^{14}C dating laboratory has long been considered the standard for Canada and has an enviable international reputation. It continues to play an essential role in dating events which occurred during the past 40 000 years.

Several scientists have been involved in various aspects of the preparation of the XIIth INQUA Congress to be held in Ottawa between July 31 and August 9, 1987. This meeting will bring together on a worldwide basis scientists concerned with the history of the Earth's natural environment in the Quaternary Period, the roughly two million year interval during and since the glacial Pleistocene Epoch. Scientists of the Subdivision are members of various committees; they helped prepare the bilingual second circular, they authored major syntheses for several symposia and they wrote guidebooks for 16 of 29 field trips. These guidebooks provide major syntheses for various parts of the country where field trips will be held before and after the meeting in Ottawa.

Highlights

Northern Region

Systematic mapping in the Bluenose Lake region, Northwest Territories, during July and August 1986 shows that the Bluenose Lake end moraine system marks the western limit of the last ice advance, probably Late Wisconsinan. Sparse erratics indicate that an older glaciation of unknown age extended further west. During the early phases of ice retreat the

Bluenose Lake depression was occupied by glacial meltwater and by large masses of dead ice. The level of "Glacial Lake Bluenose" is marked by numerous, large deltas which commonly display ice collapse features. Although the ridges in the Bluenose Lake moraine complex result from ice thrusting from the east, the Inman River drumlin field was moulded by ice moving from the basin of the Rae and Richardson rivers to the south and curving to the northwest in the vicinity of Amundsen Gulf. As a result of differential uplift the postglacial marine limit defined by numerous deltas and washed zones has been tilted up towards the southeast at a rate of approximately 45 cm/km.

The third and final field season of a project mapping the Quaternary geology of Prince of Wales Island focused on testing two hypotheses: variations in the abundance of fossil whale bones on different ages of raised beaches reflected variations in sea ice conditions during the postglacial period; and the postglacial emergence of Prince of Wales Island had occurred as uplift of a horizontal block with early Holocene shorelines on Prince of Wales Island offset from those of the same age on Somerset Island by about 100 m due to faulting. Field parties recovered 44 fossil Bowhead Whale, 13 Norwhal, 1 Walrus, 46 driftwood and 17 marine shell specimens. The Bowhead Whale seems to have been abundant throughout the region during the period of deglaciation and to have originated from a Beaufort Sea stock. Intervals of middle and late Holocene Bowhead Whale occupation are recognized in Peel Sound and around Somerset Island, but not in McClintock Channel, suggesting expansion and contraction of a Baffin Bay stock. Norwhal in any abundance were restricted to small parts of NW Prince of Wales Island and seem to appear first in the record 3500 years ago. Rare finds elsewhere in the region indicate the same time of initial appearance. Radiocarbon dating of wood and bone samples will allow testing of the "Holocene block tectonics" hypothesis through construction or refinement of several local emergence curves.

The last sector of the extreme northwest margin of the late Wisconsinan Laurentide Ice Sheet lacking field mapping was examined this summer. Three zones of glacier flow, each recording a successive stage in disintegration of the ice sheet, are clearly recorded in northeast Victoria Island by erosional and depositional glacial and glaciomarine landforms. An area of diverse flow directions imprinted in thick till (Zone I) likely records disintegration of near maximum thickness ice. Zone I is truncated by streamlined landforms (Zone II) left by a surge of grounded ice. Zone II was cross-cut at lower elevations by a later surge of a glacier of near-neutral buoyancy, with low basal shear stress -- perhaps an ice shelf in places (Zone III). Dating of the successively lower marine limits associated with Zones I and III will hopefully enable accurate correlations to be made between complex deglacial events to the west.

Western Region

In 1986 while conducting regional surficial geological surveys in the Cariboo District, a previously unknown buried valley with the potential for hosting a placer gold deposit was discovered. This discovery was reported at the joint G.S.C.-B.C. Ministry of Energy, Mines and Petroleum Resources

Open House held in Vancouver in January 1987. A report on the discovery was also released in January in G.S.C. Paper 87-1A. These reports stimulated considerable interest in the mining community. One company has staked the site and plans to spend \$100,000 on drilling and seismic profiling to further evaluate the potential for a gold placer deposit.

Limited field observations supplemented by extensive airphoto interpretation indicate that the glacial deposits and landforms of Mackenzie Mountains are divisible into 3 categories: (1) those of large valley glaciers in major valleys such as Arctic Red, Mountain and Keele that cut across the regional structural and topographic trend; (2) those of small valley glaciers emanating from cirques in the Canyon Ranges (outer ranges) of Mackenzie Mountains; (3) those of the Laurentide ice sheet that pressed against the Canyon Ranges and extended tongues up major valleys such as Arctic Red, Mountain and Keele. Deposits of types 1 and 2 are divisible into 2 age categories thought to be correlative with Reid and McConnell glaciations of central Yukon.

Field work was continued in the Cypress Lake area, Saskatchewan. Activities were focused mainly on the till stratigraphy and included studies of exposures along streams and subsurface information obtained by shallow drilling to depths of 10 to 12 m. Reconnaissance surveys were made of major sections along the South Saskatchewan River between Medicine Hat and Wellsch Valley, Saskatchewan. State of the art conclusions based on studies to date are that the two-unit till sequence within much of the area is of Late Wisconsinan age.

Regional Quaternary geological surveys and drift geochemical studies reported on in 1983 and 1985, identified the occurrence of anomalously high arsenic and gold values in overburdened sediments in the lower Seal River area approximately 40 km northwest of Churchill, Manitoba. Subsequent current and more detailed work by the Manitoba Department of Mines and Energy in 1986 defined a glacial dispersion train in the Seal River area with exceedingly high gold values. The dispersal train has been traced back to gold-bearing source rocks which afford an attractive mineral exploration target.

Eastern Region

Evidence is common in the Dryden area (and in other areas of the Canadian Shield in Ontario) of erosion features clearly of meltwater origin. These features are significant for several reasons: (1) an outcrop containing a gold property (under investigation) with visible gold, has meltwater erosion marks rather than ice scour as the latest erosion event. This will alter strategies for local drift dispersion in this area, e.g. focus on heavy minerals in addition to trace elements; (2) in some cases the conflict with suggested evidence of flow direction of an earlier glacial episode based on outcrop striations; (3) the areas with common meltwater erosion features have little or no drift which have been washed away by meltwater. A unique red clay, widespread in the Dryden area, occurs as a thicker rhythmic unit near the top of rhythmic sediments that represent over 400 years of deposition. The red clay appears to come from a discrete source, which may be from Sibley Group rocks

200-300 km eastward. The lower rhythmites however appear related to subaqueous fan deposition associated with the nearby Hartman Moraine. Refinement of these sediment distribution patterns should help mineral dispersion studies in the area. This work was carried out under the Ontario M.D.A. Program.

Research on the use of remote sensing in mineral exploration was broadened to include joint projects with the private sector. The use of Landsat Images is yielding promising results in identifying bedrock lineaments related to mineralized zones in parts of Saskatchewan. Analysis of multidata imageries over the asbestos belt near Thetford Mines (Québec) has demonstrated the possibility of using Landsat data to monitor vegetation stress related to the presence of ultrabasic debris in the soil. The research involves the development of microcomputer software to analyze and display colour imageries.

Studies of ice flow history of drift composition, completed in western Labrador, near Schefferville, and in eastern Labrador, near Makkovik, have provided new insights on the configuration and dynamics of the Laurentide Ice Sheet in the region. The work has shown a complex history of ice flow throughout central Labrador associated with change in the position of long-lived dispersal centres. Mapping the distribution of indicator erratics has allowed definition of the shape and size of glacial dispersal trains and has provided a basis for establishing the importance of the different transport phases. Stratigraphic sections that include these compositionally distinct tills have been identified in the Labrador Trough that were previously unrecognized. Geochemical analysis of till in three 1:250 000 map areas (NTS 13 J,K,L) were released on Open File.

Field checking for the compilation of a map, 1:250 000, of the Quaternary of the Gaspésie Peninsula is now 85% completed. Problem areas east and southeast of Causapscal where till deposits are often found overlain by periglacial rubble up to 1 m thick remain to be verified. Several 1:50 000 sheets in the eastern half of the peninsula, recently mapped by Quaternary geologists from MERQ but not published yet, are required before final compilation can be initiated. Field checking was carried out by Terrain Sciences and a private agency under contract during summer 1986. This map will, for the first time, provide a detailed picture of the distribution of the glacial deposits, the in situ weathered bedrock and the main directions of ice flow for the whole of the peninsula.

Mineral Exploration Methods

Under the Manitoba MDA project, surficial geology mapping and reconnaissance geochemical sampling of till continued to provide basic data to aid mineral exploration in northwestern Manitoba. A paper summarizing the Quaternary geology and till geochemistry of the Lynn Lake-Leaf Rapids area was published and an Open File of till geochemical data for the Brochet area was released. Two additional NTS sheets were sampled this year and airphoto interpretation and field checking were completed for five sheets. A previously unmapped ultramafic body was found at Osik Lake using classic glacial dispersal and boulder tracing methods. Significant

amounts of chromium and nickel are present in several samples of the ultramafic rock and it is being tested for gold and platinum group elements.

Contract work under the Manitoba MDA was started to identify the source of a large arsenic anomaly in till in the Wheatcroft Lake area. Field work consisting of sampling of till and bedrock was completed. Several small occurrences of base metal and gold mineralization are the suspected sources of the anomaly.

Research continued on the shape and composition of gold grains in glacial sediments from prospects in the District of Keewatin, northern Ontario, and southeastern Manitoba. Compositionally banded gold, which may be partly secondary, was found in glacio-fluvial sands from southeastern Manitoba.

Identification of fossil pollen and insects from buried organic materials in the Timmins area suggests that a widespread mid-Wisconsinan nonglacial unit is present there. This unit could be an important stratigraphic marker separating tills having markedly different ice-flow directions, important factors in drift prospecting for gold and base metal deposits in the region. Continuous coring of the Quaternary sequence will be undertaken in early 1987 to define this unit, as part of the Canada-Ontario Mineral Development Agreement.

Quaternary Geochronology

Terrain Sciences Division personnel with Quaternary geology expertise in the major regions of Canada comprise a Geochronology Committee which vets all samples submitted for dating; monitors all contractual arrangements with other dating laboratories; and provides advice to the Director on how the Laboratory can best meet its objectives as a National Laboratory.

The Radiocarbon Dating Laboratory, now in its 27th year of operation, has dated in excess of 4300 samples. A recently implemented computer data base allows the efficient generation of information on samples for the Laboratory's clientele. These data can be electronically transferred to the Publication Division for inclusion in the annual 'Date Lists' and other publications. The 3000 published GSC dates are now accessible on the GSC 'Date Locator File' (radiocarbon data base) for use by the scientific community. The Laboratory also provides the Canadian component to the 'Global Radiocarbon Data Base' maintained by the journal Radiocarbon (Yale University, U.S.A.).

Personnel Notes

The Quaternary Geology Subdivision consists of 18 Research Scientists (1 term), 9 Physical Scientists (3 terms), and 4 Technicians (2 terms). The Subdivision also supported 2 EMR Research Agreements.

Attendance at Meetings, Conferences and Courses

J.D. Adshead

Presented a paper at the American Geophysical Union, San Francisco, December 1986.

J.R. Bélanger

Presented a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

Presented a paper at the Canadian Advisory Committee on Remote Sensing, Toronto, January 1987.

J.J. Clague

Geological Association of Canada Annual Meeting, Ottawa, May 1986.

M.D. Clarke

Manitoba Department of Energy and Mines Current Activities Forum, Winnipeg, November 1986.

R.N.W. DiLabio

Geological Association of Canada Annual Meeting, Ottawa, May; Session Chairman.

Presented a paper at the 12th International Sedimentological Congress, Canberra, Australia, August 1986.

Presented two posters at the Manitoba Department of Energy and Mines Current Activities Forum, Winnipeg, November 1986.

Presented two posters at the 1987 Current Activities Forum, Ottawa, January 1987.

Presented a poster at the Prospectors and Developers Association of Canada Annual Meeting, Toronto, March 1987.

R.J. Fulton

Geological Association of Canada Annual Meeting, Ottawa, May 1986; led field trip.

AMQUA Biennial Meeting, Champaign-Urbana, June 1986.

Geological Society of America Annual Meeting, San Antonio, November 1986.

O.L. Hughes

Presented a paper at the Joint Canada-U.S. Conference on the Late Cenozoic Geology of Interior Alaska/Yukon, Anchorage, Alaska, February 1987.

L.E. Jackson

Poster was presented at AMQUA Biennial Meeting, Champaign-Urbana, June 1986.

Paper presented at the Joint Canada-U.S. Conference on the Late Cenozoic Geology of Interior Alaska/Yukon, Anchorage, Alaska, February 1987.

R.N. McNeely

Presented a paper at the 51st Annual Meeting of the Society for American Archaeology, New Orleans, LA, April 1986.

F.M. Nixon

Presented a paper at the 1987 Geoscience Forum, Yellowknife, December 1986.

1987 Current Activities Forum, Ottawa, January 1987.

Presented a paper at the Arctic Delta Failure Experiment Meeting, Quebec, February 1987.

S.H. Richard

Presented a paper at the Geological Association of Canada Annual Meeting, Ottawa, May 1986; participated in Field Trip 7.

D.R. Sharpe

Presented a paper at the Arctic Workshop, Boulder, April 1986.

Presented a paper at the Geological Association of Canada Annual Meeting, Ottawa, May 1986.

Presented a paper at the American Geophysical Union, San Francisco, December 1986.

F.J. Thompson

Presented a poster at the Newfoundland Open House, November 1986.

Presented a paper and a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

J-S. Vincent

Presented a paper at the 54th ACFAS Congress, Montreal, May 1986.

Presented two papers at the 2nd Canadian/American Workshop on the Late Cenozoic History of Northwestern North America, Anchorage, Alaska, February 1987.

Membership on Committees

J.R. Bélanger

Branch Computer Facilities Committee; Member

Terrain Sciences Divisional Computer Committee; Member

Canadian Remote Sensing Society; Member

Association quebecoise pour l'étude du Quaternaire; membre

J.J. Clague

INQUA Subcommittee on North American Quaternary Stratigraphy; Member

INQUA Commission on Quaternary Shorelines, Subcommittee for the Americas; Member

Canadian Journal of Earth Sciences; Associate Editor

CANQUA; Vice-President

R.N.W. DiLabio

Terrain Sciences Division Display Committee;
Member

11th International Geochemical Exploration
Symposium; Member

L.A. Dredge

Commission on Lithology and Genesis of Till
(INQUA); Member

Commission on Glaciotectonics (INQUA); Member

Commission for Quaternary Studies in Earth
Sciences, Canadian Geoscience Council; Member

R.J. Fulton

Geological Survey of Canada Radiocarbon Dating
Committee; Member

INQUA '87; Local Organizing Committee

Expert Committee on Soil Survey, Agriculture
Canada; EMR Representative

Management Panel of the Quaternary Geology and
Geomorphology Division of the Geological Society
of America

L.E. Jackson

International Conference on Palynology 1984,
Member; Organizing Committee, Member; Field
Trips Subcommittee, Chairman

D.A. St-Onge

Geological Association of Canada; Nominating
Committee

Royal Canadian Geographical Society, Vice
President; Editorial Committee and Massey Medal
Committee, Member; Lectures Committee, Chairman

INQUA '87, Organizing Committee; Vice President

Comité d'Honneur de la Fondation ACFAS, membre

A.M. Stalker

Canadian Quaternary Association; Member

International Geological Correlation Program,
IGCP Project 128; Member

INQUA Subcommittee on North American Quaternary
Stratigraphy; Member

S.I.L. Working Group on "International projects
on deep coring operations on relict lakes of the
world"; Member

Canadian National Committee for I.U.G.S.; Member

J-S. Vincent

Association québécoise pour l'étude du
Quaternaire; Président-sortant

J-S. Vincent (cont'd.)

Géographie physique et Quaternaire; rédacteur
en chef

INQUA 1987 Congress, Organizing Committee;
Co-chairman of Program Committee

Special Talks or Lectures

J.J. Clague

'Catastrophic lake drainage - recent examples
from western North America' to Department of
Geophysics & Astronomy, U.B.C., Vancouver,
November 1986.

'Catastrophic drainage of ice-dammed lakes' at
the Pacific Geoscience Centre, Victoria,
December 1986.

'Episodic Quaternary sedimentation and erosion
in British Columbia - evidence from sediments
and landforms' to Department of Soil Science,
U.B.C., Vancouver, January 1987.

'Catastrophic lake drainage - recent examples
from western North America' to Department of
Geology, Western Washington University,
Bellingham, February 1987.

'Quaternary sedimentation and erosion' to
Department of Geological Sciences, U.B.C.,
Vancouver, March 1987.

R.N.W. DiLabio

'Drift prospecting' to Exploration Geochemistry
Class, Carleton University, Ottawa, November
1987.

L.A. Dredge

'Locating aggregate and positioning airstrip at
Igloolik, N.W.T.' to Ministry of Transport,
Igloolik, N.W.T., July, 1986.

A.S. Dyke

'Quaternary geology of Prince of Wales Island:
Implications for the northwestern Laurentide Ice
Sheet' to Geology Department, University of
Massachusetts, Amherst; and to Colloquium
Series, University of Alberta, Edmonton, both in
May 1986.

L.E. Jackson

Short course on 'Glacial geology and drift
prospecting' to Mineral Exploration Geologists,
Simon Fraser University, Burnaby, B.C., April
1986.

'Quaternary geology, Pelly River basin, Yukon'
to graduate students and faculty, Geology
Department, University of Alberta, Edmonton,
March 1987.

Short course on 'Introduction to glacial
geology' to undergraduate students, U.B.C.,
Vancouver, March 1987.

'Rocks and minerals' at elementary school, Calgary, November 1986.

D.R. Sharpe

'Glacial geology' to Sedimentology Seminar, Ottawa University, Ottawa, November 1986.

'Streamlined landforms' to Sedimentology Discussion Group, Ottawa-Carleton, Ottawa, February 1987.

J-S. Vincent

'Les moraines de De Geer et la déglaciation de la région à l'est de la baie de James' to Department of Geography, University of Ottawa, April 1986.

'The Quaternary of the Quebec/Labrador Shield area' at the Institute for Quaternary Studies, Orono, Maine, January 1987.

'The Quaternary of the Northern Interior Plains and the Western Canadian Arctic Archipelago' at the Institute for Quaternary Studies, Orono, Maine, January 1987; and to Department of Geology and Geography, The University of Lethbridge, Alberta, February 1987.

'Le Quaternaire du nord-ouest canadien' to Department of Geography, Laval University, Quebec, March 1987.

Laboratory Statistics

Geochronology

Determinations completed

Conventional radiocarbon ages (GSC)	
Geological samples	200
Geochemical samples	6
¹³ C/ ¹² C ratios	199
(University of Waterloo - contract)	
AMS radiocarbon ages (IsoTrace)	32
(University of Toronto - contract)	

B.R. Pelletier (Chief)

This Subdivision was newly formed on April 1, 1987 with the overall aim of understanding and documenting environments and changes during the Quaternary Period. The Subdivision comprises two scientific research sections namely Paleocology and Glaciology, and two Divisional sedimentology laboratories. One laboratory is devoted to mechanical analyses and engineering properties of sediments, and the other is dedicated partly to mechanical analyses and partly to sample preparation for petrographic, geochemical and X-ray analyses.

The Paleocology Section, headed by T.A. Anderson, is an original Section of the Terrain Sciences Division and deals primarily with the identification of plant and insect fossils recovered from Quaternary deposits in both marine and terrestrial regions. Through these identifications and commonly ¹⁴C dating, the chronology of the deposits are established. At the same time inferences are made on climate and the environment at the time of deposition. Service work is carried out by the staff on fossil material submitted from other Divisional scientists, as well as several extra-mural workers across Canada.

The Glaciology Section, headed by R.M. Koerner, was transferred directly as a unit from the Polar Continental Shelf Project and its members continue to operate in their former style and residence. Their field work on the glaciers in the Arctic Archipelago continues, as does the laboratory work at the PCSP quarters at City Centre. The long-continued drilling program on the glaciers has yielded crucial information on the trajectory of atmospherically transported gases, volcanic material, terrestrial dust, and pollen, as well as the positioning of ancient ice margins. Results of their work are critical to an understanding of climate during the Quaternary, and hence to a direct appreciation of the environmental nature of northern Canada, at least, during that period.

Divisional Sedimentology Laboratories (Engineering, headed by R.G. Kelly; and Minerals, headed by P.J. Higgins) carry out routine mechanical and sedimentary chemical analyses on several thousand samples submitted annually by Division scientists and from those outside the Geological Survey. University theses are supported in cases where the work is tied directly to a Division project, and this serves to enhance the program of the Division and to provide opportunities for qualified students. A significant innovation in the Engineering Laboratory is the installation of a core X-ray facility, which is presently being tested in the manual mode of operation. Later this equipment will be automated, which will increase production and greatly enhance the quality of the analyses.

Staff of the Minerals Separation and Preparation Laboratory assisted in renovating and refurbishing the core room at 401 Lebreton Street in order to make it an additional hands-on working area for geologists and engineers located in the building. A general clearing-up was made, equipment and microscopes were installed, three new work benches were built and a new sink with sediment trap is to be connected to

existing utilities. These arrangements are virtually complete and the working area is fully operational. Another innovation to the laboratory (Minerals) is the acquisition of new microscopes and ancillary equipment so that an examination area with the necessary equipment, assistance, and security are readily available.

Highlights

Paleoecology Section

Sediment sampling of lakes and shoreline profiling in the North Bay-Verner area, Ontario and a re-evaluation of piston core data in Lake Erie, Lake Huron and Georgian Bay have provided evidence for two periods of overflow of glacial Lake Agassiz into the Great Lakes separated by a period of reduced input. The timing of these events correlates closely with the Moorhead, Emerson and Nipigon Phases of Lake Agassiz in central Canada.

Palynological studies on buried organic beds and lake sediment cores in Nova Scotia and New Brunswick have documented evidence for a warming trend prior to 11 ka. This was interrupted by a cold period which lasted until the abrupt Holocene warming at 10 ka. This climatic oscillation has been linked with the well known Allerod/Younger Dryas event of Europe.

Holocene climate changes in the Canadian Arctic were interpreted from existing data on driftwood in raised beach sequences, ice cores, vascular plant ranges, and peat, thermokarst and eolian deposits. Holocene warming occurred prior to 4 ka in most parts and as early as 10 ka in some western areas. Studies such as these are essential in understanding the nature and effect of climate changes particularly in light of anticipated rapid warming (7-16°C) in the Arctic over the next 50-75 years due to the greenhouse effect.

A reconnaissance survey of vegetation and surficial materials of northeastern Victoria and Stefansson islands resulted in range extensions for several calciphilous species on the highly alkaline tills and enabled the adjustments of regional boundaries such as the southward extension of High Arctic and northward extension of the Mid Arctic ecosystems. Modern pollen rain was sampled to tie in with these vegetation patterns. A preliminary synthesis of summer climate patterns and similarities with major regional vegetation patterns in the whole Arctic provided a crude calibration to enable more detailed paleoecological interpretations and predictions of response to future climate change in the Arctic. A coloured pamphlet illustrating 58 common arctic wildflowers and their habitats was prepared for N.W.T. school children and is now available to laymen and scientists.

Glaciology Section

The core records from our own cores and also from those of foreign groups working in Antarctica and Greenland have been re-examined. Our own earlier conclusions that basal ice in at least one of our own cores was deposited as snow before the last interglacial are being modified. We now consider it more likely that the basal ice, which at two core sites has an unusually high dirt content, was deposited when the ice cap began its growth during

the very early stages of the last glacial period more than 100 ka BP. Further south this period would be considered still interglacial (Sangamon). This is because high pollen concentrations occur in the basal ice along with 'warm' stable isotope values. Extending this approach to the Greenland deep cores at Camp Century and Dye-3 reveals the interesting conclusion that the same history may be applicable to those areas as well. High dirt concentrations in the basal ice, hitherto considered to be due to basal melting of the ice and subsequent refreezing, would then be explainable in terms of transport of wind-blown dust over very short distances onto the small but growing new centres of the Greenland ice sheet. This means that not only the Canadian ice caps but also the Greenland ice sheet may have suffered severe melting and shrinkage during the last interglacial. It seems likely the Canadian ice caps may have melted completely while the Greenland ice sheet must have been a small remnant of its former size at best.

This has further implications as sea level records from various coral reefs indicate that sea level was only 6 m higher than present at the warm peak of the last interglacial. Previously the consensus was that the 6 m of extra sea level was due to disintegration of the West Antarctic ice sheet. However, if the Greenland ice sheet suffered drastic 'melt-back' then the 6 m sea level rise must be attributable to Greenland and not Antarctica. Our view now is that the West Antarctic ice sheet has a stable configuration.

Personnel Notes

The Quaternary Environments Subdivision consists of 7 Research Scientists, 3 Physical Scientists (1 term) and 7 Technicians (1 term). The Subdivision also supported 2 EMR Research Agreements. Dr. Lynn Ovenden joined the Subdivision in August 1986 as a Postdoctoral Fellow in order to carry out research in paleoecology, dealing primarily with bryophytes (moss).

Attendance at Meetings, Conferences and Courses

B.T. Alt

Canadian Committee on Climatic Fluctuations and Man Annual Meeting, Ottawa, January 1987.

T.W. Anderson

Presented a paper and a poster at the Geological Association of Canada Annual Meeting, Ottawa, May 1986.

J. Bourgeois

Presented a paper at the Canadian Committee on Climatic Fluctuations and Man Annual Meeting, Ottawa, January 1987.

S. Federovich

Canadian National Committee on Ocean Drilling Project, Montreal, September 1986.

IBM Seminar "Introduction to Personal Computer", Ottawa, December 1986.

S. Federovich (cont'd.)

Presented a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

Canadian Committee on Climatic Flutuations and Man Annual Meeting, Ottawa, January 1987.

Paleolimnology Workshop on Acid Rain, Toronto, March 1987.

D. Fisher

Presented a paper at the Canadian Committee on Climatic Flutuations and Man Annual Meeting, Ottawa, January 1987.

R.M. Koerner

Presented a paper at the Canadian Committee on Climatic Flutuations and Man Annual Meeting, Ottawa, January 1987.

R.J. Mott

Presented a poster at the AMQUA Biennial Meeting, Champaign-Urbana, June 1986.

B.R. Pelletier

Geological Association of Canada Annual Meeting, Ottawa, May 1986.

1987 Current Activities Forum, Ottawa, January 1987.

Canadian Committee on Climatic Flutuations and Man Annual Meeting, Ottawa, January 1987.

Membership on Committees

B.T. Alt

Canadian Committee on Climatic Flutuations and Man; Member

Quaternary Environmental Changes Committee; Member

T.W. Anderson

Quaternary Environmental Changes Committee; Member

S.A. Edlund

Arctic Institute of North America Canadian Committee of Ecological Land Classification; Member

Canadian Committee on Ecological Land Classification, Northlands Ecoregion Working Group; Member

Canadian Committee on Climatic Flutuations and Man; Secretary

Quaternary Environmental Changes Committee; Member

S. Federovich

Quaternary Environmental Changes Committee; Member

R.M. Koerner

Canadian Committee on Climate Flutuations and Man; Member

Climate Planning Board Committee; EMR Member

Papers' Committee of International Ice Core Conference; Member

NRC Subcommittee on Glaciers; Member

Quaternary Environmental Changes Committee; Member

J.V. Matthews, Jr.

Biological Suvey of Canada, Scientific Advisory Board; EMR Representative

Climate Planning Board; Member

Canadian Committee on Climatic Flutuations and Man; Member

R.J. Mott

Quaternary Environmental Changes Committee; Member

GSC Radiocarbon Dating Committee; Member

B.R. Pelletier

Maritime Sediments and Atlantic Geology; Associate Editor

Advisory Committee on Undersea Features Names; Member

Working Group Marine Atlases for Canada; Member

Sedimentology Laboratory Committee; Member

Quaternary Environmental Changes Committee; Member

Special Talks or Lectures

J. Bourgeois

'Pollen analysis of snow and ice cores from the High Arctic' to undergraduate students, University of Ottawa, Ottawa, April 1986.

S.A. Edlund

'Bioclimatic zones in Arctic Canada' to Arctic Circle, Ottawa, April 1986.

R.M. Koerner

'Polar research and exploration' at Junior School, Ottawa, April 1986.

J.V. Matthews, Jr.

'Quaternary and late Tertiary paleoecology' to faculty and students, University of Alaska, February 1987.

'Climatic fluctuations in Alaska/Yukon during Isotope Stage 3 and 2' to Workshop audience, Anchorage, Alaska, February 1987.

R.J. Mott

'Late-glacial climatic change in Atlantic Canada' to faculty and students, University of New Brunswick, St. John's, January 1987; and faculty and students at University of Maine, Orono, Maine, February 1987.

B.R. Pelletier

'Beaufort Sea Science Program of EMR' to U.S. and Canada government agencies, and representatives from the petroleum industry in Alaska and Beaufort region, Washington, D.C., May 1986.

'Environment, morphology and sediments of the Beaufort Sea' to Department of Geology, Dalhousie University, Halifax, November 1986.

A core X-ray facility (Faxitron) was set-up in the Tunney's Pasture Laboratory. It has been examined by a National Health inspector and passed the inspection. No further safeguards are needed. Training will soon begin on this equipment.

Sedimentology Laboratory (Minerals)

601 Booth Street

	<u>No. of Samples</u>
Clay separations (for chemical analyses)	398
Heavy mineral separations	147
Seiving (for carbon & chemical analyses)	332
Carbonate/non-carbonate carbon	1604
Computer coding	11,000
Clay slides for XRD	287
Heavy mineral slides	100
Wet seiving	120

Laboratory Statistics

Paleoecology

1. Samples Processed

Diatoms	104
Palynological	300
Wood	103
Invertebrate fossils	12

2. Reports Completed

Fossil Arthropod	9
Plant Macrofossil	9
Palynological	11
Wood	79

Laboratories

Sedimentology Laboratory (Engineering)

Tunney's Pasture

Yearly Report

No. of Samples

Freeze drying	655
Complete grain size	199
Gravel-sand-silt-clay content	388
Hygroscopic moisture content	587
Seiving (sample preparation & grain size)	282
Calcite/dolomite ratio	122
Atterberg limits	69
Natural water content	235
Computer coding	1668
Special engineering analyses	132

TERRAIN DYNAMICS SUBDIVISION

J.A. Heginbottom (Chief)

The Terrain Dynamics Subdivision was formed in April 1986, as a result of the general reorganization of the Geological Survey of Canada. The Subdivision comprises three sections, drawn from different components of the Earth Sciences Sector, namely Geomorphic Processes and Engineering Geology, headed by D.G. Harry, which previously existed within this Division; Permafrost Research, headed by A.S. Judge, which came from the former Earth Physics Branch; and Terrain Geophysics, headed by J.A.M. Hunter, which came from the former Resource Geophysics and Geochemistry Division.

The responsibilities of the Subdivision are the provision of geoscientific information on: geomorphic processes active within Canada; geotechnical and engineering geologic properties of near-surface earth materials, particularly as they may affect human use of the terrain; geophysical properties of near-surface earth materials, particularly with regard to geotechnical and engineering concerns and the distribution of surficial geologic materials; geological hazards and constraints to development, both catastrophic and chronic, as they relate to surficial materials and geomorphic processes; and the development of geophysical and geotechnical equipment and techniques to assist in undertaking the foregoing tasks. A substantial proportion of the work of the Subdivision is undertaken in northern Canada, and particularly in areas underlain by permafrost. Work is also undertaken in offshore areas, again primarily in northern Canada.

The Subdivision receives substantial financial and staff resources from non-A-base sources within the Department and from Indian and Northern Affairs Canada. In 1986-87 support was received from the Panel on Energy Research and Development for research related to northern hydrocarbon transportation, particularly the problems of terrain stability and pipeline right-of-way performance in a permafrost environment, and the hazards to hydrocarbon exploration and production posed by natural gas hydrates. Support was also received from the Northern Oil and Gas Action Program (INAC), the Frontier Geoscience Program (EMR), and the Federal Nova Scotia Mineral Development Agreement. In addition, Indian and Northern Affairs Canada provided partial funding and field support for projects to examine terrain performance along the right-of-way of the Norman Wells-Zama oil pipeline.

Research facilities available within the Subdivision include a laboratory for precise determinations of the geotechnical properties of rocks and surficial materials, four cold rooms, general laboratories, workshops for the construction and maintenance of geophysical equipment, and a wide range of computer equipment for laboratory, field and office use. Specialized geophysical field instruments and laboratory equipment are available.

Highlights

Geomorphic Processes and Engineering Geology Section

Field study of periglacial processes in the vicinity of Cambridge Bay, Victoria Island, N.W.T.

was continued including installation of equipment to monitor piezometric head and water table elevation at selected sites. A study of tension cracks was initiated and data on thermokarst development were also collected. Cold room and field scale experiments to determine the effects of ice segregation on soil permeability were undertaken.

Study of the geological and geotechnical conditions of the Beaufort Sea coastline was continued with support from the Northern Oil and Gas Action Program. Trials of ground probing radar for investigation of the distribution of massive ground ice were undertaken at several sites in the Mackenzie Delta and Tuktoyaktuk Peninsula. These trials demonstrated that the radar system is capable of mapping massive ice bodies and subsurface geology to depths of 10 m and in many areas to depths of 30 m thereby enabling determination of the morphology of buried ice bodies and their origin.

Stratigraphic mapping and geotechnical investigations were carried out along the Yukon coast, Richards Island, and Tuktoyaktuk Peninsula as part of regional investigations of geological hazards and geotechnical conditions. Particular emphasis was placed on coastal retreat and the measurement of ground temperatures from instrumented boreholes.

A major study of the landslide hazard in the southern Canadian Cordillera included archival research to assemble a complete catalogue of destructive landslides in the southern Cordillera. Field work on landslides and slope deformation features in the Canadian Cordillera concentrated on (a) the north Nahanni rock avalanche triggered by the 1985 Nahanni earthquake; (b) Mount Cayley within the Garibaldi Volcanic Belt where mapping revealed the presence of a massive landslide that blocked the Squamish River in the past; (c) Mount Meager within the Garibaldi Volcanic Belt, where a large rock avalanche occurred in the spring of 1986 on the north face of Mount Meager; (d) other slope deformation sites in the Bridge River-Lillooet River area, where the massive toppling of the northeast ridge of Mount Currie, near Pemberton, was discovered and documented; (e) Muddy Lake, B.C., where detailed landslide investigations were carried out in co-operation with Chevron Canada and North American Metals Corporation. Unpublished data on a number of landslide investigations were provided to B.C. Hydro in response to their concern for the stability of slopes above several reservoirs and dams.

A final report entitled "The Parliament Hill Promontory, Ottawa: Geological conditions as they might affect and control the deep seated slope movements" was submitted to Terrain Sciences Division and transmitted to Public Works Canada in June.

Investigations of terrain conditions and terrain performance along the right-of-way of the Norman Wells to Zama pipeline were continued. While most of the pipeline right-of-way is stable, the amount of erosion on very shallow slopes was more extensive than had been originally anticipated. A final draft of an interim progress report for this project has been completed.

Studies of the growth of permafrost in drained lakes and of the growth of pingos continued in the Mackenzie Delta-Tuktoyaktuk Peninsula area including

studies of Kikoak drained lake, continued observations at Tuk 3-Pingo site, Eddie Pingo, Pingo 12, Horton River delta, Gary Island and Illisarvik.

Preparation of ground ice maps of various areas of northern Canada with several 1:250 000 scale maps were completed as a test and a satisfactory legend developed. Good progress was made on compiling a 1:1 000 000 scale map of permafrost and ground ice conditions in the northern Yukon and northwest Mackenzie District. All available source maps have been reinterpreted and reduced to final publication scale and final compilation is now in progress.

A contract with Queen's University for a study of the aggradation of permafrost in newly exposed shoreline areas was continued at Churchill, Manitoba and a new site was installed at Cambridge Bay, N.W.T. A contract has been arranged with Ecolé Polytechnique, Montreal to develop a research program for the investigation of the mechanical properties of permafrost soils, with particular emphasis on in situ testing.

Drilling, sampling and testing of frozen and unfrozen sediments in the area off northern Richards Island commenced in March 1986 and was successfully completed in April 1986. Samples were submitted to laboratories in Ottawa for testing. Additional geotechnical information and ground temperature measurements were obtained from the site during the summer. A similar program of geotechnical drilling and geophysical testing was undertaken in March 1987 in an adjacent area where the coastline has been undergoing rapid retreat for the last 45 years.

Terrain Geophysics Section

Seismic surveys of the Cumberland basin Springhill area, Cape Breton, Nova Scotia were continued as part of the Canada/Nova Scotia Mineral Development Agreement. Data collected in 1985 were interpreted and used to plan 1986 surveys. High resolution land seismic surveys covering 3.5 km were collected by GSC personnel and some 50 km of high resolution data were collected on contract.

Shallow reflection and refraction seismic surveys were undertaken at several sites in Canada in support of other Geological Survey projects. At St-George, Quebec, surveys were used to select drill sites for a Quaternary geology drilling program. At the Val Gagné test site, Ontario, 10 km of "optimum offset" shallow reflection profiles were undertaken and excellent data were obtained. A further 10 km "optimum offset" shallow reflection profiles were collected from the Fraser River Delta in August 1986. In New Brunswick a demonstration of the shallow seismic reflection technique was provided to the New Brunswick Geological Survey as part of the Canada/New Brunswick Mineral Development Agreement. Refraction and/or shallow surveys were carried out at 42 sites in New Brunswick to determine depth of bedrock in advance of a major drilling program.

A program of temperature, uphole seismic, and thermal conductivity measurements in boreholes drilled along the inshore portion of a pipeline landfall on the west coast of Richards Island, N.W.T. was completed.

Over 3000 seabottom seismic refraction records were obtained with a deep-towed eel aboard the CCGS MAHIDIK in the Beaufort Sea. These records covering approximately 200 line km with 67% seabottom coverage are used to map the presence of ice bonded permafrost within 20 m of the seafloor and to determine the velocity of the sediments at and immediately beneath the seafloor. Design of a new deep-towed eel has been completed.

Lack of movement of the Ice Island during the summer was disappointing. However, over 1000 seismic records were collected. Data processing research contracts have been arranged with universities of Western Ontario and Saskatchewan to solve problems related to the analysis of the seismic data, which is complex and difficult to analyze.

Permafrost Research Section

New digital ground-probing radar has been used in surveys both for basic science and for possible geotechnical application including performance of earth tailings dams on continuous permafrost, discrimination of frozen and unfrozen ground, detection of massive ground ice, probing the subsurface of an initiating pingo and mapping of stratigraphic horizons.

Completion and shutdown of experiments on frost heave at the Calgary Pipeline Test Facility were successfully carried out. In the final phase the existing frost-bulb was excavated, photographed and sampled on two of the sections and the others were monitored for natural summer thaw once the refrigeration was removed. All equipment was removed from the site and it was restored to the original condition prior to termination of the lease.

The deployment and monitoring of a temperature cable in an offshore well in the arctic islands are coming successfully to a conclusion. The cable was monitored using acoustic telemetry by a recording unit on the sea ice for 18 months, and several papers have been produced.

Several exchange visits have taken place on the topic of gas hydrates under the Canada:USSR Arctic Exchange Program. These led to workshops on the geology and geophysics of gas hydrates being held in Calgary, Tynmer and Leningrad and a number of visits to research laboratories.

During the year several new data files have been set up to collect existing information on the mean annual surface temperature, and the distribution and thickness of permafrost. The results have been analyzed in a preliminary fashion to look for relationships with climate, recent geological history and tectonic provinces. Although, for example, air and surface temperatures show a strong latitudinal relation, permafrost thickness does not.

The Norman Wells Pipeline Monitoring Project is now running in a successful manner with several unattended data loggers reading cables for 6-month periods without problems. An open file of temperature results has been published and extensive additional instrumentation installed to collect additional physical information on the state of the right-of-way, e.g., time domain reflectometry rods to collect unfrozen moisture content of the soils.

The cold room installed at Carleton University is now running after initial operating problems. A needle probe system for the measurement of thermal properties by the Permafrost Research Group has been used in the cold room on cores from the Norman Wells pipeline.

Personnel Notes

The Terrain Dynamics Subdivision consists of 8 Research Scientists, 7 Physical Scientists (3 terms), and 8 Technicians (1 term). The Subdivision also supported 3 EMR Research Agreements. Two Postdoctoral Fellows have worked with the Section. Wayne Pollard joined in August 1985 and remained until September 1986 when he moved to Memorial University as an assistant professor. During his tenure he continued research on ground ice and set up a shoreline experiment with DND to install a temperature cable in an angled drillhole across an arctic shoreline. Paul Laflèche joined the Section in October 1985 and is continuing for a second year. He has made a most significant contribution in the application of geophysics to permafrost mapping and has taken a lead in the radar profiling of earth dams on continuous permafrost detecting unfrozen zones and examining the integrity of the dams and underlying formations.

Attendance at Meetings, Conferences and Courses

D.S. Bromley

Presented a poster at the Nova Scotia Department of Mines and Energy Open House, November 1986.

M.M. Burgess

Presented a poster at the Geological Association of Canada Annual Meeting, Ottawa, May 1986.

S.G. Evans

Presented a paper at the American Society of Civil Engineers Convention, Seattle, April 1986.

Presented a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

R.M. Gagne

Presented a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

Presented a poster at the Prospectors and Developers Association of Canada Annual Meeting, Toronto, March 1987.

J.A.M. Hunter

Presented a paper at the Society of Exploration Geophysicists Annual Meeting, Houston, Texas, November 1986.

Presented a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

A.S. Judge

Presented a paper at the Canadian Institute of Mining and Metallurgy, Montreal, May 1986.

A.S. Judge (cont'd.)

Presented 2 papers and 1 poster at the Geological Association of Canada Annual Meeting, Ottawa, May 1986; Session Organizer.

Presented a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

Presented a paper at the Joint Canada-U.S. Conference on the Late Cenozoic Geology of Interior Alaska/Yukon, Anchorage, Alaska, February 1987.

Presented a paper at the Geology and Geophysics of Hydrates Workshop, Leningrad, U.S.S.R., March 1987.

Presented a paper at the 2nd International Conference on Cold Regions, Calgary, March 1987.

P. Laflèche

ACFAS Annual Meeting, Montreal, May 1986.

Presented a paper at the Canadian Institute of Mining and Metallurgy, Montreal, May 1986.

Presented a paper at the Geological Association of Canada Annual Meeting, Ottawa, May 1986.

Prospectors and Developers Annual Meeting, Toronto, March 1987.

Presented a paper at the 2nd International Conference on Cold Regions, Calgary, March 1987.

A. Overton

Presented a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

S.E. Pullan

Presented a paper at the Society of Exploration Geophysicists Annual Meeting, Houston, Texas, November 1986.

Presented a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

Membership on Committees

V.S. Allen

GSC Instrumentation Working Group; Member

P.A. Egginton

Committee on Climatic Change, Terrain Sciences Division; Member

D.G. Harry

Commission on the Significance of Periglacial Phenomena, International Geographical Union; Corresponding Member

Norman Wells Project Research and Monitoring Working Group, DOE; Member

D.G. Harry (cont'd.)

Canadian Section, Working Group on Ground Ice, International Commission on Snow and Ice; Member

Canadian National Review Committee, Fifth International Conference on Permafrost; Member

EMR Permafrost Committee; Member

J.A. Heginbottom

Canadian National Committee for International Permafrost Association; Secretary

Permafrost Subcommittee, NRC Associate Committee on Geotechnical Research; Member

Canadian Section, Working Group on Ground Ice, International Commission on Snow & Ice; Secretary

Commission on the Significance of Periglacial Phenomena, International Geographical Union; Corresponding Member

EMR Permafrost Committee; Chairman

XII INQUA Congress, Local Organizing Committee, Member; and Exhibits Subcommittee, Chairman

Terrain Sciences Division Display Committee; Chairman

Terrain Sciences Division Computer Committee; Chairman

Canadian National Review Committee, Fifth International Conference on Permafrost; Member

J.A.M. Hunter

U.S. Committee on Permafrost, Polar Research Board; Member

Engineering & Groundwater Committee, Society of Exploration Geophysicists; Member

Engineering Seismograph Digital Standards Subcommittee, Society of Exploration Geophysicists; Chairman

Geoexploration; Editor

A.S. Judge

Canadian National Committee on the Dynamics and Evolution of the Lithosphere; Member

Permafrost Subcommittee, NRC Associate Committee on Geotechnical Research; Member

Joint Industry/Government Committee on Northern Development Issues (Permafrost & Gas Hydrates); Co-Chairman

Geotechnical Advisory Board, Carleton University; Member

Energy R&D Permafrost and Gas Hydrates Committee; Member

A.S. Judge (cont'd.)

Energy R&D Offshore Geotechnics Committee; Member

Canada:USSR Arctic Exchange Programme, Theme 1 Geoscience and Arctic Petroleum; Delegate

Canadian National Review Committee, V International Conference on Permafrost; Member

P.J. Kurfurst

Subcommittee on Marine Geotechnical Engineering, NRC Associate Committee on Geotechnical Research; Member

Committee on Needed Research for Northern Pipelines; Member

Executive Committee, Engineering Geology Division, Canadian Geotechnical Society; Regional Representative for Northern Ontario

Committee on Offshore Geology, International Association of Engineering Geology; Canadian Representative

S.E. Pullan

Engineering and Groundwater Committee, Society of Exploration Geophysicists; Member

A.E. Taylor

Committee on Climatic Change, Terrain Sciences Division; Member

Seminar Committee, Geophysics Division; TSD Representative

Special Talks or Lectures

M.M. Burgess

'Norman Wells Pipeline permafrost and terrain research and monitoring' to Geotechnical Science students, Carleton University, Ottawa, April and November 1986; and to Norman Wells Pipeline Research & Monitoring Working Group Annual Meeting, Yellowknife, December 1986.

S.G. Evans

'The interpretation of mountain top cracks in the Canadian Cordillera' to Vancouver Island Geotechnical Society, Victoria, B.C., April 1986.

'Landslides in southwestern B.C.' to B.C. Hydro, Vancouver, B.C., April 1986.

'Landslides in the Cordillera' to Cordilleran Division, GSC, Vancouver, B.C., April 1986.

'The cost and extent of landslides in the Cordillera' to Canadian Geotechnical Group, Ottawa, August 1986.

'The north Nahanni rock avalanche' to Geophysics Division, GSC, Ottawa, November 1986.

'Evaluating ground failure hazards in the Canadian Cordillera' to Ottawa Geotechnical Group, Ottawa, January 1987.

J.A. Heginbottom

'Landslides in permafrost terrain' to Workshop on Extent and Economic Significance of Landslides in Canada, Ottawa, August 1986.

'Environmental assessment of the Norman Wells to Zama pipeline' to Norman Wells Pipeline Working Group, Yellowknife, November 1986.

'Ground ice and the landscape' to Ottawa Glaciology Group, Ottawa, February 1987.

J.A. Hunter

'Submarine permafrost', 'Deep-tow refraction technology', and 'Sub-bottom permafrost temperatures in the Beaufort Sea' to scientists at the Institute of Geology of World's Oceans, Leningrad, March 1987.

A.S. Judge

'Gas hydrates' to Chemistry Division, National Research Council, Ottawa, May 1986.

'Permafrost distribution' at Centre des Etudes Nordiques, Laval, January 1987.

'Performance monitoring arctic earth dams' at Echo Bay Mines, Edmonton, March 1987.

P. Laflèche

'Monitoring of frozen core containment dams with ground probing radar' to staff and graduate students, Ecole Polytechnique, Montreal, February 1987.

S.E. Pullan

'Shallow seismic reflection techniques' to Geology/Geophysics students, University of Ottawa, Ottawa, March 1987.

'Shallow seismic reflection mapping' to Geology/Geophysics students, Ecole Polytechnique, Montreal, March 1987.

W.W. Shilts (Head)

The Sedimentology Research Group (SRG), reporting to the Division Director, is responsible for maintaining (and developing) Divisional sedimentological expertise and advising on sedimentological research problems by (a) keeping abreast of latest developments in glacial sedimentology both inside and outside the Geological Survey, (b) carrying out innovative sedimentological and landform/sediment research in areas or on subjects for which the expertise and large logistical base of the unit and of the Geological Survey is uniquely suited, (c) developing new laboratory and field techniques for quantifying compositional properties of glacial sediments, (d) developing graphics and information processing formats appropriate for most effective presentation of quantitative sedimentological data, and (e) actively generating external funding to carry out these activities with minimal dislocation of the Divisional A-level budget.

These activities, in addition to providing useful techniques and research formats for Divisional personnel and non-Survey scientists, are particularly directed toward solution of practical problems in mineral exploration and environmental geochemistry. The function of the group is to serve as a resource unit, carrying on the non-routine part of the survey/research functions of the former Sedimentology and Mineral Tracing Section. The group generates and proves new ideas and techniques that can be adapted to routine Divisional mapping, geotechnical, and mineral exploration activities.

Highlights

In 1986-87 SRG carried out all or the bulk of Quaternary research in New Brunswick Mineral Development Agreement, Asbestos Initiatives Program, and Ontario Mineral Development Agreement. In addition, its personnel carried on research in SONAR study of lake basins and Quaternary stratigraphy of the St. Lawrence Lowlands.

A field program including drilling and regional sampling was carried out in the Eastern Townships-Beauce region of Quebec. Eighteen boreholes, comprising a total depth of 450 m, were concentrated in and around the Gilbert River placer gold property, as well as a few in the Mining Brook gold area southwest of Mount Mégantic. The aim of describing the stratigraphic setting of gold-bearing strata is to develop an interpretation of the origin of the placer gold. Preliminary shallow seismic work aided siting of the boreholes. The cores have been logged, sampled, and analyzed geochemically. At least one area, Noire River Valley, shows potential for further gold exploration activities.

Regional sampling was carried out to complement drift dispersal studies as well as the drilling. Significant study was made of several excellent sections on Plante River that are crucial to the correlation and interpretation of drill cores from Gilbert River.

Heavy mineral and clay mineral studies have confirmed that buried placers were located in stratigraphic units that predate glaciation. These units are sporadically preserved in preglacial valley bottoms that are oriented transversely to directions of movement of first glaciers to cross the region. In these valleys they were preserved from later erosion by thick covers of glacial sediments.

An area of gold-bearing till, near Coaticook, Quebec, was resampled in detail with negative results - no gold was found in any of the 150 (\pm) samples collected. This area, which is delineated on Quebec MNR economic potential maps, should probably be deleted.

Regional sampling has provided baseline geochemical data for evaluating the geological influence on patterns of maple dieback.

Sonar surveys were carried out in support of Neotectonic studies in the Charlevoix area, and in support of MDA mapping projects in eastern Ontario. Surveys of a possible slump feature in Ottawa River at Chalk River nuclear facility were also carried out.

The Quaternary geology and till geochemistry project in New Brunswick reached its peak in terms of field operations during the last fiscal year. More than 2500 samples were collected from road sides, trenches and drill cores. Although the geochemical analyses are still in progress, a series of new anomalous zones have been identified and are being investigated. Particular attention is being given to Au, W, Sn, As, U and Zn data. Two sub-till organic zones have been discovered over the Miramichi Highlands and their age suggests that some revision must be made in the glacial paleogeography. A multiple-till stratigraphic sequence has been documented during the drilling program that was completed in January of 1987, in the St. John Valley as well as in the Bathurst area.

Drilling conducted in the St. Lawrence Lowland confirmed the existence of two nonglacial breaks in the St. Lawrence Lowland Pleistocene stratigraphy. This work will be presented at the INQUA Congress and will be part of a field trip that will be conducted in southern Quebec.

Computing activities focused on the development of new data base systems and new mapping programs as well as the operation of existing data base and data display systems.

Personnel Notes

The Sedimentology Research Group consists of 3 Research Scientists (2 terms), 3 Physical Scientists (2 terms), and 1 Technician (term). Dr. Martin Rappol, a Postdoctoral Fellow within the Group, is using striation, till fabric, and stratigraphic data to work out the history and configuration of the Quebec-Maine-New Brunswick Ice Divide in support of mineral exploration research (New Brunswick M.D.A.).

Attendance at Meetings, Conferences and Courses

M. Lamothe

Presented 2 papers at the Geological Association of Canada Annual Meeting, Ottawa, May 1986.

Presented a paper at ACFAS, Montreal, May 1986.

Presented a poster at the New Brunswick Open House, Fredericton, November 1986.

Presented a paper at the 1987 Current Activities Forum, Ottawa, January 1987.

W.W. Shilts

Geological Association of Canada Annual Meeting, Ottawa, May 1986.

48th Annual Friends of the Pleistocene (Northeastern Section), Maine, May 1986.

Ontario Geological Survey Open House, Toronto, December 1986.

Presented a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

S. Smith

Ontario Geological Survey Open House, Toronto, December 1986.

Presented a poster at the 1987 Current Activities Forum, Ottawa, January 1987.

H. Thorleifson

Ontario Geological Survey Open House, Toronto, December 1986.

Membership on Committees

J.M. Aylsworth

Terrain Sciences Map Legend Committee; Member

R.K. Burns

Terrain Sciences Division Computer Committee; Member

INQUA Work Group 8 Committee; Standard of Computer Processible Files of Glacigenic Data; Member

M. Lamothe

Géographie physique et Quaternaire Award Committee; Member

L'Association québécoise pour l'étude du Quaternaire; membre

American Quaternary Association; Member

Geological Association of Canada; Member

W.W. Shilts

INQUA Commission on Genesis and Lithology of Quaternary Deposits; Corresponding Member

INQUA, Working Group 9, Glacigene Deposits as Indicators of Glacial Movements; Member

International Geological Correlation Program (Quaternary Glaciations in the Northern Hemisphere); Member

Research and Monitoring Co-ordinating Committee on Acid Rain; Member

Acid Rain Research, Geological Survey; Co-ordinator

Special Talks or Lectures

M. Lamothe

'Drift prospecting in New Brunswick' to faculty members, graduate and undergraduate students and people from industry at UQAM, Montreal and University of New Brunswick, Fredericton, March 1987.

W.W. Shilts

Short course on 'Mineral exploration in glaciated terrain', to Professionals and Explorationists, Simon Fraser University, April 1986.

'Geology of Laurentide ice sheet' to Professors and students, Syracuse University, May 1986.

'Geology of Laurentide ice sheet' to Professors, University of Laval and Lehigh University, October 1987.

'Glacial history of Eastern Townships' to Professors, University of Laval, October 1987.

'Field trip to Beauceville', Laval University students, Beauceville, October 1987.

'Gold exploration and drilling, Eastern Townships' to Professors, University of Windsor, February 1987.

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