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DEPARTMENT OF ENERGY,
MINES AND RESOURCES

GEOLOGICAL SURVEY OF CANADA

ANNUAL REPORT

APRIL 1, 1985 TO MARCH 31, 1986

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CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES

GEOLOGICAL SURVEY OF CANADA

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APRIL 1, 1985 TO MARCH 31, 1986

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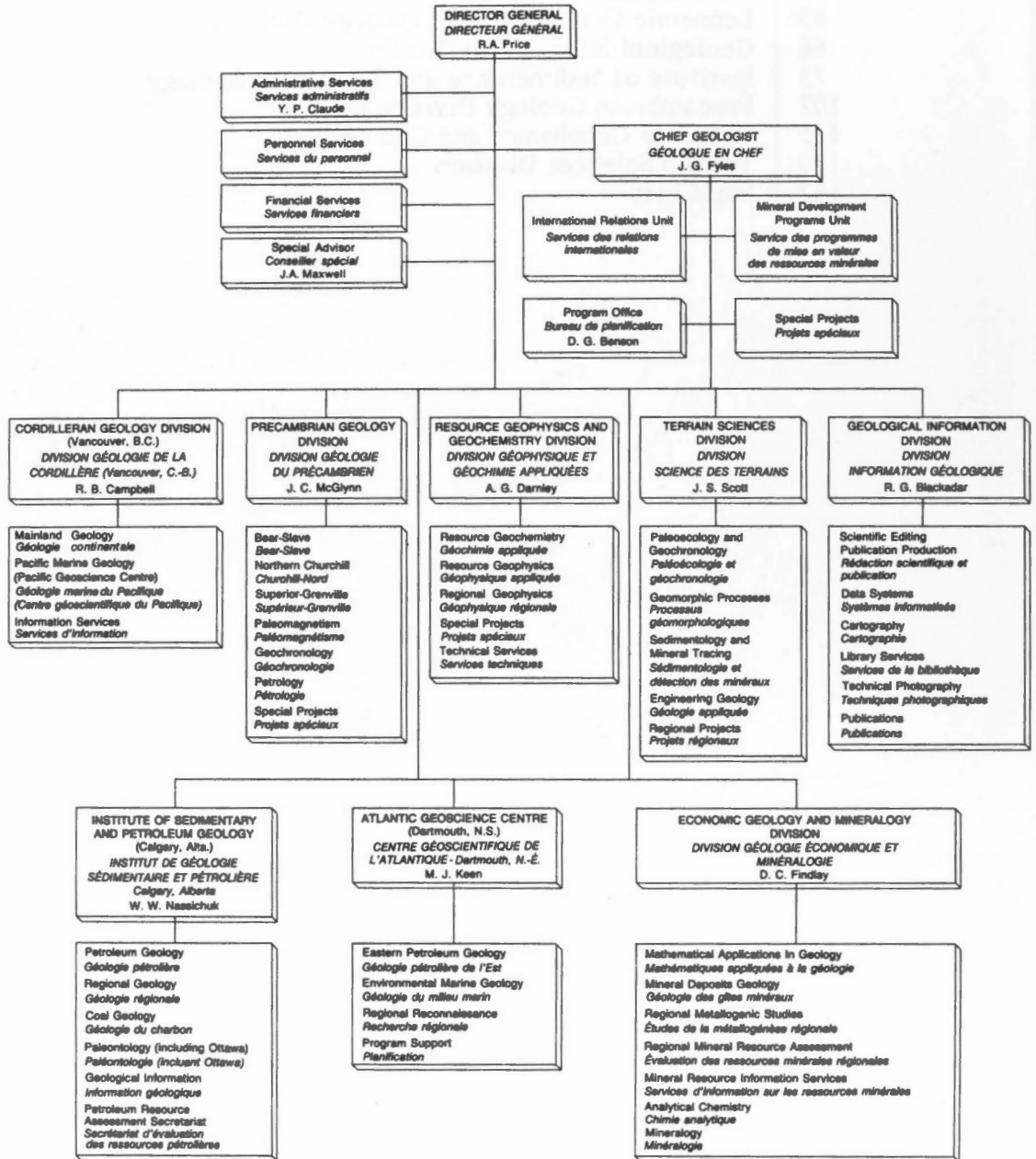
CHARLES

THE SECOND

By JOHN BURNET, BISHOP OF SALISBURY.

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Program Structures: 1985-86 Resources by sub-activity

	Salary	Operating	Capital	Total	PY
Activity Management	2 805	1 506	123	4 434	49
Atlantic Geoscience Centre	5 700	8 418	1 242	15 360	118
Cordilleran Geology	2 514	1 947	362	4 823	49
Economic Geology and Mineralogy	4 653	2 105	516	7 274	97
Geological Information	3 526	1 083	157	4 766	99
Inst. of Sed. and Petroleum Geology	7 310	6 103	1 499	14 912	157
Precambrian Geology	4 114	2 573	107	6 794	81
Resource Geophysics and Geochem.	5 221	11 062	606	16 889	107
Terrain Sciences	3 605	1 997	191	5 793	75
	\$ 39 448	36 794	4 803	81 045	832

The following items are included in the above

Energy Research and Development	3 538
Mineral Development Agreements	7 789
Frontier Geoscience Program	8 734
Northern Oil and Gas Action Program	584
Gaspé-Lower St. Lawrence Program	1 020
Asbestos Strategy	576
Bilateral Maritime Boundary Disputes	5 436
	<u>\$ 27 682</u>



Program Statement 1980-1981

Line Item	Activity	1980-81	1981-82	Total
1	Administrative	100	100	200
2	Academic	100	100	200
3	Library	100	100	200
4	Student Services	100	100	200
5	Faculty Services	100	100	200
6	Research	100	100	200
7	Publications	100	100	200
8	Travel	100	100	200
9	Equipment	100	100	200
10	Supplies	100	100	200
11	Postage	100	100	200
12	Telephone	100	100	200
13	Printing	100	100	200
14	Insurance	100	100	200
15	Utilities	100	100	200
16	Security	100	100	200
17	Legal	100	100	200
18	Medical	100	100	200
19	Other	100	100	200
20	Total	2000	2000	4000

The following items are included in the total:

- Faculty salaries and benefits
- Student salaries and benefits
- Travel expenses
- Equipment
- Supplies
- Postage
- Telephone
- Printing
- Insurance
- Utilities
- Security
- Legal
- Medical
- Other

OFFICE OF THE DIRECTOR GENERAL

R.A. Price

Attendance at Meetings, Conference and Courses

CIM Quebec City Section: Speaker - "La Commission géologique du Canada et l'exploration minérale", Quebec City, P.Q., April 1, 1985.

Département des Sciences de la Terre, Université de Québec à Montréal: Speaker - "La Commission géologique du Canada et l'exploration minérale", Montreal, P.Q., April 2, 1985.

DFO Ocean Sciences and Services Sector, Futures Conference, Institute of Ocean Sciences: Speaker (Session III) - "Sea Floor Mapping Requirements in Canadian Inshore and Offshore", Sidney, B.C., April 9-12, 1985.

Société Géologique de France, Symposium on Cordilleran Tectonics: Invited speaker - "Tectonics of the North American Cordillera as viewed from Canadian Rockies", Paris, France, April 22-23, 1985.

Institut Français du Pétrole, Paris, France, April 24-25, 1985.

Geological Survey of Israel, Jerusalem, Israel, April 25-26, 1985.

University of Tel Aviv (Gordon Centre for Energy Studies), International Workshop on Sedimentary Basins Along the Dead Sea Rift and Other Rift Zones: Speaker - "Eocene Transform Faulting, Crustal Stretching and Sedimentary Basin Formation in the Canadian Cordillera, April 27 - May 2, 1985.

Geological Society of America Cordilleran Section, 81st Annual Meeting: Co-leader with J.W.H. Monger, Field Excursion - "Cordilleran Cross-Section: Calgary to Vancouver", May 3-7, 1985; and attendance at Annual Meeting: Speaker - "Metamorphic Core Complexes of the First and Second Kind in the Cordillera of Southern Canada, and Northern USA", Vancouver, B.C., May 8-10, 1985.

National Geological Surveys Committee, Fredericton, N.B., May 14, 1985.

Geological Association of Canada Annual Meeting: Recipient - Logan Medal, Fredericton, N.B., May 15, 1985.

American Geophysical Union, Spring Meeting: Speaker - "Some Views on the Tectonic Evolution of Continental Crust and on Targets for Scientific Drilling", Baltimore, MD., May 26-31, 1985.

Meeting of Canadian Ad Hoc Committee on Scientific Continental Drilling, Dalhousie University; and visit to Atlantic Geoscience Centre, Halifax, N.S., July 17-18, 1985.

Arctic Field Trip with Minister Layton, Associate Deputy Minister Perron, and ADM Hutchison; and visit ISPG, Calgary, Alberta, July 23-29, 1985.

23rd General IASPEI General Assembly: Chairman - Annual Meetings of Inter-Union Commission on the Lithosphere, Tokyo, Japan, August 19-30, 1985.

Meetings with Ministry of Geology and Mineral Resources: Discussions and signing of Memorandum of Understanding on scientific cooperation, Beijing, China, August 30 - September 7, 1985.

Symposium on Deep Internal Processes and Continental Rifting: Speaker - "Lithosphere Stretching with Transform Faulting During Terrane Accretion in the Canadian Cordillera", Chengdu, China, September 8-19, 1986.

Canadian Geoscience Council Annual Meeting, Edmonton, Alberta, September 25-27, 1985.

Branch Management Committee Meeting, Ottawa, Ontario, October 1-2, 1985.

Second International Symposium on Observation of the Continental Crust through Drilling: Speaker - "Some Views on the Tectonic Evolution of Continental Crust and on Targets for Scientific Drilling", Seeheim, Federal Republic of Germany, October 4-6, 1985.

National Science Foundation meeting to review proposed Deep Observation and Sampling of the Earth's Continental Crust, Inc. (DOSECC) 1986 Program Plan, Washington, D.C., October 15, 1985.

Memorial University: Chairman - Meeting of Advisory Committee on Department of Earth Sciences, St. John's, Newfoundland, October 22-24, 1985.

Independent Industrial Advisory Committee on Earth Sciences meeting; and tour of Canadian-built research vessel JOIDES Resolution following Leg 105 of international Ocean Drilling Program, St. John's, Newfoundland, October 29, 1985.

Geological Association of Canada Council Meeting, Ottawa, Ontario, November 3, 1985.

NSERC/Lithoprobe Meeting, Toronto, Ontario, November 13-15, 1985.

Meeting at AGC to discuss Frontier Geoscience Program, Halifax, Nova Scotia, November 18, 1985

Earth Physics Branch Seminar: Speaker - "Transform Faulting, Evolution of the Foreland Basin and Thrust and Fold Belt, and Crustal Stretching in the Canadian Cordillera", Ottawa, Ontario, November 19, 1985.

Review of Dempster Transect Proposal to the Lithoprobe Steering Committee, University of Calgary; and visit to ISPG, Calgary, Alberta, November 23-26, 1985.

Canadian Geoscience Council-Canadian National Committee International Relations Meeting, Ottawa, November 29, 1985.

Canadian Geoscience Council Advisory Committee to Geological Survey of Canada meeting, Ottawa, Ontario, December 2-3, 1985.

Frontier Geoscience Program Technical Advisory Committee Meeting, Ottawa, Ontario, December 4, 1985.

Branch Management Committee meeting, Ottawa, Ontario, December 10-11, 1985.

Dahlem Workshop on Resources and World Development: Part A: Energy and Minerals: Invited participant, Berlin, Germany, January 12-17, 1986.

Current Activities Forum: Speaker - Welcome and Opening Remarks, Ottawa, Ontario, January 21-12, 1986.

Cordilleran Round-Up; and visit to Pacific Geoscience Centre with Dr. Perron, Vancouver, B.C., January 28-31, 1986.

Workshop on Continental Scientific Drilling in Canada: Speaker - Theme of the Workshop, Ottawa, February 3, 1986.

USGS McKelvey Forum: Luncheon Speaker - "Cordilleran Accretionary Tectonics, the Overthrust Belt and Energy Resources — a Canadian Perspective", Denver, CO., February 5-6, 1986.

Frontier Geoscience Program Technical Advisory Committee Meeting, Calgary, Alberta, February 10, 1986.

Forum on Oil and Gas Activities in Canada: Speaker - "Cordilleran Tectonic Evolution and Petroleum Geology of the Western Canada Sedimentary Basin", Calgary, Alberta, February 11-12, 1986.

IUGS 25th Anniversary Seminar: Speaker - "Issues and Objectives of the Working Group III on Global Change: Geological Processes - Past and Present"; and Chairman - International Council of Scientific Unions Committee on Global Change in the Geosphere and Biosphere, Working Group on Geological Processes, National Academy of Sciences, Washington, D.C., February 18-21, 1986.

Provincial Geologists Meeting, Toronto, Ontario, March 9, 1986.

Canadian Exploration Geophysics Society (KEGS): Speaker (Breakfast Address) - "The Future of the GSC and its Mineral Exploration Related Activities, Particularly Exploration Geophysics", Toronto, Ontario, March 11, 1986.

Prospectors and Developers Annual Meeting, Toronto, Ontario, March 9-12, 1986.

Canadian National Committee-International Geological Correlation Programme Annual Meeting, Toronto, Ontario, March 12, 1986.

Canadian Geoscience Council Annual Meeting, Toronto, Ontario, March 13, 1986.

Branch Management Committee Meeting, Ottawa, Ontario, March 18-19, 1986.

Management of Crises Course, Centre for Executive Development, Touraine, Quebec, March 25, 1986.

Membership on Committees

Member, Centennial Program Steering Committee, Geological Society of America, 1980-

Member, Canadian Geological Foundation, 1982 -

Co-Chairman, National Geological Surveys Committee, 1983 -

Member, Advisory Committee, Department of Geological and Geophysical Sciences, Princeton University, 1984 -

Member, Board of Electors, Chair in Geology, Cambridge University, Cambridge, U.K., 1983-85.

Chairman, Advisory Committee, Department of Earth Sciences, Memorial University of Newfoundland, 1985 -

North American Editor, Tectonics, American Geophysical Union, 1985 - 1988.

Member, Editorial Board, Journal of Structural Geology, 1985 -

Director, International Union of Geological Sciences Advisory Board on Research Development, 1985 -

Member, Logan Foundation Committee, Council of Geological Association of Canada 1985-86.

President, Inter-Union Commission on the Lithosphere (International Council of Scientific Unions) 1980-1985.

Member, Canadian Geoscience Council.

Member, Lithoprobe Steering Committee of Canadian Geoscience Council, 1985-

Chairman, Working Group on Geological Processes, International Council of Scientific Unions Ad Hoc Committee on an International Geosphere-Biosphere Program on Global Change, 1985-

CHIEF GEOLOGIST

J.G. Fyles

Attendance at Meetings, Conferences and Courses

National Geological Surveys Committee Meeting, Fredericton, N.B., May 14, 1985.

Canadian Geoscience Council Meeting, Fredericton, N.B., May 18, 1985.

OERD Meeting, Calgary, Alberta, June 12, 1985.

Program Review Meeting, AGC, Dartmouth, N.S., September 16, 1985.

GSC/USGS Workshop - Prospects for Mineral Resource Assessments in 1985, Washington, September 22-24, 1985.

Program Review Meeting, Cordilleran Division, Vancouver, B.C., October 10-11, 1985.

Program Review Meeting, AGC, Dartmouth, N.S., October 31, 1985.

Newfoundland Open House, St. John's, Nfld., November 6-7, 1985.

Yukon Economic Development Agreement meeting, Whitehorse, November 13, 1985.

Frontier Geoscience Program Meeting, AGC, Dartmouth, N.S., November 18, 1985.

Manitoba Mineral Development Agreement Management Committee Meeting, Winnipeg, Man., November 19, 1985.

Manitoba Open House, November 20, 1985.

Saskatchewan Open House, November 21, 1985.

Saskatchewan Mineral Development Agreement Management Committee Meeting, Regina, Sask., November 22, 1985.

Ontario Geological Survey Open House, Toronto, December 5, 1985.

OERD Meeting, Calgary, December 12, 1985.

Program Review Meeting, Pacific Geoscience Centre, Sidney, B.C., January 23, 1986.

Membership on Committees

Member, Management Committee, Canada/Manitoba Mineral Development Agreement 1984-89.

Member, Geoscience Subcommittee, Canada/Manitoba Mineral Development Agreement.

Member, Management Committee, Canada/Saskatchewan Mineral Development Agreement 1984-89.

Member, Geoscience Subcommittee, Canada/Saskatchewan Mineral Development Agreement.

Chairman, Energy Research Advisory Committee on Permafrost Research (Task 6.1.4).

Chairman, Energy Research Advisory Committee on Reservoir Characterization (Tasks 6.1.1 and 6.1.3).

Special Advisor

J.A. Maxwell

Attendance at Meetings, Conferences and Courses

As Canadian Geoscience Coordinator, Canada/Federal Republic of Germany Scientific and Technical

Cooperative Agreement, attended the Eighth Biennial Consultative Meeting in Bonn, April 14-18, 1985, followed by visits to laboratories in Norway, Sweden, Finland and the Federal Republic of Germany.

Special Assistant

G.W. Cameron

Attendance at Meetings, Conferences and Courses

OERD Meetings, Calgary, Alberta, June 12, 1985 and December 12, 1985; Ottawa, May 24, 1985 and February 7, 1986.

Membership on Committees

GSC Branch Management Committee.

Secretary, Energy Research Advisory Committee on Permafrost Research (Task 6.1.4).

Secretary, Energy Research Advisory Committee on Reservoir Characterization (Tasks 6.1.1 and 6.1.3).

GSC CARP Committee.

SPECIAL PROJECTS

T.E. Bolton

Attendance at Meetings, Conferences and Courses

Geological Association of Canada, Annual Meeting, Fredericton, N.B., May 1985.

Canadian Paleontology and Biostratigraphy Seminar, Quebec City, Quebec, September 1985.

Short Course 'Mollusks', Orlando, Florida, October 1985.

Northeastern Section, Paleontological Society, Annual Meeting, Kiamesha Lake, New York, March 1986.

Membership on Committees

Secretary, Earth Sciences Grants Committee, Natural Sciences and Engineering Research Council of Canada (to June 1985).

Chairman, Northeastern Section, Paleontological Society (Co-chairman Symposium).

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

Member, International Committee for the Study of Fossil Cnidaria, International Palaeontological Association.

Corresponding Member, IUGS Subcommission on Silurian Stratigraphy.

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

Convenor, Association of North American Paleontological Societies (ANAPS).

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 evaluated and implemented a micro-computer system for database management and computer-aided drafting. Under his direction, compilation of five

maps and correlation charts from the Precambrian Shield of Ontario and the N.W.T. west of Hudson Bay has been completed to editorial review stage. Six maps and charts from the Arctic Archipelago are at a similar stage of production. Fourteen other maps are under compilation, although progress on a few has been minimal in the past year primarily because of work of 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. About one quarter of the entire Atlas is under production. Despite delays (DNAG responsibilities with urgent deadlines), several maps should be submitted to cartography in 1986.

Atlas compilation of the Arctic Archipelago has permitted Okulitch 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 Inuitian 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 the associate editor (structure) for the Canadian Journal of Earth Sciences and assistant editor of a series of structure papers for Geoscience Canada.

Attendance at Meetings, Conferences and Courses

Geological Society of America, Cordilleran Section, Annual Meeting, Vancouver, B.C., May 1985.

Geological Association of Canada, Annual Meeting, Fredericton, N.B., May 1985.

Canadian Tectonics Group, Halifax, N.S., November 1985.

Geological Survey of Canada Current Activities Forum, Ottawa, January 1986.

ISPG Current Activities Forum, Calgary, February 1986.

Membership on Committees

Chairman, (resigned, May 1985) and Councillor, Structural Geology and Tectonics Division, Geological Association of Canada.

Associate 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

"Assessment of evidence for Paleogene crustal extension in the southern Shuswap Metamorphic Complex (SSMC), B.C." given at the Geological Society of America, Cordillera Section annual meeting, Vancouver, B.C., May 1985.

"Evolution of the Boothia Uplift, Arctic Canada" (with J.J. Packard and A.I. Zolnai) given at the Department of Geology, Erindale Campus, University of Toronto, January 1986.

INTERNATIONAL RELATIONS UNIT AND EPISODES SECRETARIAT

Inter-governmental Activities

Memoranda of Understanding were signed during the year between the GSC and the Ministry of Geology and Mineral Resources, China, and the Government of Indonesia.

Following a visit by a delegation from the Chinese Ministry, two scientific cooperative projects have been identified under the MOU. One, involving mineral deposits, with the Mineral Resources Division, Ottawa, and one involving sedimentary basin analysis with ISPG, Calgary.

Another delegation from the Chinese province of Xingjiang, interested in joint ventures with Canada, was hosted, with cooperation from the Department and Regional and Industrial Expansion, and the Mining Association of Canada.

Assistance provided to the Indonesian Directorate of Geology and Mineral Resources, (ADB Project Implementation Office), resulted in consulting contract offers to Paterson Grant & Watson and Data Plotting of Toronto.

Under the existing MOU with the British Geological Survey, a joint project to study elemental distribution in ultra basic rocks was approved, and has begun.

Inter-departmental Activities

1. In support of CIDA:

- a) Provision of inspection and monitoring services for the airborne geophysical surveys contract in Thailand by members of the Resource Geophysics and Geochemistry Division continued during the year. A full time representative for GSC was provided under contract to the CIDA Executing Agency, (SNC) for the radiometric surveys. Consulting services were also provided directly to CIDA and DMR. (Dr. A.G. Darnley).
- b) Contract inspection and consulting services for the geochemical survey in Jamaica, now being carried out by Bandan Clegg Co. were provided. (Dr. R.G. Garrett).
- c) Mr. G.G. Smith (ISPG) participated in a mission to the Republic of Niger and produced a report for a coal resource evaluation program.
- d) Mr. B.E. Manistre joined a mission to Ghana to evaluate the mining industry and related institutions, for potential Canadian aid.

2. Activities in support of the International Development Research Centre, IDRC.

Further to the demonstration of shallow seismic techniques in Malaysia and Thailand, reported last year, Drs. J.A.M. Hunter and S. Pullen participated in a training workshop and a reflection seismic program, funded by IDRC, in Bangkok. The program will continue under the auspices of the Asian Institute of Technology, using GSC developed software.

3. Activities in support of the United Nations.

GSC provided an advisor to the annual meeting of the Committee for Coordination of Joint Prospecting for Mineral resources in offshore areas (CCOP), (Dr. N. McMillan, ISPG).

Episodes Secretariat

The Episodes Secretariat, headed by Dr. A.R. Berger (Editor) continued publishing and distributing Episodes, the quarterly newsmagazine of the International Union of Geological Sciences (IUGS), and other IUGS publications, along with public relations and promotion work on behalf of the Union. During 1985-86 the Geological Survey of Canada continued to support approximately half the cost of operating the Secretariat, the other half being covered by the Union itself and the revenues generated by sales of Episodes.

Much effort was directed throughout the year to generating high quality contributions to Episodes and promoting sales and distribution. 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 advisers on publication policy provided useful assistance. A.R. Berger continued throughout the year in the part-time position of Executive Director with the Geological Association of Canada, based temporarily in St. John's, Nfld.

Attendance at Meetings, Conferences and Courses

A.R. Berger

- GAC-MAC Annual Meeting, Fredericton, May 1985.
- CSPG-CIM Conference, Edmonton, June 1985.
- SEPM Mid-year Meeting, Golden, Colorado, August 1985.
- ICSU Press Board Meeting, Stockholm, September 1985.
- GAC Executive Board Meeting, Edmonton, September 1985.
- GAC Committee Meeting, Ottawa, October 1985.
- GSA Annual Meeting, Orlando, November 1985.
- GAC Executive Meeting, Toronto, December 1985.
- GAC Council Meeting, Saskatoon, February 1986.
- IUGS Executive Meeting and Symposium, Washington, February 1986.
- ICSU Press Board Meeting, Paris, France, March 1986.

Membership on Committees

A.R. Berger

- Editor, Episodes.
- Member, IUGS Advisory Board for Publications.
- Member, Mineral Industries Panel of Intermediate Technology Development Group.
- Executive Director, Geological Association of Canada.
- Member, Board of ICSU Press.

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

Ten federal-provincial mineral development agreements (MDA) have been signed in recent years. Those with Newfoundland, Nova Scotia, New Brunswick, Manitoba and Saskatchewan were signed in 1984; those with Quebec, British Columbia, Ontario and Yukon in 1985; and that with Prince Edward Island in 1986.

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

Geoscience activities reached full level in 1985-86, the second year of the 5-year program, with 16 projects. Metallogenic studies were carried out in Labrador in the Central Mineral Belt and western part of Labrador, in the lead-zinc deposits of the carbonate terrane of western Newfoundland, in the base metal and gold deposits of some volcanic belts of central Newfoundland and in the chromite, platinum group elements and gold deposits in the ophiolite rocks of Newfoundland. Geological mapping continued in the crystalline rocks of southern and northern Long Range of Newfoundland. Lake sediment and water geochemical surveys continued in northern Labrador. GSC Skyvan conducted a gamma ray spectrometric and VLF survey in east-central Newfoundland and a contract was awarded for a gradiometer and VLF survey in west-central Newfoundland.

Reconnaissance surficial geology and till geochemistry survey continued in Labrador. Total allotment of O&M (\$1590K) and salary (7PY-\$189K) amounted to \$1779K. Anticipated expenditure (April 30/86) is 102%. Outputs comprise seven reports for Current Research and four open files. Posters were displayed at the Newfoundland annual review of activities and at the GSC Current Activities Forum.

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

The Geoscience Program of 23 projects was fully active in 1985-86, the second year of the 5-year program. A marine seismic survey was carried out to study the structure of the coal-bearing strata off Port Hood, and seismic test lines were run near Springhill in Cumberland Basin. The input of coal data to the National Coal Inventory continued. Metallogenic studies were well underway in Meguma gold and stratabound base metal deposits and in the Cape Breton Highlands. Study of the Yava sandstone Pb deposit and of the metal content of coal in the Sydney area continued. Studies of surficial geochemistry-catchment basin in the Cobequid Highlands continued while a data integration project in the Guysborough-Antigonish region was begun. Field work for geological studies was completed in the Lunenburg area and in the Antigonish Highlands. Granitic plutons were studied in eastern Meguma zone. Sedimentology and structure of the coal-bearing Stellarton graben continued. Field work for geological studies of the Port Mouton area and northern Cape Breton Highlands were begun. Provincial project leaders continued with surficial geology-till geochemistry in the Cobequid Highlands and with follow-up geochemistry studies. An aeromagnetic gradiometer and VLF survey was carried out in the Musquodoboit area, while a gamma ray spectrometric and VLF survey was flown over the Cobequid Highlands. Some gamma ray anomalies

were studied in the Musquodoboit Batholith. Total allotment of \$1938K O&M and of \$216K salary (6PY) amounted to \$2154K. Anticipated O&M expenditure (April 30/86) is 93%. Outputs comprise 13 reports for Current Research and five open files. Posters were displayed at the Nova Scotia annual review of activities and at the GSC Current Activities Forum.

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

After a rather slow beginning in 1984-85 when, with the exception of airborne geophysics, most projects were in the planning stage, the federal Geoscience Program in 1985-86 operated at full level. Anticipated O&M expenditure (April 30/86) is 86%.

Project	O&M		Subprojects	
	\$000	PY	No.	by contract
C1 Metallic Minerals	284	1	6	2
C2 Regional Geology	128	1	5	3
C3 Geochemistry	91	-	1	1
C4 Geophysics	740	2	4	2
C5 Surficial Geology	<u>137</u>	—	—	—
Total	1380	6	17	8

The northern half of the province received the greater part of the resources available. An aeromagnetic gradiometer-VLF survey was carried out in the western part. Detailed structural studies were started in the Bathurst camp. Metallogenic investigations by contract and by term staff were started in the Miramichi and Chaleur Bay belts. Regional geochemical stream sediments were sampled by a contractor of a 3900km² area south of the western part of Chaleur Bay. Granites in the northern and western part of the province was a subject of research by term staff. A surficial geology and till geochemistry study in the northern part of the province was undertaken by term staff and a Visiting Scientist.

In the southern half of the province the western part was covered by an airborne gamma ray spectrometric-VLF survey. Three subprojects on regional geology were carried out under contract on the Welsford granite-volcanic complex, on structure and diagenesis of the Albert oil shale formation and on a pluton in the eastern Caledonian Zone. A study of Cu, Ni and PGE deposits near St. Stephen was undertaken by a Visiting Scientist. A contract was let for the compilation and evaluation of uranium resources of the province.

Three reports were published in GSC Current Research and one open file was released. Posters were displayed at the New Brunswick annual review of activities and at the GSC Current Activities Forum.

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

Eighteen projects were carried out during 1985-86, the second year of a 5-year program. Alteration and metamorphic studies were carried out in the Snow Lake and Lynn Lake regions while U/Pb geochronology sampling continued in the Flin Flon-Snow Lake and Kisseynew terranes. Gold

metallogeology studies continued in the Bissett and Snow Lake areas. Studies of mafic and ultramafic intrusions were carried out on the Fox River, Bird River and Falcon Lake intrusions, as well as on intrusions between Flin Flon and Lynn Lake. An aeromagnetic gradiometer survey was flown within map areas 63K and 63N and samples for a geochemical lake sediment and water survey were collected within map areas 63L, 63N and 63O. Quaternary deposit mapping and till geochemical sampling took place within map areas 64B, 64C, 64F and 64G, south and east of the Lynn Lake region. Total allotment of \$1154K O&M and \$334K salaries (8.5PY) amounted to \$1488K. Anticipated O&M expenditure (April 30/86) is 96%. Outputs comprise two reports in Current Research and 7 open files. Posters were displayed at the Manitoba annual Meeting with Industry and at the GSC Current Activities Forum.

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

Six projects were carried out during 1985-86, the second of the 5-year program. Six projects were active. A lithostratigraphic study in the Kiseynew terrane was initiated and gold metallogeny studies were continued in the LaRonge and Creighton regions. Aeromagnetic gradiometer surveys were flown within map areas 63K, 63L and 63N along the boundary with Manitoba. Sampling for a geochemical lake sediment and water survey was completed in east-central Saskatchewan. Total allotment of \$683K O&M and \$63K salary (2PY) amounted to \$746K. Anticipated O&M expenditure (April 30/86) is 84%. One report was published in GSC Current Research and two open files were released. Posters were displayed at the Saskatchewan annual review of activities.

Other mineral development agreements - W.H. Poole, Co-ordinator

Four mineral development agreements were signed in 1985 and one in 1986.

GSC will not implement projects in the Quebec and Prince Edward Island programs, and will have only one project to implement in each of the Yukon (geochemistry) and British Columbia (aeromagnetic) programs. GSC will implement a major program in the Ontario program. During 1985-86 GSC conducted a geochemical project by contracts in the Yukon program (\$550K). Projects in the British Columbia and Ontario programs will begin in 1986-87.

FEDERAL PROGRAMS, QUEBEC

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

A total of \$610K O&M was available for 1985-86: this was made up of \$476K (the discounted allotment of \$500K) and \$134K in funds reprofiled from 1984-85. Eight of the nine projects started in 1984-85 were carried over into 1985-86, and one new project was added. A major continuing project consisted of a study of the origin and the distribution of placer gold in the Chaudière-Eaton river watersheds. In another major project, heavy mineral concentrates were collected systematically by a portable dredge throughout several map areas. Mineral deposit studies continued at the St. Roberts Metal deposit and in the West Sutton Mountains.

Five reports were published in GSC Current Research and two open files were released. Four posters were presented at the Quebec annual review of activities, and two posters were displayed at the GSC Current Activities Forum.

Plan de Développement Economique, Canada/Gaspésie et Bas St-Laurent, Volet Mines - Y.T.Maurice, Co-ordinateur

La somme de \$974,000 a été répartie sur quatorze projets au cours de l'exercice financier 1985-86. Les travaux ont été effectués surtout à contrat par des firmes spécialisées (84% du montant global).

Les études métallogéniques se sont poursuivies à la mine Gaspé, au gisement Candego, à la mine Madeleine et sur plusieurs petits gisements de plomb-zinc-barytine dans le secteur septentrionale de la Gaspésie. L'étude pétrochimique des Monts McGerrigle a montré des faits intéressants sur l'origine des gisements de cuivre le long de la périphérie du massif granitique tels que la mine Madeleine et le gisement Sullipek. On croit que la formation des phases hybrides des roches intrusives aurait pu entraîner un système hydrothermal minéralisateur et donner lieu aux concentrations métallifères. Une carte au 1:25000 montrant la géologie des roches intrusives du complexe est en préparation. L'étude des roches métamorphiques autour des massifs ultrabasiques du centre-nord de la Gaspésie s'est terminée cette année. Une des principales conclusions de ce travail est que ces roches ont été mise en place à température élevée.

	Date of Signing	Total Duration years	Federal Program Funding \$ M	Provincial Funding Share \$ M	Funding Share \$ M	Geoscience Activities		
						Implementation		
						Total \$ M	GSC \$ M	Provinces \$ M
1985								
Yukon	May 10	4	2.89	3.501	0.389	3.29	2.19	1.10
Qué.	July 5	5	100	50	50		nil	
Ont.	July 17	5	30	15	15	18.35	6.55	11.80
B.C.	July 20	5	10	5	5	7.95	0.625	7.325
1986								
P.E.I.	Jan 2	3	0.300	0.240	0.060	0.291	nil	0.291

L'étude sédimentologique des roches siluriennes du Témiscouata s'est penchée sur l'identification des sources de détritiques sédimentaire.

Dans le domaine de la géochimie et de la géologie des dépôts meubles, l'étude des dispersions d'or dans la région de Matapédia a soulevé de nouvelles hypothèses sur l'origine de l'or alluvionnaire dans ce secteur. Le projet de lithogéochimie régionale s'est poursuivi en 1985. On a maintenant complété l'échantillonnage d'environ 80% de la péninsule. Les études de dispersions glaciaires dans le secteur central de la Gaspésie et dans la région de Mont Joli se sont poursuivies comme prévu de même que la cartographie quaternaire des régions de Mont Alexandre et Cloridorme.

En géophysique, deux levés aéromagnétiques (gradient vertical et VLF) ont été effectués par la firme Sanders Geophysics de Kanata sur les terrains situés au nord et à l'ouest de ceux couverts en 1984.

Un total de 15 rapports ont été soumis en 1985-86 sur les divers projets du Plan et 9 d'entre eux ont été publiés par la Commission géologique.

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. Carried over into 1985-1986 was \$65K for publication of reports and maps. \$21K was spent on contracts and purchases, leaving a lapse of \$44K. About \$41K of publication costs for maps on the Nova Scotia side were cancelled as a result of the discretionary freeze. No new projects were implemented. Outputs during 1985-86, plus those expected early in 1986-87, comprise three GSC Papers, one short report in GSC Current Research, one A-series map, two open file maps, two open file reports and maps of projects continued in the mineral development agreement, one open file of aeromagnetic gradiometer maps and 45 open files of geochemical maps (stream and lake sediments and waters). 1985-86 is the final year for publication under the Program.

Newfoundland The Federal Mineral Program in Newfoundland (Canada-Newfoundland co-operative mineral program 1982-1984) ended March 31, 1984. Carried over into 1985-86 was \$85K for publication of reports and maps. \$6K was spent on contracts and purchases, leaving a lapse of \$79K. No new projects were implemented. Outputs during 1985-86, plus those expected early in 1986-87, comprise two GSC Papers and three open file maps of aeromagnetic gradiometer-VLF and gamma ray spectrometry-VLF. 1985-86 is the final year for publication under the Program.

OTHER PROJECTS

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

The VIBROSEIS seismic survey across the Appalachian orogen from southern Quebec to coastal Maine is a cooperative project of USGS, GSC, Earth Physics Branch, Maine Geological Survey and several universities in Canada and United States.

Dr. D.B. Stewart of USGS is project leader. Field data was acquired by a contractor in 1983 and 1984 from Lac Mégantic, Quebec to coastal Maine, a total of about 196 miles. To assist in interpretation of the reflection data, several types of data were compiled and other studies were conducted. Geology and aeromagnetic data was compiled. Gravity data were collected and surficial geology mapped along the reflection lines. Field data from the overlapping southeast end of the earlier MERQ reflection seismic line in Quebec was reprocessed. Seismic refraction studies were conducted from the St. Lawrence River to coastal Maine and along several lines at right angles to the main line. USGS contracted a marine seismic line from coastal Maine to connect with existing seismic data on Georges Bank. A workshop was held at USGS, Reston, Virginia to review the data and spur development of interpretation. Two papers have been published and several talks presented. Plans are in hand for USGS to publish the final tacks of the VIBROSEIS data.

Personnel Notes

Alan G. Galley assumed responsibility on May 8, 1985 for co-ordinator of the GSC programs in the Manitoba and Saskatchewan mineral development agreements.

At year-end, the Office consisted of three full time co-ordinators (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 Economique, Canada/Gaspésie et Bas-St-Laurent, Volet Mines; A.G. Galley for the Manitoba and Saskatchewan mineral development agreements), (F.D. Anderson) responsible for the Asbestos Initiatives geoscience program and for the New Brunswick mineral development agreement, a part-time Administrative Officer (J.G. Arnold) and a full time clerk (S.J. Gallant). Dr. Maurice and Mr. Galley also carry out scientific studies.

Attendance at Meetings, Conferences and Courses

F.D. Anderson

Management Committee meeting, Canada-New Brunswick Mineral Development Agreement, Fredericton, November 25, 1985.

New Brunswick annual review of activities, Fredericton November 25, 26, 1985.

Séminaire d'information sur les activités du Ministère de L'Energie et des Ressources, Québec, Québec, 27, 28 novembre, 1985.

GSC Current Activities Forum, Ottawa, January 21-23, 1986.

Industry Review Committee, Canada-New Brunswick Mineral Development Agreement, Fredericton, April 2 and November 25, 1985.

A.G. Galley

Management Committee meetings, Canada-Manitoba Mineral Development Agreement, Winnipeg, November 19, 1985; Ottawa, February 27, 1986.

Management Committee meetings, Canada-Saskatchewan Mineral Development Agreement, Regina, November 21, 1985; Ottawa, March 13, 1986.

Manitoba meeting with Industry, Winnipeg, November 19, 20, 1985.

Saskatchewan annual review of activities, Regina, November 21, 1985.

Manitoba Mineral Liason Committee meeting, Winnipeg, November 20, 1985.

GSC Current Activities Forum, Ottawa, January 22, 23, 1986.

Y.T. Maurice

Réunion du Comité exécutif du Plan de Développement Economique Canada/Gaspésie et Bas St-Laurent, Percé, Québec, 7-8 juillet 1985.

Annual Meeting of Members of the Mineral Exploration Research Institute, Montreal, Quebec, September 17, 1985.

Meeting of the Board of Directors of the Mineral Exploration Research Institute, Montreal, Quebec, September 17, 1985.

Séminaire d'information sur les activités du Ministère de l'Energie et des Ressources, Québec, Québec, 27, 28 novembre, 1985.

GSC Current Activities Forum, Ottawa, January 21-23, 1986.

W.H. Poole

Management Committee meetings, Canada-Newfoundland Mineral Development Agreement, St. John's, November 6, 1985; Ottawa, March 7, 1986.

Management Committee meetings, Canada-New Brunswick Mineral Development Agreement, Fredericton, November 25, 1985; Ottawa, March 6, 1986.

Management Committee meetings, Canada-Nova Scotia Mineral Development Agreement, Halifax, November 29, 1985; Ottawa, February 21, 1986.

Management Committee meeting, Canada-Manitoba Mineral Development Agreement, Ottawa, February 27, 1986.

Management Committee meeting, Canada-British Columbia Mineral Development Agreement, Ottawa, March 7, 1986.

Annual review of activities, Newfoundland, St. John's, November 7, 1985; New Brunswick, Fredericton, November 26, 1985; and Nova Scotia, Halifax, November 27, 28, 1985.

Meeting of Technical Liason Committee of Newfoundland and Labrador Explorationists, St. John's, November 6, 1985.

Meetings of Advisory Committee of New Brunswick Prospectors and Developers Association, Fredericton, April 2 and November 25, 1985.

Meetings of Advisory Committee of Nova Scotia Chamber of Mineral Resources, Halifax, May 31 and November 27, 1985.

Workshop on Prospects for Mineral Resource Assessment in 1985, Leesburg, Virginia, September 23-27, 1985.

GSC Current Activities Forum, Ottawa, January 21-23, 1986.

Workshop on Quebec-Maine-Gulf of Maine deep crustal profile, Reston, Virginia, January 28, 29, 1986.

Special Talks or Lectures

F.D. Anderson

"Federal Geoscience Program, project activities 1985-86". Presented at New Brunswick annual review of activities, Fredericton, November 25, 1985.

A.G. Galley

"Activities of the Geological Survey of Canada in Manitoba during the 1985 field season". Presented at Manitoba "Meeting with Industry", Winnipeg, November 19, 1985.

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

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.

PROGRAM OFFICE

Program Office evaluates the work of the Branch from the viewpoint of its effectiveness and efficiency in meeting Branch objectives, the Program Office Head being a senior staff adviser to Branch Management.

The Project Management System is carefully monitored and reviewed on behalf of the Chief Geologist. A complete catalogue of scientific and technical projects is prepared and published each year, as well as lists of proposed field work in the Provinces and Canada Lands. Annual reports are prepared for the EMR Annual Report, the publication on Government Activities in the North, and on statistical data for MOSST and STATSCAN. The status of mapping by the GSC is presented on a map sheet, published biennially, that shows the status of bedrock, surficial, airborne gamma-ray spectrometry, regional geochemical, aeromagnetic and shipborne magnetometer coverage.

Branch participation in the evaluation of Unsolicited Proposals for Scientific Research is co-ordinated by Program Office.

The Branch Program, the preliminary and revised estimates, and the strategic objectives and long term plans are reviewed on a division by division basis with the Chief Geologist and the individual divisions. This information and the divisional performance plans and reports are used to prepare the Branch submissions to the ADM, Earth Sciences Sector.

D.G. Benson

Attendance at Meetings, Conferences and Courses

AGC Program Review, Dartmouth, September 16-17, 1985.

CGD Program Review, Vancouver, October 10-11, 1985.

Careers 2001, Toronto, November 11, 1985.

Ministère de Québec Information Seminar, Quebec City, November 27-28, 1985.

Ontario Geological Survey Open House, Toronto, December 4-5, 1985.

ISPG Program Review, Calgary, December 12-13, 1985.

GSC Current Activities Forum, Ottawa, January 21-23, 1986.

ISPG Current Activities Forum, Calgary, February 11-12, 1986.

IGCP-CNC Eleventh Annual Meeting, Toronto, March 12, 1986.

M.A. Petre

GSC Current Activities Forum, Ottawa, January 21-23, 1986.

ISPG Current Activities Forum, Calgary, February 11-12, 1986.

Membership on Committees

D.G. Benson

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

Secretary-Treasurer, Canadian National Committee, IGCP.

ADMINISTRATIVE SERVICES

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

Departmental Administrative Forum Committee
Departmental Safety Committee
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
Capital Acquisition and Replacement Plan Committee
Contract Review Board

This year's highlights includes the implementation of the New Computerized Inventory System for the whole of GSC; a conversion of all GSC records holdings adopting a new common Classification System, indexing all holdings and centralizing all records.

BRANCH FINANCIAL SERVICES

The Branch Financial Services in the Geological Survey consists of Budgeting and Planning and Accounting Operations, both of which are the responsibility of the Comptroller.

Budgeting and Planning's main responsibilities are:

- i) The coordination of the annual Multi Year Operational Plan and Main Estimates.
- ii) The coordination and control of the Divisions' monthly expenditure forecasts and variance analysis.
- iii) Implementation of Treasury Board guidelines and departmental procedures relating to financial planning.
- iv) Providing advice to divisional administration officers on matters pertaining to finance.

Accounting Operations main responsibilities are:

- i) Processing and auditing of all supplier accounts, field accounts, travel and removal claims and other miscellaneous accounts, for all divisions of the GSC.
- ii) Payment and processing of all invoices for the Director General's office and Branch Administration.
- iii) Payment of centralized billings such as freight, Central Travel Service, telephone and taxis.
- iv) Implementation and regulation of all Treasury Board guidelines relating to accounting operation.
- v) Provide advice to divisions on accounting systems and procedures.

The following staff changes took place in Financial Services during the 1985-86 year:

Eastham, Angela:

Seconded to Financial Analysis and Planning, Financial Management Branch, 580 Booth until August, 1986.

Hall, Diane:

Joined Accounting Operations on a permanent basis September 3, 1985. Diane last worked in the accounts office of PMRL, CANMET.

Spano, Richard:

Joined Accounting Operations on a term basis October 21, 1985.

PERSONNEL UNIT

The Earth Sciences Sector Personnel Unit is responsible for the following services to the Branch: the implementation of organizational change and the classification of positions; the recruitment, selection and appointment of staff; the coordination of the Official Languages Plan and its related services; the interpretation of collective agreements and the provision of advice on conditions of work, discipline and grievances; Human Resources Planning and analysis, and the coordination of employee performance appraisals; and the provision of a complete Compensation and Benefits service.

In April 1985 the Compensation and Benefits section of the unit experienced a major technological advance with the initiation of the "ON-LINE PAY SYSTEM" joining the growing trend in this area in the Federal Public Service. This new computerized system has and will continue to enable entitlement and deduction transactions on salary accounts to be processed in a more timely fashion.

Following is a breakdown of actions completed during 1985-86.

Staffing

Appointments from outside the Public Service

Scientific and Professional	62
Administrative and Foreign Service	1
Technical	13
Administrative Support	13
Operational	8
Total	97

Appointments from within the Public Service

Scientific and Professional	79
Administrative and Foreign Service	4
Technical	38
Administrative Support	40
Operational	5
Total	166

Staffing - Student

COSEP	153
Challenge '85 Funded	98
CO-OP	58
Total	309

Classification

Term	304
Indeterminate	144
Dry-Runs	7
Total	455

REPORT ON THE 1986 CURRENT ACTIVITIES FORUM January 21-23, 1986

Chairman - J.C. McGlynn
General Coordinator - S.B. Green
Poster Sessions Co-ordinator - P. Hunt
Publicity and Publications - P.J. Griffin

The Forum was held in the Ottawa Congress Centre and was opened by Minister of State for Mines, Hon. R.E.J. Layton. Seventeen technical talks were given and 41 poster sessions were on display from the morning of 21 January, until 1300h on 23 January. The poster sessions proved to be the most popular part of the forum; the social hour (1630 to 2000h on 22 January) also proved to be successful and resulted in many useful discussions and exchanges.

Rather than distribute separates of "Current Research" articles a collected volume of all abstracts appearing in "Current Research" Part A was distributed without charge. This reduced costs considerably and was well received.

An audience of about 500 members of the public attended a well-received talk by Dr. D.J. McLaren "Meteorites, Comets and Dinosaurs".

Attendance	1986	1985	1984
GSC staff	280	216	189
Industry	137	146	90
Other governments	58	98	34
University	110	107	132
Other	30	22	22
Total	615	589	511

Costs

Space rental	\$4,100.00
Gratuities	179.07
Labour	180.00
Hospitality	926.00
Audio visuals	1,807.50
Moving	472.50
Display equipment	375.00
Total	\$8,040.07

An additional cost of \$630.00 was incurred by several divisions for specific video costs.

Publicity

Publicity for the Forum started in October with a notice in the Monthly Information Circular and this was updated until January. The Technical Program was sent to about 3,500 addresses (all Canada and New York states). This package included registration card, flyer announcing the public lecture and a notice for posting. Advertisements were placed in the Northern Miner on 11 November, 2 December and 6 January. The latter included a post in of the printed program.

The popular lecture was advertised in the Ottawa Citizen and Le Droit on 18 January and radio and T.V. stations were also advised of this event.

GSC Participation at the Prospectors and Developers Annual Convention, Toronto; 8-12 March 1986

Following the success of our participation in the 1985 meeting GSC was again offered space. Due to a freeze on discretionary spending few GSC staff could attend and most posters had to be self-explanatory. Only about 100 people visited the GSC display whereas the nearby manned provincial displays were well attended. Delegates, it would appear wish to talk about what is being presented. It was also apparent that visitors want "hands-on" displays - specimens, core samples, handouts.

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, 41 Scientific and Technical Support staff, 13 Administrative, Secretarial and Clerical staff.

ADMINISTRATION SUBDIVISION

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, two Financial Clerks, a Personnel Clerk and a Secretary. Dr. M.J. Keen, Director, was a member of the Nielsen Task Force on Resources during the year (May to July 1985). He was based in Ottawa during this period. Dr. Keen left Ottawa to go directly to the Pacific Geoscience Centre in Pat Bay for the period July 1985 to July 1986 where his primary objective was to edit DNAG. Meanwhile, back at AGC, Dr. David Ross, Assistant Director since July 1984, became Acting Director and Dr. Dirk Tempelman-Kluit from the GSC Office in Vancouver (Cordilleran Division), agreed to spend a year as Acting Assistant Director at AGC.

Attendance at Meetings, Conferences and Courses

M. J. Keen

Workshop on Offshore Surveys, Ottawa, April 24, 1985

Ocean Drilling Program Executive Committee meeting, Ottawa, April 24, 1985

Nielsen Task Force on Resources, Ottawa, May 13 to July 1, 1985

D. I. Ross

Seabed II meeting, Ottawa, April 11, 1985

CSS HUDSON cruise to Grand Banks of Newfoundland, April 17 to April 25, 1985

CSEG-CGU Annual meeting, Calgary, May 6-9, 1985

AGU Annual Meeting, Baltimore, MD, May 27-30, 1985

Marine Technical Society Conference, Halifax, June 4, 1985

DFO/EMR Guiding Committee on Offshore Surveys, Ottawa, June 5, 1985

OERD Meeting, Calgary, June 12-13, 1985

Meeting with University of Quebec Staff, Quebec City, August 9, 1985

Ocean Drilling Program Executive Committee meeting, Ottawa, September 11, 1985

GSC Branch Management Committee meeting, Ottawa, October 1-2, 1985

Boundary Dispute Program meeting, PGC, Pat Bay, October 8-10, 1985

OERD Meeting, PGC, Pat Bay, October 11, 1985

OSS/DFO Ship Requirements meeting, Ottawa, November 15, 1985

Canadian Geoscience Council meeting, Ottawa, December 3, 1985

DFO/EMR Guiding Committee on Offshore Surveys meeting, Ottawa, December 4, 1985

GSC Branch Management Committee meeting, Ottawa, December 10-11, 1985

GSC Current Activities Forum, Calgary, February 11-12, 1986

GSC Branch Management Committee meeting, Ottawa, March 18-19, 1986

M. J. Keen

DFO/EMR Guiding Committee on Offshore Surveys
BIO Directors' Committee
Dalhousie University, Adjunct Professor
Atlantic Regional Interdepartmental Committee on Environmental Issues
OSS (Atlantic) Management Committee (observer)
Canadian Geoscience Council: Chairman, Marine Geosciences Committee
Canadian Executive Committee for Ocean Drilling Program (Secretary)
Alternate Canadian Member, International Executive Committee, Ocean Drilling Program
EMR Coordinating Committee on Marine Geoscience Research (Secretary)
Advisory Board, Newfoundland Institute of Cold Ocean Sciences (NICOS)
Physics Committee, Atlantic Provinces Inter-University Council on the Sciences

D. I. Ross

Marine Technical Society, Canadian Maritime Section
Ocean Drilling Program Canadian Executive Committee
CSA Task Force on Foundations
CGC Marine Geosciences Committee
AGU Committee on International Participation

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 contact and collaboration with other federal government agencies, universities, industry, and foreign institutions.

The subdivision presently comprises 12 geophysicists, 5 technicians, one post-doctoral fellow, and one secretary. In 1984, the Frontier Geoscience Project enabled enhancement of our program. Accordingly, three new Research Scientists were hired this year. One additional NSERC fellow, and one geophysicist will soon increase that complement. 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.

SEISMIC REFRACTION AND REFLECTION SURVEYS

Our in-house system for processing and analysis of seismic refraction and single channel seismic reflection data is now complete after much effort this year. The system is proving its worth in terms of dealing with the backlog of data which had accumulated. Dramatic improvement in data quality, both refraction and reflection, is obtained by applying digital processing techniques.

This year also saw a major effort in the construction of 20 new Ocean Bottom Seismometers (OBS) for refraction studies which will complement offshore LITHOPROBE reflection lines. We also began to develop a large air gun array, for use in both refraction and single channel reflection experiments. Use of such an array is a "first" at AGC. There follows a brief description of activities.

A. Seismic Refraction Along the Polar Margin (Ice Island). The 1985 field season was successfully completed. Five reversed refraction lines were run northwest of Ellesmere and Axel Heiberg Islands. A sedimentary basin with 10km of unconsolidated and consolidated sedimentary strata overlies continental crust at the edge of the shelf. The continental crust thins from 34 to 26km beneath the

margin. This is a feature typical of rifted not transform margins. An open file data report was released and a GEOS article has been prepared on the experiment. The data has been processed and interpreted and two papers are underway.

B. Seismic Refraction Studies of the Transform Margin South of the Grand Banks. Acquisition of these refraction data was completed in 1984, and data analysis and processing have been the focus of activity in 1985/86. A paper on the results is being written. It appears that not only is the margin extremely sharp, but that there is little modification of either the continental or the oceanic crust adjacent to the margin. This may have significant implications for the geodynamics of passive margins.

C. Seismic Survey in the Laurentian Channel. The interpretation of the seismic refraction data is complete and a paper on the results has been submitted. The main conclusion is that the crustal structure of the Laurentian Channel is much the same as that of the Scotian Basin. This is an interesting result considering its proximity to the transform margin. These data can be used to interpret seismicity in the area.

D. The Seismic Survey South of Flemish Cap. This was successfully carried out, despite severe problems with the ocean-bottom seismometers (OBS), attributed to their extensive use over the past four years. The refraction data from the Flemish Cap survey have been digitized. A substantial amount of digital reflection data were obtained on this cruise. Data will be fully processed and analysed during 86/87.

E. Lithoprobe OBS. Construction of the Lithoprobe OBS are almost complete, and the large airgun array is on target. They should be ready for use in 86/87 in a major refraction experiment scheduled for the Orphan Basin and adjacent margin, to complement the Lithoprobe multichannel reflection data in that region.

F. LITHOPROBE Deep Seismic Reflection Lines. Two Lithoprobe east seismic lines have been interpreted across the northern Appalachians and northeast of Newfoundland which were shot in 1984 (lines 84-1 and 84-2). A third 1984 Lithoprobe East line was interpreted which was 600km long and passed from continental to oceanic crust just south of Orphan Knoll (line 84-3). A total of approximately 1000km of 30-fold marine seismic reflection data, recorded to 15-20 sec two-way travel time, have been gathered north and northeast of the island of Newfoundland. Lines 84-1 and 84-2 extends from the Labrador coast across the Paleozoic Humber, Dunnage, Gander and Avalon zones as defined in surface and near-surface geology. The deep seismic data constrain the extent of these zones at depth, the nature of their boundaries and, therefore, in principle the kinematics and dynamics of accretionary processes by which the zones were juxtaposed.

We have identified three seismically continuous lower crustal blocks beneath the Newfoundland Appalachians. (1) The Grenville craton, traced from surface exposures in Labrador, continues for some

70km eastward of the surface trace of the Humber-Dunnage boundary along the Baie Verte-Brompton Line. This Grenvillian crust thins from west to east, consistent with late Precambrian extension and rifting during the opening of the proto-Atlantic Iapetus Ocean. The Moho beneath the Humber zone is cut by west-dipping reflectors of uncertain age and tectonic significance. (2) A lower crustal block of uncertain affinity underlies the surface expression of the eastern Dunnage and Gander zones. This Gander block appears to have a "collisional" relationship with the Grenville craton to the west. (3) Lower crust beneath the Avalon zone exhibits a markedly different seismic character from the adjacent Gander block. The Moho beneath the Gander block is recorded as a strong, flat-lying reflector that disappears abruptly beneath the surface trace of the Dover Fault. This suggests that the Dover Fault is a major strike-slip fault cutting the entire crust and upper mantle and along which the Avalon zone was accreted to the system. The Dover Fault is the only major surface lineament that has any clear expression in the deep seismic record.

Our preferred regional tectonic interpretation for the evolution of the Appalachian Orogen involves continent/arc collision between the offset Grenville craton (Precambrian rifting is known to have produced a 300-400 km right-lateral offset in the margin, which is preserved as the Quebec Reentrant and the St. Lawrence Promontory) and a relatively straight eastward dipping subduction zone to produce the Taconian Orogeny. Acadian shortening in Newfoundland was then accommodated by lithospheric delamination of the lower lithosphere beneath the Grenville of the St. Lawrence Promontory with simultaneous tectonic wedging of the lower lithosphere which formerly underlaid the Dunnage back-arc basin. To the south, in New Brunswick and Quebec, further Acadian emplacement of the overthrust wedge onto the craton occurred. Major Acadian overthrusting in the northwestern Maritimes is supported by recent observations, although the absolute partitioning of Taconian versus Acadian shortening remains uncertain.

A deep marine seismic reflection profile was obtained across the Orphan Basin, a segment of the continental margin northeast of Newfoundland. This profile crosses two major geologic features; the sedimentary basin situated on the margin and the transition between oceanic and continental crust. These features were formed during the mid-Cretaceous continental breakup and the creation of the first oceanic lithosphere between western Europe and North America. Interpretation of the seismic data across the sedimentary basin shows a decollement zone below the faulted continental basement. These normal faults in basement tend to be planar, rather than listric in shape. The continental crust thins across the sedimentary basin but thinning of the upper brittle crust appears to be less than in the lower ductile(?) region. These results have important implications for the processes of formation of extensional basins. The ocean-continent transition is marked by a landward dip of the oceanic crust which disappears below the thinned continental crust near the transition. This suggests lateral continuity and underplating of the oceanic crust below the

continent. This deep oceanic layer which underplates the thinned continental crust may be reflected in the presence of high velocity lower crustal layers at many continental margins.

The crustal thinning which is observed on the Lithoprobe East line 84-3 is modelled by a two-layer stretching model. Average measured values of syn-rift sediment thickness and total subsidence are used to constrain the model. Stretching factors in upper and lower lithospheric layers are derived as functions of the depth of the boundary between the upper and lower layers. In most parts of the line lithospheric extension in the upper layer of more than 100% is predicted using the model. In addition, most regions of the line require less stretching in the upper layer than in the lower layer if the constraints are to be satisfied. The calculated depth of the Moho appears to be independent of the depth of the boundary between the upper and lower layers, and it also agrees both with the depths to Moho which are tentatively identified along the line, and with a depth to Moho which has been determined from refraction measurements.

In 1985 three lines totaling about 1500km were shot in the southern Grand Banks area as part of the Frontier Geoscience Program. All lines were shot and processed by GSI, Calgary. These lines cross the basins of the southern Grand Banks, the Horse-shoe and Whale sub-basins, and the more northerly basins, the Jean d'Arc (in the vicinity of Hibernia) and the Flemish Pass. In addition, they cross the ocean-continent boundaries in the Newfoundland Basin-Flemish Cap region. These data were processed in 85/86 and are now available for interpretation. Together with line 84-3 they make a unique data set in an economically important, complex region of extension.

POTENTIAL FIELDS GROUP

A. National Gravity Data Base. All AGC marine gravity data were adjusted and entered into the National Gravity Data Base. East Coast data sets have an overall accuracy of better than 2.5 mgals, and an internal consistency of from +/- 1 to +/- 5 mgals.

A report written to document all data processing procedures from acquisition at sea to least squares adjustment was issued as an Open File, along with the more than 300,000 new gravity records added to the data base.

A variety of software was developed or modified to facilitate the extraction of data and its subsequent processing for analytical purposes.

B. Satellite Altimetry. A contract study with the University of New Brunswick has resulted in a new procedure for converting satellite altimetric data to gravity anomalies, which also provides a method of spatial decomposition of the geoidal information. This allows an assessment of the contributions to the geoidal anomaly within a variable area.

C. Aeromagnetic Surveys

Aeromagnetic surveys were carried out northeast of Newfoundland and over the Laurentian Channel.

The first survey was done in two parts: one consisted of a closely-spaced grid over the Northeast Newfoundland Shelf and the Orphan Basin, designed to delimit basement structure in this potentially hydrocarbon-rich area; the other consisted of a series of regional lines intended to identify spreading anomalies in the southeast Labrador Sea. Nearly 130,000 line kilometres were flown in this operation. The project was particularly noteworthy in that it was carried out jointly between the GSC and a consortium of five oil companies, and it used advanced navigation procedures involving the integration of Loran-C and GPS data.

The second survey was designed to trace the deep-seated geological trends that link Nova Scotia and Newfoundland. About 85,000 line kilometres were flown over grids of varying densities that covered the south shore of Newfoundland, parts of St. Pierre Bank, the east coast of Cape Breton Island, and Cabot Strait.

D. Interpretive Studies. Interpretive studies were initiated or continued in a number of areas.

Magnetic depth to basement calculations over Georges Bank, and comparisons with existing seismic data, were the topics of two contracted studies. These yielded refinements to earlier descriptions of basement structure in the region, while providing some valuable insights into the effectiveness of various interpretive techniques.

A wide-ranging review and compilation of existing data in the Laurentian Channel region has been undertaken, preparatory to the receipt and analysis of aeromagnetic data collected in the survey described above. In the process, a number of interesting techniques have been implemented for displaying and comparing complementary data sets.

A joint contract has been issued to a geophysical consulting firm by the GSC and four oil companies, for the interpretation of detailed aeromagnetic data collected northeast of Newfoundland. A preliminary review of regional aeromagnetic profiles collected in the southeast Labrador Sea has improved our confidence in the identification of spreading anomalies and in the location of the Charlie-Gibbs Fracture Zone.

One dimensional cross-spectral methods are being applied to examine isostatic response at a number of locations along the eastern continental margin.

E. Computing Facilities

Two MicroVAX computers have been installed in a network configuration and linked to other computers in order to accomplish a number of tasks in the handling, display, and analysis of potential fields data. Some production packages have been ported from other computers, while others are the subject of vigorous development.

BAFFIN BAY

After drilling one site above the Arctic Circle in Baffin Bay, and two others in the Labrador Sea as part of the north-south transect between 53° and 71°N, the JOIDES Resolution docked at St. Johns, Newfoundland on October 27. The major objectives of ODP Leg 105, for the 61 days of iceberg and storm-ridden operations, were to investigate the paleoclimatic and paleoceanographic changes in this climatically sensitive high-latitude region over the last 55 million years, and to unravel the Paleogene to Recent tectonic history of Baffin Bay and the Labrador Sea. These seas may have constituted an important corridor for exchange of surface and deep-water masses between the Arctic and Atlantic since as early as the Late Cretaceous, and the only connection until the formation of the Norwegian-Greenland Sea during the Eocene.

Continuous, high sedimentation rate (ranging from 40-130 m/m.y.) sequences of Plio-Pleistocene age were penetrated at all three sites. These sequences provide the means by which the rhythmic sedimentation and floral and faunal changes resulting from high-frequency climatic oscillations will be studied in detail. Drilling results also confirm a 2.5 Ma timing of initiation of ice-rafting in the northwestern Atlantic, but may also indicate an earlier beginning of glaciation in the Baffin Bay region. Climatic deterioration and southward transport of arctic water masses began in the middle Miocene or earlier in Baffin Bay, and significant cooling of surface waters as early as the late Eocene. A climatic optimum occurred during the late middle Miocene in the region. The results of drilling also demonstrate that building of major sedimentary drifts resulting from intensified deep-water circulation, began in the middle to late Miocene in southwestern Baffin Bay and in the Labrador Sea on Eirik Ridge and Gloria Drift. An oceanic crustal age of 55-56 Ma was obtained at Site 647 in the Southern Labrador Sea; the age obtained by drilling agrees with that assigned on the basis of magnetic anomaly correlations and confirms a tectonic model that requires a major re-orientation of seafloor spreading centers in the Labrador Sea at about that time. Subsidence at Baffin Bay Site 645 follows a path that suggests that spreading and subsidence began at about the same time (63-55Ma). Extrapolation of sedimentation rates at Site 645 to a major deep regional reflector suggests an Eocene-Oligocene age for it. Because this reflector extends across the entire basin, Baffin Bay must have ceased forming by 36Ma at the same time that spreading ceased in the Labrador Sea.

The north-south transect of sites drilled during ODP Leg 105 provides the opportunity for detailed regional paleoceanographic studies and composes part of an east-west transect that will allow comparisons of the timing and rates of climate and ocean circulation changes over the whole of the North Atlantic and Norwegian Sea region from the Paleogene to Recent. The dating of major seismic stratigraphic units will allow further understanding of basin wide sedimentation and tectonic events.

During 85/86 several of the contributions to DNAG from individual members of the Subdivision have been completed.

Srivastava finished his contribution to the chapter with Gradstein & Jansa entitled "Evolution of the Western North Atlantic", for the volume "Geology of the Continental Margin: Eastern Canada".

Srivastava revised the Plate Kinematics paper for DNAG Vol 1.

Jackson completed the sediment thickness map of the Arctic Ocean produced for DNAG. A variety of data sources were employed to develop this map, nevertheless, the striking observation from this compilation is the paucity of data throughout the region.

Jackson completed the chapter prepared for DNAG on seismic reflection and refraction in the Arctic.

Macnab and others are completing potential field maps and contributing to the tectonic map of Canada.

PERSONNEL NOTES

Dr. G.S. Stockmal (tectonics), formerly at Dalhousie University; Dr. J. Verhoef (potential fields), formerly at the University of Utrecht; and Dr. F. Marillier (seismology), formerly at the University of Brest, have joined the Subdivision as Research Scientists. We look to them for many new ideas in future projects.

Dr. B. Mudford joined the subdivision as a NSERC fellow. Dr. S. Ojo, also an NSERC fellow, returned to Nigeria.

Mr. R. Bendokas became Subdivision Secretary early last year. He has now left and has been replaced by Ms. C. Fisher.

Attendance at Meetings, Conferences and Courses

- JACKSON, R.: March 17, 1986, Ottawa meeting re: Ice Island refraction management.
- JACKSON, R.: January 21-24 1986 Ottawa for GSC Forum
- JACKSON R.: April 4 to June 5, 1985, to Ice Island
- JACKSON, R.: April 1, 1985, attend MIT in Boston to discuss FRAM II data.
- KAY, W.: February 10-14, 1986, Calgary to visit GSI & STACS re: Lithoprobe and help with poster at GSC Oil and Gas Forum.
- KEEN, C.: March 25-26, 1986, Ottawa re: Lithoprobe.
- KEEN, C: March 19-21, 1986, Ottawa to visit Headquarters and work on Lithoprobe.

- KEEN, C.: March 14-15, 1986, New York to give invited talk and visit Lamont.
- KEEN, C.: March 6-8, 1986, Ottawa to attend Lithoprobe Steering Committee meeting.
- KEEN, C.: February 10-14, 1986, Calgary to speak at Oil and Gas Forum and visit GSI re: Lithoprobe.
- KEEN, C.: February 5-6, 1986, Ottawa meeting Canadian National Committee on the dynamics & Evolution of the Lithosphere.
- KEEN, C.; October 28-31, 1985, Orlando Florida, to attend GSA annual meeting & give oral paper.
- KEEN, C.: May 14-17, 1985, Fredericton to attend GAC meeting and Lithoprobe East meeting and present talk.
- KEEN, C.: May 7-10, 1985, Calgary to visit GSI and present talks at CSEG/CGU Convention in Calgary.
- KEEN, C.: April 16-21, 1985, attended Conference in Druham and presented an invited paper.
- LONCAREVIC, B.: May 20-26, 1985, Zurich to attend meetings re: KSS-30 Sea Gravimeter.
- LONCAREVIC, B.: April 22-24, 1985, Calgary to attend meeting re: Orphan Basins Aeromag Survey.
- LONCAREVIC, B.: July 19-20, 1985, Ottawa for discussion with EPB re: Sea Gravity Measurements
- MACNAB, R.: February 16-18, 1986, Washington, DC, to represent AGC at Circum-Atlantic project meeting.
- MACNAB, R.: February 2-7, 1986, San Diego to attend 4th working symposium on oceanographic data systems in capacity of session chairman.
- MACNAB, R.: October 2-3, 1985, Washington, US EEZ Symposium.
- MACNAB, R.: January 22-24, 1986, Calgary to attend meeting with industry reps and to review progress on Orphan Basin Aeromag Survey and discuss interpretive follow-up.
- MACNAB, R.: Dec 3-4, 1985, Ottawa to discuss map production, data bases, and to attend DFO-EMR Guiding Committee.
- MACNAB, R.: September 29-October 4, 1985, Boston and Washington to visit Woods Hole, attend EEZ symposium and visit Naval Research Lab.
- MACNAB, R.: July 26-August 10, 1985, Lausanne to attend meeting on potential fields, Brest; France, to visit IPREMER.
- MACNAB, R.: June 23-26, 1985, Calgary to review bidders' proposals for N.E. Newfoundland Aeromag Survey and to discuss with industry.
- MACNAB, R.: June 2-3, 1985, Ottawa to discuss plans & specifications for Orphan Basin Aeromag Survey.
- MACNAB, R.F.: May 26-27, 1985, Ottawa to attend meeting for review of plans and specifications for Orphan Basin Survey.
- MACNAB, R.: April 2, 1985, to EPB Ottawa re: Applicon colour plots.
- MUDFORD, B.: February 4-5 Ottawa to visit COGLA for consultations on overpressures in Venture Gas Field.
- MUDFORD, B.: December 8-13, 1985, San Francisco for AGU fall meeting.
- PRIME, W.: May 27-31, 1985, Ottawa to examine computer software in Ottawa office.
- PRIME, W.: April 2, 1985, to EPB Ottawa re: Applicon colour plots.
- SRIVASTAVA, S.: February 9-13, 1986, Calgary to attend current activity Forum (ISPG) and to present posters. Visit Petro Canada to see some of their seismic data.
- SRIVASTAVA, S.: May 29-June 2, 1985, College Station to attend co-chiefs meeting of Leg 105 - ODP
- SRIVASTAVA, S.: May 14-17, 1985, Fredericton to attend GAC meeting and to present a paper on Leg 105 program.
- SRIVASTAVA, S.: May 6-11, 1985, Calgary to attend CGU-CSEG meeting and to deliver a talk on ODP Leg 105 program. Also to visit Petro-Canada on May 7 to discuss seismic compilation in Baffin Bay.
- SRIVASTAVA, S.: August 14, 1985, Slavinger to join JOIDES RESOLUTION (Aug 15-Nov 1, 1985) for Leg 105.
- SRIVASTAVA, S.: April 1-2, 1985, New Orleans and College Station - Safety Pannel Meeting.
- SRIVASTAVA, S.: May 23-24, St. John's, NFLD, meeting with COGLA and Innuit representative concerning Leg 105.
- STOCKMAL, G.S.: January, 24 and 27, Quebec City, to visit SOQUIP offices and examine seismic data.
- STOCKMAL, G.S.: January, 22-23, Ottawa, to give oral and poster presentations at GSC Forum
- STOCKMAL, G.S.: January 17-18, Amherst, N.S., to attend AGX annual symposium and give oral paper
- STOCKMAL, G.S.: October 28-31, Orlando, Florida, to attend GSC annual meeting and give oral paper.
- STOCKMAL, G.S.: September 30, Vancouver, to give talk on Lithoprobe East at UBC.
- STOCKMAL, G.S.: September 27, Sidney, B.C., to give invited talk on Lithoprobe East at PGC.
- STOCKMAL, G.S.: September 26, ISPG (Calgary) meeting Re "Basin Analysis" organized by A. Jessop (EPB).
- WOODSIDE, J.: January 21-23, 1986, Ottawa project review meeting at EPB and GSC Current Activities Forum.
- WOODSIDE, J.: June 25, 1985, Fredericton to monitor progress on contract (project 850022) at UNB (Satellite Altimetry Applications)

WOODSIDE, J.: June 13, 1985, Ottawa to participate in gravity adjustment and draft part of report at EPB.

WOODSIDE, J.: November 12, 1985, Fredericton to monitor progress on contract at UNB.

WOODSIDE, J.: December 9, 1985, Ottawa to give lectures at CHS and work at EPB on data report.

WOODSIDE, J.: September 17, 1985, Ottawa to give lectures at CHS and discuss gravity adjustment at EPB.

WOODSIDE, J.: August 16, 1985, Lawrencetown to visit Nova Scotia Land Survey Institute and discuss co-op student projects and image analysis systems.

WOODSIDE, J.: September 24, 1985, Ottawa, to discuss data base problems and Open File of data.

Membership on Committees

R. Jackson

- (Member) International Lithosphere sub-committee on the Arctic

C.E. Keen

- (Member) CNC Lithosphere
- (Member) WG2 Arctic of CC7 ILP
- (Member) CMG (IUGS)
- (Member) Lithoprobe Steering Committee
- (Member) NSERC Commission on Strategic Grants
- (Member) Wilson (CGU) and Miller (Royal Society) Medal Committees

R.F. Macnab

- (Member) BIO Sensing Committee

B. Nichols

- (Member) Remote Sensing Committee
- (Member) AI Committee

S.P. Srivastava

- (Member) Tectonophysics Panel of the Ocean Drilling Program
- (Member) International Association of Geomagnetism and Aeonomy

STOCKMAL, G.S.

- (Secretary) Organizing Committee, "Basins of Eastern Canada and Worldwide Analogues", AGS, Aug 13-15, 1986, Halifax
- (Member) Scientific Program Committee, as above

J.M. Woodside

- (Member) Directing Board of Bureau Gravimetrique International

Subdivision Publications

During the fiscal year April 1, 1985 to March 31, 1986, the Subdivision staff were involved in

the production of: ten abstracts, two open files, four internal reports, one internal and eight external published papers, and one cruise/field report.

Environmental Marine Geology Subdivision

David J.W. Piper

The subdivision is responsible for surficial marine geology of marine areas off the eastern and northern coasts of Canada.

Geographically, our work is concentrated on the coast and shelf of Eastern and Arctic Canada, but also includes international areas of interest to Canada. The purpose of these studies is to map the distribution of surficial sediments, to provide improved knowledge of recent and Quaternary geological processes, and to provide timely and accurate advice concerning the rational management of the marine environment in the identification, conservation and development of natural resources.

The subdivision participates in several programs partly funded by agencies outside the G.S.C.; notably work under the Conventional Energy R & D Task of the Office of Energy Research and Development (OERD), the Northern Oil and Gas Action Program (NOGAP), and studies of seabed disposal of nuclear waste with Atomic Energy of Canada Limited (AECL).

The subdivision provides most of the expertise within A.G.C. for environmental advice and assessment to regulatory agencies and other levels of government.

Highlights

PERD Offshore Geotechnics Projects

The Dynamics of Iceberg Grounding Study (DIGS), funded principally by ESRF, was coordinated through AGC as part of the PERD activities. The successful experiment obtained full documentation of the motion and dimension of several icebergs in contact with the seabed, and PISCES IV was used to investigate the resulting seabed deformation.

Work with PISCES IV at Hibernia was prevented by bad weather, but work through C-CORE with Cormorant documented up to 60 m of sediment transport by passive tracer methods, and investigated the origin of enigmatic pits at Hibernia, which are probably produced by icebergs. Biostratigraphic and mineralogic analysis of surficial sediments at Hibernia has continued, and a composite map of the surficial geology of the Hibernia area has been released.

A cruise to map the distribution of near-surface faults on the eastern Scotian Shelf was only partly successful because of very poor weather. Faults were mapped only in the vicinity of the Cape Breton Shelf.

A synthesis of the Quaternary lithostratigraphy of Banquereau, and its implications for exploration drilling, was completed. An ESRF-funded experiment to measure rates of sand transport using radioactive tracer was completed on Sable Island Bank; data show poor agreement with model studies, and the reason for this discrepancy is being investigated. PISCES IV was used to investigate bedform mobility on Sable Island Bank.

PERD Long Term Studies in Marine Geology

Development of the international Long Coring Facility has continued. The Canadian barrel disconnect system has been completed. A test cruise in June 1985 showed up some unexpected problems with the facility, which are now being corrected. Planning proceeded for use of the facility from CSS HUDSON in October 1986.

The PISCES IV was used to ground truth sidescan sonar in the region of the epicentre of the 1929 Grand Banks earthquake. This and continuing analysis of photographs and cores demonstrate that over 100 cubic kilometers of sand on the upper continental slope failed in the 1929 event.

Field programs on the continental slope were hampered by ship delays and bad weather; additional information was obtained on the central Scotian Slope and Flemish Pass. A preliminary inventory of basic geotechnical properties in type areas of the slope has been completed. An evaluation of shallow constraints to development in Flemish Pass has been completed. Stratigraphic analysis of upper Scotian Slope data demonstrates that the evolution of the present conditions on the eastern Canadian continental slopes results from lowering of sea level beginning about 3 Ma and repeated shelf-crossing glaciations beginning about 1 Ma ago.

Northern Oil and Gas Action Program

Work in the Sverdrup Basin has concentrated on data acquisition and technique development. A through-the-ice sediment sampling program successfully recovered shallow sediment cores. Aerial reconnaissance was made of ice lead distribution in preparation for a 1986 field program in the leads. Both cores and acoustic profiles were obtained from Byam Martin Channel from a Coast Guard icebreaker. Most of the data collected this year has been analyzed, and preliminary reports have been released.

On the Beaufort coast, a wave and sediment transport study was completed at King Point (Yukon) to evaluate the rates of longshore sediment transport. A nearshore seismic/sidescan survey was carried out along the coast west of King Point, which showed a marked unconformity between coastal sediments and underlying Pleistocene sequences. Analysis of the data from the north head borehole program shows that conventional geological facies analysis can provide important geotechnical information.

Frontier Geoscience Program

The development of an engineering geology capability at AGC has been one of the main thrusts of the FGP activities in 1985. Laboratory facilities have been built up for x-radiographic analysis of cores, undisturbed core extrusion, and routine split core geotechnical measurements. An experimental stress history laboratory facility has been developed. Greater coordination was provided to regional geotechnical studies.

A workshop was organized to evaluate in situ geotechnical tools for use in the Canadian offshore.

Related developments include the cone penetrometer through NORDCO, and a piezometer for Ralph.

A joint borehole program with Petro-Canada at the Cohasset site was only partly successful due to poor weather; the borehole samples provide groundtruth for existing acoustic information at the site.

FGP has also accelerated the A-base programs of surficial geological mapping and stratigraphic analysis off eastern Canada. For example, on the Labrador Shelf, a major synthesis of the glacial history and a series of 1:250,000 isopach maps have been completed.

On the Grand Banks, a mapping cruise provided a regional high-resolution seismic and sidescan framework for more detailed site specific investigations. Subsequently, PISCES IV was used to groundtruth specific geological problems. The new data suggest that glaciation extended across the Grand Banks of Newfoundland. A review paper was prepared on the geological engineering constraints to hydrocarbon resource development on the Grand Banks, and significant progress was made on the release of regional mapping data from the southern Grand Banks.

A major cruise on CSS HUDSON investigated Quaternary and bedrock geology of parts of the southeast Baffin Shelf and Hudson Strait. Paleozoic or early Mesozoic rocks are present on the southern part of the Northeast Baffin Shelf, in contrast to late Cretaceous and early Tertiary rocks to the south. Cumberland Sound is underlain by a Barremian to Cenomanian (Cretaceous) half graben. Hudson Strait is largely underlain by Ordovician and Silurian carbonate rocks.

Development of the IAS image analysis system for palynological analysis has continued, and new applications to sediment analysis have been made.

A-base Programs

1. Coastal Programs

Coastal air-video survey of the west coast of Newfoundland was flown, thus effectively completing video coverage for the Island.

Investigation of gravel resources in the nearshore zone of Nova Scotia and their mobility has continued through the use of PISCES IV, Ralph and a depth of disturbance rods program funded by ESRF. The morphodynamic behaviour of gravel beaches in storms and their potential for failure was evaluated by repetitive surveys through the winter, and related to wind, wave and current measurements made during the Canadian Atlantic Storm Project.

Monitoring of till cliff recession has continued in the Maritime Provinces, with average rates of up to 3.8 m/yr being determined.

Aerial video coverage was obtained of part of the coastline of Baffin Island, and the shores of Lougheed, Cameron and Melville Islands. Field surveys were made of the major barrier beaches of eastern Bylot and northern Baffin Islands, the associated concentrations of placer minerals, and the role played by permafrost in beach stability.

2. Coastal Inlets and Deltas

A three week PANDORA/PISCES IV cruise to the Baffin Island fiords investigated sediment dynamics associated with ice margins and the stability of sediments in the fiords. Associated coastal work investigated sandur deltas. Analysis and reporting of previous Baffin fiord data by the many SAFE participants within and outside the GSC has been proceeding rapidly.

High-resolution seismic data from Saguenay fiord has been analyzed to document the sediment failure effects in the 17th century. Additional field work was completed in Saguenay fiord as part of ongoing work on paleoclimatic changes and the history of earthquake activity in the area.

Geotechnical data from the intertidal zone of Minas Basin shows that strengths of sediment are much higher than expected (probably due to subaerial exposure); this has considerable impact on current sediment transport models.

A synthesis of the sedimentology of Chignecto Bay (Bay of Fundy) has been completed, which relates modern sediments to facies models developed for ancient sediments.

3. Geochemistry

Dr. M. A. Rashid retired from the GSC after a career devoted to the application of organic geochemistry to marine and petroleum geology. His major synthesis, a book on "Geochemistry of Marine Humic Compounds", was published by Springer-Verlag during the year.

The work of the international Seabed Working Group culminated with a multi-nation cruise (ESOPE) to abyssal plain regions of the North Atlantic to investigate constraints to seabed disposal of nuclear waste. The Canadian group from AGC was responsible for much of the geochemical and lithological work. 35-m long piston cores were obtained: the longest cores ever obtained by piston coring in the deep sea. These long cores allow a much better evaluation of pore-water profiles and diagenetic changes in near surface sediments. Early diagenesis of iron silicate has been shown to be an important process. Work has also continued on evaluating the role played by compaction faults in the deep sea in providing pathways for advection of formation water.

4. Regional geology and stratigraphy

Coring facilities were established on the Ice Island, and sediment samples, seismic data and bottom photographs were obtained. Siliceous sponges have created 6-10 m high reef-like features at the seabed. Beneath a 15 cm layer of red mud is an older sediment unit with high meltwater influx of sediment.

Sampling for palynomorph stratigraphy was carried out on ODP Legs 104 and 105. Neogene-Quaternary dinoflagellate stratigraphy, based primarily of DSDP Leg 94, has been completed for subtropical to sub-arctic regions of the North Atlantic.

A method has been developed to monitor changes in bottom water salinity related to changes in glacial

meltwater supply and the behaviour of the Labrador current, using oxygen isotope composition of benthic foraminifera. Analysis of stable isotopes in Arctic Ocean microfossils has shown new constraints on using oxygen isotope stratigraphy in these areas.

A short cruise to the Bras d'Or Lakes in cooperation with the Université de Québec has defined a late Quaternary seismostratigraphy for the Lakes. Analysis of cores is underway to provide information on age and paleoenvironments.

Provision of Advice

Provision of technical advice continues to be a major part of the work of the subdivision. The highlight of the year was the provision of technical response to the Hibernia EIS. The subdivision also reviewed preliminary environmental assessments of Georges Bank. Close cooperation with offshore operators in PERD and FGP results in continued exchange of information with industry. There was an increase in demand for information on nearshore sediments this year as interest in offshore aggregates and placer gold continued. Demand for advice on coastal problems from Parks Canada and the Maritime Provinces continued. The subdivision continues to review ocean dumping applications.

EMG staff played a major role in organizing two highly successful conferences: the annual meeting of the Underwater Mining Institute and the 14th Annual Arctic Workshop. Both led to important exchanges of scientific ideas and the development of new initiatives.

The preparation of the new Geology of Canada volume on the East Coast Offshore has taken a lot of the time of subdivision staff over the last year. The subdivision has been largely responsible for three chapters on Quaternary Geology, Sedimentation Processes and Constraints to Development.

PERSONNEL NOTES

Dr. M. Rashid retired effective April 1, 1986, after many years of service to the GSC in research on marine organic geochemistry.

Ms. Kate Moran joined the Subdivision as the new Frontier Geoscience Program Marine Geotechnical Engineer. She previously worked with the OERD Beaufort Sea program.

Mr. Harold Christian joined the Subdivision as a Geotechnical Laboratory Engineer. He was previously working on his Masters degree at the University of Alberta.

Dr. Jay Stravers joined the Subdivision to work on his post-Doctoral Fellowship. When he completes his work here, he will return to Colorado, U.S.A.

Dr. Denis Bonifay joined the Subdivision on a contract basis, under the Canada-France cooperant program, to study the sediments on the St. Pierre Bank slope. When he completes his contract in June 1987, he will return to France.

Mrs. Cynthia Moors joined the Subdivision as secretary in place of Carmelita Fisher. She previously worked with CEIC in Ottawa.

Ms. A. Nicky Gray joined the Subdivision as assistant to the secretary. She previously worked with Lavalin Inc.

Mr. Dan Praeg joined the Subdivision as a term Marine Geoscience Technician.

Mr. Paul Durling joined the Subdivision as a term Marine Geological/Geophysical Technician.

MEMBERSHIP ON COMMITTEES

S.M. Blasco

Chairman, PERD Offshore Geotechnics Committee.

Member, PERD Marine Engineering Committee.

Member, PERD Permafrost Committee.

Member, DIAND Arctic Waters Advisor Committee (AWAC).

Member, NRC - ACGR Associate Committee on Permafrost Research.

D.E. Buckley

Member, Canadian Ocean Dumping Advisory Committee - Environmental Assessment of Impact of Dredging in Miramichi Estuary.

Member, Nuclear Energy Agency, Seabed Working Group - Site Assessment Task, and editorial board, ESOPE program.

R.E. Cranston

Canadian Delegate Seabed Working Group (SWG); NEA/OECD, and geochemistry coordinator, ESOPE program.

Regional Editor, Water Pollution Control Journal of Canada.

G.B. Fader

Scientific Advisor, Seabed II, Huntex '70 Ltd. - Technical Management Committee.

Atlantic Geoscience Centre representative, Departmental Committee on Ocean Mining.

Member, local organizing committee for Underwater Mining Institute Symposium, October 1985, Halifax, N.S.

Co-Chairman, Mobil Oil Hibernia Environmental Impact Statement Assessment Committee for Geological Survey of Canada.

Secretary, Nova Scotia Quaternary Association - "NSQUA".

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 Oil Spill Response.

Member, Organizing Committee, Canadian Coastal Conference 1985.

C.F.M. Lewis

Chairman, Seabottom Ice Scour Committee, Environmental Studies Revolving Funds.

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

Member, Joint Industry/Government Working Group on Ice Scour Research.

K.M. Moran

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

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.

D.J.W. Piper

Member, Canadian Coastal Sediment Study Steering Committee.

Member, Bottom Sediment Transport Committee, Environmental Studies Revolving 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.

K.R. Robertson

Member, College of Cape Breton, Environmental Technology Advisory Committee.

Member, College of Cape Breton, Chemical Technology Advisory Committee.

C.T. Schafer

EMR Representative, Canadian Committee on Climate Fluctuations and Man.

AGC/BIO Representative, Canadian Task Force on Proxy Climate Data.

Member, Working Group for Point Lepreau Environmental Monitoring.

AGC Representative, Nova Scotia Climate Advisory Committee (AES).

J.P.M. Syvitski

Chairman, IUGS Committee on Grain Size Analysis of Sediments.

R.B. Taylor

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

G. Vilks

Chairman, 14th Arctic Workshop Steering Committee.

ATTENDANCE AT MEETINGS, CONFERENCES, COURSES, SPECIAL TALKS, AND LECTURES

Carl Amos

ESRF meeting re Tracer Experiment, Ottawa, April 11, 1985.

IAS Conference to present two papers, Utrecht, Holland, August 22, 1985.

Seabed Stability Workshop to present two papers at BIO, Dartmouth, June 12, 1985.

Husky/Bow Valley re Lithostratigraphy of Banquereau, St. John's, July 15, 1985.

Sable Gas Systems re Bedform Stability of Sable Island Bank, Halifax, September 18, 1985.

APENS special lecture; Maritime Museum, Halifax: Sand Transport on Sable Island Bank, October 17, 1985.

ESRF meeting at COGLA re Radio Isotope Tracer Experiment, Halifax, February 27, 1986.

Steve Blasco

OERD contract reviews on acoustic drill and Beaufort Shelf biostratigraphy - St. John's, April 18, 1985.

Annual AWAC Committee meeting; joint meetings with Industry - Field Programs 1985; OERD research reviews: U of Calgary/Geoterrex; meeting with Elverhoi of NGI, Norway - Calgary, April 21, 1985.

Coordinating meeting for DNAG Arctic Volume: two-day workshop; CSEG/CSU annual meeting - Calgary, May 4, 1985.

OERD Permafrost Committee meeting; OERD meeting on Program 6.3; Spring Drilling Program review with DIAND; ESRF Ice Scour Data Base meeting - Ottawa, May 22, 1985.

OERD Program 6.3 East Coast Review Committee meeting - Halifax, June 12, 1985.

OERD Program 6.3 Beaufort Sea Annual Review; OERD contract reviews; Planning Industry/Government field programs 1985 - Calgary, July 7, 1985.

OERD contract review - Acoustic Drill/Biostratigraphy; research review C-Core/Stirbys - St. John's, July 31, 1985.

Review of acoustic drill contract; review biostratigraphy results; C-Core Annual Program Review - St. John's, October 29, 1985.

Arctic Land-Sea Interaction Workshop, Halifax, November 5, 1985.

OERD contract reviews: Ice Scour, Pleistocene Geology - Ottawa, November 11, 1985.

Present paper at Subsea Permafrost Workshop; meeting with NRC Subcommittee on Permafrost - Edmonton, November 17, 1985.

Annual AWAC Committee meeting; 1986 Field Programs - Inland Waters (F&O) - Winnipeg, December 10, 1985.

OERD meeting and contract reviews - Ice Scour, Pleistocene Geology - Ottawa, December 17, 1985.

OERD contract review - Permafrost; Beaufort Sea review meeting with ISPG - Calgary, November 20, 1985.

Sidescan Sonar Technology meeting with contractor, Toronto, December 20, 1985.

Beaufort Sea Field Programs 1986: Coop with Industry; EPS Pipeline Study Review Committee meeting; EG/DNAG; ESRF Ice Scour Data Base final meeting; OERD contract reviews: Permafrost, DMAPS - Calgary, January 6, 1986.

Meeting with TSD: Beaufort-Mackenzie Geology; OERD contract reviews - Ice Scour, Pleistocene Geology - Ottawa, January 22, 1986.

NRC In-situ Geotechnical Instrumentation Workshop, Halifax, January 27, 1986.

GSC Forum - Beaufort Sea presentation and poster, Calgary, February 10, 1986.

1986 cruise planning - CSS Tully, February 12, 1986.

BP Canada: Beaufort Sea presentation; OERD contract reviews: Permafrost, DMAPS - Calgary, February 15, 1986.

Dale Buckley

Seabed Working Group meetings; Royal Society of London meeting to present paper "Dissolved Iron Silicates in Deep Sea Sediments", London, England, January 25 - February 1, 1986.

Harold Christian

Meeting with Tony Stirbys of C-CORE re piezometer development, July 25-28, 1985.

38th Canadian Geotechnical Conference, Edmonton, and lab visit at NRC, September 22 - October 1, 1985.

14th Arctic Workshop on Land-Sea Interaction, BIO, Dartmouth, November 6-8, 1985.

Course "Geotechnical Analysis on Microcomputers, University of Wisconsin, January 13-14, 1986.

Workshop on Geotechnical In-Situ Testing for the Canadian Offshore, BIO, Dartmouth (Secretary for Session II), January 27-28, 1986.

MED Course at N.S. Nautical Institute, Halifax, March 11-28, 1986.

Ray Cranston

Interdepartmental meeting on future of Sub-Seabed Disposal Program in Canada, Ottawa, September 19, 1985.

Attend meeting to discuss ESOPE Program Results; prepare for a 1-year visit to Italian lab; present ESOPE results to Geological Society of London; and attend interim SWG meeting - Italy/London, England, January 22 - February 1, 1986.

Jean Dabros

Image Analysis Methods Workshop, GAC meeting, Fredericton, May 14, 1985.

Gordon Fader

Departmental Committee on Ocean Mining meeting, Ottawa, January 4, 1985.

Seabed II Project Technical Management Committee meeting; finalize paper on Seabed II, Toronto, January 29, 1985.

Workshop on Hibernia Environmental Impact Statement Assessment, St. John's, February 5, 1985.

Office of Energy Research and Development Offshore Workshop (OERD); present paper "Surficial Geology of the Grand Banks of Newfoundland", BIO, Dartmouth, June 12, 1985.

Seabed II Technical Management Committee meeting, Toronto, June 18, 1985.

Interdepartmental Committee on Environmental Issues Related to Hibernia Oil Development meeting, St. John's, June 19, 1985.

EIS meeting, St. John's, July 16, 1985.

Underwater Mining Institute Committee meeting, Ottawa, August 22, 1985.

Planning meeting for UMI meeting in Halifax, August 27, 1985.

APENS Ocean Engineering Seminar; present paper "Wisconsinan Glaciation of the Continental Shelf Off Eastern Canada", Halifax, October 15, 1985.

Attend Hibernia EIS public meeting as department representative, St. John's, October 24, 1985.

Environmental Assessment Panel Hearings, St. John's, October 30, 1985.

Canadian Offshore Resources Exposition, Halifax, October 1985.

Underwater Mining Institute Symposium, Halifax, October 1985.

Present paper "Surficial Geology Studies of the Atlantic Geoscience Centre, Geological Survey of Canada" at St. Mary's University, Hope-Simpson Club, Halifax, October 1985.

14th Arctic Workshop, Arctic Land and Sea Interaction; present paper "Evidence for 100-120m Lowered Sea Levels from the Canadian East Coast Offshore" at BIO, Dartmouth, November 6-8, 1985.

Attend Dalhousie University's Geology Department for lecture, and present paper "Marine Geology and International Boundaries", Halifax, December 1985.

Stargate Management Course, Dartmouth, November 1-15, 1985.

Attend Geotechnical In-Situ Testing for the Canadian Offshore Workshop and present paper "High-Resolution Seismic Reflection Interpretation - Science or Black Art" at BIO, Dartmouth, January 27-28, 1986.

Don Forbes

ACROSES Canadian Coastal Conference Organizing Committee meetings, St. John's, May 21-22 and July 22-24; coastal surveys and Newfoundland Government consultation, August 11-17, 1985.

Parks Canada request for consultation, Dalvay, P.E.I., September 6-8, 1985.

ACROSES meeting, Toronto, December 9-10, 1985.

Robert Harnes

PERD Program 6.3 Annual Technical Review meeting, Calgary, July 8, 1985.

Phil Hill

Liaison with Terrain Sciences Personnel - Beaufort Area Stratigraphy, Ottawa, January 23, 1986.

Workshop on Environmental Studies Design Criteria - Beaufort Sea, Vancouver, February 5, 1986.

GSC Oil & Gas Forum Poster Presentation, Calgary; Laboratory work at Inuvik Scientific Resource Centre; NOGAP project start-up meeting (Project 86), Victoria, February 10, 1986.

Annual OERD Review meeting, Calgary, July 8, 1985.

Review OERD contract work with E. Burdon, MUN, St. John's, December 12, 1985.

Heiner Josenhans

Attend bidders conference for DIGS experiment at COGLA offices and brief contractors, St. John's, May 23, 1985.

Review DIGS results and plan data analysis, St. John's, September 30, 1985.

Discuss geotechnical analysis of samples from fresh iceberg scour with C-Core staff and prepare report, St. John's, October 28, 1985.

Review and interpret DIGS Huntex and Sidescan Data, St. John's, December 11, 1985.

Present poster session at GSC Current Activities Forum in Ottawa, Ottawa, January 21, 1986.

Attend GSC Current Activities Forum and present poster in Calgary; discuss Hudson Bay Quaternary Stratigraphy in Winnipeg, February 10, 1986.

Mike Lewis

DIGS experiment meetings at C-CORE and Geonautics, St. John's, Newfoundland, June 24, 1985.

ESRF Ice Scour Committee Meeting, Ottawa, September 26, 1985.

Attend and provide expert advice for public hearings of Mobil's Hibernia EIS, St. John's, Newfoundland, October 23, 1985.

DIGS Review Meetings and C-Core Associate Meeting, St. John's, Newfoundland, October 28, 1985.

ESRF Advisory Board Meeting; review ESRF Ice Scour Workshop Procedures, Ottawa, November 28, 1985.

ESRF DIGS Review Meeting at Geonautics Ltd. and C-Core, St. John's, Newfoundland, December 11, 1985.

ESRF Ice Scour Committee; review DIGS and repetitive mapping projects, St. John's, Newfoundland, February 13, 1986.

Bob Miller

Canadian Offshore Resources Exposition, Halifax, October 1985.

Underwater Mining Institute Symposium, Halifax, October 1985.

14th Arctic Workshop, Arctic Land and Sea Interaction, BIO, Dartmouth, November 6-8, 1985.

Kate Moran

NRC Sub-Committee meeting on Marine Geotechnical Engineering, Vancouver, June 23, 1985.

Present Task 63014 at the Beaufort Sea Review Meeting, Calgary, July 8, 1985.

International Conference on Soil Mechanics and Foundation Engineering, San Francisco, August 11, 1985.

Foundations Task Force meeting on CSA Standards for Offshore Structures, Toronto, October 22, 1985.

Attend meeting with C-CORE to discuss Labrador Shelf geology and geotechnical studies and visit ODP Resolution, St. John's, Newfoundland, October 29, 1985.

Attend meeting of MIT/SEAGRANT/SOHIO Joint Research Program on Beaufort Sea Silts and visit ODP (College Station) to discuss pressuremeter, Dallas, Texas, November 4, 1985.

Attend meeting with C-Core on Geotechnical Research and Centrifuge Models, St. John's, Newfoundland, November 25, 1985.

Process cores at Research Laboratory in Inuvik; visit EBA consultants in Edmonton; visit Gulf Canada Resources in Calgary; and discuss CSA Standards for offshore structures in Toronto - February 13, 1986.

Peter Morgan

OERD meetings, Calgary, July 8, 1985.

Polar Shelf meetings, TFSS meeting and NRC meeting, Ottawa, November 26, 1986.

Peta Mudie

Dino III Third International Conference on Modern and Fossil Dinoflagellates, Egham, Surrey, U.K., August 11, 1985.

Attend meeting with Dr. Svein Manum and study dinoflagellates collected on ODP Leg 104 and DSDP Leg 38, Norwegian Sea, Oslo, Norway, August 18, 1985.

Visit GSC to study automated image analysis systems located there, Ottawa, October 10, 1985.

Visit George Plant, Graham Bonham-Carter (EMR) re Image Analysis Systems, Ottawa, October 29, 1985

EPB Meeting on CESAR, Ice Island and Future Arctic Ocean Science, Ottawa, November 12, 1985.

ICSU meeting on International Geosphere Biosphere Program - Study of Global Change, Ottawa, December 9, 1985.

Russ Parrott

Attend cruise-planning meeting for ESRF-sponsored "Dynamics of Iceberg Grounding and Scouring" DIGS, and participate in cruise, St. John's, July 26 - August 26, 1985.

Attend meeting to review data collected and plan report for ESRF DIGS project, St. John's, September 30, 1985.

Society of Exploration Geologists annual meeting and track show, Washington, D.C., October 6-10, 1985.

BRUTIV Users' Group meeting to plan on-going development and funding of system, St. Andrews, Saint John, November 1, 1985.

International Underwater Mining Institute meeting and present talk "Acoustic Techniques for Marine Geological Studies", Halifax, October 1985.

David Piper

Discussions re Bras d'Or Lake Cruise, Montreal, August 29, 1985.

CCSS meeting; consult with TS Division, Ottawa, November 21, 1985.

ESRF Bottom Sediment Transport Committee meeting, Ottawa, April 11 and Toronto, November 21, 1985.

FGP meeting at GSC in Ottawa; meet with G. Reeves, Univ. of Quebec in Montreal, December 4, 1985.

CCSS meeting, Montreal, January 30, 1986.

Present papers at GSC forum, Calgary, February 10, 1986.

Kevin Robertson

College of Cape Breton Advisory Committee meeting, Sydney, November 5, 1985.

Charles Schafer

Discuss slump experiments and subsample a suite of grab samples from Dixon entrance to evaluate nearshore foram assemblages - Vancouver and Victoria, January 14, 1985.

Consult with Geophysicists at the U.S. Geological Survey and PGC on interpretation of Labrador Slope Seamarc Data - Victoria and San Francisco, December 3, 1985.

With a colleague from the Atlantic Oceanographic Laboratory, visit mainland China. The trip was sponsored by the International Development Research Centre as part of a proposed collaboration between ABC and Nanjink University to investigate the potential environmental impacts of new harbour construction/expansion at several localities on the south and west coasts of Hainan Island - China, February 15 - March 15, 1986.

Gary Sonnichsen

Annual Polar Continental Shelf Project meeting regarding 1986 field programs, Ottawa, November 26-29, 1985.

Attend meeting with CCGS Des Groseilliers on Arctic Islands Seismic Survey, Resolute, August 15, 1985.

Study Landsat imagery of Arctic Island Channels at Canadian Centre for Remote Sensing, Ottawa, June 6-7, 1985.

Aerial reconnaissance of ice conditions and coastal video survey, Resolute, July 11, 1985.

Robert Taylor

Attend Regional Environmental Emergencies Team (REET) meeting on behalf of D. Buckley, Halifax, June 1985.

Deliver lecture "Coasts of Atlantic Canada" at the Nova Scotia Land Survey Institute, Lawrencetown, December 1985.

Deliver lecture "Arctic Coasts: Their Morphology and Processes Which Affect Them" at Geology Department, St. Mary's University, Halifax, March 1986.

Gus Vilks

Chair 14th Arctic Workshop at BIO, Dartmouth, November 6-8, 1985.

Gary Winters

14th Arctic Workshop on Land-Sea Interaction; present paper "Distribution and Dynamics of Suspended Articulate Matter in Baffin Island Fjords" at BIO, Dartmouth, November 6-8, 1985.

LABORATORY STATISTICS

SEDIMENTOLOGY LABORATORY	1984-85	1985-86
Manual Sieve Analysis	26	14
Sieve and Pipette Analysis	0	176
Settling Tube Analysis	894	578
Sedigraph Analysis	633	274
Coulter Counter Analyses	1,652	1,320
Organic Carbon Analysis	980	2,650
GEOCHEMISTRY LABORATORY		
Elemental Analysis, Organic	55	0
Elemental Analysis, Inorganic	15,700	24,561
RADIOGRAPHIC LABORATORY		
X-Radiographs of Sedimentary Core	1,180	1,107
X-Ray Diffraction Analyses	825	75
OCEAN DUMPING		
PERMIT EVALUATIONS	158	88

J.S. Bell

Introduction

The objectives of the Eastern Petroleum Geology Subdivision 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.

The Subdivision's studies of the Atlantic continental margin are based primarily on industry generated, multichannel reflection seismic data and the approximately 239 offshore wells drilled to date. About 750,000 km of multichannel seismic are now available for examination. Well data studied include logs, samples and drilling histories. The data base for information for the Upper Paleozoic investigations includes surface sections, coal, salt and potash mines, and some core holes, as well as a limited number of offshore wells. No exploration is currently underway involving Upper Paleozoic prospects.

Offshore eastern Canada encompasses an area stretching from 41°N to 76°N. Specific areas include: Baffin Bay, Davis Strait, Hudson Bay and Hudson Strait, the Labrador Shelf, Northeast Newfoundland, the Grand Banks, the Gulf of St. Lawrence, the Scotian Shelf, and the Bay of Fundy. Contiguous areas studied by the Subdivision's scientists include the North Atlantic, Labrador Sea and Baffin Bay (including ODP drill holes), western Europe (surface sections), and the U.S. Atlantic continental margin (wells).

The twenty-five scientific projects in the Subdivision can be classified in one of four categories: basin analysis; resource appraisal; biostratigraphy; and data bases. Basin analysis and petroleum geology utilise the disciplines of petroleum geology, geophysics, lithostratigraphy, geochemistry, sedimentology and biostratigraphy. Resource appraisal draws on seismic stratigraphy and geochemical information. Biostratigraphy includes palynology and micropaleontology. The major data bases under development are: WELLSYS, BIOSTRAT, KREMPFILE, LOGFILE, LITHFILE and SEISMIC. Although the data base programme is treated separately, it spans all the scientific studies. Highlights are discussed in the following section according to programme.

The oil industry's exploratory activity offshore tends to influence the Subdivision's workload. For example, the Venture and Hibernia discoveries have focussed attention on the Scotian Shelf and East Newfoundland Shelf respectively. As a result there has been a marked increase in the number of wells drilled and seismic surveys conducted in these areas during the past few years. Accompanying this has been a slowdown in drilling in other east coast areas such as the Labrador Shelf. This means that the second generation data base tends to be concentrated around areas which have experienced exploration success. These are the areas where the most detailed

work can be done, and which usually provide the best case histories.

The resource appraisal programme is part of E.M.R.'s interbranch assessment. It has been carried out in collaboration with the federal regulatory agency, Canada Oil and Gas Lands Administration (COGLA), and with staff of the Petroleum Resource Appraisal Secretariat at the Institute of Sedimentary and Petroleum Geology in Calgary. Until recently COGLA has been responsible for the curation of all industry data on the offshore east coast of Canada. With the signing of the Atlantic Accord, part of this responsibility has been transferred to the Canada-Newfoundland Offshore Petroleum Board and a similar responsibility transfer is anticipated for the other Atlantic provinces. Future resource assessment studies are, therefore, likely to involve the Subdivision staff in working with regional regulatory agencies. At this time, all seismic records pertaining to offshore Newfoundland and Labrador are now curated in St. John's but all well samples are still stored at the Bedford Institute, where they are available for study to any interested party after lapsing of the confidential period.

Highlights**BASIN ANALYSIS AND PETROLEUM GEOLOGY****Scotian Shelf**

A major thrust is now underway to delineate in detail the structure of the Scotian Shelf and to define the form and extent of the major paleotectonic features of this classic passive margin province. Some 112 wells have now been drilled on the Scotian Shelf. Eight of them penetrate Paleozoic basement and all of them document facies variations within the Mesozoic and Cenozoic prograding wedges which have built up the continental margin. In this fiscal year, we have acquired an additional 50,000km of high quality recently shot oil industry multichannel reflection seismic lines. Much of this data is still confidential and interpretations based on it cannot be published before 1988-89. It promises to provide a very detailed understanding of such features as the Abenaki carbonate bank and the down-to-basin growth fault configuration. Simplified structure and isopach maps supported by released seismic profiles have been prepared for the Decade of North American Geology/Geology of Canada volume, "The Continental Margin: Eastern Canada".

The new data also provide the documentation required for sequence mapping. It is planned to integrate such interpretations with lithologic and paleofacies data derived from sample examination, Lithfile and biostratigraphic studies. Lithfile has already generated lithofacies maps of the Logan Canyon Formation in the Scotian Shelf which hint at multiple source areas for the sands.

During the current year two major compilations have been completed as chapters for volume 9 of the Geology of Canada Series. In one study the stratigraphy of the Georges Bank is broken down into units based primarily on seismo-stratigraphy with an informal correlation to Scotian Shelf nomenclature.

Our current understanding of the Scotian Basin is summarized in a second chapter. Major conclusions are much the same as those published in G.S.C. Paper 74-30 but new insights include the restriction of the Abenaki Formation to a narrow zone west of Sable Island and the identification of the thick limestones east of the island as beds within a very thick Mic Mac clastic sequence. The Roseway limestone unit is recognized as being the lateral time equivalent of the Missisauga formation. Thick Jurassic sediments in the outer shelf area mean that basement may reach depths of up to 16 km.

Reflectance levels of 1.0 Ro to 1.2 Ro, which are assumed to represent peak gas generation, occur around 5000 m in the gas-prone Verrill Canyon Formation source rock.

Geopressures on the Scotian Shelf are being studied by numerical modelling using COGLA's data base of subsurface formation pressures. It is planned to attempt to simulate the generation and evolution of the geopressed section and gain insights into the factors that exert the most control.

A method has been developed for deriving in-situ stress magnitudes from the drilling records of offshore wells, by reference to pressure tests and information collected by downhole logging tools. This approach has been applied in the Venture area to provide in-situ stress magnitudes and to show that, over depths of 500 m to 5500 m, the largest and smallest principal stresses are horizontal, and the intermediate principal stress is vertical. Earlier studies of breakout orientations showed that the greater horizontal stress is oriented NNE-SSW. This stress regime is believed to be regional in extent and to reflect mantle tractions acting on the base of the North American lithospheric plate.

Geochemical studies of the Mesozoic volcanics encountered in the Glooscap C-63 well are in progress, and further studies of the problematic astrobleme structure at Montagnais I-94 have been undertaken. Geochemical studies of the Argo Salt on the Scotian Shelf are being undertaken to define geochemical signatures and assess precise depositional conditions.

Grand Banks

During the past year, the East Newfoundland Shelf area was studied intensively in response to the active and successful hydrocarbon exploration program currently underway in the Jeanne d'Arc Basin. These programs involved several operating companies and have provided detailed suites of logs and well samples for investigating the evolution of the basin. During the fiscal year, work continued on defining the stratigraphic framework of the Jeanne d'Arc Basin and our understanding of the succession has now reached the stage when it is feasible to define rock stratigraphic units and formalize the lithostratigraphy. Log data, biostratigraphy and seismic profiles have allowed the recognition of a complex configuration of unconformities affecting the Cretaceous and Jurassic units. During the year contracted studies provided much petrographic information on the reservoir sandstones in the Jeanne d'Arc Basin.

Regional seismic interpretation is ongoing on the Grand Banks and surrounding areas. A "Base Event" (partially equivalent to the Avalon Unconformity) has been widely mapped at a scale of 1:250,000. An updated regional Basement/Tectonic map has also been prepared for inclusion in the GCOS, volume 9, compilation. A major feature of this map is the great thickness of sediments along the axis of the Jeanne d'Arc Basin where the top of Basement is at a depth of 15 km or deeper.

A chapter summarising the stratigraphy and structure of the Grand Banks and adjacent areas has been prepared for GCOS, volume 9, which emphasises that complexities of this region relate in part to its situation in the transition zone between the seafloor spreading regime of the North Atlantic and that of the Labrador Sea. Mesozoic deposition on the Grand Banks commenced in ?Late Triassic time and the early sequence is characterized by red beds followed by evaporite and carbonate deposition. The present configuration of Mesozoic basins on the continental margin around Newfoundland was established through subsidence beginning in Middle to Late Jurassic time, with deformation persisting into Late Cretaceous. The depositional record of this period is dominated by clastic sediments. Restricted circulation east of the Avalon Uplift resulted in the deposition of the organic-rich Kimmeridgian shales which source the oil discovered in the Jeanne d'Arc Basin. The potential of these source rocks north and east from the Jeanne d'Arc Basin remains to be fully explored.

Single channel seismic reflection records from the Avalon Platform have been analysed in conjunction with biostratigraphic data. They reveal that an Ordovician-Silurian sequence, folded about N-S axes, is overlain unconformably by ?Devonian red beds. The lower Paleozoic rocks stratigraphically overlie the early Paleozoic sequence exposed onshore on the Avalon Peninsula and extend the record of shelf sedimentation in the area.

Paleozoic rocks are encountered in wells drilled on the Grand Banks and East Newfoundland shelves. Information has been compiled for a chapter in GCOS, volume 9. The main conclusions are that folded Avalon Zone rocks are extensively present offshore of Newfoundland, and that a series of mildly deformed late Paleozoic structural basins are present in the subsurface of the Grand Banks and East Newfoundland Shelf.

Over the past year, vitrinite reflectance values were measured on samples from 8 additional wells on the East Newfoundland Shelf. These organic maturation profiles augmented our data base to the level where regional variation could be mapped, and it became clear that maturation/depth relationships varied significantly over the Jeanne d'Arc Basin. These insights are summarized in a paper which concludes that the thickness of the oil generative window was controlled by the structural configuration of the basin and demonstrates that the oil window is thickest immediately downdip of the oil-rich trans-basin fault trend.

Geochemical studies undertaken in collaboration with staff of the Institute of Sedimentary and Petroleum Geology have shown that all the oil discovered

in the Jeanne d'Arc Basin can be attributed to a rich widespread source rock sequence of Kimmeridgian age. Time Temperature Index modelling is underway to assess when oil generation may have occurred. An Eocene generation episode appears probable in areas around the basin margin; in the basin centre, oil generation may have begun during Late Cretaceous time.

A preliminary review of geopressures has been made. Unlike the Scotian Shelf, geopressures in the Jeanne d'Arc Basin appear to be more stratigraphically controlled and the rocks involved are undercompacted. Very significant overpressuring is present and levels equal to those measured on the Scotian Shelf have been encountered.

Drilling records and log data have been examined to assess the offshore in-situ stress regime of the Grand Banks and adjacent areas. Data coverage and quality is uneven, but indicate that the largest and smallest principal stresses are horizontal and the intermediate principal stress is vertical. The area appears to be under regional compression directed NE-SW, but there are anomalous areas, possibly associated with recent faulting.

A report summarizing extensive geochemical and petrographic studies of the Mesozoic volcanics concludes that they are alkaline intra-plate extrusives associated with late Early Cretaceous plate rearrangement. Grand Banks evaporites have been comprehensively studied and a report prepared.

Labrador Shelf

Because of the cessation of industry exploration activity and lack of staff, little work has been done on oil industry samples and data from the Labrador Shelf during the past fiscal year.

A compilation of the Mesozoic and Cenozoic geology of the Labrador Shelf has been prepared externally for GCOS, volume 9, with input from Subdivision staff. The Paleozoic geology and structure of the southern Labrador Shelf has been compiled for GCOS, volume 9.

Dipmeter logs and drilling records have been analysed for 14 wells on the Labrador Shelf and in Davis Strait to determine the present day in-situ stress regime. Initial results suggest that the maximum horizontal principal stress is oriented NNE-SW, and that a compressional regime is present.

Gulf of St. Lawrence and surrounding areas

An intensive contractual study of industrial seismic lines shot across the Gulf of St. Lawrence is in progress which is aimed at delineating the geometry of the Magdalen and Anticosti basins so that their evolution can be numerically modelled. A fall-out of the study will be an increased understanding of the hydrocarbon generation regime for incorporation into future resource studies.

During the past year, a summary and compilation of the geology of the Gulf of St. Lawrence and surrounding areas has been prepared for GCOS, volume 9, as part of a chapter describing the Paleozoic geology of

offshore Eastern Canada. Preliminary indications are that the Upper Paleozoic sequence in the Magdalen Basin may reach a thickness of 12 km in the axial zone, and the study gives a new appreciation of the former extent of Late Paleozoic sedimentation. The compulsory study of Upper Paleozoic evaporites in southeastern Canada has been completed, and is now being edited for publication.

Vitrinite reflectance measurements on coal samples have been used to infer time of faulting in the Mabou-Inverness area, Cape Breton, and coal maceral studies undertaken in the Sydney coal field.

The geological interpretation of the Northumberland F-25 well has been reassessed and the results suggest that some of the basalts previously thought to be Paleozoic are, in fact, Triassic and their intrusion related to the late stages of rifting associated with the opening of the Atlantic Ocean.

RESOURCE APPRAISAL

The Subdivision has undertaken studies in the Jeanne d'Arc Basin during this fiscal year, as part of an evaluation exercise aimed at updating the assessment of hydrocarbon potential. These studies concentrated on organic maturity, source rock potential and the hydrodynamic framework of the basin. At year's end Subdivision staff, working in collaboration with COGLA, had completed compilation of regional geological data, geochemical analysis, stratigraphy and play definition. This data was presented at the first committee meeting in February 1986. COGLA provided quantitative parameters for statistical analysis, which is currently in progress.

A new appraisal of the potential for coal reserves in the Gulf of St. Lawrence has emerged from a study of the offshore extent of coal seams recorded in exploration wells. This assessment is the subject of a report entitled "The Gulf of St. Lawrence Carboniferous Basin; the largest coal field of Eastern Canada" by P.A. Hacquebard, which is currently in press.

An overview of offshore Eastern Canada's hydrocarbon discoveries and resource potential was presented at the G.S.C. Forum in Calgary in February 1986. The presentation was based on a paper entitled "The continental margin of eastern Canada - geological framework and petroleum potential" by A.C. Grant, K.D. McAlpine and J.A. Wade, which is now in press. This study presents a regional tectonic overview of the offshore basins, outlines the trapping regimes of significant hydrocarbon accumulations, discusses the types and origins of the trapped hydrocarbons and their local setting, and includes estimates of future potential.

The report "Petroleum Resources of the Scotian Shelf" by J.A. Wade, G.A. Campbell, R.M. Procter and G.C. Taylor has been completed, reviewed and approved for publication as a G.S.C. Paper.

Vitrinite reflectance measurements made during the previous year have provided information on organic maturation in 8 wells on the Grand Banks and 2 onshore coal mining areas, and comprehensive Open File

reports have been issued. This information is critical for estimating organic maturation levels and, with biostratigraphic zonations, permits us to model hydrocarbon generation and estimate when it is likely to have occurred at a particular location. Also critical are the Subdivision's ongoing investigations of the overpressure regime on the Scotian Shelf, which are expected to impact future resource assessment activities.

In addition to these ongoing studies, the Subdivision has been represented at meetings of the Petroleum Resources Appraisal Secretariat and staff have been involved in working meetings with Secretariat and COGLA colleagues.

Oil samples have been recovered from a previously documented seafloor oil seep at Scott Inlet in Baffin Bay. Earlier reports of the seeping oil had aroused interest in exploration circles. Preliminary chemical analyses suggest that the oil is very immature and probably not suitable for commercial exploitation.

BIOSTRATIGRAPHY

The objectives of this programme are to develop and implement a detailed biostratigraphic zonation and paleoecologic framework for the Upper Paleozoic, Mesozoic and Cenozoic rocks of the sedimentary basins of eastern Canada, onshore and offshore, and contiguous regions. It is also our longterm objective to develop qualitative and quantitative biostratigraphic, paleoecologic, paleobiogeographic, and paleo-oceanic models for passive continental margins and the adjacent oceanic basins.

Within the biostratigraphic programme, the two major disciplines are palynology and micropaleontology.

In 1985, one of the Subdivision's paleontologists, Dr. F.M. Gradstein, published (with Agterberg, Brower and Schwarzacher) a book entitled "Quantitative Stratigraphy". The text discusses and describes modern statistical methods of zoning and correlating fossil-bearing rock sequences quantitatively. It also covers application of these quantitative techniques to time scale definition and for calibrating subsidence and sedimentation history models. In essence, the book describes practical, and widely feasible, analytical methods for making the most of the incomplete fossil record normally available for analysis. These quantitative stratigraphic methods have been applied to microfossil assemblages recovered from Grand Banks and Labrador Shelf wells to define optimum zonations and correlations for these areas.

At the present time the rate of exploration drilling on Canada's East Coast continental shelves is decreasing. However, over the past several years extensive drilling has been undertaken and most of the wells have been deep, usually exceeding 4500 m (15,000 ft). The recent exploration spurt has left the Subdivision with a large backlog of wells for which basic biozonations are required and a need for more detailed studies of particular parts of the section to allow more focussed correlation of lithostratigraphic units. The F.G.P. Basin Atlas program will lean heavily on good biostratigraphic control

and it is planned to augment in-house efforts with contracted studies.

During the report year, emphasis has been placed on developing and refining biozonations of Jurassic and Cretaceous sequences on the Scotian Shelf and Grand Banks. There is an ongoing requirement for precise Jurassic and Early Cretaceous biozonation of the hydrocarbon-bearing reservoir intervals in these two regions. As has been true in the past, most of the material studied has been derived from ditch cuttings, which inevitably contain caved material. Extensive core material is sometimes available, and this provides uncontaminated in-situ samples. However, Eastern Petroleum Geology biostratigraphers frequently cannot examine material from sidewall cores, which is routinely available to their oil industry counterparts and often to consultants, therefore, their biostratigraphic results may be less precise than those obtainable through use of in-place material. At the present time, collection of sidewall core material is not routinely undertaken by the regulatory agencies.

Palynology

Problem intervals in the deeper parts of the following Scotian Shelf wells have been studied and reports compiled for: Cohasset D-42, Cree E-35, Demascota G-32, Olympia A-12, Venture B-43 and Venture B-52. In addition, parts of the succession encountered at Cohasset L-97 and Penobscot L-30 have been studied and the Jurassic sections at Iroquois J-17 and Primrose N-50 have been re-examined. Contractual analysis of the calcareous dinoflagellate record in Bonniton H-32 has also been completed, and late Paleozoic spore assemblages from field samples collected by the Nova Scotia Department of Mines and Energy have been described.

A major study proposing a suprageneric classification for fossil and living dinoflagellates is an advanced stage of preparation as is a study of the taxonomy and biostratigraphy of schizaelean spores from the Jurassic-Cretaceous boundary interval in the Aklavik Ranges, Northwest Territories. The conclusions of this study have application to palynological research in Eastern Canada, especially for long range correlations that cross boundaries between facies and faunal realms.

An index to genera and species of anemiacean, schizaeacean and related spores has been published and is now being distributed. The fourth edition of the internationally recognized index to fossil dinoflagellate genera and species by J.K. Lentin and G.L. Williams has been completed, published and circulated.

A refined palynostratigraphic/lithostratigraphic report of Late Jurassic-Middle Cretaceous strata of the Jeanne d'Arc Basin is in the final stages of preparation.

As discussed later the Subdivision's data bases containing palynological information have been greatly expanded and improved during the report year. Video-taping techniques are also being developed for documentation and data exchange and S.E.M. photography is being applied in taxonomic research.

Micropaleontology

Computerized well reports of foraminiferal assemblages, including range plots, have been generated for the following previously studied wells in the East Newfoundland Basin-Flemish Pass area: Mobil et al. Rankin M-36, Mobil et al. Hibernia I-46, Mobil et al. Hibernia J-34, Mobil et al. Hibernia O-35, Mobil et al. Hibernia K-18, Mobil et al. Hibernia G-55, Chevron et al. Hibernia P-15, Mobil et al. Hibernia B-08, Mobil et al. Hebron I-13, Mobil-Gulf Bonniton H-32, Petrocan. et al. Terra Nova K-08, and Esso Voyageur Gabriel C-60.

Zonations and correlations have also been provided for the COST G-1 and COST G-2 wells on Georges Bank. This information is being published in *Geology of Canada Series, Volume 9*.

During the current year, biostratigraphic reports reporting on Mesozoic foraminifera and ostracod zonations and depositional environments have been prepared for the following wells: Uniacke C-72, Glenelg J-48 and West Esperanto B-78 on the Scotian Shelf and Emerillon C-56 on the Grand Banks.

A paper has been completed on the Berriasian and Valanginian foraminiferal zonation of the Atlantic Margin of North America which extends these newly established zones from Flemish Pass, on the Grand Banks, to the Baltimore Canyon area, U.S. east coast.

Detailed comparisons of microfossil assemblages used to define the Jurassic-Cretaceous boundary in eastern Canada and Europe are underway to improve the precision of analyses and validate the proposed zonation. In this regard, calpionellids are proving to be excellent index species.

Mesozoic and Cenozoic paleoceanography of the North Atlantic is discussed in a chapter prepared for Volume 9 of the *Geology of Canada Series* and incorporates conclusions derived from new studies of eastern Canadian microfossil assemblages.

A significant contribution to IGCP Project 148 has been the development and application of computer programmes in the ranking and scaling of biostratigraphic events. The Ranking and Scaling Programme (RASC) provides an optimum sequence for the stratigraphically useful species and estimates the spacing or relative distance between events. This provides a relative time scale. Other aspects of the programme highlight deviations of taxa ranges from the normal or standard in individual wells. The successor to RASC is CASC, Correlation and Subsidence Curves. CASC is intended to provide linear time correlation of wells and sedimentation plots. It is proving useful for probabilistic geohistory analysis.

During the past year a CASC manual has been issued and a report prepared on numerical methods for determining porosity-depth relationships and burial histories at well locations. Splines on RASC sequences have been used to develop a regional time scale for use in the East Newfoundland Basin, Scotian Basin, Labrador Sea and North Sea. Initial dating of regional hiatus show some congruence with Cenozoic eustatic events identified independently.

An effective biozonation of a turbidite sequence containing hydrodynamically mixed faunas has been derived from the Shell 30/19-1 well in the North Sea, after applying RASC and CASC to generate preliminary zonations and correlations for more than 25 wells in the area.

DATA BASES

The objectives of this programme are to develop and maintain major data bases covering all aspects of subsurface studies conducted or used by the Subdivision. Those now operational are WELLSYS, BIOSTRAT, RASC, KREMPFILE, LOGFILE, LEXFILE, and LITHFILE.

WELLSYS, the well data base, contains geographic, geologic, and engineering data on all offshore east coast wells. It now lists basic geographic and engineering data on 259 wells. The data source includes well history reports on file with COGLA, EPG internal reports, and some publications by EPG staff and COGLA. A major effort is now underway to load all relevant publications.

During the fiscal year, basic geographic and engineering data on all offshore East Coast wells were incorporated into WELLSYS. This data base was also updated so that all Eastern Petroleum Geology's internal reports on stratigraphy, lithology, organic maturation, and paleontology to the end of 1985 are now included in the file. Loading of test results is nearing completion with detailed testing data on 52 wells loaded to date. Relevant outside publications are also being loaded into the data base. To date 39 papers have been processed. During the year, WELLSYS provided information to EPG staff and COGLA officials in Halifax and Dartmouth.

BIOSTRAT contains detailed palynological analyses of more than 100 wells, plus formation picks, ages, visual kerogen, and vitrinite reflectance data. Foraminiferal data from 22 wells have been loaded. Sophisticated range plots have been produced for all these wells using a relative time scale. Using this capability, it has been possible to produce range charts of more than 400 selected dinoflagellates that have stratigraphic significance on a world scale. The latest binomial combination for each taxon can be generated through BIOSTRAT, which features a taxonomic dictionary that is currently being updated. This dictionary can produce alphabetic listings according to genus or species, with author and date of publication.

PALYLIT is a palynological data base which includes only published information. It is a jointly funded endeavour supported by an industrial consortium with operations supervised within the Eastern Petroleum Geology Subdivision. Using contractual assistance supplied by the consortium, 1400 new publications have been abstracted. 1200 of these have been passed through check programs and along with the documents updated last year, have been loaded into the data base. Palynodata Inc. set up as a non-profit organisation to carry on the project and provide public access to the data, has accomplished this goal. The file is housed at MCRB in Hollywood, California.

LITHFILE contains lithological data on all released offshore Eastern Canadian wells. Sample descriptions are purchased from Canadian Stratigraphic Services and reformatted for A.G.C.'s System 2000

data base. Outputs include lithofacies information for selected intervals for incorporation into maps and sections and vertical histograms of specified lithologic data for chosen wells. Software has been developed for generating vertical profiles. LITHFILE maps will be used extensively in the upcoming Basin Atlas compilations.

LEXFILE is a data base which has been built from the information gathered during the preparation of the Lexicon of Canadian Stratigraphy, Volume VI: Atlantic Region, which was largely compiled within the Subdivision and will shortly be published. LEXFILE presently contains 2451 entries summarizing information on stratigraphic units which can be searched by age, name, location, ranking and history. It is being maintained and developed by Subdivision staff in cooperation with earth scientists in Atlantic provincial departments and universities. So far as we are aware, this is the first stratigraphic Lexicon data base to be developed, and we anticipate long term usefulness as a stratigraphic tool and rapid information source for earth scientists in Atlantic Canada.

OCEAN DRILLING PROGRAMME

This year the Glomar Explorer drilled 2 ODP research holes in the Labrador Sea and one in Baffin Bay, with participation by A.G.C. scientists, and Subdivision staff are analysing some of the samples recovered. Subdivision staff also participated in ODP drilling on Galicia Bank.

Personnel Notes

The Subdivision has a permanent staff of twelve scientists, seven technicians, two draftsmen and one secretary. During the year, one scientist (P.A. Hacquebard) has been working on a 1/3 time contract and three technicians have been employed on a temporary basis or through contracts.

Sebastian Bell assumed the position of Subdivision Head on April 15th, 1985. He replaced the former Head, Graham Williams, who is undertaking a special assignment in palynology.

Nelly Koziel accepted permanent employment as the Subdivision's secretary in June 1985.

Aubrey Fricker transferred from the Program Support Services Subdivision to Eastern Petroleum Geology in June 1985.

Dr. Federico Oloriz, a Mesozoic ammonite specialist from the University of Granada, visited the Subdivision in December 1985 to work with Dr. P. Ascoli.

Graham Williams spent part of February and March 1986 at the Pacific Geoscience Centre working with Dr. M.J. Keen.

Attendance at Meetings, Conferences and Courses

P. Ascoli

Paleontology Institute of Erlangen-Nürnberg University, West Germany, June 1985.

Centre de Paléontologie Stratigraphique, Claude Bernard University, Villeurbanne, France, July 1985.

M.P. Avery

Canadian Coal Petrographers meeting and field trip to Minto Mine, Fredericton, May 13-15, 1985.

The Society of Organic Petrology Annual Meeting, Houston, Texas, November 8-9, 1985.

Atlantic Geoscience Society Annual Colloquium on Current Research, Amherst, January 17-18, 1986.

M.S. Barss

Mid-year meeting of American Association of Stratigraphic Palynologists, New York, April 17-19, 1985.

Meeting of Palynodata Inc., Irving, Texas, August 21-23, 1985.

Annual Meeting of Geological Survey of Canada Palynologists, December 9-12, 1985.

J.S. Bell

Geological Survey of Canada, Oil and Gas Forum, Calgary, February 11-12, 1986.

Continental Scientific Drilling in Canada, Ottawa, February 3-5, 1986.

Canadian Geophysical Union/Society of Exploration Geophysicists Meeting, Calgary, June 1985.

R.A. Fensome

Meeting of Geological Survey of Canada's palynologists, Calgary, December 1985.

A. Fricker

Atlantic Geoscience Society Colloquium on Current Research, Amherst, January 17-18, 1986.

University of New Brunswick Computer Science Cooperative Program Advisory Committee, Fredericton, October 1985.

Association of System 2000 users for Technical Exchange, Austin, Texas, June 1985.

Canadian Association for Information Science, Montreal, May 1985.

F.M. Gradstein

Undergraduate symposium in honour of Dr. C. Milligan, Dalhousie University, April 1985.

O.D.P. symposium, G.A.C. Fredericton, May 1985.

Deep Water Benthics Meeting, Woods Hole, May 1985.

Deep Water Benthics Meeting, Houston, 1985.

A.C. Grant

S.E.G. - C.G.U. Meeting, Calgary, May 8-10, 1985.

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Fredericton, May 14-17, 1985.

Hydrocarbon Inventory Meeting, Halifax, June 24-25, 1985.

Hydrocarbon Inventory Meeting, Dartmouth, November 12, 1985.

Geological Survey of Canada Forum, Calgary, February 11-12, 1986.

Hydrocarbon Inventory Meeting, Dartmouth, February 26-28, 1986.

P.A. Hacquebard

Coal Seminar for Chinese delegation; organized by COGLA, Halifax, August 26, 1985.

Atlantic Geoscience Society Symposium, Amherst, January 18, 1986.

Canadian Coal Petrography Group (workshop), Fredericton, May 13-15, 1985.

R.D. Howie

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Fredericton, May 15-17, 1985.

Geological Survey of Canada Forum, Calgary, February 11-12, 1986.

B.C. MacLean

Joides, Safety Panel Meeting, Paris, France, October 22-23, 1985.

W.C. MacMillan

Atlantic Geoscience Society Colloquium on Current Research in the Atlantic Provinces, Amherst, January 17-18, 1986.

D-Base III course, Dartmouth, March 3-5, 1986.

K.D. McAlpine

Geological Survey of Canada Forum, Calgary, February 11-12, 1986.

J.A. Wade

Geological Society of America, Orlando, Florida, October 28-31, 1985.

G.L. Williams

Dino III, London, England, August 12-16, 1985.

Atlantic Geoscience Society Colloquium, Amherst, January 17-18, 1986.

Membership on Committees

P. Ascoli

Member, Organizing Committee "Benthos '86".

M.S. Barss

Officer, Palynodata Inc.

J.S. Bell

Member, Canadian National Committee on the Lithosphere.

Member, Atlantic Ocean Drilling Project, Downhole Measurements Panel.

Vice Chairman, Organizing Committee, A.G.S.-C.S.P.G.-I.U.L. Basins of Eastern Canada Symposium.

Member, Geological Association of Canada - Past President's Medal Committee.

G.A.C. Representative, World Petroleum Congress.

R.A. Fensome

Secretary/Treasurer, Canadian Association of Palynologists.

Assistant Secretary, International Federation of Palynological Societies.

A. Fricker

President, Atlantic Geoscience Society.

President, Association of System 2000 users for Technical Exchange.

Councillor, Atlantic Chapter, Canada Association for Information Science.

F.M. Gradstein

Chairman, International Committee for Quantitative Stratigraphy.

Member, Canadian National Committee Ocean Drilling Project.

Member, Indian Ocean Panel, O.D.P. 1984-1986.

Member, Working group 82 of Scientific Committee on Ocean Research dealing with Mesozoic-Cenozoic Deep Water Circulation.

Chairman, Canadian Ocean Drilling Project, National Workshop, Hamilton, Ontario, September 1986.

Co-chairman, 2nd Arenaceous Foram Workshop, Vienna, June 1986.

Co-leader, Deep Water Foraminifera Benthics Project, Woods Hole, 1981-1986.

Adjunct Professor, Dalhousie University, Halifax.

Associate Editor, Micropaleontology.

Editorial Board Member, Geologie en Mijnbouw.

P.A. Hacquebard

Councillor, Council of Min. Soc. of Nova Scotia at Sydney, November 30, 1985.

L.F. Jansa

Member, Atlantic Regional Panel.

Co-chairman, Technical Session at XII Sedimentological Congress, Canberra, Australia.

B.C. MacLean

Backup representative for Canada on Joides Safety Panel.

W.C. MacMillan

Secretary, Atlantic Geoscience Society.

Member, Organizing Committee, A.G.S.-C.S.P.G.-I.U.C. Basins of Eastern Canada Symposium.

G.L. Williams

Chairman, C.S.P.G. National Liaison Committee.

Chairman, G.A.C. Special Projects Committee.

Chairman, APICS Geology Committee.

Chairman, A.A.S.P. Awards Committee.

Special Talks, Lectures and Poster Sessions

P. Ascoli

Half-day seminar on practical utilization of microfossils for biostratigraphic purposes on the Canadian Atlantic Shelf given to Dalhousie University graduate students. Halifax, February 1986.

M.P. Avery

Vitrinite Reflectance as a maturation determination technique. A.G.C. Science Hour (with J.A. Wade, G.L. Williams, K.D. McAlpine), November 1985.

Indications of source area for Hibernia oil from vitrinite reflectance studies, Grand Banks of Newfoundland (with K.D. McAlpine and J.S. Bell). Atlantic Geoscience Society Colloquium, Amherst, January 1986.

J.S. Bell

The Geological Structure of the Paleozoic rocks on the Avalon Platform, offshore Newfoundland (with P.W. Durling, G.B. Fader). Atlantic Geoscience Society Colloquium, Amherst, January 1986.

Stress orientations from borehole ellipticity. Continental Scientific Drilling in Canada, Ottawa, February 1986.

Stress refraction by basement highs - example from Western Canada (with P.F. Lloyd). Canadian Geophysical Union/ Society of Exploration Geophysicists Meeting, Calgary, June 1985.

The present day stress regime of the Scotian Shelf. Canadian Geophysical Union/Society of Exploration Geophysicists Meeting, Calgary, June 1985.

Hydrocarbon generation - offshore Eastern Canada. St. Mary's University, Halifax.

In-situ stress regime - offshore Eastern Canada. Memorial University of Newfoundland, St. Francis Xavier University and St. Mary's University.

Subtle is the Lord (a talk on the evolution of life). St. Francis Xavier University.

Organic maturation measurement and TTI modelling. Dalhousie University and St. Mary's University.

R.A. Fensome

Poster Session: Suprageneric classification of dinoflagellates. Dino III, England, August 1985.

A. Fricker

The stratigraphic nomenclature of Atlantic Canada (with G.L. Williams, W.C. MacMillan, J.A. Watt). Atlantic Geoscience Society Colloquium on Current Research, Amherst, January 1986.

Banquet address: Computing Science Club, Acadia University, Wolfville, March 1986.

Canadian Association for Information Science, Montreal, May 1985.

Association of System 2000 users for Technical Exchange, Texas, June 1985.

Project Bibliography (with A. Samson).

F.M. Gradstein

Mesozoic timescales. O.D.P. Symposium, G.A.C., Fredericton, May 1985.

North Sea Arenaceous Foram Stratigraphy using RASC. Deep Water Benthics Meeting, Houston, 1985 and Deep Water Benthics Meeting, Woods Hole, May 1985.

Jurassic quantitative paleoecological models (with B. Stam). Deep Water Benthics Meeting, Houston, 1985.

Course: Modern stratigraphic methods. Dalhousie University, Halifax, January 1986.

A.C. Grant

Basin eversion: an example from Solander trough, New Zealand. S.E.G.-C.G.U. Meeting, Calgary, May 1985.

Regional geology of Grand Banks. Hydrocarbon Inventory Meeting, Halifax, June 1985.

Faulting in soft sediments. A.G.C. Science Hour, October 1985.

Petroleum geophysics. Nova Scotia Institute of Technology, November 1985.

Unexpected bottom features. A.G.C. Science Hour, December 1985.

East coast hydrocarbon discoveries, a regional overview (with D.K. McAlpine, J.A. Wade). Geological Survey of Canada Forum, Calgary, February 1986.

Petroleum geophysics, with east coast samples. Dalhousie University graduate students, Halifax, February 1986.

P.A. Hacquebard

Geology of Sydney coalfield with emphasis on submarine mining. Coal Seminar for Chinese delegation, Halifax, August 1985.

Interpretations of offshore coal drilling results from downhole logging data. Coal Seminar for Chinese delegation, Halifax, August 1985.

The Gulf of St. Lawrence Carboniferous Basin; the largest coalfield in eastern Canada. A.G.C. Science Hour, April 1985 and Atlantic Geoscience Society Colloquium, Amherst, January 1986.

Lectures in Coal Geology and Coal Petrography at three universities: Aachen (Germany), Cape Town (South Africa), Regina (Saskatchewan).

L.F. Jansa

Jurassic of the North Atlantic. On board Resolution.

Results of Leg 103. A.G.C.

Mesozoic of North Atlantic with emphasis on the Grand Banks - Iberia geology. Department of Geology, University of Bilbao, Spain,

Carbonates on passive continental margins. Dalhousie University,

Stratigraphy - method and application. Dalhousie University,

Results and implications of Leg 103. McGill University,

Deep sea drilling off Iberia opens new potential for resources exploration. Dalhousie University,

W.C. MacMillan

Poster session: The stratigraphic nomenclature of Atlantic Canada. Atlantic Geoscience Society Colloquium on Current Research in the Atlantic provinces, Amherst, January 1986.

K.D. McAlpine

Hydrocarbon generation in the Jeanne d'Arc Basin, offshore Newfoundland (with J.S. Bell, M.P. Avery, L.R. Snowden, P.W. Brooks). Geological Survey of Canada Forum, Calgary, February 1986.

East coast hydrocarbon discoveries - a regional overview (with J.A. Wade, A.C. Grant). Geological Survey of Canada Forum, Calgary, February 1986.

Indications for source area for Hibernia oil from vitrinite reflectance studies, Grand Banks of Newfoundland (with J.S. Bell, M.P. Avery). Atlantic Geoscience Society Colloquium on Current Research in the Atlantic provinces, Amherst, January 1986.

F.C. Thomas

Lower Scotian Slope foraminiferal faunas, past and present - M.Sc. thesis defence. Dalhousie University, Halifax, October 1985.

G.L. Williams

A suprageneric classification of dinoflagellates. Dino III, London, England, August 1985.

The stratigraphic nomenclature of Atlantic Canada (with A. Fricker, W.C. MacMillan, J.A. Watt). Atlantic Geoscience Colloquium on Current Research in the Atlantic provinces, Amherst, January 1986.

Laboratory Statistics

Drafting

Original figures	280
Revisions in person hours	285
Exhibition displays in person hours	82

Micropaleontology

Samples picked	1479
Slides prepared	1482
S.E.M. photographs	603
Microscope photographs	317

Coal Petrology

Reflectance analyses	234
Maceral analyses	24

Palynology

Palynology samples processed	1372
Kerogen samples processed	213

Sedimentary Petrology

Thin sections	421
Compilations (figures)	10
Films printed	10

During the year, the Subdivision staff produced 4 G.S.C. papers, 4 contributions to G.S.C. Current Research, 22 outside papers, 15 published abstracts, 16 G.S.C. open file reports and 2 books. In addition, 15 biostratigraphic reports on wells, 15 vitrinite reports and 19 stratigraphic reports were completed as internal reports during this period.

PROGRAM SUPPORT SUBDIVISION

K.S. Manchester

The mandate of the Program Support Subdivision is to provide effective central support in electronic and mechanical engineering, data management, information system 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, ATV's, 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

Pisces IV - Pandora Operations

The DFO Pisces IV submersible with its tendership Pandora was on the east coast of Canada for the period May 9 to November 6, 1985. During this period AGC was the primary user with eight AGC cruises out of a total of 14, covering areas of interest from Halifax Harbour, Scotian Shelf and Slope Grand Banks, Labrador Shelf, to Baffin Island fiords and Baffin Shelf. The subdivision provided all the technical and logistic support to these AGC cruises similar to the previous east coast visit in 1981. Poor diving weather was encountered during some of the cruises which caused some objectives not being met. However, this was the only problem and generally the program

was a success.

Program Support Subdivision Field Operations

The 1985/86 season was a very busy and varied year with staff involved in field projects or cruises in geographic areas from the Arctic Ocean in the north to the Kane Fracture Zone at 23°N on the mid-Atlantic Ridge in the south and to the Beaufort Sea in the west. Technical staff supported 16 B.I.O. originated cruises, two in the Beaufort Sea plus the Ice Island reflection and refraction programs and also a number of joint AGC/industry cruises. In total there were in the excess of 300 project days supported by one or more PSS staff. The Pandora/Pisces IV program went very smooth in comparison to the previous 1981 east coast visit. The Ice Island sampling program had sampling winch problems that were impossible to overcome in the 1985 season. However, major efforts were put into improving the sampling facilities for the 1986 Ice Island field season that should ensure a very successful 1986 refraction seismic and geological sampling program.

NORDCO Limited Underwater Auger Drill Development

This project started in 1982 via a NRC PILP project awarded to NORDCO Limited, St. John's, Newfoundland to design and construct an underwater auger drill and sampling system with AGC providing the project scientific authority and shiptime for testing. The PILP project was completed in March 1984 with the basic system constructed and tested. During latter 1984, additional DEM&R contracts were awarded to NORDCO to design and construct a diamond drill system for the unit and to also convert the system from a two part umbilical system to a single umbilical system to improve its shipboard handling. In April further sea trials were successfully carried out on CSS Hudson with further dock trials at B.I.O. in May - June. A contract was awarded to NORDCO Limited to provide the system with operators for the Hudson cruise 85-027 to the Baffin Shelf and Hudson Strait areas where it performed well in collecting bedrock samples.

In early 1986 the project goals were completed with a long term agreement made between NORDCO Limited and the G.S.C. for future use of the system to meet G.S.C.'s requirements. Continuing improvements and capabilities are being implemented by NORDCO Limited with the addition of a cone penetrometer being added that will allow collection of in situ geotechnical information.

Ocean Bottom Seismometers at AGC 1975 to 1986

We bought two OBS's from the Hawaiian Institute of Geophysics in 1975. In 1976 we redesigned the instrument, built several for ourselves and started collecting useful data. The OBS's have been undergoing constant refinement and more were built in house (and lost). The instruments have contributed valuable scientific data throughout their development. In 1982 the University of British Columbia built six OBS's using the AGC design and in 1984 Dalhousie University used our design as the starting point for their digitally recording OBS. In 1985/86 Canadian Marconi Corporation built 20 new OBS's under the guidance of AGC as the AGC contribution to the Lithoprobe project. These units (costing less than \$20,000 each) may be the first commercially available OBS's to be delivered

in the world. Canada's collection of 30 OBS's probably represents the largest set of identified instruments now owned by any country.

RALPH 1985/1986

RALPH was little used for the first part of this year as development was proceeding on MUDL (the Massive Underwater Data Logger) and other refinements. MUDL is still not operational but RALPH has been reconfigured with a large solid state data logger and has been gathering data for two months on the CASP (Canadian Atlantic Storm Project) experiment in conjunction with a large array of oceanographic and atmospheric sensors.

Microfilming of Geophysical Records

Final testing of the Tameran TFC 2000 microfilm camera for the continuous duplication of AGC's underway geophysical records was completed in cooperation with the Public Archives of Canada. The results indicate the feasibility of using the camera for the duplication of most of AGC's geophysical records and with special film processing (presently under investigation) duplication of all of AGC's geophysical records. AGC is now searching for a private firm willing to purchase and operate the camera.

More Reliable Computer Generated Maps

The contents of AGC's data base of navigation for geophysical records has been verified against original records and cruise documentation dating back over twenty three years. The completion of this major task improves the reliability of computer produced maps used by AGC staff and other clients of Data Section.

Development of Prototype Coastal Information System Complete

Data Section of PSS in cooperation with staff from EMG and EPG completed the development of the prototype Coastal Information System with the exception of implementing the enhanced digital coastline feature used in computer generated mapping. This feature, delayed in implementation by the late delivery of new coastline data, will be operational in early 1986/87.

The year also saw the inclusion in the data base of a major new data set from the Beaufort Sea.

Data Section, in cooperation with staff in EMG, initiated discussions with the Nova Scotia Land Survey Institute for a cooperative project investigating the use of Geographic Information System (GIS) technology for managing and display of AGC's coastal information.

Historical Map and Chart Data Base Developed

Data Section of PSS developed a microcomputer based dBASE III data base and supporting graphical display and reporting for historical maps and charts from the St. Pierre and Miquelon area as part of its responsibility to support boundary dispute studies. This work supported the research efforts of Ed Tompkins of the Newfoundland and Labrador Provincial Archives.

The graphical display routines were developed through a cooperative training program with the Nova Scotia Land Survey Institute.

Laser Printing Comes to AGC

Data Section of PSS as coordinator of microcomputer acquisitions and through participation in the Computer Graphics Committee at the Bedford Institute of Oceanography introduced laser printing technology to AGC with the acquisition of a Hewlett Packard Laserjet Plus and a QMS Model 1200.

New Data Base Systems For Shipboard Use

A new system to acquire information on sample procurement, handling and storage and underway geophysical data collection has been developed by Data Section of Program Support Subdivision. It will be used on all 1986 AGC field programs to improve the accuracy and decrease discrepancies in information returned to Data Section for entry into the mainframe index data bases.

The new system has been developed using IBM compatible microcomputers and dBASE III relational data base management system.

Cruise Documentation Standards Policy Implemented

During any given field season the Atlantic Geoscience Centre can conduct as many as 20 sampling programs from seagoing research vessels. To provide a complete and convenient documentation of all work conducted by AGC personnel, standards have been implemented by AGC to ensure that those details pertaining to where, when, how, why and by whom the data has been acquired are properly addressed. Prior to the commencement of any given field season, chief scientists are required to meet with Data Section to review documentary procedures and to ensure that all cruise logs i.e., cruise, navigation, seismic and sidescan, Ships Division's Forms A, B and C and ROSCOP and appropriate AGC sample information sheets will be completed at a determination of a cruise.

The policy defines and sets timelines for the submission and review of cruise documentation.

A standard for the cruise report is also included.

The policy and standards will enhance not only the effectiveness of AGC's curation program but the usability of the data for the scientist and any future user.

Curation Progress

AGC continued to improve its system for cataloging and storing geological samples. The system aims to ensure the quality control of sample material and maintain it in as close to its original condition as possible. The associated standard sample information has been maintained within the "Sample Inventory Data Base" (SID). To date the collection has grown to more than 4,466 unconsolidated sediment cores, 210 drill cores and more than 135,000 processed samples.

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.

Attendance at Meetings, Conferences and Courses

W. A. Boyce

Visit Hunttec facility to amalgamate & inventory Seabed II system parts, Toronto, Ont., February 4 & 5, 1986.

I. A. Hardy

GSC & ad hoc committee meeting, Ottawa, Ont., January 10, 1986.

D.E. Heffler

Meeting with Knudsen Engineering re K-65, Ottawa, Ontario, September 13, 1985

D. Langdon

Data Base & Implementation course, Austin, Texas, June 5-7, 1985.

Technical meeting of system 2000 users, Austin, Texas, June 9-12, 1985.

Advanced Plex Planning, Austin, Texas, June 13 & 14, 1985.

St. Pierre Boundary Dispute-Boundary Studies Data Base workshop, Victoria, B.C., October 7-12, 1985.

W. MacKinnon

GSC Orientation course, Ottawa, Ontario, September 9-12, 1985.

Visit to Wood's Hole Oceanographic Institute, Woods Hole, Massachusetts, December 9&10, 1985.

K.S. Manchester

Ocean Surveying meeting, Ottawa, June 5-7, 1985.

Hunttec Seabed II meeting, Toronto, Ontario, June 18, 1985.

Meeting with M.O.T. to review Polar 8 Icebreaker Scientific Specifications, Ottawa, Ontario, November 7, 1985.

TEDCOM meeting, Boston, Massachusetts, November 26, 1985.

Visit to I.S.E. to inspect ROV, Victoria, B.C., January 8, 1986.

DFO ROV Technical Advisory Group meeting, Vancouver, B.C., January 9, 1986.

Hunttec Seabed II meeting, Toronto, Ontario, January 29, 1986.

ODP TEDCOM meeting, Marseille, France, February 17-20, 1986.

Meeting to discuss possible future use of SAGA-1 in Canada with Comex, Marseille, France, February 21, 1986.

A. G. Sherin

St. Pierre Boundary Dispute-Boundary Studies Data Base workshop, Victoria, B.C., October 7-14, 1985.

Toronto Computer Show, Toronto, Ontario, November 8-21, 1985.

Observing Tests of Flow Camera, Cleveland, Ohio, December 9&10, 1985.

Membership on Committees

A.S. Atkinson

Electronics Stores Committee

C.B. Chapman

Industry Advisory Committee to the Electronic Engineering Technician Program for the Department of Education for the Province of Nova Scotia.

M.E. Gorveatt

BIO Safety Committee

BIO Container Committee

I.A. Hardy

Management Committee for BIO Storage Areas

Arctic Land Sea Interaction Workshop '85 Steering Committee

Long Core Drilling Program Sable Island Advisory Committee (1985)

Quaternary Paleoceanography of Eastern Canada Committee

AGC Curation Committee

D.E. Heffler

BIO Instrumentation Development Review Committee

M.D. Hughes

BIO Safety Subcommittee

D. Langdon

BIO Communications Sub Committee

BIO Artificial Intelligence Committee

K.S. Manchester

Canadian member on the Technical and Engineering Development Committee of the Ocean Drilling Program

AGC representative on the BIO Ship Users Committee

Member of the Ocean Engineering Committee of the Association of Professional Engineers of Nova Scotia

Energy, Mines & Resources representative on the DFO Class II Ship Design Committee

A.G. Sherin

BIO Computer Advisory Committee

AGC Data Management Advisory Committee

Chairman BIO Computer Graphics Committee

AGC Curation Advisory Committee

APICS (*) Computer Science Committee

Subdivision Manuscripts

The Subdivision staff produced one published paper, three abstracts, one Open File Report and four Internal Reports.

Data Management Requests For Services

	<u>Internal</u>	<u>External</u>
Data (computer & analogue:	218	20
General Info:	5	4
Reproduction:	412	2
Computer:	30	2
GSC/EPB Open Files:	22	7
	33 by AGC	
Purchasing Services:	7	0
Stationery (Microform:	3	0
Susan	44	13
Larry	57	3
Darrel	52	12
Samples:	1150	131
Sample plots/prints SID (June/85 - March/86)	40	39

*APICS—Atlantic Provinces Council on the Sciences

Internal

Subsampling:	
x-radiographs	102
Foraminifer	1638
Palynology	634
Diatoms	460
Coccoliths/smear slides	232/266
Lithologic analyses (carbonate)	66
Thin sections	23
Core photographs	84

Geotechnical:

Atterberg's Limits	125
Water Content	956
Sediment Slabbing	13
Swedish cone test	5
Shear vane	286
Porewater Chemistry	25
Consolidation	11
Specific gravity	27
Bulk density	46

Dating:

C14	31
O18	1
Tandem Accelerator	63
Total Organic Matter	70
Lead 210	41
Magnetic Susceptibility	239

Sediment Size Analyses:

	1277
Heavy Minealls	5
Trace Elements	16

CORDILLERAN GEOLOGY DIVISION

R.B. Campbell

The Cordilleran Division is responsible for geological studies in most of the Canadian Cordillera and the adjacent offshore regions. These studies are aimed at increasing the knowledge of the composition, age, distribution and origin of regionally mappable rock units to assess mineral and hydrocarbon potential, to guide mineral exploration and to aid in the planning of the orderly development of land utilization.

The Division includes a Marine Geology Section based at the Pacific Geoscience Centre, Sidney, Vancouver Island. Its scientists carry out stratigraphic biostratigraphic, sedimentological and structural studies of the Pacific Continental Shelf and adjacent areas with particular emphasis on assessing hydrocarbon potential; seismic and magnetic studies in conjunction with investigations by the Earth Physics Branch to determine the disposition of shallow to deep crustal layers on the Pacific continental shelf and slope; terrain sciences projects dealing with surficial sediments in the offshore areas and geomorphic processes along the coasts to aid in coastal management. Of recent importance are a variety of surveys and research studies of the Juan de Fuca Ridge system. The Vancouver based part of the Division is involved in a broad spectrum of research in those parts of the Cordillera mainly southwest and west of the areas of existing major hydrocarbon production. Therefore, emphasis is placed on projects that are important for mineral exploration and assessment. 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. Gross sales in F/Y 1985-86 were approximately \$106,000.

Highlights

Regional Geology Subdivision

Work on the geothermal program, which is winding down for the Division, was concentrated on a shallow reflection seismic survey of the graben at Lakelse Lake and associated hot springs near Terrace with a view to outlining the form of the graben and the subsurface stratigraphy of the graben fill. The survey identified impervious layers capping probable aquifers which may carry warm water. Test drilling is now required. Drs. J.A.M. Hunter and S.E. Pullen brought the contractor up to date on the newest techniques and methods prior to the start of the Survey.

The "Anahim Belt" dyke swarm near Bella Bella was mapped in detail. Like the volcanoes elsewhere in the belt the rocks exhibit bimodal compositions - peralkaline rhyolite dykes in the axial part of the belt and basaltic dykes for at least 20 miles to the north and south.

Conodont determinations continue to provide invaluable information for members of the Division. Development of the technique of recovering conodonts from chert has been very successful and has attracted the attention of conodont specialists from many parts of the world.

Several years of careful, detailed stratigraphic and structural studies with minimal resources in the Ogilvic Mountains near Dawson and the western Selwyn Basin near Ross River has brought those projects (Thompson and Gordey respectively) to the point where coverage can be greatly accelerated. This will require more resources than in the past and larger operations are planned for 1986-87. Although it covers a huge area the Selwyn Basin Paleozoic "shale facies" is not thick (less than 500 m) but is extensively imbricated on low-angle, shallow detachments of large overlap thus superficially it appears to be very thick. Much of this structural complexity could not be unravelled without conodont determinations. Both projects are situated in regions of high mineral potential where geological control is an essential element to successful exploration.

Field work for a thesis study on the Sylvester Allochthon, the site of asbestos and gold deposits, is now complete and has shown conclusively that some granitoid rocks of probable Early Permian age are included in imbricated thrust sheets of the allochthon and are not related to the mid Cretaceous Cassiar Plutonic Suite as previously thought.

Initial structural studies along the eastern margin of the Bowser Basin has shown that the intense folding of the Bowser Lake Group also involves underlying Lower Jurassic volcanic rocks (Toodoggone). The folding and related eastward directed thrusting implies a regional decollement at relatively shallow depth beneath the basin. On the northwestern side of the Bowser Basin Lower Jurassic Toodoggone volcanics have been found to be much more extensive than previously thought thus widening the exploration field for related gold deposits. Along the western margin of the basin new stratigraphic information on Paleozoic, Triassic and Jurassic volcanic and sedimentary rocks (including Toodoggone equivalents) will help focus exploration activity in the region. This work is leading to extensive revisions of earlier information and will have a bearing on coal exploration in the basin.

Separate studies of the Whitehorse Trough in northern British Columbia and southern Yukon involving biostratigraphy on the one hand and structural geology on the other both lead to the conclusion that the Triassic and Jurassic rocks of the trough are at least in part shallowly detached and that major elements of the trough are tectonically juxtaposed.

Evidence now seems conclusive that strata of the enigmatic "Snowshoe Formation" near Barkerville can be traced directly into and correlated with the Horsethief Creek Group which extends continuously from the Rogers Pass region into the southern Cariboo Mountains near Blue River. If the Snowshoe, as some evidence suggests, includes Paleozoic rocks as well as late Proterozoic, then the Proterozoic Kaza Group and Proterozoic and Paleozoic Cariboo Group must be tectonically juxtaposed against both the Snowshoe and Horsethief Creek Group contrary to the opinion that the Horsethief Creek lies stratigraphically below the Kaza Group. Hopefully isotopic dating of some of the rocks will help settle the problem which has important implications on the understanding of the tectonic evolution of the Omineca Belt.

Pacific Marine Geology Subdivision

Continued biostratigraphic studies in the Queen Charlotte Islands on Jurassic and Cretaceous strata have shown that potential hydrocarbon source and/or reservoir beds of Early Jurassic and Early Cretaceous ages are more extensive and extend farther south than previously known thus significantly adding to the potential for hydrocarbon resources. This detailed work is permitting a reordering of Cretaceous stratigraphy and paleogeography which may be important in the interpretation of bore hole data if and when exploration resumes.

The Tertiary Masset volcanics of the Queen Charlotte Islands are found to be cut by ENE verging thrust faults and NE trending strike slip faults of Neogene age. Both appear to be related to a Neogene episode of crustal shortening that is responsible for the uplift of the Queen Charlotte Ranges and for tectonic thickening of the Tertiary succession. Because of tectonic thickening the Masset volcanics may be thinner than has been supposed hence careful mapping and structural analysis may lead to the determination of optimum sites to drill through them to test for hydrocarbon potential in underlying strata. An understanding of the Masset evolution provides important data relative to the tectonic evolution of the Pacific margin.

Mapping at 1/50,000 was completed on the main Vancouver Island Lithoprobe transect (by contract). The work has shown that the Cowichan Lake and Beaufort Range faults are parts of the same westerly

directed thrust system of probable Santonian (late Cretaceous) age. The mid Jurassic Bonanza Group volcanics appear to be part of a major caldera complex. They include significant silicic volcanic rocks and may thus offer a previously overlooked mineral exploration target. The mapping has confirmed the existence of thrust faults interpreted from the seismic data.

Detailed study of plutons along the transect revealed that all are composite intrusions ranging from diorite and quartz diorite to quartz monzonite. The plutons intrude the mid Jurassic Bonanza Group and are overlain by the Upper Cretaceous Nanaimo Group. The heterogeneous mafic phase is similar to and displays similar intrusive relations and inclusion lithologies to the more extensive West Coast Complex.

In the offshore 650 km of deep, multichannel seismic reflection profiles were run from the Vancouver Island margin to the Juan de Fuca Ridge. The data are being processed but preliminary stacks clearly show the subducting Juan de Fuca Plate and complex structures above it. One of the profiles is a seaward extension of the Vancouver Island Lithoprobe profile. With completion of processing the data, combined with Lithoprobe, will provide perhaps the best seismically documented subduction zone in the world.

During the summer systematic Natural Resource Charting of the Canadian Exclusive Economic Zone was completed out to the 200 nautical mile limit. This comprises magnetic, gravity and bathymetric data, collected in conjunction with EPB and CHS, from Dixon Entrance to the Strait of Juan de Fuca. A Seamarc II survey provided sonar images of part of the Juan de Fuca Ridge and the continental margin off Vancouver Island and southern Queen Charlotte Islands. In addition to details of the ridge the images clearly show the trace of the Queen Charlotte fault and highlight features resulting from massive slides on the slope.

Cooperative work of the Fraser Delta involving drilling (SFU) shallow seismic (RGG), electrical resistivity (CD) and surficial geology (CD and TSD) promises to develop into an exciting and productive study on the architecture of the delta. Such knowledge is vital because of the extreme demands for geoscience information required as heavy urban and industrial development proceeds. This program will be relevant to assessment of seismic risk.

A member of the Division, together with scientists from 3 U.S. institutions were hosted by Shandong College P.R.C. for a joint study of the sedimentary processes and surficial geology of the Huanghe (Yellow) River delta in the Bohai Sea. This delta, because of the huge volume of sediment supplied by the river, offers a unique opportunity to study sedimentary processes

that occur regularly in this unique environment. This information can then be applied to other deltas where similar information is not readily available but where sedimentary processes may have a significant impact on industrial development (e.g. the Mackenzie delta).

During a cruise to the Juan de Fuca Ridge GSC and EPB scientists from PGC recovered a sediment core with significant sulphide concentrations as previously reported.

Personnel Notes

The Cordilleran Division has 41 full-time employees, 28 at Vancouver and 13 at Pacific Geoscience Centre. At Vancouver there are 16 scientists and 12 staff in administration, sales office, library and technical support services. In addition, K.M. Dawson of Economic Geology Division and L.E. Jackson and J.J. Clague of Terrain Sciences Division are stationed at Vancouver. At Pacific Geoscience Centre the Pacific Marine Geology Subdivision staff consists of 5 scientists and 8 support and administrative staff. R.G. Currie is the subdivision head.

Vancouver Office

Dr. J.E. Reesor retired in June, 1985 but had continued on one-third time in order to complete a report on his current project. He continues to reside in Ottawa.

Mrs. Elsie Gillis resigned from the administrative staff in February, 1986.

Dr. John Luternauer transferred from Pacific Geoscience Centre to the Vancouver office in January, 1986.

Pacific Geoscience Centre

Dr. Patrick McLaren resigned in September, 1985 and has established a consulting practise in England.

Attendance at Meetings, Conferences, Courses

R.G. Anderson

Geological Society of America, Cordilleran Section, May 8-10, 1985, U.B.C., Vancouver, B.C.

Canadian Institute of Mining and Metallurgy, Geology Division, "Granite-Related Mineral Deposits: Geology, Petrogenesis, and Tectonic Setting", September 15-17, 1985, Halifax, N.S.

Geological Association of Canada, Cordilleran Section, Short Course No. 5, "Canadian Cordillera - What and How", January 28, 1986, Vancouver, B.C.

B.C. and Yukon Chamber of Mines, Cordilleran Geology Round Up, January 29-31, 1986, Vancouver, B.C.

Geological Association of Canada, Cordilleran Section, Short Course No. 7, "Tectonic Principles, Evolution of Sedimentary Basins and Their Structural Styles", February 21, 1986, Vancouver, B.C.

B.D. Bornhold

8th International Estuarine Research Conference, July 1985, Durham, N.H.

International Tsunami Symposium, Aug. 5-9, 1985, Victoria.

Society of Economic Paleontologists and Mineralogists, Mid-Year Meeting, Golden, Co. Aug. 11-14, 1985.

American Geophysical Union, Fall Meeting, Dec. 1985, San Francisco.

R.B. Campbell

Geological Society of America, Cordilleran Section, Annual Meeting, Vancouver, B.C., May 8-10, 1985.

Geology and Exploration Roundup, British Columbia and Yukon Chamber of Mines, Vancouver, B.C. 29-31 January, 1986.

H. Gabrielse

Geological Society of America, Cordilleran Section Annual Meeting, Vancouver, B.C., May 8-10th, 1985.

Cordilleran Geology and Exploration Roundup; Vancouver, B.C. Jan. 29-31, 1986.

Short Course on Plate tectonics, structural styles and evolution of sedimentary basins; Cordilleran Section, Geological Association of Canada, Feb. 21, 1986.

S.P. Gordey

Cordilleran Geology and Exploration Roundup, sponsored by B.C. and Yukon Chamber of Mines, B.C. Ministry of Energy, Mines and Petroleum Resources,

Geological Survey of Canada, and Department of Indian Affairs and Northern Development (Yukon), January 23-25, Vancouver, B.C.

81st Annual Meeting, Cordilleran Section, Geological Society of America, May 8-10, 1985, Vancouver, B.C.

Field Trip - Stratigraphy and sedimentology of the Eocene Chukanut Formation on Bellingham Bay, Washington, May 7, 1985 (pre-meeting field trip in conjunction with G.S.A. meeting).

Field Trip - (accompanied J.G. Abbott, Dept. Indian Affairs & Northern Development) Brooks Range (led by John Dillon, Alaska State Survey) and Alaska Range (led by Tom Buntzen, Alaska State Survey) Alaska, August 7.

Thirteenth Whitehorse Geoscience Forum, December 2-4, 1985, Whitehorse, Yukon.

T.S. Hamilton

GSA Cordilleran Section Meeting May 8-11, 1985 Vancouver.

International Tsunami Symposium, Victoria and Sidney, B.C., August 6-9, 1985.

J.L. Luternauer

Symposium on the paleo-environmental reconstruction of the Late Wisconsinan deglaciation and the Holocene, Lethbridge, Alberta, August 21-24.

J.W.H. Monger

Geological Society of America, Orlando, Florida, October 28-31, 1985.

Meeting at American Geophysical Union, San Francisco, on Global Geoscience Transects, Dec. 10, 1985.

Cordilleran Geology and Exploration Roundup; Vancouver, B.C., Jan. 29-31, 1986.

Cordilleran Tectonics workshop, Queen's University, Feb. 14-16, 1986.

M.J. Orchard

Geological Society of America, Cordilleran Section Meeting, Vancouver, B.C., May '85.

ECOS IV, 4th European Conodont Symposium, Nottingham, England, July '85.

Cordilleran Geology and Exploration Roundup; Vancouver, B.C., Jan. 29-31, 1986.

Oil and Gas Roundup, Calgary, Feb. 1986.

J.A. Roddick

Annual Meeting, Cordilleran Section, Geological Society of America, Vancouver, B.C., May 8-10, 1985.

Annual Meeting, Geological Society of America, Orlando, Florida, October 27-31, 1985.

J.G. Souther

Geothermal Energy status and review; Canadian Geothermal Energy Association, Annual Meeting, Pat Bay, April 18, 1985.

Post Accretionary Volcanism in the Canadian Cordillera, G.S.C., Cordilleran Section Meeting, Vancouver, May 10, 1985.

Geothermal Potential of the Garibaldi Belt - Mount Meager and Mount Cayley, Conference on Geothermal Resources of the Cascade Range, Menlo Park, California, May 22-23, 1985.

L.C. Struik

Juan de Fuca Ridge Symposium - Pacific Section of Geological Association of Canada, March 21, 1986.

Interuniversity - G.S.C., Cordilleran Workshop, Queen's University, February 15-16, 1986.

Cordilleran Geology and Exploration Roundup - B.C. & Yukon Chamber of Mines, Vancouver, January 29-31, 1986.

R.I. Thompson

SEPM conference on Foreland Basins, Fribourg, Switzerland (including 5 day field trip in the Swiss Alps), Sept. '85.

Geoscience Forum meeting in Whitehorse, December '85.

Geoscience meeting in Ottawa, January '86.

H.W. Tipper

Geological Society of America; Cordilleran Section, Annual Meeting, Vancouver, B.C. May 8-10, 1985.

Cordilleran Geology and Exploration Roundup; Vancouver, B.C., Jan. 29-31, 1986.

J.O. Wheeler

Geological Society of America, Annual Meeting, Orlando, Florida, October, 1985.

Lithoprobe Review Committee Meeting, Toronto, Nov. 14-15, 1985.

B.C. Yukon Chamber of Mines "Roundup" - Vancouver, B.C., January 29-31, 1986.

G.J. Woodsworth

Cordilleran Section of Geological Society of America, Annual Meeting, Vancouver, May 8-10, 1985.

Cordilleran Geology and Exploration Roundup, Vancouver, B.C., Jan. 29-31, 1986.

C.J. Yorath

Geological Association of France; Special Symposium on the North American Cordillera; Paris, France, April 1985.

Geological Society of America, Cordilleran Section Annual Meeting; Vancouver, May 1985.

Special Talks and Lectures

R.G. Anderson

"Variation of Mesozoic to Tertiary plutonic style with tectonic setting in the northern Cordillera" (15 mins.), invited paper at symposium: DNAG -- Western Canada Preview, Geological Society of America, Cordilleran Section, May 8-10, 1985, Vancouver, B.C.

"An overview of some Mesozoic and Tertiary plutonic suites and their associated mineralization in the northern Cordillera" (25 mins.), invited paper at Canadian Institute of Mining and Metallurgy symposium: Granite-Related Mineral Deposits: Geology, Petrogenesis and Tectonic Setting, September 15-17, 1985, Halifax, Nova Scotia.

B.D. Bornhold

U.B.C. Department of Oceanography "Vancouver Island Continental Shelf Sedimentation".

Shandong College of Oceanology, Qingdao, P.R.C. - "Continental Shelf Sedimentation off western Canada".

G.A.C. Pacific Section - Juan de Fuca Ridge Symposium - "Sedimentation on the Juan de Fuca Ridge".

H. Gabrielse

"Tectonic framework of north-central British Columbia and its relationship to mineral deposits"; Cordilleran Geology and Exploration Roundup, Vancouver, B.C. Jan. 29, 1986.

S.P. Gordey

Poster - Regional Mapping in the Selwyn Basin, Yukon; Cordilleran Geology and Exploration Roundup, January 23, 1985, Vancouver, B.C.

Lecture - Evolution of the Cordilleran Miogeocline (with Bob Thompson principle lecturer); part of a graduate course (by GSC) titled "Evolution of the Cordillera", University of British Columbia, January 31, 1985, Vancouver, B.C.

Poster - (with M.J. Orchard as co-author) Stratigraphic evolution and conodont dating of the outer Cordilleran miogeocline, Yukon and N.W.T.; 81st Annual Meeting, Cordilleran Section, Geological Society of America, May 8, 1985, Vancouver, B.C.

Talk - Devonian-Mississippian sedimentation and tectonism in the Canadian Cordillera (20 mins, in Symposium titled DNAG - Western Canada Preview); 81st Annual Meeting, Cordilleran Section, Geological Society of America, May 10, 1985, Vancouver, B.C.

Lectures - Sedimentary and metamorphic rocks (2-2 hr. sessions); presented Oct. 8 and 10, 1985, Vancouver, as part of the British Columbia and Yukon Chamber of Mines Prospecting and Mining School, Vancouver, B.C.

Talk - What's happening in the Selwyn Basin? (25 Mins); Thirteenth Annual Whitehorse Geoscience Forum, December 2, 1985, Whitehorse, Yukon.

T.S. Hamilton

"Volcanics of the Cenozoic Masset Formation: Implications for Geological and Tectonic Evolution of the Queen Charlotte Islands, British Columbia, Canada", GSA Cordilleran Section Meeting, Vancouver, B.C., May 8-11, 1986.

"The Foreslope Hills of the Fraser Delta: Implications for Tsunamis in Georgia Strait", International Tsunami Symposium, Victoria and Sidney, B.C., Aug. 6-9, 1985.

J.W.H. Monger

Tectonics Workshop "Coast Cascade Structural Evolution"

"Crustal transect construction from a largely geological perspective; the southern Canadian Cordilleran Experience", Cornell University, Logan Club, GSC, Ottawa, Geophysics & Astronomy, U.B.C.

M.J. Orchard

Are Cache Creek conodonts "exotic"? G.S.A., Cordilleran Meeting, Vancouver, May 1985.

Conodonts from the chert terranes of Western Canada, ECOS IV, July 1985.

On the nature, affinities, history and use of conodonts, U.B.C., Geosciences Dept., 3 lectures, March 1986.

J.A. Roddick

Field guide for Coast Plutonic Complex part of Cordilleran cross-section, Calgary to Vancouver, Geological Society of America, Cordilleran Section Meeting, Vancouver, B.C., May 4-7, 1985.

J.G. Souther

"The Anahim Belt - a continental hotspot trace", G.A.C. lecture series, Victoria, Feb. 12, 1985.

"Neogene Volcanism in B.C.", U.B.C. Dawson Club lecture, Vancouver, Feb. 14, 1985.

"Post Accretionary Volcanism in the Cordillera", U.B.C. Grad. Course lecture, Vancouver, March 14, 1985.

"Neogene and Tertiary Volcanism", U.B.C. Regional Geology Course, Vancouver, April 3, 1985.

"Geothermal Energy status and review"; Canadian Geothermal Energy Association, Annual Meeting, Pat Bay, April 18, 1985.

"Post Accretionary Volcanism in the Canadian Cordillera", G.S.A., Cordilleran Section Meeting, Vancouver, May 10, 1985.

"Geothermal Potential of the Garibaldi Belt - Mount Meager and Mount Cayley", Conference on Geothermal Resources of the Cascade Range, Menlo Park, California, May 22-23, 1985.

L.C. Struik

"Paleozoic Geology of Cariboo Mountains and implications for S.E. British Columbia", in house seminar lecture at

Geological Branch of B.C. Ministry of Energy, Mines and Petroleum Geology, Victoria, B.C., March 14, 1986.

"Are the Cariboo Mountains allochthonous?", present talk at interuniversity - G.S.C. Cordilleran Workshop, Queen's University, February 15-16, 1986.

"Quesnel Lake Map Area", present poster at G.S.C. contribution to the Cordilleran Geology and Exploration Roundup sponsored by B.C. & Yukon Chamber of Mines, January 29, 1986.

"Thrust and strike-slip faults bounding tectonostratigraphic terranes, central British Columbia", conduct field trip as part of G.S.A., Cordilleran Section Meeting, Vancouver, May 10-12, 1985.

R.I. Thompson

"Structural Style of the Canadian Cordillera", keynote address delivered to SEPM meeting on Foreland Basins (Fribourg, Switzerland) Sept. 1985.

"The Canadian Cordillera: What and How", short course on Cordilleran Geology delivered four times: University of Alberta, Feb. '85; Cordilleran Division of G.A.C., Feb. '85 and Jan '86 (twice), Can. Society of Petroleum Geology, Feb. '86.

"Geology of British Columbia and the Yukon", B.C. and Yukon Chamber of Mines prospectors course, Nov. 1985.

"Exciting Opportunities in the Earth Sciences", (10 one hour sessions presented to grade 8 students at Point Grey Mini School.

"Geology and Mineral Potential of the Ogilvie Mountains", Geoscience Forum, Whitehorse, Dec. 1985..

"Extension and its Influence on Geologic Evolution, Ogilvie Mountains, Yukon", Geoscience Forum, Ottawa, Jan. 1986.

"Extension in the Ogilvie Mountains", poster session, Cordilleran Roundup, Jan. 1986.

"Geologic Maps: How they are used" workshop to Science Teachers, Vancouver School Board, March 1986.

"Evolution of the Cordilleran Passive Margin" Pacific Geoscience Centre, March 1986.

J.O. Wheeler

"New geological map, Canadian Cordillera", U.B.C., Dept. of Geology, March 17, 1986.

"Geological Belts of the Canadian Cordillera", Geological Society of America Cordilleran Section meeting, Vancouver, B.C., May, 1986.

G.J. Woodsworth

"Mesozoic and Tertiary Evolution of the Coast Plutonic Complex", talk given at University of Washington, U.B.C., and Cordilleran Geology and Exploration Roundup.

"Mountain safety and travel", B.C. & Yukon Chamber of Mines, short course, Vancouver, April 1985.

C.J. Yorath

Lithoprobe - southern Vancouver Island: Geological Interpretation of Seismic Reflection Profiles - delivered to 1 + 2 above.

Pacific Section - Geological Association of Canada; Lithoprobe symposium.

Membership on Committees

R.G. Anderson

President of Geological Association of Canada, Cordilleran Section.

Thesis Supervision: formally on thesis committee for M.Sc. thesis (Derek Brown) and informally on committees supervising B.Sc. (Mike Gunning) and B.A.Sc. (Susan Gareau) thesis projects in conjunction with U.B.C., Department of Geological Sciences supervisors.

B.D. Bornhold

Advisory Committee on Undersea Feature Names.

Departmental Coordinating Committee on Ocean Mining.

Environmental Studies Revolving Fund - Bottom Sediment Transport Committee.

Ocean Drilling Program - Southern Ocean Panel.

SEPM Nominating Committee.

R.B. Campbell

B.C. and Yukon Chamber of Mines, Member of Board.

H. Gabrielse

Canadian Society of Petroleum Geology; Member of Douglas Medal Committee.

Geological Society of America; Member of Nominations Committee.

Geological Society of America; Member of Education Committee.

Committee, Structural Geology and Tectonics Division.

S.P. Gordey

Representative on British Columbia and Yukon Chamber of Mines Safety Committee.

T.S. Hamilton

Western Councillor, G.A.C. Volcanology Division.

J.L. Luternauer

Appointed Adjunct Professor to Simon Fraser University.

Scientific advisor to Fraser River Delta Roberts Bank Environmental Review

Committee and Provincial Order in Council 908 Environmental Committee which assess impact of development on the delta fore shore.

Committee member on Simon Fraser University Ph.D. and Master's thesis programs.

J.W.H. Monger

Council, Geological Society of America.

Chairman, Penrose Medal Committee of G.S.A.

Coordinator, International Lithosphere Program's "Global Geoscience Transects" Project.

J.A. Roddick

Editor for I.G.C.P. Project 220, Tin and Tungsten granites of southeast Asia and western Pacific.

J.G. Souther

Sub-program Co-ordinator (Cordillera) of the EMR geothermal program.

Member GSA Bulletin Board of Associate Editors.

Member of Canadian Earthquake Prediction Evaluation Committee.

Member C. Hickson Ph.D. Thesis Committee, U.B.C.

Vice President Canadian Geothermal Resources Association.

R.I. Thompson

Member, North American Commission on Stratigraphic Nomenclature.

Member, Canadian National Committee on Dynamics and Evolution of the Lithosphere.

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

General Chairman, 1990 Annual GAC/MAC meeting in Vancouver.

J.O. Wheeler

Geological Society of America Centennial Project Steering Committee.

Honorary Member - Lithoprobe Steering Committee.

J.G. Woodsworth

Canadian Permanent Committee on Geographic Names (member).

Advisory Committee on Glaciological and Alpine Nomenclature (member).

ECONOMIC GEOLOGY AND MINERALOGY DIVISION

D.C. Findlay, Director

General

The Division has a continuing staff strength of 88 person years plus (currently) 9.5 person years in term positions that are mainly assigned to activities in federal-provincial Mineral Development Agreements (MDAs) in Manitoba, Saskatchewan, New Brunswick, Nova Scotia and Newfoundland.

The Division has six main responsibilities:

1. To maintain a national information base on the nature, distribution and geological characteristics of Canada's non-hydrocarbon mineral resources;
2. To conduct research into the mechanisms of formation of mineral deposits;
3. To interpret the relationships of mineral deposits to the geological characteristics of Canada's principal geographic and geological regions;
4. To provide, through the integration of the results of 1 to 3 above, guidelines and models for use by the Canadian exploration industry and input to government policies in resource management and land-use planning activities.
5. To provide analytical services and mineralogical expertise in support of research activities of EGM and other GSC Divisions, and to develop new or refined analytical techniques for use by GSC and for transfer to commercial laboratories.
6. To develop and curate National and Branch rock, mineral and meteorite collections and to provide mineralogical information to the Canadian public.

To carry out these responsibilities, the Division is organized into an Administrative Unit, an Economic Geology Subdivision (five sections, a Special Projects Unit and a Mineral Deposits Laboratory) and a Mineralogy and Chemistry Subdivision (Analytical Chemistry and Mineralogy Sections). The objectives and roles of the separate units and highlights of their activities are presented under the relevant headings on the following pages.

During 1984/85 the Division supported 11 EMR Research Agreements and 42 outside research contracts (6 A-Base, 36 externally funded).

Highlights (Division Summary)

During the year, the Division introduced changes in response to recommendations of the Canadian Geoscience Council Advisory Committee on Mineral Deposits Research at the Geological Survey. These changes relate mainly to the establishment of an internal Research Advisory Committee (in process) and to measures to improve laboratory productivity. The report of the Advisory Committee, completed in late 1985, will be published as a Geological Survey Paper in 1986.

Economic Geology Report 36 ("Canadian Mineral Deposit Types - A Geological Synopsis"), released last year, continued to be in strong demand. It resulted in a request from the Prospectors and Developers Association for Division staff to present a Short Course on mineral deposit types at the Association's annual meeting in Toronto in March 1986.

With the Bureau of Mineral Resources, U.S. Geological Survey, Division staff organized and co-hosted a five-day workshop entitled "Prospects for Mineral Resource Assessment in 1985 - Metals on Public Lands" in Leesburg, Va, September 23-27. The Workshop attracted about 125 participants (by invitation) from federal, state and provincial agencies and U.S. and Canadian industry and University sectors.

Five members of the Division received Public Service merit awards for their roles in the Sudbury Timmins Algoma Mineral Program (STAMP), a special employment program carried out in Northern Ontario in 1983/84.

The Division continued active participation in a number of international scientific projects, including ISMI (International Strategic Minerals Inventory), the UNESCO/IUGS (International Union of Geological Sciences) Mineral Deposit Modelling Programme, various IGCP (International Geological Correlation Program) projects and projects under the auspices of IAEA (International Atomic Energy Agency). Collaborative research projects were carried out with other national geological surveys under Memoranda of Agreements with the British Geological Survey and the U.S. Geological Survey. Closer to home, Division scientists participated in a variety of collaborative research projects with industry personnel and companies (e.g. Hemlo, Ontario; Greenland) and Canadian university staff through research contracts and participation in DSS (Department of Supply and Services) Unsolicited Proposal contracts and EMR Research Agreements. The Division continued to act on behalf of the Branch in supplying a Laboratory Manager and part time technician support to the joint University of Ottawa-Carleton University-GSC Stable Isotope Laboratory.

In March preparations were underway to accommodate the Resource Geochemistry Subdivision and much of the Resource Geophysics Subdivision of Resource Geophysics and Geochemistry Division within a new Division (Mineral Resources), effective April 1, 1986.

ADMINISTRATION

This unit, comprising the Director, Assistant, Secretary, Administrative Officer and two Financial Clerks, provides general administrative support and manages the financial and personnel resources for the Division.

Personnel Notes

After 23 years with the Public Service including 10 years with GSC, **Mrs. J.E. Clemmer**, Administrative Clerk in the Division, retired in December 1985. We welcome to our Administrative Office, **Miss Line Sanctuaire** who transferred from the Canada Oil Substitution Program.

Attendance at Conferences, Meetings, and Courses

D.C. Findlay

Prospectors and Developers Association, Toronto, March 1986.

Workshop on Canadian Continental Deep Drilling Program, Ottawa, February 1986. TALK: "The International Upper Mantle Project."

Steering Committee, UNESCO-IUGS Mineral Deposits Model Programme, Paris, January 1986.

Joint Geological Survey of Canada/United States Geological Survey Workshop on "Prospects of Mineral Resource Assessment in 1985", Leesburg, Virginia, September 1985; co-organizer and workshop leader. TALK: "Canadian Northern Mineral Resource Assessment" (with C.W. Jefferson and R.F.J. Scoates).

Symposium on the Metallogeny of Basic and Ultrabasic Rocks, Edinburgh, April 1985.

C.R. McLeod

16th Annual Underwater Mining Institute, Halifax, October 1985.

L. Picard-Charron

Departmental Computer Course, February 2 to 5, 1986.

Membership 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.

USGS/GSC Resource Assessment Methodology Workshop Organizing Committee, Member.

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.

ECONOMIC GEOLOGY SUBDIVISION

Subdivision activities directed at carrying out its responsibilities include:

1. The continuing investigation through field and laboratory studies of mineral deposits in all regions of Canada, with particular focus on the geology of those containing major metal commodities such as copper, nickel, lead-zinc, gold, silver, iron, molybdenum and uranium, coupled with special investigations of tin,

tungsten, chromium, platinum-group metals, rare-earth metals and such other deposits as strategic and economic priorities dictate;

2. The development and maintenance of national information files, both manual and computerized, on Canadian mineral deposits and mineral deposit types. As a part of the national data base the Division maintains and curates the Economic Geology Research Collections, an extensive collection of ore and host rock samples representing a wide variety of Canadian mineral deposits and localities, as well as reference materials from foreign deposits;
3. The application of specialized research techniques such as isotope studies, computer simulations and mathematical and statistical correlation methods as aids to the interpretation of ore-forming mechanisms;
4. The development and application of methods, including mathematical methods, to evaluate the potential of various geological regions to contain undiscovered mineral resources;
5. The design and implementation of mineral deposit related projects (incorporating elements of items 1-4 above) for federal-provincial Mineral Development Agreements and other externally funded programs, either by supervision of contracted studies or by direct participation.

In all of these activities, interaction and cooperation with scientists in industry, the universities, other federal and provincial agencies is an important continuing component.

At the end of the report period the Subdivision staff comprised 28 research scientists, 12 physical scientists and 4 technical and clerical support persons.

Mineral Deposits Geology Section

J.M. Duke

The major objectives of the Section are to develop and maintain mineral deposits expertise on a national basis and contribute to the success of exploration efforts by the mineral industry. These are accomplished by

- a) acquiring and synthesizing data on Canadian mineral deposit types, so that their common characteristics and critical differences are more fully appreciated, and
- b) developing and improving genetic models for major deposit types, and testing these models by further observation and research.

Highlights

Volcanogenic Massive Sulphide Deposits

Study of the Mathiati massive sulphide deposit (Cyprus) led to a number of significant findings with implications for the investigation of modern hydrothermal systems on the Juan de Fuca Ridge as well as ancient deposits on the Canadian landmass including:

- hot springs occurred on an active spreading centre
- surface manganese deposits and subsurface quartz-sulphide-gold mineralization are related to the same graben system
- pervasive sodium addition is associated with the ore horizon
- association of titanium rich basalts with mineralization as is the case with certain modern seafloor deposits (e.g., 13 North, East Pacific Rise).

Sedimentary Metallogeny

Laboratory experiments to simulate the evaporitic differentiation of seawater have demonstrated that magnesium, molybdenum, nickel, iron, cobalt and zinc are enriched in residual brines, strontium, manganese, cadmium, barium and lead are removed from the brine by the precipitation of halite, and barium, strontium and copper are removed from the brine primarily during the precipitation of gypsum. The strong depletion of cadmium with the precipitation of halite was unexpected and suggests that cadmium may be used as a chemical marker in evaporitic sequences. The removal of copper from solution during the precipitation of gypsum and subsequent remobilization upon diagenetic conversion of gypsum to anhydrite is being investigated as a possible source of metal for evaporite associated sedimentary copper deposits which constitute one of the world's major copper resources. Experimental reaction of brines with rock forming minerals are also yielding interesting results. For example, whereas silica is readily leached from clays by normal seawater at 90 degrees, the amount of silica dissolved decreases drastically with increasing salinity. Iron on the other hand is much more readily leached from clays by the more saline solutions. These data suggest some interesting implications for the origin of iron formations.

Waters sampled during visits to potash mines in the Saskatoon area appear to be true residual brines. Subsequent analyses have shown these to be enriched in magnesium, calcium, bromine, boron, lithium and iodine. If preserved in sufficient quantities, these waters may constitute a previously unrecognized and unexploited Canadian resource.

Gold Deposits

Laboratory work carried out as part of a comparative study of gold occurrences in the Contwoyto Lake area (N.W.T.) has confirmed the presence of two types of gold mineralization. As well as the stratiform "Lupin type" in which gold is uniformly distributed in sulphide-rich iron formation, nonstratiform occurrences of gold associated with late quartz veins in locally sulphidized oxide-facies iron formation have now been documented (i.e., "Geraldton type"). Although stratiform occurrences have a strong syngenetic (syndimentary) signature, gold and possibly sulphur may have been introduced during an initial phase of progressive metasomatism related to the intrusion of S-type granitoids and culminated in addition of silica, arsenic and tungsten during quartz vein formation. Investigation of the distribution of gold in rocks in the Matthews Lake and Salmita Mine area (N.W.T.) were initiated. Contrary to recently published accounts, gold occurrences there have many similarities with mesothermal vein deposits of the Superior Province and are not of the "Lupin type".

Reconnaissance in the Dunnage Zone of Newfoundland revealed similarities to classic gold producing areas such as the Mother Lode of California and indicate potential for gold occurrences. Ongoing contract studies of the gold-bearing Falcon Lake stock in southeastern Manitoba have shown that its emplacement was fracture controlled.

Mineral Deposits Associated with Felsic Magmatism

Studies of comb quartz layers in felsic intrusions have demonstrated a relationship between magmatic processes within the intrusions and hydrothermal ore formation outside the intrusions, and indicate furthermore that existing magmatic-hydrothermal models for the formation of porphyry deposits require significant revision. Specifically, the comb quartz layers indicate that the deposits form early rather than late in the crystallization history of the intrusion.

Recognition of topaz-bearing felsic intrusive and extrusive rocks ("topaz rhyolites") in the northern Canadian Cordillera suggests that these rocks may be more widespread than currently believed. Comparisons with similar rocks elsewhere in the world suggests a heretofore unrecognized potential for associated beryllium, fluorite, tin, silver-lead-zinc and, possibly, gold deposits.

Ongoing studies of the tungsten, molybdenum and tin deposits and associated granitic rocks in the Mount Pleasant area, New Brunswick indicate that the granitic rocks are of the anorogenic or A-type.

Good progress has been achieved on the development of a database for world molybdenum deposits. Integration of data from a computer file of grade and tonnage information with a lithochemical file has shown that deposits of particular metal associations (Mo, Mo-Cu, Mo-Cu-W, Cu, etc.) occur in intrusions with characteristic chemical or modal compositions.

Mineral Deposits Associated with Mafic Magmatism

New analyses of sulphide bearing ultramafic rocks of the Fox River layered intrusion revealed for the first time elevated PGE concentrations associated with thin cumulate layers of evolved composition. Detailed mapping of the Bird River sill in southeastern Manitoba has further delineated a harrisitic sulphide-bearing layer first identified last year and found to be moderately enriched in platinum group elements. This layer appears to be continuous over a strike length of at least 2.5 kilometres, and is up to 3 metres wide. A genetic model has been proposed which involves ponding of PGE and volatile enriched pore liquid beneath relatively impermeable chromitite layers and subsequent degassing of the volatile phase. Coarse grained sulphide-bearing pyroxenite in the Clam Lake intrusion in Saskatchewan was found to have very low levels of PGE but an anomalously high gold content. Mafic-ultramafic intrusions in the Lynn Lake and La Ronge greenstone terranes are very depleted in PGE whereas intracratonic intrusions such as those at Rottenstone and Namew Lake are enriched.

It was found that the selenium/sulphur ratio of the Bird River PGE layer is ten times the chondritic ratio and is thus the highest yet encountered in magmatic sulphides. The PGE rich layers in the Bushveld Complex of southern Africa and the PGE rich

mineralization of the Rottenstone deposit in Saskatchewan also have anomalously high Se/S ratios. The coincidence of anomalous Se/S ratios and PGE concentrations has important implications for mineral exploration.

Structural studies of the Lewis Hills ophiolite in southwestern Newfoundland, carried out under contract, have revealed that chromite mineralization is more extensive than previously known. The chromite deposits are structurally disrupted layers rather than discontinuous pods as believed previously.

Isotopic Studies

Studies of light stable isotopes have focussed on (i) the role of magmatic degassing in plutonic and volcanic regime and the significance of this process in ore genesis, and (ii) the kinetics of water-magma interaction. Significant results include:

(a) Hydrogen isotope studies show that magmatic degassing played a significant role in the Mount Emmons porphyry molybdenum deposit, and that meteoric water reacted with the magmatic rocks subsequent to ore formation. (b) Magmatic water and hydrogen isotope contents of obsidian from Taupo, New Zealand indicate large scale degassing is associated with the Plinian deposits.

(c) The first experimental data on hydrogen isotope exchange between water and rhyolite magma has been obtained in a cooperative study with SANDIA Laboratories. Oxygen isotope studies in collaboration with Los Alamos Laboratory indicate that measurable O¹⁸ depletion in magmas due to interaction with meteoric waters require time scales longer than those of eruptions.

(d) Large differences in the isotopic composition of oxygen and carbon of carbonates on the scale of 1 millimetre in metasomatic veins in Bergell, northern Italy define metasomatism as an infiltration rather than diffusion process.

Precise analysis of U/Pb isotopes in zircons from volcanic rocks of the Abitibi greenstone belt have led to the development of general terrestrial lead evolution models based on ore lead isotope data for Archean massive sulphide deposits in Abitibi as well as western Superior Province. These models will allow (i) identification of different mantle sources of lead in the deposits and possible contributions of crustal lead, and (ii) determination of more accurate model ages for certain deposits. These results mean that careful re-evaluation of other isotopic systems (e.g., Nd-Sm, Rb-Sr) will be required to establish the cross relationships and to constrain their interpretation in terms of mantle sources.

Personnel Notes

A. Pastichniak, S. Thompson and P. Schwann provided term support in the Section during the year.

J. Mortensen and S. Adcock began Visiting Fellowship terms; support for their work was also provided by Precambrian Geology and Resource Geophysics and Geochemistry Divisions.

Attendance at Conferences, Meetings and Courses

J.J. Carriere

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

J.M. Duke

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. TALK: "Layer Disruption, PGE Mineralization and the Role of Supercooling in the Crystallization of the Bird River Sill, Manitoba; (with R.F.J. Scoates, O.R. Eckstrand and B. Williamson).

Symposium on the Metallogeny of Basic and Ultrabasic Rocks, Edinburgh, April 1985. TALK: "A model for the Origin of Disseminated Magmatic Sulphides in Komatiitic Intrusions."

H.E. Dunsmore

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. POSTER SESSION: "Unconventional resources within residual evaporitic brines, Western Canada Basin."

O.R. Eckstrand

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting in Fredericton, May 1985, Symposium on gold deposits hosted by turbidites. TALK: "Vesicles in the Dundonald Komatiites" (with B.L. Williamson).

Prospectors and Developers Association Annual Convention, Toronto, March 1986. TALK: "Porphyry deposits" in seminar on "A Synopsis: Canadian Mineral Deposit Types of Current Interest." (Jointly with W.D. Sinclair, F. Robert and J.M. Franklin.)

Fourth Platinum Symposium, Toronto, Ontario, August 1985. TALK: "Potential for platinum group elements in the Fox River Sill, Manitoba" (with R.F.J. Scoates).

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

S.B. Green

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting in Fredericton, May 1985.

Joint Geological Survey of Canada/United States Geological Survey Workshop on "Prospects of Mineral Resource Assessment in 1985", Leesburg, Virginia, September 1985.

Ontario Geological Survey Current Activities Seminar, Toronto, December 1985.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

Prospectors and Developers Association Annual Convention, Toronto, March 1986.

L.J. Hulbert

Manitoba Department of Energy and Mines, Open House, Winnipeg, November 1985.

Saskatchewan Department of Energy and Mines, Open House, Saskatoon, November 1985. TALK: "Ni-Cu-PGE Mineralization associated with the Rottenstone Lake Harzburgite-Pyroxenite Intrusion: Preliminary Findings."

Prospectors and Developers Association Annual Convention, Toronto, March 1986. POSTER SESSION: "The Rottenstone Ni-Cu-PGE Mine, Northern Saskatchewan."

J.A. Kerswill

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting in Fredericton, May 1985, Symposium on gold deposits hosted by turbidites. TALK: "Gold metallogeny of Archean iron formation hosted by turbidites in the Contwoyto Lake area, NWT."

Canadian Institute of Mining and Metallurgy Annual Meeting, Vancouver, April 1985, Special Session on Gold Deposits of NWT. TALK: "Gold mineralization hosted by iron formation in the Contwoyto Lake area, NWT."

Geological Society of America Annual Meeting, Orlando, October 1985, Society of Economic Geologists' Symposium on Gold deposits in metamorphosed terrains. TALK: "Gold, sulphur and arsenic in metamorphosed iron formation of the Contwoyto Lake area, NWT, Canada."

Yellowknife Geoscience Forum, Yellowknife, December 1985. TALK: "Gold mineralization hosted by iron formation in the Contwoyto Lake area, NWT" (updated version of CIM talk).

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

R.V. Kirkham

Canadian Institute of Mining and Metallurgy Symposium on Granite-related Mineral Deposits, Halifax, September 1985. TALKS: "Comb quartz layers in felsic intrusions and their relationship to porphyry deposits" (with W.D. Sinclair); "Tectonic and petrochemical controls on distribution and metal contents of granite-related molybdenum deposits".

Cordilleran Round-up", Vancouver, January 1986. TALKS: as above and a POSTER SESSION.

Geological Association of Canada-Mineralogical Association of Canada Annual Meeting in Fredericton, May 1985, TALK: "Base metal occurrences in carboniferous rocks, Sydney area, Nova Scotia."

J.W. Lydon

Metallogeny of Basic and Ultrabasic Rocks, Edinburgh, April 1985. TALK: "The genetic significance of chemical and mineralogical zonation of the Mathiati alteration pipe, Cyprus."

Genesis of sediment-hosted stratiform Zn-Pb deposits, Stanford University, California. POSTER SESSION: "Genesis of stratiform barite-sulphide deposits of Selwyn Basin".

Newfoundland Department of Mines and Energy Open House, St. John's, Nfld., November 1985.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. POSTER SESSION: "Chemical and mineralogical zonation of Mathiati alteration pipe Cyprus and its genetic significance."

W.D. Sinclair

Canadian Institute of Mining and Metallurgy, Annual General Meeting, Vancouver, B.C., April 1985.

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting in Fredericton, May 1985.

Canadian Institute of Mining and Metallurgy Symposium on Granite-related Mineral Deposits, Halifax, September 1985.

6th International Strategic Minerals Inventory Working Group Meeting, St. Ives, Cornwall, United Kingdom, October 1985.

13th Geoscience Forum, Whitehorse, Yukon, December 1985. TALK: "Topaz rhyolites and associated deposits in the northern Canadian Cordillera."

Current Activities Forum, Geological Survey of Canada, January 1986.

Prospectors and Developers Association Annual Convention, Toronto, March 1986. TALK: "Porphyry deposits" in seminar on "A Synopsis: Canadian Mineral Deposit Types of Current Interest."

B.E. Taylor

Canadian Institute of Mining and Metallurgy Symposium on Granite-related Mineral Deposits, Halifax, September 1985. TALK: "Degassing of rhyolitic magmas: hydrogen isotope evidence and implications for magmatic-hydrothermal ore deposits."

American Geophysical Union Meeting, Baltimore, May 1985. TALKS: "Hydrogen isotope exchange and water solubility in experiments using natural rhyolite obsidian"; "Degassing of obsidian dome magma: hydrogen and oxygen isotope studies in the Inyo Dome Chain, Long Valley area, California"; "Volatile content of Obsidian Dome and the Inyo Dike."

R.I. Thorpe

Current Activities Forum, Geological Survey of Canada, January 1986.

B. Williamson

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting in Fredericton, May 1985. POSTER SESSION: "Vesicles in the Dundonald Komatiites" (with O.R. Eckstrand).

Manitoba Geological Services Meeting with Industry, November 1985, Winnipeg, Manitoba. POSTER SESSION: "Bird River Sill Project - Canada/Manitoba MDA" (with R.F.J. Scoates and J.M. Duke).

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1985. TALK: "Layer disruption, PGE mineralization, and the role of supercooling in the crystallization of the Bird River Sill, Manitoba" (with R.F.J. Scoates, J.M. Duke, O.R. Eckstrand).

Effective Oral Presentation, Public Service Commission Personal Development Course (February-March 1986), Carleton University Continuing Education, Hull, Quebec.

Special Talks and Lectures

J.M. Duke

"Chromite Deposits, Bird River Sill, Manitoba; Winnipeg", November 1985. (with R.F.J. Scoates and B.L. Williamson.)

H.E. Dunsmore

"Solar energy, evaporites and ore deposits", University of Waterloo, Waterloo, Ontario, March 1986.

J.A. Kerswill

A somewhat simplified version of the talk presented at the CIM Annual Meeting was also presented to the Chinese gold delegation during their visit in September 1985.

J.W. Lydon

"Geology and genesis of Cyprus volcanogenic sulphide deposits"; lecture to students of Loeben University, Austica, Nicosia, May 1985.

W.D. Sinclair

"Impressions of tin, tungsten and some other granite-related deposits in southeast China"; Ottawa Mineral Exploration Group, Ottawa, April 1985.

"Tin and tungsten deposits in southeast China and western Tasmania, and comparisons with similar deposits in the northern Canadian Cordillera"; Canamax Resources Ltd., Vancouver, B.C., April 1985.

"Tin deposits in western Tasmania: some observations and comparisons with Canadian tin deposits"; Canadian Institute of Mining and Metallurgy Branch Meeting, Whitehorse, Yukon, July 1985.

B.E. Taylor

"Hydrogen isotope evidence for the degassing of rhyolitic magmas and implications", U.S. Geological Survey, Reston, VA, May 1985.

"Hydrogen isotopic evidence for degassing of rhyolitic magmas and implications for magmatic-hydrothermal deposits", McGill University, Montreal, April 1986.

R.I. Thorpe

"Lead isotope studies of gold deposits of the Canadian Shield", to members of the Gold Working Group, Geological Survey of Canada, April 1985; and to visiting gold delegation from the People's Republic of China, September 1985.

Membership on Committees

J.M. Duke

Editorial Board, Economic Geology, member.

Mineralogical Association of Canada, Member of Finance Committee; Chairman, Program Committee; Vice President.

Canadian Institute of Mining and Metallurgy, Ottawa Branch Executive Committee, member.

O.R. Eckstrand

Thompson Nickel Belt Working Group (Friends of the Nickel Belt).

International Geological Correlation Programme, Project 161, "Magmatic Sulphide Deposits in Mafic and Ultramafic Rocks", Canadian representative.

S.B. Green

Geological Survey of Canada Current Activities Forum, General Coordinator.

Geological Association of Canada/Mineralogical Association of Canada Technical Services Committee, Chairman.

GSC/USGS Joint Workshop Planning Committee, Canadian Coordinator.

R.V. Kirkham

Canada-Newfoundland Geoscience Co-operative Mineral Program, Coordinator of Buchans Projects.

Publications Committee, Society of Economic Geologists.

Planning Committee for Special MDD-GAC-MAC Symposium on "Sediment-hosted stratiform copper deposits".

Nova Scotia Mineral Development Agreement (ERDA) Co-ordinator for Economic Geology and Mineralogy Division's projects.

W.D. Sinclair

Canadian Institute of Mining and Metallurgy, Geology Division, Convention Committee for Symposium on "Granite-related Mineral Deposits", Field Trip Leader.

International Strategic Minerals Inventory Working Group, member.

Canada - New Brunswick Mineral Development Agreement (ERDA), project coordinator.

B.E. Taylor

Management Committee, Joint OCCGS/GSC Stable Isotope Laboratory.

R.I. Thorpe

Interdepartmental Working Committee on Northern Mineral and Energy Resource Assessment, Member.

Regional Metallogenic Studies Section
S.M. Roscoe

The Section objective is to carry out investigations of the distribution of different types of mineral concentrations in terms of their relationships to geologic histories of distinctive domains within major tectonic units throughout Canada. These are required for:

(1) elucidations of the economic significance of features outlined in other geological publications; (2) selection of desirable foci for geological mapping and other work; (3) critical tests of an alternate genetic hypothesis for the formation of mineral deposits, leading to refinements of conceptual models used in exploration; and (4) evaluations of mineral resource potential in designated areas.

Extensive field work and laboratory studies are required to:

(1) establish the characteristics of known mineral deposits; (2) distinguish geological and other features that are genetically associated with the deposits from those that are merely coincidentally associated; and (3) seek documentation of occurrences of the most critical features in areas where related mineral deposits have yet to be discovered.

Highlights

The formation of a Divisional Gold Working Group has focussed efforts on this commodity, both by involved Section scientists and through research contracted to university staff under Mineral Development Agreement projects. The work has resulted in a better understanding of the relationship of gold distribution to shear zones at Star Lake, Saskatchewan, Timmins, Ontario and Val d'Or, Quebec, and the recognition of potential new gold environments in the Elbow Lake area of Manitoba where most of the available ground was staked by industry in 1985.

A class of Cordilleran mesothermal Au-quartz veins, similar in many characteristics to equivalent deposits in Archean greenstone belts, has been recognized. Examples and host allochthonous terranes (parentheses) include Atlin (Cache Creek), Erickson Creek (Slide Mountain), Bralorne (Bridge River), Carolin (Methow) and Mother Lode, California (Foothills). Pb isotopic and fluid inclusion data support a host rock rather than a granitic source of Au. Potentially mineralized districts include the Yalakom and Pinchi fault zones, Germanson Creek, Weaton River and Dease Lake areas of British Columbia and the Klondike district in Yukon.

A recently recognized belt of Ag-Pb-Zn replacement deposits hosted by lower Paleozoic carbonates of the Cassiar Terrane in the northern Cordillera have many geological characteristics in common with classical Mexican manto deposits. Pb and K/Ar isotopic studies clearly discriminate syngenetic exhalative deposits in the belt from epigenetic replacement deposits and define three periods of epigenetic mineralization at ca. 70, 60, and 50 Ma.

Presentations and discussions at the Leesburg, Virginia, GSC-USGS workshop on mineral resources on public lands underlined the increasing importance that has been accorded such assessments due partly to developments of improved assessment techniques by both organizations.

Middle Proterozoic basins of the Churchill structural Province preserve several unique features that suggest contemporaneity: a) development and preservation of a thick saprolitic profile that is pre-sedimentation; b) similar depositional environment and type of sediments through the development of the basins; and c) similar prolonged diagenetic histories. Research on the saprolitic profiles beneath the Thelon Formation central Northeastern Shield and the Kombolgie Formation, Australia, suggests they are identical to documented stratigraphic variations in the sub-Athabasca saprolite. Isotopic dating of phosphatic Thelon sediments and phosphate-bearing saprolite places a minimum age of sedimentation at 1680 Ma. This age is comparable to other sandstone basins, Hornby Bay Group in Churchill Province and suggests that the Athabasca Basin is older than recently published ages. This provides a better understanding of the geological environment in which important sub-Athabasca and sub-Thelon uranium deposits occur.

Under the Seafloor Sulphides Program the discovery of a major massive sulphide deposit in the sediment-filled Middle Valley of the Endeavour segment of the Juan de Fuca Ridge followed systematic topographic, sonar and geophysical surveys. This deposit is in a different geological setting than those of the volcanically active areas of the ridge. Discovery of very large base metal deposits in this environment may lead exploration companies to re-evaluate the potential for their presence within preserved sedimentary sequences in volcanic-dominated parts of the Canadian Shield, for example.

Photography of the Explorer Ridge using a deep-towed super-sensitive real-time video camera has enabled us to survey the distribution of the massive sulphide deposits and geologically map over 500 sq. km. of the ridge area in under three weeks. Precise acoustic navigation will aid in determining the size of individual deposits.

Personnel Notes

Drs. A.L. Sangster and G.P. Watson joined the Section in July 1985 to lead metallogenic projects and coordinate Division activities in Nova Scotia and New Brunswick, respectively, under the Federal-Provincial Mineral Development Agreements with those provinces. A. Galley and D.E. Ames continued work under Saskatchewan and Manitoba MDAs, S. Swinden and Z.D.G. Richardson in Newfoundland, C.D. Anglin under the Boundary Disputes Program and A. Pasitchniak and R. Bretzloff provided additional term support for Section projects.

Attendance at Conferences, Meetings and Courses

K.M. Dawson

Canadian Institute of Mining and Metallurgy Annual Meeting, Vancouver, April 1985.

Geological Society of America, Cordilleran Section Annual Meeting, University of British

Columbia, May 1985 (Chairman of Economic Geology Session).

Geoscience Forums, Whitehorse and Yellowknife, December 1985. TALK: "A new belt of AgPbZn deposits in the Cassiar Terrane of the Northern Cordillera."

Cordilleran Geology and Exploration Roundup, Vancouver, January 1986. TALK and POSTER SESSION: "Review of metallogenic studies in Cassiar (Midway, Cassiar, Ketz R.), Alexander (Windy Craggy, Mt. Henry Clay) and Oceanic (Erickson, Atlin, Bralorne) Terranes."

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

Geological Association of Canada Cordilleran Section, Short Course "Plate tectonics, structural styles and evolution of Sedimentary Basins", Vancouver, February 1986.

J.M. Franklin

Canadian Institute of Mining and Metallurgy, Annual General Meeting, Vancouver, B.C., April 1985. TALK: "Massive Sulphide Deposits on Active Spreading Ridges - A comparison with Preserved Deposits".

American Geophysical Union Meeting, San Francisco, December 1985.

Geological Association of Canada Cordilleran Section, Victoria, March 1986. TALK: "Compositional characteristics and volcanic setting of massive sulphide deposits" (with E. Kappel).

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

Prospectors and Developers Association Annual Convention, Toronto, March 1986. TALK: "Vein gold deposits" in a seminar entitled "A synopsis of Canadian mineral deposit types of current interest".

A.R. Miller

International Geological Correlation Programme, Project 160: Precambrian Exogenic Processes, Ottawa. TALK: "Carpenterian (1650 Ma) saprolitic weathering: mineralogy, geochemistry and diagenetic modification, Pine Creek Geosyncline, Northern Australia" (with R.S. Needham and P.G. Stuart-Smith).

K.H. Poulsen

Institute on Lake Superior Geology Annual Meeting, Kenora, Ontario, May 1985.

Canadian Institute for Mining and Metallurgy, Geology Division Symposium, Saskatoon, Saskatchewan, September 1985. TALK: "Auriferous Shear Zones - Examples from the Western Shield."

Canadian Tectonics Study Group, Annual Meeting, Halifax, Nova Scotia, November 1985.

Manitoba Department of Energy and Mines, Open

House, Winnipeg, Manitoba, November 1985. TALK: "Structural analysis of the San Antonio Mine and surrounding area, Bissett, Manitoba".

Saskatchewan Department of Energy and Mines, Open House, Regina, Saskatchewan, November 1985. TALK: "The Federal MDA Geoscience Program 1985."

Ontario Geological Survey Open House, Toronto, Ontario, December 1985.

Workshop on the Tectonic Evolution of Greenstone Belts, Lunar and Planetary Institute, Houston, Texas, January 1986.

F. Robert

Prospectors and Developers Association Annual Convention, Toronto, March 1986. TALK: "Vein gold deposits" in a seminar entitled "A synopsis of Canadian mineral deposit types of current interest".

S.M. Roscoe

GSC-USGS Joint Workshop on Prospects for Mineral Resource Assessments on Public Lands, Leesburg, VA, September 1985. TALK: "Bathurst Inlet Project - methodology case history."

A.I. Sangster

Canadian Institute of Mining and Metallurgy Symposium on Granite-related Mineral Deposits, Halifax, September 1985.

Nova Scotia Department of Mines and Energy, Open House, December 1985. TALK: "Zinc mineralization at Lime Hill".

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. TALK: "Willemite-native silver at Kirkmount".

Prospectors and Developers Association Annual Convention, Toronto, March 1986. TALK: "Willemite-native silver at Kirkmount".

G.P. Watson

New Brunswick Department of Forests, Mines and Energy, Annual Review of Activities, November 1985. POSTER SESSION: "Metallogeny of Chaleur Bay Belt."

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. POSTER SESSION: "Mount Cotigan Breccia-Pipe".

Prospectors and Developers Association Annual Convention, Toronto, March 1986. POSTER SESSION: "Mount Cotigan Breccia-Pipe."

Special Talks and Lectures

K.M. Dawson

"Alteration with respect to precious metal deposits", summary lecture of workshop, December 1985; "Regional metallogeny of the Canadian Cordillera", graduate summer course on Cordilleran Geology, April 1985, at University of British Columbia, Department of Geological Sciences.

"Plate tectonics and the distribution of ore deposits"; B.C. & Yukon Chamber of Mines course 'Exploration and mining for brokers', Vancouver, October 1985.

"Regional Metallogeny of Cordilleran gold deposits", to delegation from People's Republic of China, Vancouver, September 1985.

K.H. Poulsen

"Gold and Shear Zones", University of Manitoba, March 1986.

F. Robert

"The Sigma gold deposit, Val d'Or", Gold Exploration 1985 Seminar, Queen's University, May 1985.

"Structure, paragenèse, altération et inclusions fluides du gîte d'or de la mine Sigma, Val d'Or, Québec", Université du Québec à Chicoutimi, March 1986.

Membership on Committees

K.M. Dawson

Circum-Pacific Map Project, Northeast Pacific Panel, Canadian representative.

Geological Association of Canada, Mineral Deposits Division, Newsletter editor.

International Geological Correlation Programme Project 187: Siliceous Sediments Canadian Working Group, member.

Mining Exploration Group, Vancouver, Speakers Committee, member.

Northern Miner Magazine, Cordilleran Editor.

J.M. Franklin

Canadian Institute of Mining and Metallurgy, Geology Division, Chairman of the Research Committee and CGC representative.

Geological Association of Canada, Mineral Deposits Division, Councillor.

Canadian Geoscience Council, member.

K.H. Poulsen

Economic Geology and Mineralogy Division EMR Research Agreement Committee, Chairman.

Organizational Committee for Workshop on the Tectonic Evolution of Greenstone Belts, LPI, member.

Institute on Lake Superior Geology, Field Trip Committee, Kenora Meeting, member.

Regional Mineral Resource Assessment Section

V. Ruzicka

The Section conducts assessments of non-renewable resources in specific areas. These studies include: (a) resource appraisals of uranium-bearing areas; (b) estimates of resources additional to reserves in identified uranium deposits and; (c) analysis of

economic geological significance of data resulting from exploration activities for uranium conducted by industry; (d) general assessments of mineral resource potential in northern Canada for land use planning activities including national parks and other conservation areas. The assessments are based on regional metallogenic studies and on studies of mineral deposits and their geological environments. Analyses of exploration data are applied to resource appraisals of uranium-bearing areas.

The uranium resource evaluation component encompasses a range from inferred extensions of reserves in identified deposits to prognosticated and speculative resources of less-explored areas. The assessment is conducted biennially in cooperation with industry, the provinces, the Department of Indian and Northern Affairs, Canada Centre for Mineral and Energy Technology and Uranium and Nuclear Energy Branch of Energy Mines and Resources. Interim Assessments of Estimated Additional Resources-I (Inferred) and analyses of results of exploration activities in Canada are conducted during alternate years. The reports are submitted to the Uranium Resource Appraisal Group and used as input to the management of Canada's uranium and nuclear energy policy.

Mineral resource assessments of northern areas yield qualitative ratings of mineral resource potential based on probabilities of occurrence of individual deposit types. The reports are published as GSC Open Files and are used in northern land use policy and planning.

In addition the Section participates in integrated metallogenic studies of specific geological environments, and supervising and monitoring projects in various federal-provincial Mineral Development Agreements (MDAs).

Highlights

Field and laboratory studies on uranium and uranium-polymetallic deposits associated with the pre-Helikian unconformities led to formulation of complementary criteria in conceptual modelling of this deposit type, namely: (a) contemporaneity of the main mineralization processes and the thermal events associated with intrusion of diabase dyke swarms during the period from about 1.3 Ga to about 0.8 Ga; (b) determination of at least three phases of the mineralization: polymetallic (U+Ni+Co+Ag+As), oligometallic (U+Cu+Fe) and monometallic (U); (c) individual phases are present in various degrees of development in various deposits; (d) the most complete mineral succession is apparently present in the Cigar Lake deposit - the world's largest high grade uranium deposit containing about 110,000 tonnes U in ores grading 12% U and an additional 40,000 tonnes U in ores grading 4% U.

A preliminary map, two extensive published reports and two open house talks documented the geological history and mineral deposits of the Proterozoic of the Wernecke Mountains, Yukon, provided critical support for comparison between the Proterozoic of South Australia and the Canadian Cordillera and importantly underscored a very high potential for extensive polymetallic deposits (Cu, U, Pb-Zn, Au).

Pb isotope dating of uraniferous phosphatic beds in Labrador Trough established an age of 1710 Ma for onset of the latest orogeny. It compares favourably with recalculated Rb-Sr dates and suggests need for assessment of the so-called "Hudsonian" in this area.

Study of exploration drilling in Okanagan Highlands revealed that: 1) late Miocene-Pliocene basalts formed an important damming phenomenon, which in turn 2) controlled important facies changes and development of uranium deposits in epiclastic rocks in the uppermost paleovalleys, and 3) apparent late Pliocene sudden uplift is most likely due to a long period of basalt cover protection and its subsequent removal in the late Pliocene and Pleistocene. An absolute minimum date of 3 Ma for U deposits is established. The paragenesis of mineral deposits is established as pitchblende + coffinite + ningyoite + saleeite + autunite + uranophane.

Mineral resource assessment studies of the Wager Bay area resulted in preparation of two 1:50,000 sheets of preliminary geological maps, a detailed grid map documenting relative chronology, and a summary of the rock units. Supracrustal rocks in this area form narrow but extensive belts with numerous gossans and locally elevated base metal contents in pyrrhotitic schists.

"Northern Canada Mineral Resource Assessment" projects in Banks-Victoria Islands, Wager Bay and Nahanni Park, demonstrated useful applications of mineral deposit models to geological domains and a time versus resource potential matrix indicating increasing confidence with time and the need for continuing reassessment.

An absolute age of 780 Ma on zircon from diorite in Mackenzie Mountains compares with that of Mount Harper Volcanics in Ogilvie Mountains demonstrating consanguinity of rift-related igneous events in the northwestern Canadian Cordillera.

Discovery of several additional Pb-Zn-Cu occurrences in Aphebian dolomite at Artillery Lake and the mineral resource assessment of this new metallogenic district, have resulted in modification to the boundary of a proposed National park in the East Arm (Great Slave Lake)-Artillery Lake area. Parks Canada is initiating a public debate on the proposed park in 1986. The public will have access to the first comprehensive mineral resource assessment of the area which points out the potential for deposits of various types in different parts of the proposed park.

Recognition of the potential for economically attractive unconformity-related uranium deposits in the southwestern part of the Helikian Thelon sandstone overlying Aphebian graphitic meta-sediments led to the 1985 mapping of the previously little known basement rocks from the Thelon Basin boundary to Lynx Lake, in an area 70 x 40 km. This revealed that the paragneiss is far more extensive than hitherto realized. The predominant rock-type is garnetiferous quartzofeldspathic gneiss, which was migmatized, later intruded by a major sill-like intrusion of syenite-granite and then folded into a broad anticline 40 km wide and plunging gently to the west-southwest. A mylonite zone of regional significance was recognized south of the anticline. The zone is 6 km wide, vertical, trends northeasterly and is coincident with a steep regional

magnetic gradient. Under the Thelon Formation it consists of graphitic metapelite, which was intersected by exploration drilling.

Important advances have been made in understanding the metallogeny of the Central Labrador Mineral Belt through studies undertaken as part of continuing uranium resource assessment and Federal-Provincial MDA programs. One salient aspect is the recognition of a major U-Mo metallogenic province of Early Proterozoic age that extended from the Labrador coast through south Greenland to northern Sweden, prior to the Phanerozoic continental drift. It is characterized by abundant felsic volcanic and related magmatic-hydrothermal U and Mo deposits displaying significant sodic metasomatism of the host rocks. The deposits in Greenland and Sweden have come to light only recently. New isotopic age determinations and tectonic studies have provided a sound basis for the definition of the major metallogenic province.

Attendance at Conferences, Meetings and Courses

R.T. Bell

Annual Geoscience Forum, Whitehorse, December 1985. TALK and POSTER SESSION: "Update on Wernecke Megabreccias".

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. TALK: "Wernecke Megabreccias: Geological and Metallogenic aspects and significance."

S.S. Gandhi

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting in Fredericton, May 1985. TALK: "Stratigraphy, structure and Pb-Zn-Cu mineralization in Aphebian Artillery Lake Formation, Northwest Territories."

GSC-USGS Joint Workshop on Prospects for Mineral Resource Assessments on Public Lands, Leesburg, VA, September 1985.

Concentration mechanisms of uranium in geological environments, Nancy, France, October 1985.

M.N. Henderson

Macro-Meso-Micro, International Conference on Tectonic and Structural Processes, United Kingdom, April 1985 (including field trip re extensional tectonics, and seminars on 'Deformation Mechanisms in sediments and sedimentary rocks (London); and 'Continental Extensional Tectonics' (Durham).

Canadian Tectonics Group, Halifax, Nova Scotia, November 1985.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

Northeastern Geological Society of America, Kiamesha Lake, NY, March 1986 (including short course and field trip).

V. Ruzicka

International Atomic Energy Agency (IAEA) Technical Committee Meeting on 'Recognition of

Uranium Provinces', London, UK, September 1985. TALK: "Geology and Metallogeny of early Proterozoic Blind River-Elliott Lake Basin"; Advisory Group and Consultants Meeting on Uranium Resources, Vienna, Austria, September-October 1985. Two TALKS: "Estimation of Low-Cost Uranium Resources".

New Brunswick Geological Survey Open House, Fredericton, N.B., November 1985.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

R.F.J. Scoates

International Geological Correlation Programme, Project 161 Magmatic Sulphides Field Conference in Ketchikan, Alaska and Nye, Montana, July 1985. TALK: "The Fox River and Bird River Sills, Manitoba".

Fourth Platinum Symposium, Toronto, Ontario, August 1985. TALK: "Potential for platinum group elements in the Fox River Sill, Manitoba" (with O.R. Eckstrand).

International Symposium on Mafic Dyke Swarms, Toronto, Ontario, June 1985. TALK: "Geochronologic interpretations of Pb isotope ratios of the Molson Dyke Swarm, northern Manitoba." (Coauthor with G.L. Cumming who presented talk.)

Manitoba Department of Energy and Mines Annual Meeting with industry, Winnipeg, November 1985. TALK: "The Bird River Sill Project" (with B.L. Williamson and J.M. Duke).

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. TALK: "Layer disruption, PGE mineralization and the role of supercooling in the crystallization of the Bird River Sill, Manitoba" (with J.M. Duke, O.R. Eckstrand and B.L. Williamson).

GSC-USGS Joint Workshop on "Prospects of Mineral Resource Assessment in 1985" in Leesburg, Virginia, September 1985. TALK: "Canadian Northern Mineral Resource Assessment" (with C.W. Jefferson and D.C. Findlay).

Special Talks and Lectures

R.T. Bell

"The Wernecke Megabreccias: mapping, description, dating and comparisons with South Australian Proterozoic metallogeny", Geological Survey of Canada Cordilleran Division, Vancouver, December 1985.

S.S. Gandhi

"Uranium mineralization and associated soda metasomatism in rhyolites of the Aillik Group, Labrador", at Symposium on Geochemistry and Mineralization of Proterozoic Volcanic Suites, Nottingham, UK, April 1985 (presented by W.R.A. Baragar).

V. Ruzicka

"Uranium Deposit Types", series of four talks for

Nuclear Materials Corporation of Egypt, March 1986.

"Uranium Potential of Sinai Peninsula and Eastern Desert of Egypt" at Nuclear Materials Headquarters, Cairo, Egypt, March 1986.

R.F.J. Scoates

"PGE and chromite mineralization in the Fox River Sill and Bird River Sill, Manitoba", Queen's University, February 1986.

"Significant factors governing PGE distribution in the Fox River Sill and Bird River Sill, Manitoba" at 'Exploration in the Precambrian' Seminar, Utah Mines Ltd., Toronto, March 1986.

Membership on Committees

R.T. Bell

Subcommittee on Estimated Additional Resources of Uranium, Uranium Resources Assessment Group, member.

C.W. Jefferson

Chairman of Committee for Field Trips; GAC/MAC/CGU Annual Meeting to be held in Ottawa, 1986.

M.N. Henderson

Geological Association of Canada, Structural and Tectonics Division, Secretary-Treasurer.

V. Ruzicka

Energy, Mines and Resources Uranium Resource Appraisal Group, Subcommittee on Estimated Additional Resources, Chairman.

Editorial Board, Elsevier's Journal 'Uranium', member.

International Atomic Energy Agency (IAEA), Advisory Group on Uranium Resources, consultant; Uranium Resource Appraisal Group of Consultants, consultant.

Editorial Board, Canadian Institute of Mining and Metallurgy, Special Volume on Canadian Uranium Deposits, member.

R.F.J. Scoates

Advisory Board of the Centre for Precambrian Studies, University of Manitoba, Member.

GSC Steering committee for proposed USGS/GSC Workshop on Resource Assessment Methods, Member.

Thompson Nickel Belt Working Group (Friends of the Nickel Belt); Founding Member.

GSC - Working Committee on Northern Mineral Resource Assessment, Member.

Adjunct professor, Department of Earth Sciences, The University of Manitoba.

Associate Editor, The Canadian Mineralogist.

Logan Club Chairman, 1985/86.

The objectives of the Section are: (i) to develop and apply probabilistic methods of mineral resource estimation for land-use planning purposes; (ii) to provide statistical expertise and services to projects throughout the Geological Survey; (iii) to develop statistical exploration methods for use by the mineral industry; (iv) to develop and apply new methods for the integration and interpretation of various geoscience data sets, including LANDSAT and other remotely sensed data.

These objectives are met by maintaining a long-range research program 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.

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.

Highlights

Methods of multivariate analysis for estimating probabilities of occurrence of mineral deposits and their frequency of occurrence in larger unit areas were further developed. The leverage and influence of local environments on a final solution for a region is being investigated to determine similarities between the host rocks of deposits and to identify unique events which do not occur elsewhere within the region. The new methods were applied to express occurrences of hydrothermal vents in terms of volcanic and tectonic features on the East Pacific Rise at 21° North. A second application dealt with the volcanogenic massive sulphide deposits in the Abitibi Volcanic Belt of the Canadian Shield.

Final description of the RASC computer programme for ranking and scaling of stratigraphic events with applications to wells on the Labrador Shelf and Grand Banks were published in 1985 in 4 chapters of the UNESCO/Reidel guidebook on "Quantitative Stratigraphy". A final version of the RASC programme in FORTRAN 77 with syllabus was published as a GSC Open File in collaboration with the Atlantic Geoscience Centre and Alethic Software Incorporated in Halifax. A preliminary version of the CASC computer program for automated stratigraphic correlation and isochron contouring was also made available in open file form.

New methods are being developed for fitting spline-curves by cross-validation and estimating their precision by using the Jackknife method. The purpose of these methods is to automatically determine age-depth and sediment rate curves for wells, as well as to

calculate geologic time-scales with estimates of their precision.

Development of "confidence bands" for quantile (percentile) function and distribution function on truncated and/or censored data, a classic problem in the application of statistics to various kinds of geoscience data has been completed resulting in: (i) development of the computer program, WIENER (to be published as a GSC Paper); (ii) the methodology being applied to economically truncated data for mineral resource evaluation, an important cornerstone in the development of the statistical techniques for resource evaluation; and, (iii) several new statistical techniques being developed as an offshoot of this study.

SIMSAG, an integrated system for resource evaluation, has been successfully implemented on the CHROMATICS colour computer system.

As input to the Radwaste program, investigations were carried out on the use of (i) quantile function and "percentile residual lifetime" on the measured length of fractures at the surface of a granitic pluton near Lac du Bonnet, Manitoba; and (ii) distribution function of uranium and thorium in core samples from a granitic pluton near Lac du Bonnet, Manitoba.

Software has been developed for the Chromatics and VAX computers that permits analysis of remotely sensed data. This included satellite data and a unique package to analyze high resolution data from airborne scanners. Several studies of enhanced LANDSAT data have illustrated strong correlation with known geologic structures in the Atlin, B.C. and Bathurst, N.B. areas.

A poster illustrating catchment basin analysis of surficial geochemical data, and relationship to mapped units in Cobeguid Highlands was awarded 'Best Poster' at the International Geochemical Exploration Symposium in Toronto, April 1985. This was a joint effort with P.J. Rogers (NSDME) and D.J. Ellwood (RGG).

Raster-scanning equipment at Lands Directorate (Environment Canada) has been used for capture of geological maps, and creation of printer-ready colour-separated transparencies of geological images. This work has been demonstrated using geological maps and catchment basin maps, reported in Canada Lands Data System (CLDS) Bulletin, and used in a recent GSC paper. In the carbonate platform of Newfoundland a project was successfully completed to illustrate the quantitative relationship between lineaments and zinc deposits.

A new method used to test the spatial association of lineaments and mineral deposits shows that Meguma (N.S.) gold occurrences lie closer to NNW-trending fractures than would be expected if gold occurrences and this NNW-fracturing event were independent processes. Quantitatively-demonstrated links between structural directions and mineral occurrences are important to resource evaluation and exploration.

Analysis of micropaleontological data from offshore wells (Labrador and Scotian shelves) using multivariate statistical techniques has shown that the competing effects of proto-Gulf Stream and proto-

Labrador currents waxed and waned during the Cenozoic. This is not only important for understanding Cenozoic sedimentation along the N.W. Atlantic margin, but also for distinguishing paleoenvironmental from evolutionary effects on the micropaleontological data used to correlate stratigraphy from one offshore well to another.

Personnel Notes

S.N. Lew continued as scientific programmer until the end of the year at which time he joined the Department of National Defence in a permanent position.

C. van der Grient participated in Section activities using an ERDA term position.

Attendance at Conferences, Meetings and Courses

F.P. Agterberg

NATO Advanced Research Workshop on "Marine Minerals and Resource Assessment Strategies", University of Wales, June 1985. TALK: "Estimation of the probability of occurrence of polymetallic massive sulfide deposits on the ocean floor."

Geological Society of London meeting on "Marine Mineral Resources", London, June 1985. TALK: "Spatial analysis of patterns of land-based and ocean-floor ore deposits."

GSC-USGS Joint Workshop on "Prospects of Mineral Resource Assessment in 1985" in Leesburg, Virginia, September 1985. TALK: "Canadian experience in application of multivariate analysis techniques."

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

G.F. Bonham-Carter

International Geochemical Exploration Symposium, Toronto, April 1985. POSTER SESSION: "Catchment basin analysis applied to surficial geochemical data, Cobequid Highlands, Nova Scotia." (Won best poster award.)

14th Annual Geochatouqua, Wichita, Kansas, October 1985. Two TALKS: "Geographic distribution of Cenozoic Foraminifera, Dinoflagellates, and Spores in offshore wells on the Labrador and Scotian Shelves"; and "Spatial dependence of pinnacle reefs and faults in Silurian limestones of SW Ontario."

GSC-USGS Joint Workshop on "Prospects of Mineral Resource Assessment in 1985" in Leesburg, Virginia, September 1985. TALK: "Multiple dataset integration". Discussion group - "Export Systems: link to economic and policy issues."

Nova Scotia D.M.E. Open House, Halifax, November 1985. POSTER SESSION: "Catchment basin analysis of surficial geochemical data, Cobequid Highlands, Nova Scotia."

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. TALK: "Remote

and ground-based detection of a carbonatite biogeochemical anomaly in SE Ontario" (with A.N. Rencz).

Computer applications in Mineral Exploration Conference, January 1986. TALK: "Multiple data set integration in E. Nova Scotia: Some Preliminary Results" (with A.N. Rencz, J. Broome and J.R. Harris).

C.F. Chung

Stochastic Processes and their applications, The 15th Conference, July 1985, Nagoya, Japan. TALK: "Computational aspects of Probabilistics associated with the Wiener and Brownian bridge processes".

A.N. Rencz

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. TALK: "Remote and ground-based detection of a carbonatite biogeochemical anomaly in SE Ontario" (with G.F. Bonham-Carter).

Special Talks and Lectures

F.P. Agterberg

"Quantitative stratigraphic correlation" (jointly with F.M. Gradstein), Canadian Society of Petroleum Geologists, Calgary, June 1985.

"Multivariate statistical analysis in regional mineral resource appraisal", Ecole Polytechnique, Montreal, November 1985.

"Frequency distributions of spatial random variables", University of Hong Kong, November 1985; and Carleton University, Ottawa, January 1986.

"Statistics in Geology, course GEO3100, Department of Geology, University of Ottawa, January-March 1986.

"Probabilistic Mineral Resource Appraisal", one-week Short Course, Wuhan College of Geology, Chinese Academy of Geological Sciences, Beijing and Ministry of Metallurgy, Kweilin, China, October-November 1985.

C.F. Chung

"Multivariate Statistical Analysis for Regional Resource Evaluation", Korean Institute of Energy and Resources, August 1985.

Membership on Committees

F.P. Agterberg

International Commission on Stratigraphy, Committee on Quantitative Stratigraphy, voting member.

International Geological Correlation Programme Project 148, Quantitative Stratigraphic Correlation Techniques, Leader, International Working Group.

Carleton University, Department of Mathematics and Statistics, Adjunct Professor.

University of Ottawa, Department of Geology, Adjunct Professor and Graduate School member.

Commission on Tectonics of Ore Deposits
Working Group No. 3, Chairman.

Computers and Geosciences, Editorial Advisory
Board.

Geo-Processing, Editorial Board.

Canadian Mining and Metallurgical Bulletin,
Geology Division, Editorial Board.

Geologie en Mijnbouw, Associate Editor.

Global Tectonics and Metallogeny, Advisory
Editorial Council.

G.F. Bonham-Carter

Canadian Advisory Committee on Remote
Sensing, Geobotany Working Group.

Geological Survey of Canada Data Integration
Committee.

C.F. Chung

NATO/ASI Organizing Committee on "Statistical
Treatment for Estimation of Mineral and Energy
Resources", Director.

A.N. Rencz

Canadian Advisory Committee on Remote
Sensing, member.

Mineral Resource Information Services Section

D.F. Garson

The Section has overall responsibility for all commodity and metallogenic files of the Economic Geology Division. Document files and related scientific materials are retained mainly by individual project scientists in the Division. However MRIS (Mineral Resource Information Services) acts as the compiler and curator of the Divisional computerized mineral deposits database (CANMINDEX) as well as providing assistance relating to computer-based geoscience data management and display. The section also provides divisional library and reference services relevant to mineral deposits research.

Highlights

In order to expand the mineral deposits database available to Survey geologists, computer tapes of the mineral deposits files from the Ontario Geological Survey (5554 deposits) and the Nova Scotia Department of Mines and Energy (894 deposits) were acquired. The Nova Scotia file is being integrated into the CANMINDEX system in cooperation with a GSC-Nova Scotia Mineral Development Agreement project. MRIS can now provide GSC projects with access to data on approximately 30,000 deposits in GSC files and in publicly available files from other federal agencies and from provincial departments.

MRIS staff provided many hours of consulting in the fields of data management and manuscript preparation on microcomputers, mainframe computing, data communications, datafile building, computer plotting and related fields. This has led to progress in many endeavours by division scientists, one of the more

notable being the preparation of manuscripts on computers by individuals and electronic transfer of that information to the Word Processing Centre for final formatting for publication purposes.

Computer processing support was provided for generation of the final bibliography for GSC EG 37 (in press), Geology of Lead-Zinc Deposits in Canada.

GSC Open File 1087 - Mineral Inventory of the Sudbury, Timmins, Algoma area, including basic data on 2260 mineral deposits, was released. Computer processing and data validation for this report was done by MRIS staff.

MRIS assisted with the compilation, maintenance and graphic display of data for several hundred porphyritic intrusion-associated Cu-Mo deposits in support of a presentation at a CIM Symposium. This project involved collating data from several computer files and has resulted in the development of a system similar to CANMINDEX for international files and also the development of programs to plot geographic locations on various world maps.

Thirty-one retrievals of mineral deposit information from the Economic Geology mineral deposits database were processed for: officers in this division (19), Precambrian (2); Terrain Sciences (3); Regional Geophysics and Geochemistry (6). Most of these retrievals involved searching one or more files and producing hard copy listings and plots.

One hundred and ninety-four publications were ordered and received for Economic Geology Subdivision personnel. A microcomputer database has been developed as an aid for keeping track of these publications.

Attendance at Conferences, Meetings and Courses

A.G. Douma

Back Care Program (EMR), Ottawa, November 1985.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

First Aid Refresher Course, EMR, March 1985.

D.F. Garson

Tutorial French, GSC, 2hrs/week (ongoing).

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

S.A. Scully

French Course, EMR, November-December 1985.

Tutorial French, GSC, 2hrs/week (ongoing).

J.A. Shaw

Back Care Program (EMR), Ottawa, November 1985.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

Tutorial French, GSC, 2hrs/week (ongoing).

Special Projects

Three senior staff geologists have responsibilities that include: the geology of iron, manganese, lead and zinc deposits in Canada; the geology of ocean mineral resources; and the curation and management of collections of ores and host rocks.

Highlights

Following field examination and limited petrographic studies, sixty-one mineral occurrences in the western Newfoundland carbonate platform could be grouped into two broad types. Type I possesses geological characteristics of "Mississippi Valley-type" lead-zinc deposits, similar to the currently-producing Newfoundland Zinc mine near Daniel's Harbour. The amount of sulphides and gangue present is a function of secondary porosity of the host rock; this secondary porosity was found to decrease with age of host rock. Type II occurrences are lead-zinc-calcite-barite veins or open-space fillings. Vein-forms are found in the less permeable Cambrian and Ordovician strata; open-space style of mineralization occurs in the more permeable Mississippian rocks.

Field examination of vein mineralization in a 100 km² area northwest of McGerrigle Mountain granitic complex revealed the following: (i) quartz, calcite and dolomite are the dominant vein minerals; (ii) sulphides are composed of sphalerite, galena, chalcopyrite, and pyrrhotite. Studies of mineral zoning have shown the presence of two quartz-rich, carbonate-poor "corridors" within the otherwise carbonate-dominated veins of the region. Chalcopyrite, pyrite and pyrrhotite are present throughout the area but sphalerite and galena are only present locally.

Field examination and limited microscopic studies of lead-zinc occurrences in the Gaspé region of Quebec revealed that they can be divided into two broad groups: (i) vein-bound occurrences of sphalerite and/or galena, and (ii) disseminated galena with or without sphalerite. The vein-bound type can be further subdivided into four groups according to dominant gangue and sulphide species. The occurrences of disseminated galena have, until now, not been recognized as a separate deposit-type in Gaspé. Because many of their geological features are similar to those characteristic of sandstone-lead deposits which constitute a viable lead source in other countries, the presence of this deposit-type enhances the lead-zinc potential of this part of Gaspé.

Research on the metallogenetic significance of ironformation and stratafer chemical sediments shows that common facies of Algoma type ironformation contain a significant background content of gold; ironformations containing large resources of rare earth elements of syngenetic origin studied in China (1984) are providing important reference data needed for the identification of similar types of resources in Canada; and chemostratigraphic data was obtained for 35 elements in lithofacies of Lake Superior type ironformation from 8 stratigraphic sections in the Knob Lake basin in Quebec and Labrador.

A classification of hydrothermal mineral deposits located on the deep seabed has been developed on the basis of their form, tectonic setting, types of sedimentary facies, and depositional environment, to show genetic relationships between modern and ancient deposits, to facilitate genetic modelling and to provide

a scientific basis for resource appraisal.

Attendance at Conferences, Meetings and Courses

L.M. Cumming

Canada-wide Science Fair, Cornwall, May 1985.

National Toponymic Data Base Symposium, Surveys and Mapping Branch, Ottawa, May 1985.

Microcomputer concepts and applications Workshop, IBM, Ottawa, July 1985.

Continental Scientific Drilling Program Conference, Ottawa, February 1986.

G.A. Gross

16th Annual Underwater Mining Institute, Halifax, October 1985. TALK: "Deep Seabed Resource Potential."

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

D.F. Sangster

Joint GSC/USGS Workshop on "Prospects for Mineral Resource Assessment in 1985", Leesburg, Virginia, September 1985. TALK: "Summary - Deposit Models Revisited".

Society of Economic Geologists Annual Fall Meeting, Orlando, Florida, October 1985.

M.E.R.I. Short Course, "Fluid inclusion techniques and their application to the earth sciences and exploration", McGill University, Montreal, March 1986. TALK: "Problems of age and source of mineralization in Mississippi Valley-type deposits", 15th Annual Adams Club Symposium, February 1986.

Special Talks or Lectures

L.M. Cumming

Geology of Gros Morne National Park", Western Brook Pond, Newfoundland, August 1985.

"Geology as a Career", Sir Robert Borden Secondary School, Ottawa, January 1986.

D.F. Sangster

"A geo-tour of major Canadian base-metal districts"; "Canadian Precambrian volcanogenic massive sulphide deposits"; "Results of research on a Canadian sandstone-lead deposit of Carboniferous age"; at University of New York at Buffalo, Department of Geology, November 1985.

Membership on Committees

L.M. Cumming

Ottawa Branch CIM, Executive Committee, member.

Youth Science Foundation, Executive Committee, member, representing Geological Association of Canada.

Canada-wide Science Fair, Judge of earth science exhibits

Baillie Report Ad Hoc Committee, Geological Survey of Canada, member.

Canadian Committee on the History of Geological Sciences, member.

G.A. Gross

Precambrian Research Editorial Board, member.

Canada - USSR Mixed Commission on Economic Industrial, Scientific and Technical Cooperation, Applied Geology Working Group, Canadian Co-chairman.

Geological Survey of Canada Task Group on Submarine Metalliferous Hydrothermal Systems, member.

EMR Departmental Committee on Ocean Mining, member.

International Geological Correlation Program Project 91, Metallogeny of the Precambrian, Canadian Co-ordinator; Project III, Manganese Ore deposits, member; Project 187, Siliceous Sediments, member.

D.F. Sangster

Society of Economic Geologists, member of; Thayer Lindsey Speakers Committee; Committee on Committees.

Ph.D. and M.Sc. thesis Committees, at M.U.N. and Ottawa University.

Mineral Deposits Laboratory

R.D. Lancaster

The Mineral Deposits Laboratory is responsible for the processing of rock specimens through sorting, slabbing and polishing samples and through the preparation of polished sections and mineral separations. Specimens are slabbed to provide a flat, fresh surface for examination and to divide the sample for various other uses, e.g. chemical analyses, mineral separation, polishing.

Preparation of polished sections involves cutting, mounting, grinding, impregnation and regrinding and three stages of machine polishing of the ground surfaces. Polished sections are prepared both for conventional ore microscopy and for electron microprobe studies.

Mineral separations are obtained by selective grinding of rock samples to a specific grain size and subsequent processing by various combinations of magnetic, heavy liquid and superpanner methods of concentration to produce monomineralic fractions primarily for isotopic and trace elements analyses.

Production Statistics for the Year

Specimens Slabbed for:

Economic Geology and Mineralogy	7456
Resource Geophysics & Geochemistry	320
Precambrian Geology	120
Terrain Sciences Division	3
CANMET	4
TOTAL	7843

Specimens Slabbed & Polished for:

Economic Geology & Mineralogy	942
Resource Geophysics & Geochemistry	261
Precambrian Geology	14
Terrain Sciences Division	7
CANMET	6
TOTAL	1230

Polished Sections Prepared for:

Economic Geology & Mineralogy	536
Resource Geophysics & Geochemistry	97
Director General's Office	24
Terrain Sciences Division	6
TOTAL	663

Specimens ground for:

Economic Geology and Mineralogy	436
Resource Geophysics and Geochemistry	32
Precambrian Geology	45
TOTAL	513

Mineral Separations Prepared for:

Economic Geology & Mineralogy	598
Resource Geophysics & Geochemistry	28
Precambrian Geology	66
TOTAL	692

The unit is responsible for the maintenance of a research microscopy laboratory, cathodoluminescence equipment, and a heating-freezing stage and ancillary equipment for fluid inclusion studies. Divisional drafting services are also the responsibility of this unit.

Attendance at Conferences, Meetings, and Courses

R.D. Lancaster

Current Activities Forum, Geological Survey of Canada Ottawa, January 1986.

Membership on Committees

R.D. Lancaster

Branch Safety Committee, Member.

MINERALOGY AND CHEMISTRY SUBDIVISION

A.G. Plant

The main responsibilities of the Subdivision are as follows:

1. To provide chemical and mineralogical support (data, advice, assistance) as required for Branch scientific projects, and occasionally for other projects and organizations, through the development and operation of chemical and mineralogical laboratories;
2. To develop and maintain, by means of ongoing research and development on methods and instrumentation, an up-to-date capability to provide the expertise required;
3. To carry out mineralogical research studies on minerals and selected mineral deposits, independently or in collaboration with other geoscientists;
4. To develop and curate National and Branch rock, mineral and meteorite collections;
5. To provide mineralogical information to the Canadian public.

At the end of the report period the Subdivision comprised 2 research scientists, 12 physical scientists, 2 chemists and 22 scientific and technical support staff.

Mineralogy Section

The Section provides the facilities and expertise for mineralogical studies by maintaining and developing laboratories for X-ray diffraction and crystallography, electron microprobe analysis and scanning electron microscopy. These are complemented by the sample preparation and mineral separating laboratories, the latter being almost exclusively devoted to the needs of geochronological research. The Section has responsibility for the Reference Collection Facility at Tunney's Pasture where it maintains the GSC rock collection, while the Reference Series of the National Mineral Collection (approximately 14 000 specimens) and the National Meteorite Collection are housed at 601 Booth Street. Information to the public is provided through the preparation and sale of sets of rocks and minerals, the free examination of specimens submitted by the public, and the preparation and publication of guidebooks to Canadian mineral areas as an aid to collectors and tourism.

X-ray Diffraction, Electron Microbeam Analysis and General Mineralogy

Four hundred and ninety-nine (499) 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 74 projects, an increase of 10% from 1984-85. This work included 1223 mineral identifications by Debye-Scherrer powder camera and 64 new standard reference patterns, 1338 X-ray diffractometer scans, 122 autoradiographs, and 3750 hours of instrument time in the electron microprobe and scanning electron microscopy laboratories. The studies encompassed a very broad range of geological topics and included studies in economic geology (including seafloor sulphides), petrology, geochemistry, sedimentology, mineralogy, paleontology, and the nuclear waste disposal program.

The acquisition of a microcomputer for the X-ray diffractometer has improved the capacity of the laboratory to provide mineralogical identifications, particularly with the use of new search/match software incorporating mineral data available from the Joint Committee on Powder Diffraction Data. During the year considerable effort was devoted to familiarization with the hardware and software of the new image and particle analysis system, and to bringing the system into routine use. Procedures and analytical routines have been developed in response to analytical requisitions and have included extensive work on chromite assemblages and on the occurrence of gold grains in sediments.

Mineralogical studies have been completed on drill core samples collected from 25 holes at the main Hemlo gold deposit and the results have been discussed with the three companies developing the deposit. The mineralogical data are assisting the geologists to understand the interplay between mineralogy and metal zones, have outlined zones where some milling problems may be encountered, and are contributing to the interpretation of the origin of the deposit.

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 95 requisitions in support of 38 projects, and showed a 53% increase over 84-85.

	PC	EGM	RGG	DGO	TS	Other	Total
Forwarded							
84-85	115	0	0	0	0	0	115
Received							
85-86	546	2422	291	113	299	6	3677
Completed							
85-86	580	2362	291	113	227	6	3579
Carried							
86-87	81	60	0	0	72	0	213

Sample preparation and mineral separation for geochronology included the following: 2 potassium-argon and 16 rubidium-strontium whole rock samples; 93 zircon, 93 monazite, 23 biotite, 24 amphibole, 15 muscovite and 4 other mineral concentrates. In addition, separations were completed for 136 miscellaneous mineral concentrates for other projects.

Assistance to the Public

Information provided to the public by the Curatorial Services Unit required the identification of more than 220 rock and mineral samples, with results being communicated in 40 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: 48 office visits, 60 telephone enquiries and 27 letters. Identifications were provided for 108 specimens.

Preparation of Rock and Mineral Sets

Nine thousand, five hundred and seventy-three (9,573) sets of rocks and minerals were prepared and shipped during the year, a 25% increase over the 7624 sets in 84-85. The distribution of these across Canada was as follows:

	1984-85	1985-86
Alberta	1,075	578
British Columbia	147	351
Manitoba	144	263
New Brunswick	180	138
Newfoundland	64	10
Nova Scotia	340	457
N.W.T.	27	20
Ontario	1,307	1,320
P.E.I.	27	18
Quebec	1,782	3,405
Saskatchewan	74	109
Yukon	180	354
G.S.C. Offices	1,306	1,600
E.M.R. Offices	890	850
Other	81	100

At the request of the National Film Board, 25 collections were prepared and supplied to accompany Earth Science Filmstrip Kits. Revenue from the sale of all sets and collections payable to the Receiver General, was \$38,417.00 (\$30,621.00 in 84-85). The large increase in the distribution of rock and mineral sets to the Province of Quebec is due to the use of a

new school manual (Initiation aux sciences) at the Secondary School level.

Special requests for specimens were filled for: National Museum Mobile Exhibits; Information Division EMR for display at Canadian Pacific Exhibition, Vancouver; CANMET; Minister's Office, EMR; and Canadian Pacific for use in the construction of a cairn at Craigellachie, near Revelstoke, B.C. to commemorate the 100th anniversary of the 'Last Spike'.

Fieldwork was undertaken at 54 localities in Newfoundland, Nova Scotia, New Brunswick, Quebec and Ontario. The work involved more than 25,000 km of travel and the collection of 22 tons of minerals, rocks, ores and fossils.

Curation of Collections

Curation of the National Mineral Collection, Systematic Reference Series, resulted in the addition of 156 specimens, including 31 species new to the collection, 5 of the latter being type material. Notable among the 50 bulk accessions were a large number of rare species obtained from W.W. Pinch of Rochester, New York, and suites of minerals from Kombat and Tsumeb, Namibia. The National Mineral Collection computer database was significantly improved with the addition of 499 specimen records, including 152 records of specimens in the type collection. Several new fields were added to the database, increasing the cross-indexing and search capabilities. Data on 14250 specimens are now available. Field work in support of the mineral collection was carried out in the Yukon, British Columbia and the Northwest Territories; of particular interest is a large suite of material from the beryllium-rare earth deposit at Thor Lake, NWT. Curation of the National Meteorite Collection resulted in the addition of 16 samples (11 new to the collection, including GIROUX, Manitoba). There were noteworthy additions of CANON DIABLO and TRENTON irons, IMILAC pallasite and MURCHISON carbonaceous chondrite. Numerous inquiries for information about meteorites were answered, and information sent to Mines and Energy personnel in St. John's, Nfld. after a spectacular fireball over Buchans in January 1986. Curation and development of the GSC Rock Collections and their auxiliary files housed in the Reference Collection Facility, Tunney's Pasture resulted in the addition of over 850 pairs of current project material. The facility was consulted on over 150 occasions by personnel from all Divisions and others. A compilation of all materials held at the Reference Collection Facility in the collections of rocks, thin sections, cores, field notes and project materials was completed. It contains the names of 517 scientists whose current or archived materials are at the RCF. The Ad Hoc Committee to consider the Baillie Report on Sample Repository Services at GSC held two meetings, and completed a revised edition of the Committee's report to be submitted to Branch Management after discussion in GSC Divisions.

Personnel Notes

Mr. Moe Huot retired from the Public Service in January 1986 after 19 years at the Geological Survey working in the Sample Preparation and Mineral Separation Laboratories. **Mr. Rick Gordon** resigned in September 1985 after working for three years in the Sample Preparation Laboratories to accept a position with National Defence.

Sandra Thompson, Alan McRae and Gerry Gagnon provided term support for parts of the year.

Attendance at Conferences, Meetings, and Courses

H.G. Ansell

Twelfth Annual Rochester Academy of Sciences Mineralogical Symposium, Rochester, New York, April 1985. TALK: "What's New in Minerals."

Canadian Heritage Information Network PARIS (Pictorial and Artifact Retrieval and Information System) User Representatives Training Seminar, Ottawa, November 1985.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

Envoy 100 Training Seminar, Ottawa, February 1986.

St. John Ambulance Safety Oriented First Aid Course, March 1986.

D.C. Harris

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. POSTER SESSION: "Mineralogy of Hemlo Gold Deposit."

R.K. Herd

Twelfth Annual Rochester Academy of Sciences Mineralogical Symposium, Rochester, New York, April 1985.

Harvard Mineralogical Museum Association Franklin Celebration, Boston, Massachusetts, June 1985.

National Research Council of Canada Associate Committee on Meteorites Annual Meeting, Ottawa, October 1985.

Polar Continental Shelf Project, General Planning Meeting, Ottawa, November 1985.

Job Description Writing Seminar, Professional Institute of the Public Service, Ottawa, December 1985.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

Tucson Gem & Mineral Show, Tucson, Arizona, February 1986.

G.M. LeCheminant

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting in Fredericton, May 1985. TALK: "Phlogopite from 1.8 Ga Lamprophyres and Trachyandesites, District of Keewatin: Petrologic Implications" (with A.N. LeCheminant).

Applications of Electron Microscopy in the Earth Sciences, Mineralogical Association of Canada Short Course, May 1985.

Advanced Image Analysis, Cambridge Instruments Inc., Monsey, NY, November 1985.

Current Activities Forum, Geological Survey of

Special Talks and Lectures

Canada, Ottawa, January 1986. TALK: "Massive Sulphides Discovered in a Sedimented Rift Valley, Northern Juan de Fuca Ridge: Geological Setting, Mineralogy and Geochemistry" (with W.D. Goodfellow, E. Davis, B. Bornhold, J. Adshead, B. Blaise). POSTER SESSIONS: "Uranium and Uranium-polymetallic deposits associated with unconformities" (with V. Ruzicka); contributed to "Studies of the Juan de Fuca Ridge".

A.G. Plant

Executive Committee Meeting, Spectroscopy Society of Canada, Kingston, June 1985.

Microbeam Analysis Society Annual Meeting, Louisville, August 1985.

National Research Council of Canada Associate Committee on Meteorites, Ottawa, October 1985.

Steering Committee, Isotrace Laboratory, Toronto, January 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

A.C. Roberts

Twelfth Annual Rochester Academy of Sciences Mineralogical Symposium, Rochester, New York, April 1985.

Mineralogical Society of America Short Course on Mathematical Crystallography, Orlando, FL, October 1985.

Joint Committee for Powder Diffraction Standards, Biannual Meeting, Philadelphia, PA, October 1985 and March 1986.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986.

A.P. Stenson

Geological Association of Canada/Mineralogical Association of Canada Annual Meeting in Fredericton, May 1985; and attendant Executive Committee meetings for MAC (Fredericton in May 1985 and Ottawa in October 1985) and Joint MAC/GAC (Fredericton, May 1985).

International Centre for Diffraction Data, Essington, Pennsylvania, March 1986 and October 1985.

W.U. ter Haar Romeny

St. John Ambulance Safety-Oriented First Aid course, Ottawa, March 1986.

D.A. Walker

Scanning Electron Microscopy Symposium, Las Vegas, April 1985.

Advanced Image Analysis, Cambridge Instruments Inc., Monsey, NY, November 1985.

Current Activities Forum, Geological Survey of Canada, Ottawa, January 1986. POSTER SESSION: "Geological Applications of Image and Particle Analysis."

R.K. Herd

"Identification of rocks and minerals for children", Brook Lane Public School, Nepean, June 1985; Ottawa Public Library, July 1985; and General Vanier Public School, Ottawa, January 1986.

"Geology of the Gatineau Park" Field trip and lecture, Canadian Nature Federation, Ottawa, July 1985.

"The effect of iron on the stability of sapphirine-bearing assemblages", University of Leicester, England, November 1985.

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.

R.K. Herd

Ad Hoc Committee on Baillie Report on GSC Sample Repository Services, Chairman.

National Research Council of Canada Associate Committee on Meteorites (also Education, Canadian Arctic Meteorite Project, and Research Subcommittees), member.

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

Spectroscopy Society of Canada, Past-President (until June 1985).

Steering Committee, Isotrace Laboratory, University of Toronto.

Branch Management Standing Subcommittee on New Technology for Data and Information Acquisition and Processing, member.

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.

A.C. Roberts

Joint Committee for Powder Diffraction Standards - International Centre for Diffraction Data, member; Minerals and Ceramics Subcommittee and task groups within Metals and Alloys 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.

Analytical Chemistry Section

G.R. Lachance

The ongoing objective of the Analytical Chemistry Section is to provide compositional data on a wide variety of geological materials submitted by GSC scientists. Currently, the short term objectives are to upgrade instrumentation and methods to bring them to "state of the art" levels in order 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 concentrations on much larger numbers of samples required for some projects. While some progress has been made in extending the range of analytical services offered, some non-routine analytical requests (e.g. speciation, highly mineralized samples, constituents at ultra-trace levels) cannot be met adequately in-house at present.

The various analytical techniques used to provide compositional data for rock, ore and mineral samples range from classical chemical methods for unusual samples to instrumental techniques that include atomic absorption (flame and graphite furnace), infra-red analysis, ICP-emission spectroscopy, and X-ray fluorescence spectrometry with both wavelength and energy dispersive systems. Method development is a necessary prerequisite for the laboratories and is undertaken, often concurrently, with requests for analyses of materials for which the Section does not have established methods. The Section also takes a

leading role in the study and certification of international standard reference materials for chemical analyses.

During the report period, the activities of the Section have been directed towards improving productivity, reducing turnaround time for the completion of analyses, upgrading instrumentation, undertaking method development to broaden the analytical capabilities of the laboratories, and the establishment of analytical contracts with commercial laboratories to support the Mineral Development Agreements and to assist with the needs of A-Base projects.

The Section processed 189 requisitions, with an average of 40 samples per requisition, for analytical services in the support of A-Base projects. The most common request was for whole rock analysis, including major, minor and trace elements, and this involved the determination of 36 constituents per sample. With the additional determination of the rare earth elements, 45 determinations were reported on each of 500 samples. The status of samples processed is as follows:

	Carried over	Received	Completed	Carried Forward
CG	0	278	215	63
EGM	503	2716	2804	415
PC	210	980	983	207
RGG	340	1744	1367	717
TS	64	181	204	41
OTHER	40	95	130	5
TOTAL	1157	5994	5703	1448

There was a 41% increase in the number of samples received compared to 1984-85 (4241 samples), and a 10% increase in the number of samples completed. The continued success of the ICP spectrometer has contributed to this level of productivity and has offset the impact of the XRF spectrometer that has been out of commission for the past six months. Although the present backlog has increased, all 1448 samples have been received since January 1, and 90% were received after February 1. Analytical contracts to support A-base projects for the determination of elements not available in house and to assist with special problems totalled \$24 000.

In addition to these A-base activities, 29 requisitions were received for the analysis of 1255 samples (1156 - EGM and 99 - PC) to support Mineral Development Agreements in Newfoundland, Nova Scotia and New Brunswick. Data have been reported for 758 samples. The discretionary spending freeze during February and March has contributed to some delays in the completion of contract analyses and the backlog is higher than had otherwise been expected. Although all of these samples were contracted out, the process involved considerable paperwork to ensure that the analytical requirements were fulfilled completely. The submission of blind duplicates and a number of international reference materials within each suite of samples provided valuable information on the precision and accuracy of the analytical results received.

The replacement of the XRF spectrometer was a major priority and a comprehensive evaluation of the X-ray fluorescence spectrometers available from four manufacturers was completed in July. The new sequential XRF spectrometer was received at GSC in

late March and it is expected to be operational within a few weeks. This is a major acquisition for the Section and will contribute substantially to increasing the analytical capacity of the laboratory. Instrumentation for the determination of carbon and water was also evaluated during the year and a new carbon analyzer was purchased. This is a semi-automated instrument that permits the analysis of 100 samples per day.

A method for the determination of 8 elements in the rare earth group based on ion exchange/preconcentration and ICP spectrometry was developed and evaluated. It is now in routine use and 40 samples can be processed per week. Also methods were developed for the determination of major and trace constituents in brines, sea water, lake waters, vegetation and acid soluble constituents from mineralized rocks, and for the specific dissolution of barite in the presence of barium-bearing silicates.

Personnel Notes

Mr. Paul McManus resigned from the Public Service in July 1985 to resume his academic studies after 2.5 years employment in the Analytical Chemistry Section. **Mr. Rick Pittuck** provided term support for part of the year.

Attendance at Conferences, Meetings and Courses

P.G. Belanger

Laboratory Chemicals and Waste Management Course, Ottawa, April 1985.

Congress on Advances in Spectroscopy and Laboratory Science, Toronto, October 1985.

S. Courville

Pré-retraite, Phase II, Ottawa, Fevrier 1986.

R.D. Faulkner

St. John Ambulance Safety-oriented First Aid Course, Ottawa, February 1986.

V. Grushman

Pre-retirement Course, Phase II, Ottawa, October 1985.

G.R. Lachance

34th Annual Denver X-ray Conference, August 1985 (Workshop organizer for Quantitative X-ray Fluorescence Analysis).

Congress on Advances in Spectroscopy and Laboratory Science, Toronto, October 1985.
TALK: "A comparison of ICP and XRF techniques for the analysis of geological materials."

R.M. Rousseau

Congress on Advances in Spectroscopy and Laboratory Science, Toronto, October 1985.

J.G. Sen Gupta

Pre-retirement Course, Phase I, June 1985.

Special Talks and Lectures

G.R. Lachance

Resource person at X-ray Clinic, State University of New York at Albany, Albany, NY, June 1985.

Organized and presented a series of lectures at a Colloquium on Quantitative XRF Analysis, Quebec, November 1985.

R.M. Rousseau

"Théorie 85: algorithme Rousseau"; "Application générale: recommandations", et "Application aux oxydes, roches, ciments et autres" au Colloque sur les méthodes d'analyse par fluorescence des rayons-X, Centre de Recherches Minérales, Québec, novembre 1985.

Membership on Committees

J.G. Sen Gupta

Branch Safety Committee.

R.G. Blackadar

The Division operated through five sections during the year: Scientific Editing, Publication Production and Publication Distribution, Data Systems, Library Services, Cartography and Reproduction Services and Divisional Administration.

The effects of the near doubling of the funding available to the Branch through programs such as the Mineral Development Agreements and Frontier Geoscience began to be reflected in contributions to "Current Research" and in the Open File system. "Current Research" Part A comprised 826 pages - 250 of these reported MDA results. Many of the Open Files released comprised multiparameter geochemical, MDA-funded surveys. The sheer volume of material requiring distribution to four to eight coast-to-coast outlets to meet timed releases placed a significant demand on staff. Increasing use was made of contract services paid for out of the funds available to the "add-on" programs. The main areas where such services are being used are in-put word processing and cartography. This approach has freed staff time to do work that cannot easily be contracted. The experience gained proved useful as final plans are prepared for processing the 9-volume "Geology of Canada" series.

The Division produced a display on Mineral Resources and Exploration Technology for use at the GAC Annual Meeting in Fredericton. This display, requiring several thousand hours of work to prepare, was subsequently used in whole or in part by several universities as well as for other GSC purposes.

In 1985-86 about 6000 pages of text was forwarded for printing. This included about 800 pages for Open File releases and 700 reprints of out-of-print reports. The total would have been at least 500 pages more but for the freeze imposed on discretionary spending by Treasury Board in mid-February which lasted until early April 1986.

During 1985-86 we published

- 3 memoirs
- 4 bulletins
- 26 papers (including two volumes of "Current Research")
 - 1 economic geology report
 - 3 miscellaneous reports
 - 17 multicoloured maps
 - 2 preliminary maps
 - 3 reprints of reports
 - 1 reprint of a map
- 109 Open Files
- 124 geophysical maps
- 67 reprints of geophysical maps

Personnel Notes

J. Caron, who had been acting as Division Secretary, was appointed to the full-time continuing position in December 1985.

M.J. Kiel successfully completed French Language training in September 1985 having gained exemptions for two factors and level C for the other.

W.C. Morgan successfully completed part-time French Language training in June.

Attendance at Meetings, Conferences, Courses

R.G. Blackadar
Decade of North American Geology Steering Committee; Orlando, Fla., Oct. 26-31, 1985.

P.J. Griffin
Association of Earth Science Editors, Lawrence, Kansas, October 1985.
GAC/MAC Annual Meeting, Fredericton, N.B., May 1985.

Membership on Committees

R.G. Blackadar
- Branch Management Committee
- Secretary, EMR Committee on Scientific Publications in Both Official Languages
- Earth Sciences Sector Communication Committee
- DNAG Steering Committee
- Chairman, GEOSCAN Management Subcommittee.

P.J. Griffin
- GAC-MAC '86 Special Events Committee
- Ad Hoc Committee to consider the Baillie Report
- Publicity, 1986 Current Activities Forum.

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 branch staff in the broad areas of Information Systems policy, hardware and software. The section head was named GSC/Earth Science Sector Informatics Advisor responsible for providing GSC input into departmental informatics policy. The section continued to provide assistance in the selection and installation of computer hardware, the specification and acquisition of computer software both purchased off the shelf and contracted out, and in the development of computer systems.

The annual Information Technology and Systems Plan (ITSP) was compiled and submitted to the Informatics Policy and Planning Secretariat for inclusion in the overall departmental ITSP. The section continued to monitor computer acquisitions to confirm that the specific policies established by Treasury Board are adhered to, and to assist branch staff in obtaining the required approvals for their acquisitions.

This year's projects included the investigation of available laser/scanner/plotter hardware and software for use both in production cartography and in research. As a result, a Branch Data Integration Committee was established to determine the amounts and types of data available for possible integration and to investigate possible methods.

Attendance at Meetings, Conferences and Courses

P.B. Charlesworth

HP3000 System Manager
4th Generation Data Management Software
Power Communication Skills

J. Glynn

System Manager for PDP-11 with RSX-11M

K. Gunn

Advanced Powerhouse Seminar
Data Processing Institute Annual Conference

T. Scaga

Data Communications, Components, Systems and
Networks
Data Processing Institute Annual Conference

Membership on Committees

P.B. Charlesworth

- Chairman, EMR Computer Users' Committee
- GSC Computer Management Committee
- VAX Facilities Management Committee
- EMR Ad Hoc Telecommunications Committee
- EMR Data Management Committee
- HP3000 Facilities Management Committee
- GSC Data Integration Committee
- Ad hoc Baillie Report Subcommittee

LIBRARY SERVICES

A.E. Bourgeois

The GSC Library's role is to provide library 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 continues 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 Library was again able to increase its human resource base by effective use of special programmes such as the Cooperative Student Program and Challenge '85; an additional three person-years were acquired through these programs which represents a 12% increase in PY's.

There was a marked increase in the demands placed upon library activities during the review period; a 17% increase in information delivery, a 35% increase in map circulation, a 75% increase in document analyses and an increase of 6.5% in document acquisition.

Information Services

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

- Staff underwent extensive training in accessing the library's online catalogue and order database as well as training in the use of the GEOSCAN database.
- Information Services participated in the design and revision of the menus for the online catalogue.

- An automated interlibrary loan system (PEBILL) was developed.

- Map cataloguing activities focused on the development of the MAPS subset of the automated catalogue; improvements were effected throughout the course of the year to increase and refine retrieval capabilities.

Technical Services

1. Acquisitions

- A more efficient control of expenditures for library materials was effected.
- Increased efficiency in the library's automated acquisition system improved the quality and quantity of orders processed.

2. Cataloguing

- In addition to the indexing of 1985 GSC publications indexing of the 1980-84 backlog was completed and over 2000 records in GEOSCAN were verified and revised.
- Conversion of serials into machine readable formats was initiated and with the help of the Cooperative Student Program approximately 4000 titles were converted.
- Bilingual access to the library's resources continued to be improved by the revision of all French language records in the library's database and by editing of authority files to maintain bilingual practices in assigning access points.

3. Systems Management

- The system conversion of more than 13 500 records into MINISIS format was completed.
- Various authority files were created using source data from GEOCAT, the library's online catalogue.
- Software was developed to produce catalogue products in-house such as shelf-list cards, book labels, the microfiche catalogue and the accession list.
- A contract to provide user interface for the online catalogue was completed.
- Access to GSC's records in GEOSCAN has been provided through the online catalogue eliminating the need to search in two different systems for library holdings.
- The 5-year index to GSC Publications was formatted and produced through the MINISIS software.
- The systems librarian provided account management support to the CCRS, Earth Physics and HQ libraries who have adopted HERMES, the library's automated acquisition system.

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 searches, maintaining communications with participating agencies, processing information 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:

- Reorganization of the thesaurus including assigning of term relationships was initiated.
- Significant progress was made on a major project to review and correct records converted from the RAID format.
- A major revision was made to the GEOSCAN Reference Manual and Indexers' Guide.
- Procedures manuals were produced for the following system activities: BATCH Load, Thesaurus Load, Electronic Mail, System Crash Recovery, Editor/HP3000, GEODIAL Download and Ontario System 2000 Download.
- A GEOSCAN presentation was made at a workshop on Northern and Frontier Information Sources and GEOSCAN papers were presented at the Geoscience Information Society Annual Meeting and at the CAME '86 meeting (Computer Applications in Mineral Exploration).
- An automated system to monitor and control NGC finances was developed and implemented.
- Serious system problems were discovered during the summer of 1985. The problems resulted from hardware failure that corrupted data during STORE/RESTORE processes. Considerable time was spent identifying the problems and making corrections to approximately 1000 corrupted records.

Personnel Notes

Brian Drysdale, after a year as a term Interlibrary Loans Assistant has left to pursue other job contracts.

Mrs. E. Klobouk became a permanent member of the staff as Original Cataloguer/Indexer.

Brian McDonald is the new photocopy operator, taking over from Michel Desjardins who left to start a term position with the RCMP.

Rosemary Swan returned from maternity leave to resume her duties as Head Reference and Circulation.

Attendance at Meetings and Conferences

- A. Barkworth
National GEOSCAN Data Base Committee Meeting, May 1985, Ottawa.
International MINISIS Users' Group Meeting, Nov. 1985, Washington, D.C.
- A.E. Bourgeois
Geoscience Information Society Annual Meeting, Oct. 1985, Orlando Florida.
- D. Bouchard
Advanced MICOM Training Course, March 1985, Ottawa.
- E. Frebold
Canadian Library Association, Annual Conference, June 1985, Calgary, Alberta.

- A. Kopf-Johnson
Geological Association of Canada Annual Meeting, May 1985, Fredericton, N.B.
- T. Naraynsingh
Association of Canadian Map Libraries Annual Conference, June 1985, Winnipeg, Manitoba.
Special Libraries Association Annual Meeting, June 1985, Winnipeg, Manitoba.
- D.S. Reade
National GEOSCAN Data Base Committee Meeting, May 1985, Ottawa.
Northern Frontier Information Sources, Oct. 1985, Ottawa.
Geoscience Information Society Annual Meeting, Oct. 1985, Orlando Florida.
CAME '86 (Computer Applications in Mineral Exploration), Jan. 1985, Toronto, Ontario.
- W.P. Stark
International MINISIS Users' Group Meeting, Nov. 1985, Washington, D.C.
Canadian Library Association, Annual Conference, June 1985, Calgary, Alberta.
- J. Wilks
Canadian Association for Information Science Annual Conference, May 1985, Montreal, Quebec.

Membership on Committees

- S.O. Alexander
- Ottawa-Hull Utlas Users' Committee.
- A.E. Bourgeois
- Geoscience Information Society Executive Committee (President)
- Planning and Priorities Committee of the Council of Federal Libraries
- Steering Committee, Council of Federal Libraries
- EMR Standing Committee of Head Librarians.
- E. Frebold
- Geoscience Information Society's Directory of Geoscience Libraries 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.
- W.P. Stark
- Application Managers' Group, GSC
- Systems and Network Committee, Council of Federal Libraries
- Microcomputers Users' Network, Council of Federal Libraries.
- D. Tedford
- Envoy 100 Users' Group.

- J. Wilks
 - CAN/SDI Centres Committee
 - Canadian Association for Information Science, Ottawa Chapter Executive (Secretary)
 - Ottawa Online Users' Group.

STATISTICS: 85/86

1. GSC LIBRARY

A. Information Delivery	
Supplied by Library	16 831 (99%)
Referred to other sources	140 (1%)
B. Document Delivery	
Items requested	47 004
Items supplied	
- from GSC collection	45 278 (96%)
- from other libraries	1 131 (2%)
TOTAL	46 409 (98%)
C. Document Analysis	
Monographs, serials, reports, etc.	5 990
Maps	932
GSC publications	491
TOTAL	7 413
D. Collection Growth	
Monograph volumes	1 246
Map sheets	3 583
Microforms (reels/sets)	3 287
Serial volumes	2 071
(issues: 12 490)	
(new titles: 42)	
TOTAL	10 187
Linear meters	97.37

2. NATIONAL GEOSCAN CENTRE

A. Database Growth	
Records added to database	4 449
Total records in database	78 330
B. Information Delivery	
Custom indexes	19
On-line retrievals	
(by GSC 71)	
(by other agencies ca 300)	371
C. Participating Agencies	
	12

CARTOGRAPHIC AND REPRODUCTION SERVICES SECTION

J. Bill

The Cartographic and Reproduction Services Section provides a comprehensive cartographic, graphic, photomechanical and photographic service to the Branch.

As the result of a reorganization of GID the Photographic Services Section was transferred to this section April 1, 1985.

The first of many multicolour MDA maps, Map 1630A, Quaternary Geology and Till Geochemistry of the Western Port-Cumberland County, N.S., was published late in the year.

Some other notable products released were:

- Map 1627A - Diabase Dyke Swarms of the Canadian Shield
- Map 900A - 35th Edition (English and French) - Principal Mineral Areas of Canada
- Misc. Report 38 - Marine Science Atlas of the Beaufort Sea - Sediments
- Map 1580A - Second Edition - Revised and redesigned bilingual edition of Systematic Investigations by the Geological Survey of Canada (previously separate edition)

A digital typesetting work-station, acquired late the previous year, came into production with type encoding, previously done by the Surveys and Mapping Branch, now being done entirely in-house. With this capability available in the immediate work area, significant improvements in response and turn-around times have occurred.

The PDP11 digitizing system, installed in 1970, was replaced at year-end with a new micro-driven digitizing work station. This maintains our manual digitizing capability into the future, with the accompanying software providing some improved capability in basic graphics automation.

Investigations into computer-assisted cartographic production systems continued during the year with a number of raster and vector based system being evaluated. Tests, using GSC data, were conducted by two systems vendors. One particularly thorough test was done by the vendor of a raster based system using a portion of a complex GSC bedrock geology map. The test was quite successful with the production of all thematic detail; i.e. geological boundaries, symbols and colours, being automated from scanner input of author's manuscript to laser plotter print-ready film output within what appears to be considerably less production time than by current manual methods.

The Photomechanical camera room had out dated equipment replaced and upgraded. The small horizontal copy camera was replaced by a new computerized vertical copy camera resulting in faster and higher quality output. The large-format copy camera was refurbished with some mechanical improvements and the fitting of new modern high-quality lenses, providing, at relatively low cost, state-of-the-art image resolution as well as an extended equipment life expectancy.

An interdepartmental photomechanical training program was initiated during the year by GSC and Agriculture Photomechanical Units. A schedule of sessions has been established for the upcoming year and is designed to accommodate the exchange of knowledge, ideas and information primarily between these two units, and occasionally including other units from this and other departments.

The Photographic Unit received a new automated film-print processor late in the year, replacing a similar worn out machine.

A 15-20% increase in demand for miscellaneous drafting and photomechanical, and photographic services was met, with the high level of service provided for overall work load being maintained. This increase represents approx. 1.9 person years of additional work.

PRODUCTION DATA

Cartography:

Maps and illustration received during the fiscal year:

	<u>1984-85</u>	<u>1985-86</u>
Multicoloured geological maps	17	15
"B" Series Maps	9	3
Figure illustrations (pocket)	23	31
Figure illustrations (page)	341	147
Geophysical Maps and Indexes	44	61
Special Projects - Beaufort Sea Atlas	0	31
Open Files Maps	0	14
Multicoloured geological maps - Reprints	1	4

Maps, illustrations completed by Cartography Section:

	<u>1984-85</u>	<u>1985-86</u>
Multicoloured geological maps	16	19
"B" Series Maps	4	2
Figure illustrations (pocket)	21	28
Figure illustrations (page)	232	145
Geophysical Maps reprinted	0	18
Multicoloured maps reprinted	0	2
Preliminary geological maps reprinted	2	0
Indexes to Publications revised	0	30
Open Files Maps and Profiles	121	40
Special Projects		
- Panels for Display	12	12
- Beaufort Sea Atlas	32	0

Carry-over of maps and illustrations in progress at the end of fiscal year:

	<u>1984-85</u>	<u>1985-86</u>
Multicoloured geological maps	20	25
"B" Series Maps	10	11
Figure illustrations (pocket)	16	18
Figure illustrations (page)	341	270
Open File Maps and Profiles	193	12
Geophysical Maps and Indexes	40	70
Special projects - Beaufort Sea Atlas	40	77

There were 546 miscellaneous (Z numbered) drafting jobs completed during the year, which took 11 500 person hours. 1984-85 had 473 jobs which took 10 637 hours.

A total of 375 (285 in 84-85) requisitions for Compugraphics typesetting for Ottawa, Calgary and Dartmouth cartographers were coded in the Section and processed by S&M Branch,

Photomechanical:

	<u>1984-85</u>	<u>1985-86</u>
Camera		
Film and paper-line copies	6 754	7 416
Direct B & W prints (PMT)	1 253	853
Direct colour prints (PMT)	25	129
Halftones	123	237
Continuous tones	0	249

Contact

Film and papers	27 973	29 820
Keys	617	872
Peelcoats	318	302
Transfers	19	0
Final Pre-Screen	210	715
Colour Proofs	152	90
White prints	7 500	7 400

In addition to the normal map production operations, the photomechanical unit processed 1660 (1386 in 84-85) miscellaneous (X numbered) jobs for various authors and divisions.

There were 902 (736 in 84-85) master topographic negative packs requisitioned from S&M Branch for reproduction in Photomechanical for authors and cartographers in Calgary, Ottawa and Vancouver.

Digitizing:

	<u>1984-85</u>	<u>1985-86</u>
Point Mode - R.G.G.	72	105
- E.G.M.	2	0
- T.S.	3	0
Line Mode - R.G.G.	32	6
- E.G.M.	14	10
- T.S.	3	10
Total days	126	131

Checking Unit:

	<u>1984-85</u>	<u>1985-86</u>
'A' Series maps checked at proof stage	14	15
'B' Series maps checked at proof stage	2	10
Pocket, page figures, misc.	52	67
	68	92

Photography:

	<u>1984-85</u>	<u>1985-86</u>
Photographs Produced		
Equipment-Labs-Portraits-etc.	221	264
Continuous tone maps-charts	725	1 205
Line copies	525	186
Rock & mineral specimens	549	646
Thin sections	515	545
Fossil negatives	297	289
Colour slides	4 175	5 464
B & W slides	922	1 115
Duplicate slides	1 496	1 400

	1984-85	1985-86
B & W negs. from colour slides	932	1 122
Overhead Transparencies	33	17
Reverse text slides	44	36

Prints and Enlargements

B & W	8 228	9 666
Colour	1 437	1 338
Prints from Photo Centre	3 124	3 894

Other Operations

Prints and enl. number and stamped	5 782	3 949
Prints and enl. to outside agencies	647	1 022
Slides mounted	5 915	7 120
Requisition processing of colour rolls	24	52

Personnel Notes

Gilles Lemieux was confirmed as Head Photographic Unit replacing J. Kempt who retired in July, 1985.

Louis Renaud was promoted by competition to supervisor of Drafting Unit B-1.

Arthur King was the successful candidate for the vacant checker position in the Quality Control Unit.

Martina Wecke came from Kenting Earth Sciences to join the staff of Cartography Unit B.

Mario Méthot joined the staff of Cartography Unit A, coming from the S&M Branch.

Rachel Clairoux came from the S&M Branch to join the staff of the Photomechanical Unit.

Attendance at Meetings, Seminars and Courses

Cartographic Workshops - Cartotechniques V - OICC - Algonquin College, Ottawa, May 1984

20 cartographers attended

General Graphic Arts - Graphic Arts International Union - Ottawa - Winter 1985-86 (10 evenings)

G. Currie

Advanced Camera and Colour Separation - Graphic Arts International Union - Ottawa - Winter 1985-86 (30 evenings)

G. McNeill

Graphic Trade Show - Toronto - Oct. 85

F. Williams, G. Wylie

I.S.P.G. - Calgary - Nov. 85

G. Wylie

Preparing for Competitions - EMR - Ottawa

7 employees

Human Relations - Assertiveness - Algonquin College - Ottawa

L. Renaud

Back Care Training - EMR - Ottawa

2 employees

Career Advancement Seminar for Women - EMR - Ottawa

K. Blacklock, M. DiMillo

Pre-Retirement Course - EMR - Ottawa

4 employees

Long Term Financial Planning Workshop - EMR - Ottawa

1 employee

Employee Orientation - EMR - Ottawa

M. Méthot, M. Wecke

Membership on Committees

J. Bill

- Advisory Committee for the Surveying and Mapping Technology Program - Algonquin College
- Treasury Board - Classification Standard Review Committee - Drafting and Illustration Group.

V. Foster

- Board of Directors, Ontario Institute of Chartered Cartographers
- EMR Interdepartmental Topographic Map Design Committee.

F. Williams

- EMR Reproduction and Quality Assurance Advisory Committee.

L. Renaud

- Board of Directors, Ontario Institute of Chartered Cartographers.

F. Heney

- Branch Safety Committee.

PUBLICATIONS DISTRIBUTION OFFICE

J.L.L. Touchette

The following publications were received during the year:

Economic Geology	1
Economic Geology (Reprinted)	1
Memoirs	3
Memoirs (Reprinted)	1
Bulletins	4
Preliminary Papers	26
Misc. Report Series	3
Misc. Report Series (Reprinted)	1
Index to Publications	1
Misc. Geology	23
Open Files	4
Maps "A" Series	17
Maps "A" Series (Reprinted)	1
Preliminary Maps	2
Geophysical Maps	124
Geophysical Maps (Reprinted)	67
Revised Indices to Maps	26

DISTRIBUTION DATA

Maps	36 426
Reports	30 287
Indices, listings, posters, etc.	<u>132 758</u>
Total distribution (free and paid)	<u>197 471</u>

OTHER DATA

Requests for information, publications, rocks and mineral sets, etc.	13 767
Visitors (cash sales 912) (others 1843)	2 755
Notification Lists sent out	12

REVENUE

Derived from sales of reports, maps, rock and mineral sets, photographs, etc.	* \$115 083.95
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* Unadjusted

(\$ value) Products supplied to regional offices	<u>53 374.70</u>
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TOTAL SALES VALUE	\$168 458.65
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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 hydrocarbon 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 on the resources of petroleum and coal.

The Institute is organized into six subdivisions: Regional Geology, Paleontology, Coal Geology, Petroleum Geology, Geological Publications and Administration, each comprising several sections; together with the Petroleum Resource Assessment Secretariat.

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 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, Petroleum Geology, and Coal Geology Subdivisions, in concert with the Petroleum Resources Assessment 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 162.5 person years including 79 scientific and professional positions, 8 operational, 40 technical, 4 administrative and foreign service, and 31.5 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

Meetings regarding bilateral Canada-Poland Scientific Exchange, and talks on Arctic geology, oil and gas resources, Sosnowiec, Warsaw, Poland, May 23-June 7, 1985.

Branch Management Committee Meeting, Ottawa, September 29-October 3, 1985.

Meetings of the Geological Society of America, and talk on Arctic Permian faunas, Orlando, Florida, October 26-31, 1985.

Meeting with B.C. Ministry of Energy, Mines and Petroleum Resources, Victoria, November 13-14, 1985.

Meetings of the Canadian Geoscience Council, Ottawa, and Frontier Geoscience Program meeting, Ottawa, December 1-5, 1985

Branch Management Committee Meeting, Ottawa, December 9-11, 1985.

Meetings with Alberta Research Council and Alberta Geological Survey, Edmonton, January 9, 1986.

Branch Management Committee Meeting, Ottawa, January 19-11, 1986.

Meeting with C.F. Minerals, Kelowna, and talk on geology of China presented at Okanagan College, Kelowna, February 24-25, 1986.

Branch Management Committee Meeting, Ottawa, March 17-20, 1986.

W.W. Nassichuk

May 1985 University of Silesia in Katowice, Poland; "Geology of the Canadian Arctic Archipelago."

October 1985 Geological Society of America Annual Meeting in Orlando, Florida; "The distribution of Boreal Permian faunas in North America."

February 1986 Okanagan College, Kelowna; "The geology and mineral resources of China."

Membership on Committees

W.W. Nassichuk

Vice-Chairman (Past) and Newsletter Editor, Subcommittee on Permian Stratigraphy, International Union of Geological Sciences.

Corresponding Member, Subcommittee 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

Chairman, ISPG Ad Hoc Committee on Open House.

Chairman, 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, logistical and building maintenance services to the Division.

The Subdivision is manned by a full-time continuing staff of 21. During the fiscal year 1985-86, the following staff changes occurred:

During this fiscal year, a 2500 m² extension to this Division's Core and Sample Repository was added to the building. The new extension not only improved the Repository's facilities but should look after ISPG's Core and well log storage requirements for the next 10 years. In addition, an extensive mechanical retro-fit designed to modify and modernize the building's air conditioning system was completed.

Transfers

D. Brandly, on STS-03 was transferred from the Ministry of Transport to join the ISPG Stores staff on July 19, 1985.

T. Morriveau, a CR-3 was transferred from Customs and Excise to join the ISPG Finance and Accounts staff on August 20, 1985.

M. Novati, an STS-03 transferred from the Ministry of Transport to join the ISPG Stores staff on September 20, 1985.

E. Hau, an LS-02 transferred from the Department of Agriculture to join the ISPG Library staff on November 4, 1985.

Resignations

Mr. R.P. Morgan, an LS-02 resigned on July 19, 1985 to accept another position in the private sector.

D. Brandly, an STS-03 resigned on August 28, 1985 to accept a position in the private sector.

T. Morriveau, a CR-03 resigned on November 2, 1985 due to relocation of her spouse.

M. Brown, a SCY-02 resigned on December 10, 1985.

Appointments

Mrs. M. Kowalsky was appointed to the Office Services section as a CR-03 on August 12, 1985.

Attendance at Meetings
Conferences and CoursesK.M. Cameron

Staffing Course on sub-delegation to Managers, Calgary, Alberta, October 1-2, 1985.

M. Kowalsky

Beginners Pay Input Course, Edmonton, Alberta, October 21-25, 1985.

P.C. Broad

Staffing Course on sub-delegation to Managers, Calgary, Alberta, October 1-2, 1985.

D.K. Albert

DSS Course and briefing on "Payment-on-due date", Edmonton, Alberta, January 13-14, 1986.

ISPG Library

Bob Morgan resigned in July 1985. His vacancy of Assistant Librarian was filled by Edward Hau in November. Flora Fritz, Head Librarian and Fontaine Hwang, Library Technician, went on maternity leave in September and November. Gail Kessler joined in December as Library Clerk. She later won the competition to become term Library Technician replacing Fontaine. Flora resigned at the end of March 1986 to care for her new baby.

Automation of library procedures continued. Starting April, 1985 the cataloguing module of MINISIS, our integrated online library system become operational. The card catalogue was frozen as new records were entered on computer only. By year end there were approximately 4300 records searchable online. A training course for staff on searching the online catalogue was held in June. As part of the process to automate our subscription and check-in procedures, all periodical titles and holdings were entered in the Cardex module.

Service improvement took place in other areas, notably in subscription management. Early in the fiscal year, the service of subscription agent was discontinued. Although this change resulted in an increased workload for the Acquisitions Clerk, it was considered an improvement over the long run. Agents have not proved themselves satisfactory in alleviating the library workload. Once the Cardex module is operational, it is expected her workload will decrease. In July the first computerized accessions list was produced. Since December its legibility has been greatly improved by using the laser printer for production.

To reduce the cost of long-distance calls while speeding up the turn-around time for interlibrary loan requests the library became a subscriber to the ENVOY 100 electronic mail system offered by Telecom Canada.

The valuable 19-volume Royal Society Catalogue of Scientific Papers 1800-1900 and its accompanying 4-volume index received cleaning and new binding. Frequently used to verify bibliographic citations, the restored set is expected to last for many more years.

Attendance at Meetings, Conferences and Courses

F. Fritz

Boundary studies meeting held in May (ISPG) and in August (Pacific Geoscience Centre)

Invitational Workshop on Northern and Offshore Information Resources held at the University of Calgary in May 1985

Canadian Library Association Annual Conference, Calgary, June 1985

iNet 2000 electronic information system training course, Calgary, September 1985.

E. Hau

Foothills Library Association Workshop on "Calgary Libraries in Action", Calgary, January 1986

F. Hwang

iNet 2000 electronic information system training course, Calgary, September 1985

DOBIS cataloguing system training course, Calgary, October 1985

R. Morgan

Canadian Library Association Annual Conference, Calgary, June 1985

S. Webber

Canadian Library Association Annual Conference, Calgary, June 1985 (partial attendance)

Library Statistics 1985-86

Acquisitions

Books, etc., acquired by purchase	575
Books, etc., acquired by gift or exchange	1045
Maps added	271

Circulation

Books and periodicals (to staff only)	7926
Interlibrary loans	
Borrowed	255
Loans and photocopies provided	273

Reference

Phone queries handled	698
Online searches	35

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.

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. Frontier Geoscience funding, and the establishment of an ice island research station, have permitted major new initiatives, particularly the continuation and future planning of reflection and refraction seismic programs on the continental shelf. There, programs are being carried out in cooperation 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. Under the Frontier Geoscience Program the deep structural geometry of sedimentary basins is being studied by the application of reflection seismic techniques. Refraction seismic programs are being considered for the future. 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 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, and a small fee is charged. Files are maintained of all the logs and other data related to more than 70 thousand wells drilled in Western and Arctic Canada. The repository was closed to the public from March 11, 1985 to June 17, 1985 due to extensive renovations and expansion of the facility. The repository has been expanded by the addition of about 3 thousand square metres of floor area and 400 metres of storage racks. The area for study of samples and cores has been expanded and modernized. More than 317 520 kilograms of well materials had to be moved to new locations during and after construction. The newly upgraded facility including the core storage, sample storage, sample examinations, core examinations, log storage and administration areas now covers an area of 4866 square metres.

Arctic Islands

The timing and origin of igneous activity on northern Ellesmere Island have been clarified by U-Pb age determinations. Granitic intrusions derived from the Middle Proterozoic crystalline basement were emplaced during the Middle Ordovician and near the Middle/Late Devonian boundary. Bimodal volcanism occurred in Late Cretaceous. These results increase our understanding of the tectonic development of both the Franklinian and Sverdrup Basins.

Seismic refraction and reflection studies carried out under the Frontier Geoscience Program using the Ice Island as a base have increased our understanding of the structure of the Arctic Continental Shelf. Proterozoic-Lower Paleozoic basement rocks are interpreted to occur near the sea bottom along the inner shelf north of Axel Heiberg Island. Near the seaward margin of the shelf the sedimentary strata overlying basement are 12 000 m thick, and are interpreted to consist of 2000 m of undeformed Neogene strata overlying 10 000 m of deformed Cretaceous to Lower Tertiary strata.

Potential source beds in the lower Paleozoic strata of western Melville Island include the noticeably petroliferous Kitson Formation (80 m of Lower Devonian black shales), and unnamed petroliferous limestones in the upper 325 m of the Raglan Range inlier (Upper Silurian to Lower Devonian). The upper member of the Ibbett Bay Formation in Canrobert Hills comprises 560 m of Upper Silurian to Lower Devonian black shale and is also a potential hydrocarbon source rock.

Structural studies on western Melville Island have established the presence of a triangle zone 80 km long wherein Middle and Upper Devonian clastic rocks have been raised along a south-facing homoclinal flexure, which has been underthrust from the north. The study of Ordovician to Devonian facies patterns in this area suggests that prospective hydrocarbon reservoirs of the pre-Middle Devonian carbonate shelf to basin transition exist beneath this triangle zone.

Structural analysis of the Carboniferous and Permian rocks on Melville Island suggests that east-west strike-slip faulting dominated during the Upper Paleozoic. The Upper Carboniferous basal unit of the Sverdrup Basin on Melville Island appears to have been deposited in a series of pull-apart basins. Clast composition and facies patterns within this unit show that Raglan and Spencer ranges were syndepositional highlands which shed sediments both to north and south. This style of sedimentation was terminated on northwestern Melville Island by east-west dextral strike-slip faulting and transpressional folding of the Melvillian Disturbance. Similar Upper Paleozoic basins occur in the subsurface and may be prospective for petroleum.

Mesozoic strata contain important hydrocarbon reservoirs and source rocks in the Arctic Islands. Examination of these strata on Ellesmere and Axel Heiberg islands, has resulted in the identification of: (1) three transgressive-regressive cycles in the Lower Triassic; (2) bituminous shales which are potential petroleum source rocks in the upper Blind Fiord Formation; (3) a major unconformity at or near the Lower/Upper Cretaceous boundary; (4) thick Cretaceous volcanics unconformably overlying Upper Paleozoic strata. Joint field work with a Norwegian geologist on both Ellesmere Island and Svalbard has allowed

detailed correlations of Mesozoic strata to be made between the two areas and regional tectonic influences on the evolution of the petroliferous Sverdrup Basin are now better appreciated.

A sedimentological study of the Triassic-Jurassic Heiberg Formation, an important hydrocarbon reservoir unit, indicates that the formation represents a tide-dominant deltaic system which prograded northwestwards into the Sverdrup Basin.

A Paleocene shale unit up to 300 m thick, delineated within the sandstone-dominant Eureka Sound Formation on central Ellesmere Island, allows three rock stratigraphic units to be mapped for the coal-bearing Eureka Sound. A syntectonic conglomerate characterized by diabase clasts occurs in the Eureka Sound Formation on eastern Axel Heiberg Island and its occurrence indicates that significant tectonism occurred during the Eocene.

Northern Mainland

Shooting of the Mackenzie Delta reflection seismic line was in progress at year end. This project is funded by the Frontier Geoscience Program and was designed to elucidate deep structural controls on the evolution of the oil and gas bearing basins beneath the Mackenzie Delta-Beaufort Sea. It is being managed through collaboration with scientists at the University of Calgary. Preliminary examination of field records are very encouraging because reflectors down to a depth of 10 km, that were expected from previous examination of industry data, are clearly visible, as are even deeper reflectors that have not previously been seen. It is anticipated that the shallower reflectors will be identified when the records are tied to well and outcrop control on the southern part of the seismic line and these, along with the deeper records will provide important data on the structural geometry of the sedimentary wedge in general and on the Campbell Lake Uplift and Eskimo Lakes Fault Zone in particular.

Paleomagnetic data from the Mackenzie Mountain Supergroup provide an Apparent Polar Wander curve that post-dates, and is distinct from the "Grenville Loop". The success of this study holds promise for future correlation and relative dating of other Proterozoic successions in the northern Cordillera such as the Pinguicula Group or the Muskwa Assemblage.

Mapping in the Selwyn Mountains has resulted in the recognition of a major decollement sheet (the Nidderly Decollement Sheet) which extends across most of the eastern Selwyn Basin. This structural sheet appears to be the basal detachment surface to a stack of large overthrusts which are in contact with, and outcrop to the west of, the exposed decollement zone. Recognition of the extent and character of this structural feature greatly increases the mineral potential of the area in which it outcrops. Around many Cretaceous plutons, for instance, it is anticipated that tungsten and precious metal skarns will be repeated several times, greatly enhancing the possibility of a significant deposit.

Southernmost exposures of strata equivalent to the Silurian-Devonian Ogilvie Formation in the Northern Yukon Territory contain a discontinuous reef-mound facies near the paleo-shelf edge that bordered Selwyn Basin. The discontinuous aspect of the reef-mound facies may be purely depositional in origin or due to differential erosion prior to

deposition of the overlying Upper Devonian fine grained siliciclastics (McCann Hill or Canol equivalent strata). In either case the reef-mound facies should be a seismically identifiable stratigraphic hydrocarbon play in the Eagle Plains area.

Fluid inclusion and strontium isotope evidence indicate that dolomite of the Manetoe Facies was precipitated from hot (150-210°C) hypersaline (Ionic strength - 3.9 to 5.8) solutions within a paleokarst system. These fluids may have been residual evaporitic brines from the Elk Point Basin that were recirculated through the Manetoe paleokarst system during an anomalous Late Devonian thermal event. The widespread documentation of this thermal event from Alberta to the Northwest Territories precludes the use of organic maturation indices as estimators of burial depth for early Paleozoic strata in this region, and as a method of evaluating the hydrocarbon potential of the area.

Geological investigation in the southern part of the District of Mackenzie indicate that the area between Kakisa Lake and Redknife River was emergent during the Late Givetian. In this region the pre-Watt Mountain unconformity is overlain by shaly beds equivalent to the Fort Vermilion and upper limestone members of the Slave Point Formation. The underlying Sulphur Point limestone is brecciated and includes karst-like dissolution features. This breccia facies is locally gas bearing.

Southern Mainland

An abrupt E-W jog in the western margin of the Western Canada Sedimentary Basin has been recognized near 54°N. Thickness and facies changes in Upper Proterozoic and Cambrian strata indicate the margin's shape was established during Late Proterozoic (Windermere) extension with these structures reactivated during the Cambrian. Original basin shape had a pronounced effect on the orientation of Mesozoic thrusts and folds: anomalous E-W trending structures occur within the E-W zone of thickness and facies change.

Frasnian stratigraphy in the subsurface of central Alberta is more complicated than previously recognized. A complex distribution of reef, platform and basin filling sedimentation has been documented, on a set of stratigraphic cross-sections. These have been released as an open file report in response to demand from oil industry exploration personnel.

The causes of a major faunal extinction at the Frasnian-Famennian boundary were investigated at a section near Jasper, Alberta. Sedimentologic and S³⁴ isotopic changes indicate abrupt flooding of the western Alberta Shelf by anoxic waters.

Regional stratigraphic studies of the Upper Devonian in the southern Rocky Mountains indicate that the Cline Channel separating the Cairn-Southesk and Fairholme reef complexes in the east, is blocked to the west by a thick reef front that connects the two reef complexes.

An episode of Late Carboniferous erosion and block faulting disrupted sedimentation in the Western Canada Sedimentary Basin of east-central British Columbia. Toward the southwest, the upper Viséan to lower Serpukhovian Stoddart Group and the underlying middle Tournaisian to upper Viséan Rundle Group are progressively truncated (locally to zero) by a regional unconformity. In the Rockies, the lower Moscovian Hannington Formation locally overlies

the unconformity. The stratigraphic relationships indicate that faulting and differential erosion occurred between the early Serpukhovian and early Moscovian.

Combined lithostratigraphic and biostratigraphic study of the Carboniferous in the Rocky Mountains of southwestern Alberta have shown that a second major transgressive-regressive cycle occurs in the Tournaisian of this area as it does to the east. This has resulted in a major revision to the paleogeographic interpretation. Shelf grainstone of the middle to upper Tournaisian Pekisko Formation pass basinward into slope carbonates of the Banff Formation rather than into shelf grainstone of the Livingstone Formation as previously thought.

The regional pattern of maturation of Cretaceous strata has been determined using vitrinite reflectance for the western part of the plains between 54° and 57°N. Time-depth burial modelling suggests the marked decrease in level of maturation of Cretaceous and older strata north of Peace River is largely a result of the marked northward decrease in thickness of the Late Cretaceous-Tertiary (Laramide) clastic wedge. Rapid thinning of this wedge above the ancestral Peace River Arch indicates reactivation of old basement structures during Laramide orogenesis and loading.

Personnel Notes

Dr. Margaret McMechan and Dr. W. Kalkreuth (Coal Subdivision) received the 1985 CSPG Medal of Merit for their paper entitled "Regional pattern of thermal maturation as determined from coal rank studies, Rocky Mountain Foothills and Front Ranges, north of Grande Cache, Alberta - implications for petroleum exploration". The medal is awarded for the most significant paper dealing with the petroleum geology of Canada's sedimentary basins.

Dr. B. Richards received a promotion to RES-2 effective April 1, 1985.

C. Harrison, who had held a term position, was appointed to a PC-2 position on June 7, 1985. In the fall of 1985 he went to Rice University, Houston, Texas on educational leave to study for a Ph.D. degree. His thesis topic deals with the structure and tectonics of Melville Island, and is an integral part of our Arctic Islands program.

Dr. A. Embry accepted his duties as Section Head of the Arctic Islands Section in October 1985. Dr. R. Thorsteinsson asked to be relieved of Section Head responsibilities, but continues as an important Arctic authority and advisor.

Elsbeth Snow returned to the Subdivision after a 5 month secondment in the Publications Subdivision where she acted as Editorial Assistant while the incumbent was on maternity leave.

Karen McInness started as a casual CR-3 working with Elsbeth Snow on October 29, 1985.

Cindy Riediger, who worked in the field on Melville Island during the summer of 1985, was hired in a term PC-1 position on November 21, 1985 to study upper Carboniferous stratigraphy relating surface to subsurface on Melville Island. Her term finishes in May 1986.

D. Yuzwak started as a casual STS-3 in the Core and Sample Repository on December 23, 1985.

Billie Chiang joined the staff as a SCY-2 on January 13, 1986. She came to us as a transfer from CANMET which is closing its Calgary office on March 31, 1986. Regional Geology shared a secretary with Paleontology Subdivision previously. Billie, the first appointee to the new position, is setting a very high standard of cheerful efficiency and initiative.

Dr. R. Thorsteinsson, due to retire on January 21, 1986, has decided to continue his active research career in Arctic Islands geology.

Dr. L. Lane accepted employment as a RES-1 in November 1985, but due to commitments to Carlton University will not join us till May 1986. He is a structural geologist who will be assigned responsibilities for analyzing the structure and tectonics of the northern Yukon, Mackenzie Delta, and Beaufort Sea.

Dr. I. Banerjee and Mr. K. Williams were transferred to the Petroleum Subdivision in October 1985.

Attendance at Meetings Conferences and Courses

J.D. Aitken

Canadian Cordilleran Geology: What and How, CSPG Course, Calgary, February 1986.

M.P. Cecile

GSA Cordilleran Section, Annual Meeting, Vancouver, May 1985.

R.L. Christie

8th International Workshop and Seminar on Phosphorite, IGCP Project 156, N. Carolina and Florida, May 1985.

GSA, Rocky Mountain Section, Phosphoria Symposium, Boise, Idaho, May 1985.

D.G. Cook

GSA Cordilleran Section, Annual Meeting, Vancouver, May 1985.

GSA Annual Meeting, Orlando, Florida, November 1985.

J. Dixon

SEPM Workshop on Sea-Level Changes, Houston, Texas, October 1985.

Canadian Cordillera Geology: What and How, CSPG Course, Calgary, February 1986.

A.F. Embry

SEPM Workshop on Sea-Level Changes, Houston, Texas, October 1985.

GSA Annual Meeting, Orlando, Florida, November 1985.

H.H.J. Geldsetzer

SEPM Annual Meeting, Golden, Colorado, August 1985.

U. Mayr

GAC Annual Meeting, Fredericton, May 1985.

M.E. McMechan

B.C. and Yukon Chamber of Mines, Exploration Update, Vancouver, January 1986.

Canadian Cordilleran Geology: What and How, CSPG Course, Calgary, February 1986.

N.C. Meijer-Drees

National Conference on Earth Science "Evaporites and Hydrocarbons", Banff, October-November 1985.

H.P. Trettin

GSC Current Activities Forum 1986, Ottawa, January 1986.

Special Talks and Lectures

M.P. Cecile

"Ordovician and Silurian of western Canada", with B.S. Norford, DNAG Symposium, GSA Meeting, Vancouver, May 1985.

"Paleogeographic significance of two late Ordovician brachiopod faunules from the Misty Creek Embayment, Selwyn Basin, N.W.T." (senior author A.W. Potter), GSA Meeting, Vancouver, May 1985.

"Lower Paleozoic embayments, troughs and arches, Northern Canadian Cordillera", GSC Oil and Gas Activities Forum, Calgary, February 1986.

D.G. Cook

"Balancing basement cored folds - a unique solution", GSA Annual Meeting, Orlando, Florida, November 1985 and CSPG Structural Division, Calgary, October 1985.

R.L. Christie

"The phosphate industry in Canada and Canadian occurrences of phosphorite", GSA Rocky Mountain Section, Boise, Idaho, May 1985.

"Geological exploration in the Canadian Arctic", Arctic Inst. of N.A., Calgary, June 1985.

J. Dixon

"Geology, biostratigraphy and geochemistry of Jurassic to Pleistocene strata, Beaufort-Mackenzie area", CSPG Continuing Education Course, Calgary, November 1985 (one of six GSC personnel to present the course).

A.F. Embry

"Triassic eustatic sea level changes", SEPM Workshop on Sea Level Changes, Houston, Texas, October 1985.

"Origin of the Amerasian Basin", CSPG Luncheon Address, Calgary, November 1985.

"Sverdrup Basin and Arctic continental shelf studies", GSC Oil and Gas Activities Forum, Calgary, February 1986.

H.H.J. Geldsetzer

"The Frasnian-Famennian boundary near Jasper, Alberta, Canada" prepared abstract and slides, (presented by D.J. McLaren), GSA Meeting, Orlando, Florida, November 1985.

"Devonian reef - offreef relationships, Ancient Wall reef complex, west-central Alberta", GSC Oil and Gas Activities Forum, poster display, Calgary, February 1986.

U. Mayr

"Variations in Lower Paleozoic carbonate shelves, Canadian Arctic Archipelago", GAC Annual Meeting, Fredericton, May 1985.

M.E. McMechan

"Foothills structural style: Athabasca River to Halfway River", P.S. Warren Geological Society, University of Alberta, Edmonton, January 1986.

"Thermal maturation and burial history, Canadian Rocky Mountain Foothills" (co-authors A.C. Cameron, J.D. Hughes, W.D. Kalkreuth), GSC Oil and Gas Activities Forum, Calgary, February 1986.

D.W. Morrow

"The interpretation of lead isotopes in ore deposits", Seminar class on ore deposits at University of Calgary, Calgary, November 1985.

B.C. Richards

"Carboniferous stratigraphy and sedimentation, Western Canada Basin", GSC Oil and Gas Activities Forum, and poster display, Calgary, February 1986.

H.P. Trettin

"Pearya: a fragment of the Caledonides in northern Ellesmere Island", GSC Current Activities Forum, Ottawa, January 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" (DNAG; GSC Sp. Publ. No. 2).

Member, ISPG Committee on Guided Tours.

M.P. Cecile

Member, Technical Program Committee, 2nd International Symposium (responsible for western Canada and Alaska).

Member, CSPG Technical Committee, 1987 Canadian Reef Inventory Project (responsible for the Ordovician system).

Chairman, CSPG International Liaison Committee.

Member, CSPG Executive Nomination Committee.

Associate Editor, Geoscience Canada.

Member, National Earth Science Advisory Committee.

R.L. Christie

Canadian Corresponding Member, IGCP Project 156 (phosphorites).

Member, ISPG Exhibits Committee.

D.G. Cook

Vice President, CSPG.

Member, CSPG 1986 Convention Committee.

Member, ISPG Ice Island Committee.

J. Dixon

Member, ISPG Stratigraphic Nomenclature Committee.

Member, ISPG Committee to review publications procedures/policies.

Senior Editor, CSPG.

CSPG Editor for "Oil and Gas Fields of Canada".

Member, CSPG-GAC Joint Committee to produce paleontological monographs.

A.F. Embry

Chairman, North American Commission on Stratigraphic Nomenclature.

Chairman, ISPG Stratigraphic Nomenclature Committee.

Chairman, Technical Program Committee, 2nd International Devonian Symposium.

Chairman, ISPG Ice Island Committee

Member, International Subcommittee on Stratigraphic Classification.

Co-editor, Proceedings of the 2nd International Devonian Symposium.

H.H.J. Geldsetzer

Member, Organizing Committee, 1987 Canadian Reef Inventory Project (responsible for the editorship of CSPG Reef Inventory volume).

M.E. McMechan

Councillor, GAC.

Member, CSPG National Conferences on Earth Science, Advisory Committee.

Member, ISPG Library Committee.

N.C. Meijer-Drees

Chairman, CSPG Sedimentology Division.

Chairman, CSPG Core Conference.

D.W. Morrow

Associate Editor, CSPG.

Member, Technical Program Committee, 2nd International Devonian Symposium (responsible for western Canada and Alaska).

Member, Ph.D. Thesis Committee, University of Calgary.

B.C. Richards

Member, ISPG Stratigraphic Nomenclature Committee.

E.G. Snow

Chairman, ISPG Support Staff Field Trip Committee.

Member, CSPG Logan Day Committee.

Member, CSPG Core Conference Committee.

Assistant Registrar, 2nd International Devonian Symposium.

D.F. Stott

Co-editor, "Sedimentary Cover of the North American Craton: Canada" (DNAG; GSC Sp. Publ. No. 2).

H.P. Trettin

Editor, "Inuitian Orogen and Arctic Platform" (DNAG; GSC Sp. Publ.).

Member, ISPG Ice Island Committee.

Lapidary

Thin sections, standard	595
Thin sections, stained	55
Polished slabs	60

Core and Sample Repository

Well Samples received:

Alberta	313 776
British Columbia	18 824
Saskatchewan	27 876
Manitoba	-
Off-shore Territories	6 600
	<u>37 750</u>
	<u>404 826</u>

Mechanical logs received (Alberta, British Columbia, Saskatchewan, Manitoba and the Territories) 7058

Territories Core Received (boxes) 1600

Visitors requiring core, samples, or related information 1225

5500 boxes of core were made available for examination and samples from some 875 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

A.C. Higgins

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. Most of the Subdivision's activities are in northern and western Canada, but a significant number of projects deal with onshore basinal areas in eastern Canada. In all these

areas, paleontology plays an important role in GSC basin analysis programs for evaluation of energy reserves.

The Subdivision develops and maintains biostratigraphic standards for regional and international correlation and carries out a continuing program for improvement of zonal schemes and more effective interpretation of paleo-environments. Most projects are directed toward well-known fossil groups that display rapid evolutionary changes and are therefore particularly useful for biostratigraphy, but relatively poorly known fossil groups are also 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 comprises 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 graptolites, conodonts 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 145 paleontological reports on 2040 collections of fossils from outcrop and subsurface. Additionally, thermal maturity assessments of a further 500 samples were presented in report form. 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.

Paleontological contributions to the highly successful GSC Oil and Gas Forum included a talk on the use of fossils in basin analysis and several posters illustrating the use of

fossils in thermal maturation and biostratigraphic studies in the Arctic Islands, Beaufort Sea, western and eastern Canada.

Activity under the Frontier Geoscience Program remains high. Foraminiferal and palynological characteristics of the Mesozoic-Cenozoic strata of the Beaufort-Mackenzie Basin were presented by two members of the Subdivision as part of a short CSPG course on the geology, paleontology and geochemistry of the basin given by members of ISPG for oil industry staff, in Calgary. Biostratigraphic correlations based on diatom zones in the Beaufort-Mackenzie Basin were presented in a poster display at the GSC Oil and Gas Forum. The diatoms, used for the first time in this area, provide easily recognized datums for correlation in strata that are notoriously difficult to correlate. Extensive sampling of the Middle and Upper Devonian rocks of the Parry Island Fold Belt as part of Operation Melville has led to the first detailed and comprehensive biostratigraphic correlation of these rocks based on their palynology and shown the formations to be diachronous, younging significantly towards the west. A joint study between members of the Coal and Paleontology Subdivisions on the maturity of Arctic Island wells, part of the Frontier Geoscience maturity program, was a contribution to an Oil Industry study of the region. A further joint study between these Subdivisions has led to the use of a new fossil thermal indicator based on the reflectivity of scolecodonts. Biostratigraphic results of the Mesozoic were summarised in a joint presentation by scientists of the Paleontology and Regional Subdivisions, to the Geological Association of Canada, Annual Meeting, titled 'Middle Jurassic to Cretaceous stratigraphy of the Arctic Islands and implications for the opening of the Amerasian Basin'.

A visit to the all-Union Research Institute for Geology and Mineral Resources of the World Ocean (VNIIOkeangeologia) in October, by a paleontologist from ISPG and a scientist from the University of Toronto, marked the beginning of the USSR portion of the Canada-USSR exchange. Discussions of circum arctic correlation of the Lower and Middle Paleozoic began the compilation study of joint correlation tables. A talk on "The status of Canadian Paleontology" was given by the ISPG representative.

Several members of the Subdivision attended IUGS Stratigraphic Subcommittee meetings as Canadian representatives. A new reference stratotype was selected for the Middle-Upper Devonian boundary at a locality in the Montagne Noire, France, at a meeting of the Devonian Stratigraphic Subcommittee. At the same meeting discussion was initiated on the position of the lower boundaries of the Pragian, Emsian and Givetian stages. One member of the Subdivision organised and chaired a plenary session of the IUGS International working group on the Cambrian-Ordovician Boundary which was held in Calgary, July, 1985. At this meeting it was proposed that a section in Newfoundland be selected as the stratotype section for this boundary.

A joint study between scientists from the Coal and Paleontology Subdivisions on the Cretaceous-Tertiary boundary formations in Alberta has shown that the southern Alberta Foothills are characterised by non-coal bearing, caliche dominated sediments with low diversity pollen floras, indicative of a warm, semiarid environment which contrasts with the wetland forest area which characterised central Alberta. This interpretation provides confirmation of Russell's suggestion that the dinosaurs of the Late Maastrichtian of central Alberta indicate the presence of another major environment close by.

The establishment of a computerised curation system at ISPG has been a major factor in enabling the curator to maintain control of the movement of samples and to access samples and reports from the computer files. The increase in the number of samples being prepared in the Paleontology laboratories, under the Frontier Geoscience Program, has given this facility increased importance.

Personnel Notes

The Subdivision includes 30 permanent positions (18 scientists, 8 technicians, 2 secretaries, 2 curators) and a number of temporary assistants. During the year J. White was appointed to the research scientific staff, M. Smith was appointed to the support staff. M. Gee, R. Gee, J. Mamo and I. Feuer were term employees in the curation unit and D. Haddad was a term employee in the micropaleontology section. Dr. P. Sartenaer, from the Musee Royale de Belgique, was a visiting scientist from September-December, 1985, working on a collaborative project on the brachiopod and conodont faunas of the Bituminous Limestone Member of the Pine Point Formation, Devonian, from the south side of Great Slave Lake. Dr. Wang-Zhi-Hao, visiting scientist from the Nanjing Institute, China, is currently working on a joint project on Carboniferous and Permian Conodont faunas from the Arctic Islands. Dr. J. Federowski, University of Poznan, Poland, is currently working on a joint project on the Carboniferous-Permian coral biostratigraphy of the Arctic Islands.

Attendance at Meetings, Conferences and Courses

9th International Symposium on Ostracoda, Shizuoka, Japan, July 29-August 2, 1985.

M.J. Copeland

Geological Association of Canada Annual Meeting, Fredericton, May, 1985.

G.S. Nowlan
J.H. Wall

Fourth European Conodont Symposium (ECOS IV), Nottingham, U.K. August, 1985.

A.C. Higgins
G.S. Nowlan

Canadian Paleontology and Biostratigraphy Seminar, Quebec, September, 1985.

G.S. Nowlan
J. Utting

International Conference on Modern and Fossil Dinoflagellates, Royal Bedford and Holloway College, University of London, England, August, 1985.

D.J. McIntyre

Sixth Gondwana Symposium, Ohio State University, Ohio, August, 1985.

J. Utting

GSC Conodont Workers Annual Meeting, ISPG, Calgary, February, 1986.

G.S. Nowlan,
A.S. McCracken
T.T. Uyeno
A.C. Higgins

GSC Palynologists Meeting, ISPG Calgary, February, 1986.

D.C. McGregor
J. Utting
D.J. McIntyre
A.R. Sweet

Plenary Session of the International Working Group on the Cambrian-Ordovician Boundary, University of Calgary, July, 1985.

B.S. Norford

IGCP Project 203-Permo-Triassic Events of Eastern Tethys, Columbus, Ohio, August 22nd, 1985.

E.T. Tozer

American Association of Stratigraphic Palynologists, El Paso, Texas, October, 1985.

A.R. Sweet

ISPG Professional Staff Field Trip, Drumheller and vicinity, October, 1985 (Guides).

J.H. Wall
A.R. Sweet

Special Talks and Lectures

G.S. Nowlan

Thermal histories of sedimentary basins in Eastern Canada determined from conodont colour alteration data. Geological Association of Canada, Annual Meeting, Fredericton, N.B., May 16th, 1985.

Application of conodont CAI data to the tectonic history and economic geology of the St. Lawrence platform and Appalachian Orogen, Canada. Fourth European Conodont Symposium (ECOS IV), Nottingham, August, 1985.

Conodonts as indicators of time, tectonic history and hotspots tracks, and their application to mineral and hydrocarbon exploration. Invited lecture given at University of Ottawa, December, 1985, and University of Windsor, January, 1986.

Recognition and reliability of multielement species in the Phylum Conodonta. Geological Society of America, Northeast Section, Kiamesha Lake, N.Y., March, 1986.

Thermal Maturation of the Paleozoic of Eastern Canada. GSC Open Forum on Oil and Gas in Canada, Calgary, February, 1986 (poster display).

D.J. McIntyre

Tertiary and Cretaceous palynology of the Beaufort Sea-Mackenzie area. CSPG short course "Geology,

Biostratigraphy and Organic Geochemistry of Jurassic to Pleistocene Strata, Beaufort-Mackenzie area, northwest Canada, Calgary, November, 1985.

Late Turonian marine and nonmarine palynomorphs from the Cardium Formation, North-Central Alberta Foothills, Canada. GSC Open Forum on Oil and Gas in Canada, Calgary, February, 1986 (with A.R. Sweet).

D.H. McNeil

Geology of the Beaufort-Mackenzie Basin. Saskatchewan Geological Society, Regina, March, 1986.

Tertiary Foraminiferal Biostratigraphy of the Beaufort-Mackenzie Basin, CSPG short course Geology, Biostratigraphy and Organic Geochemistry of Jurassic to Pleistocene Strata, Beaufort-Mackenzie area, northwest Canada, Calgary, November, 1985.

Tertiary Microfaunas of the Beaufort-Mackenzie Basin, GSC Open Forum on Oil and Gas in Canada, February, 1986, Calgary, (poster display).

B.S. Norford

Philosophy for selection of stratotypes. Plenary session of International Working Group on the Cambrian-Ordovician Boundary, July, 1985, Calgary.

The challenge of change. Convocation address, University of Calgary, November, 1985.

The use of fossils in basin analysis. Geological Survey of Canada, Open Forum on Oil and Gas in Canada, February, 1986, Calgary.

J.H. Wall

Middle Jurassic to Cretaceous stratigraphy of the Arctic Islands and implications for the opening of the Amerasian Basin (Jointly with A.F. Embry). Geological Association of Canada, Annual Meeting, Fredericton, New Brunswick, May, 1985.

Mesozoic microfaunal stratigraphy of Lougheed Island and petroliferous offshore environs, Canadian Arctic Archipelago, (poster display). GSC Open Forum on Oil and Gas in Canada, February, 1986, Calgary.

A.C. Higgins and E.W. Bamber

Carboniferous stratigraphy and sedimentation, Western Canada Sedimentary Basin, GSC Open Forum on Oil and Gas in Canada, February, 1986, Calgary. Poster Display (with B.C. Richards).

A.E.H. Pedder

The status of Canadian Paleontology, Research Institute for Geology and Mineral Resources of the World Ocean, Leningrad, USSR, August, 1985.

A.R. Sweet

The Saunders Group in the Central Alberta Foothills: A new stratigraphic subdivision and the palynological

definition of the Cretaceous-Tertiary Boundary (co-presented with T. Jerzykiewicz) CSPG Coal Group and as visiting speaker to the Department of Geology, University of Alberta.

Cretaceous-Tertiary Boundary in Alberta (with T. Jerzykiewicz), GSC Open Forum on Oil and Gas in Canada, February, 1986, Calgary. Poster Display.

Caliche in the Paleocene and Upper Cretaceous of southern Alberta: implications for paleoclimate and coal distribution. GSC Open Forum on Oil and Gas in Canada, Calgary, February, 1986. Poster Display (with T. Jerzykiewicz).

Membership on Committees

E.W. Bamber

Dinantian Working Group, International Subcommittee on Carboniferous Stratigraphy.

North American Study Group, International Subcommittee on Permian Stratigraphy.

M.J. Copeland

International Union of Geological Sciences, Subcommittee on Silurian Stratigraphy, 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

ISPG Safety Committee, Member

W.H. Fritz

Precambrian-Cambrian Boundary Working Group, International Union of Geological Sciences, International Geological Correlation Program, voting member.

A.C. Higgins

Secretary, Mid-Carboniferous Boundary working group of IUGS Subcommittee of Carboniferous Stratigraphy.

Corresponding Member, IUGS Subcommittee of Carboniferous Stratigraphy.

Alternate Member to the Alberta Paleontological Advisory Committee.

Canadian Paleontological Monograph Series (GAC-CSPG), Business Manager of Committee for Palaeontographica Canadiana.

Mississippian and Middle Pennsylvanian Working Groups, IUGS Subcommittee of Carboniferous Stratigraphy.

Secretary, Paleontological Division of the Canadian Society of Petroleum Geologists.

Geology and Geophysics Dept., U of Calgary-ISPG Liaison Committee member.

D.C. McGregor

International Federation of Palynological Societies, President.

IUGS Subcommittee 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.

Award Committee, American Association of Stratigraphic Palynologists.

D.H. McNeil

Canadian Paleontological Monograph Series (GAC-CSPG), Associate Editor, Secretary of committee for Palaeontographica Canadiana.

ISPG Exhibits Committee.

B.S. Norford

Working Group on Cambrian-Ordovician Boundary, International Commission on Stratigraphy, Chairman.

Working Group on Ordovician-Silurian Boundary, Corresponding Member.

International Commission on Stratigraphy, Corresponding Member.

Palaeontographica Canadiana, Associate Editor.

Board of Directors Canadian Energy Research Institute

Chancellor, 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

Subcommittee 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

Chairman of the Joint Committee on Paleontological Monographs representing GAC.

IUGS Subcommittee on Silurian Stratigraphy, Titular Member.

IUGS Ordovician-Silurian Boundary Working Group, Corresponding Member.

Chairman, Publications Committee, Geological Association of Canada, (Editor, GEOLOG).

Member, Executive of Geological Association of Canada.

Advisory Committee for Ms. I. Munro, Ph.D. candidate, Ottawa University.

Member, North American Ordovician Chronostratigraphy Working Group, IUGS Subcommittee on Ordovician Stratigraphy.

Member, Public Information Committee, Geological Association of Canada

Special Series Editor, Geoscience Canada.

Adjunct Professor, University of Ottawa School of Graduate Studies, University of Ottawa, member.

Associate Editor, Canadian Journal of Earth Sciences.

A.E.H. Pedder

Subcommission on Devonian Stratigraphy, Titular Corresponding Member

International Union of Geological Sciences, Corresponding Member.

North American Devonian Study Group

Editor, Technical Program and Scientific Exhibits Committees of the CSPG Second International Symposium on the Devonian System.

T.P. Poulton

ISPG Nomenclature Committee, Member.

Alberta Paleontological Advisory Committee

IUGS Jurassic Subcommittee; full member; Member of 2 working groups.

Canadian representative to IGCP Project 171 (Circum-Pacific Jurassic) and on 4 working groups.

A.R. Sweet

Sixth International Palynological Conference, organizing committee.

D.R. Then

ISPG Support Staff Annual Field Trip Committee, Member

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.

International Palynological Conference -organizing committee.

IUGS Working Group on the Permian-Triassic Boundary.

IUGS Subcommittee on Carboniferous Stratigraphy, Corresponding Member

IUGS Subcommittee on Carboniferous Stratigraphy, Corresponding Member.

ISPG Safety Committee, Chairman.

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.

Laboratory Statistics - Calgary

Foraminifer Laboratory

992 samples were processed, 155 from core, 466 from cutting and 377 from outcrop. All samples for study by J.H. Wall and D.H. McNeil.

Conodont Laboratory

469 well and outcrop samples were processed in the laboratory. In addition the laboratory technician organized data and shipping and monitored results for the processing of 570 samples on separate outside contracts. Faunas from 62 samples were picked under outside contract. All samples are for study for A.C. Higgins and T.T. Uyeno.

Palynology Laboratory

1528 surface and subsurface samples were processed for miospore studies. Most of the preparations were made to provide palynological results requested by coal and regional geologists for their projects, and for research work undertaken by palynologists, D. McIntyre, A. Sweet and J. Utting. 73 samples were run for service projects outside of the ISPG to fulfil contractual commitments undertaken by the Subdivision.

Brenda Davies assisted the palynologists in drafting and in the preparation of their displays for the GSC Oil and Gas Forum held at the Convention Centre, Calgary, Feb. 11, 12, 1986.

The research project on the fossil fungal fructifications from the Bonnet Plume Formation, Yukon Territory, completed by R. Kalgutkar appeared in Current Research, Part B, GSC Paper 85-1B, p. 259-268. He is currently working on the morphology, taxonomy and phylogeny of fossil fungal genus *Pesavis* from western Canada and the manuscript is in the final stages of preparation.

R. Kalgutkar spent some time in Houston, Texas, in consultation with Dr. W.C. Elsik of the Exxon Company, U.S.A. to discuss fossil fungal material from the Bonnet Plume Formation. During his stay in Houston, he participated in discussions with the Exxon Company palynologist, Dr. Nicos Ioannides, the palynological group and the laboratory staff on the recovery of palynomorphs from the organic rich shale.

Macropaleontology Laboratory

The major output consisted of 1682 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 56, fossils were picked from 8 acid residues.

Curation Statistics - Calgary

"C" Numbers Issued	10,800
Transferred from Ottawa	327
Transferred to Ottawa (Ottawa & Calgarys nos.)	199
Samples circulated within ISPG	1887
Samples shipped out for processing, study loans, gifts	2,136

The above agencies include universities, foreign government agencies, museums and companies

Laboratory Statistics - Ottawa

Lapidary Laboratory

Rock thin sections	
Standard, produced by laboratory	4,325
Oriented	400
Large	250
Polished, purchased by contract	2,558
Polished, produced by laboratory	30
Standard (on overtime)	2,882
Large (on overtime)	105
Polished rock surfaces	120
Rock trim cuts	5,110
Levelled rock surfaces and saw cuts	3,925

Paleontology Laboratory

Preparation:	
Thin sections	103
Plaster casts	217
Rubber moulds	9
Silicone Rubber moulds	1
Presentation pieces	32
Curation:	
Parcels received	100
Parcels shipped	88
Fossil localities catalogued (GSC Localities 10 12 18 to 10 1657)	440
Collections received with Calgary numbers	112

Palynology Laboratory

In the Ottawa palynology laboratory, supervised by D.C. McGregor, G. Buckler processed 246 surface and subsurface samples were processed, and 1,120 slides were prepared containing marine and non-marine palynomorphs of Ordovician to Devonian age.

Conodont Laboratory

In the Ottawa conodont laboratory, supervised by G.S. Nowlan, 310 samples were acidized and 410 samples were organized for picking on outside contract.

Publications	PC	Camb.	Ord.	Sil.	Dev.	Carb.- Perm.	Jur.	Cret.	Tert.- Recnt	Total	Nfld	NS	NB	Que	Ont	Alt	BC	Yuk	NWT	Other	
GSC Bulletins																					
363 (Forams)									59	59										X	
GSC Papers																					
83-13 (Ichnofossils)	12	13								25							X				
83-18 (Graptolites, conodonts)				65	24					89								X			
85-1A (Corals, bryozoans, graptolites)			68		10					78		X						X	X		
85-1B (Corals, brachiopods, ostracodes, palynomorphs)				3	20				13	36								X	X		
Subtotals (GSC)	12	13	68	68	54				72	287											
Can. J. Earth Sci. (Corals, graptolites, gastropods, trilobites, conodonts, palynomorphs)																					
	8		188	8		24			10	238	X			X				X	X	X	
J. Pal. (Eurypterids, conodonts, ichnofossils)																					
	24		101	14	148	5				292	X							X		X	
Other (Forams, Protista, corals, brachiopods, graptolites, ammonites, arthropods, palynomorphs, ichnofossils)																					
	115	33	49	2	102	133	96	147	556	1233			X	X	X	X	X	X	X	X	
Subtotals (Outside)	123	57	338	24	250	162	96	147	566	1763											
Total	135	70	406	92	304	162	96	147	638	2050											

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 strengths of the Institute as required or appropriate, including regional geology, paleontology, organic petrology and coal geology, and approaches developed in the Petroleum Resource Appraisal Secretariat (P.R.A.S.). Petroleum Geology Subdivision personnel are active and continuing contributors to the continuing resource appraisals of P.R.A.S.

Funding of the work of the Subdivision is obtained from A-base, Office of Energy Research and Development (O.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 OERD-funded).

In order to encourage a maximum of cooperation between individual scientists, geological/ geophysical personnel of the Subdivision are assigned to groups paralleling

those of Regional Geology: Arctic Islands, Northern Mainland, and Southern Mainland. Work of these individuals 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. 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 (eg. 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 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 migration or biodegradation. To date, most of these studies have been carried out on

material from frontier areas (Arctic Islands, Mackenzie Delta and Atlantic Continental Margin): increasingly, there is a need to examine oils, oil-source correlations and related aspects from the Western Canada Basin.

The Petroleum Geology Subdivision also has responsibility for maintaining 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

In September, the Petroleum Geology Subdivision was organized into working units paralleling those of Regional Geology: Arctic Islands, and Northern and Southern Mainland. Geochemistry continues as a separate Section within the Subdivision. The reorganization is designed to emphasize the habitat of hydrocarbons, and to promote ties with Institute members involved in regional studies. Also, Petroleum Geology has grown by the addition of four scientists previously assigned to full-time resource assessment within the Petroleum Resource Appraisal Secretariat. These developments add strength and enthusiasm to the group, and should encourage the easy flow of ideas and insights on the diverse aspects of sedimentary basins and their economic resources. In September, Dr. R.W. Macqueen, formerly of the Department of Earth Sciences, University of Waterloo, joined ISPG as head of the Petroleum Geology Subdivision.

Organization and presentation of the first GSC Oil and Gas Forum in Calgary in February 1986, in which several Subdivision personnel played a key role, is one of the major accomplishments of the report year. More than 1500 individuals attended the two day Forum, which featured 19 formal talks and 52 poster sessions: seven of the talks and eleven of the poster sessions directly involved personnel of the Petroleum Geology Subdivision.

For the Arctic Islands, a large number of seismic reflection lines have been studied from the subsurface of the Sverdrup Basin and Parry Islands Fold Belt, leading to the production of a number of 1:125,000 scale maps of individual reflectors illustrated by 100 millisecond contours, to depths of about 5 seconds travel time. These maps are calibrated by regional petroleum exploration wells, and are elegant displays of stratigraphy and structure, especially valuable where borehole information is sparse or non-existent. Open file release of some of these maps is under discussion; eight are essentially complete and four more are close to completion. Ordovician oil shales of Southampton Island were investigated and sampled during the field season to determine whether these oil shales may be a source of liquid or gaseous hydrocarbons, especially in deeper parts of the Hudson Bay Basin: results are available as of March, 1986 as an Open File report.

Work in the Beaufort Sea - Mackenzie Delta area has reached a level of sophistication suitable to the organization of a one and one half day short course presented by ISPG personnel in Calgary in November, 1985, at the request of the Canadian Society of Petroleum Geologists. Three Petroleum Geology personnel contributed, in addition to two Paleontologists and one Regional Geologist. An assessment was completed by 31 March 1986 of the geology and potential resources of the 141°N offshore area (Boundary Dispute area), which is currently under dispute as regards ownership. For the Mackenzie Corridor region, approximately twenty 1:1

million geological maps and twenty-five well-log cross-sections are being completed for open file release. These are masterful summaries of surface and subsurface information pertinent to petroleum exploration in the area from the Canadian Shield to 136°W, excluding the Mackenzie Delta and Eagle Plains. A separate study of the Eagle Plains has begun, particularly of the Chance Sand and Jungle Creek subsurface reservoirs.

A major crustal seismic refraction survey, one of the most ambitious programs of its kind ever undertaken in Canada, was completed in the Peace River Arch area of northwestern Alberta and northeastern British Columbia in early July. The survey constituted seismic recordings at 385 sites along 1300 km of line, from explosions detonated at eleven different sites. It was coordinated by ISPG personnel and involved personnel and equipment from the universities of British Columbia, Alberta, Saskatchewan, Western Ontario, Toronto, and Memorial University of Newfoundland, as well as ISPG and the Earth Physics Branch. The refraction data are now being assembled and processed at UBC: forthcoming interpretations should provide unique information on the relationship between the Peace River Arch, and basement and crustal structures and crustal and mantle densities. An open file report containing preliminary records and interpretations was submitted in March, 1986. Such interpretations should constrain geodynamic models, now being developed, of the mechanical and thermal evolution of the Arch and similar structures in the Western Canada and other sedimentary basins. Through in-house studies and contractual arrangements with the Alberta Geological Survey, geological studies have begun on some of the stratigraphic units which overlap the Arch. Dr. Randell Stephenson joined ISPG as a geophysicist in June, 1985, and is coordinating the Peace River Arch geophysical studies as well as serving as leader of an informal Peace River Arch working group at ISPG. This project is funded mainly from Office of Energy Research and Development (OERD) funds. Dr. Stephenson is also our main field representative on the Ice Island Arctic Offshore Frontier Geoscience Project, which involves personnel from the Atlantic Geoscience Centre and Ottawa, and has A.F. Embry of Regional Geology as component manager.

A second OERD-funded project underway is the identification and assessment of potential petroleum source rocks of the Williston Basin in Saskatchewan. Analysis of approximately fifteen complete well sections by Rock-Eval pyrolysis has led to recognition of a number of potential petroleum source rocks. Cores from a number of potential petroleum source rocks have also been sampled for extraction: hydrocarbons obtained from these samples will be compared with those present in appropriate oil samples. Approximately 100 oil samples have been obtained from Saskatchewan government agencies and oil companies, and these will facilitate precise oil-source correlations involving biomarker geochemistry.

Personnel of the organic geochemistry group participated directly and indirectly in a number of oral and poster presentations at the GSC Oil and Gas Forum. Contributions were made to East Coast Offshore, Beaufort-Mackenzie and Saskatchewan projects. Two sets of short course notes were prepared and lectures presented on the geology, biostratigraphy and geochemistry of the Beaufort-Mackenzie area and on the interpretation of geochemical data in petroleum exploration studies.

A summary paper on the oil shale resources of Canada was published as GSC Paper 85-13. Papers concerning 1) the stable isotope distribution in Beaufort-Mackenzie crude oils;

2) the source potential of two Tertiary shale units in the Beaufort-Mackenzie; 3) the biomarker content of Beaufort-Mackenzie crude oils; and 4) the occurrence of novel and possibly diagnostic biomarkers in Beaufort-Mackenzie crude oils, are in press. The last two papers shed considerable light on the origin of some of the Beaufort-Mackenzie Basin oils, and are effective demonstrations of the application of the biomarker approach to answering geological questions centred around oil-source correlations, and the importance of individual source beds as contributors to a particular oil or suite of oils. Two Frontier Geoscience Project-funded cores were cut from the Mesozoic sequence of the Sverdrup Basin, Arctic Islands, and sampling is underway for detailed source rock evaluation and mass transfer of elements during diagenesis. These cores are the only ones available of source rock facies in the whole of the Arctic Islands, and thus research results will be of considerable interest to industry. Analysis of hand-picked drill cuttings from the Mesozoic sequence of the Arctic Islands has yielded exciting new results on biomarker oil-source correlations and maturation histories. These findings accord well with the geological framework and add hitherto unavailable quantitative aspects to it in the area of subsidence-uplift behaviour of the sedimentary succession. Regional-scale data acquisition phases of source rock studies in the Arctic Islands and Northern Interior Plains were completed. Data acquisition is continuing for Beaufort-Mackenzie, Saskatchewan and east coast offshore studies. A computer package of statistical techniques was developed and applied to aid in the interpretation and correlation of large numbers of analytical parameters from large numbers of samples. Extensive effort has been put into development and publication of low temperature ashing techniques in the preparation of coal samples for mineralogical and elemental analysis.

The organic geochemical group awaits the arrival of Dr. Martin Fowler, formerly of the University of Newcastle-upon-Tyne, who will be joining ISPG in April, 1986, with responsibilities for east coast studies and hydrous pyrolysis of asphaltic materials, the latter of strong interest to the nature and origin of Alberta's oil sands.

In inorganic geochemistry, two papers concerning detailed three dimensional studies of the Crystal oil field and reservoir diagenesis of several Viking field reservoirs (Cretaceous) are in press with the CSPG Bulletin. X-ray diffraction and X-ray fluorescence analytical equipment was commissioned and used along with other analytical methods to carry out mineralogical and major and trace element determinations on suites of coal samples, probable paleosol units from the Cretaceous of the western Canada Basin, and suites of volcanic rocks, mainly from the Sverdrup Basin of the Arctic Islands. During the year Dr. A.E. Foscolos resigned to accept a position in Greece. It will be essential to our inorganic geochemical program to obtain a skilled and experienced scientist as a replacement for Foscolos, at an early date.

Personnel Notes

The Petroleum Geology Subdivision employs a permanent staff of 17 scientists, 9 technicians and one secretary, and normally has several casual employees available as support staff. R.W. Macqueen joined ISPG as Head of the Petroleum Geology Subdivision in September 1985, from the University of Waterloo where he remains an Adjunct Professor. Also joining the Subdivision in 1985-86 from positions elsewhere were Dr. D.A. Leckie, a sedimentologist with interest in the Cretaceous of the

Western Canada Basin, and Dr. M.G. Fowler, an organic geochemist with special expertise in hydrous pyrolysis of naturally occurring heavy oils and bitumens. During the year Dr. R.A. Stephenson joined the permanent staff as a geophysicist following a period as a post-doctoral fellow at ISPG and Dr. D.N. Skibo and Mr. J.R. Dietrich transferred to the Subdivision from P.R.A.S. Dr. N.J. McMillan, former Acting Head of the Subdivision, is now a senior petroleum scientist in P.R.A.S. Dr. A.E. Foscolos, clay mineralogist, resigned from ISPG effective September 1986. Other changes during 1986 include the transfer of Dr. I. Banerjee and Mr. G.K. Williams to the Subdivision from Regional Geology, and the retirement of Mr. M.O. Fuglem in mid 1985.

Attendance at Meetings, Conferences and Courses

I. Banerjee

CIM-CSPG Annual Meeting, Edmonton, Alberta,
June 2-5, 1985

P.W. Brooks

Kratos Users Meeting, Edmonton, Alberta, October 3-4,
1985

Kratos Users Group, American Society of Mass
Spectrometers, Annual Meeting, San Diego, California,
May 23 - June 1, 1985

European Association of Organic Geochemists Annual
Meeting, Julich, West Germany, September 14-21, 1985

GSC Oil and Gas Forum, Calgary, Alberta,
February 12-13, 1986

A.A. Densmore

CSEG-CGU Annual Meeting, Calgary, May, 1985

A.E. Foscolos

International Clay Conference, Denver, Colorado, July
27 - August 2, 1985

R.W. Macqueen

Hydraulic Theory of Petroleum Migration and Its
Potential Application to Exploration and Basin Analysis,
two day CSPG-sponsored course given by Prof. J. Toth,
Calgary, Alberta, December, 1985

Continental Scientific Drilling in Canada, Halifax, Nova
Scotia, July, 1985; Ottawa, Ontario, February, 1986

E.M. Northcott

Kratos Users Meeting, Edmonton, Alberta, October 3-4,
1985

K.G. Osadetz

GAC Annual Meeting, Fredericton, New Brunswick,
May 15, 17, 1985

J.A. Podruski

Evaporites and Hydrocarbons, Banff, Alberta, October,
1985

L.R. Snowdon

Oil and Gas Technical Workshop, Rio de Janeiro, Brazil,
November 30 - December 9, 1985

R.A. Stephenson

CSEG-CGU Annual Meeting, Calgary, May, 1985 (co-
chaired one session), presented two papers
Pacific Northwest AGU, Vancouver, British Columbia,
September, 1985

Special Talks and Lectures

P.W. Brooks

"Source for the Tertiary Oils in the Beaufort Mackenzie
Basin", European Association of Organic Geochemists
Annual Meeting, Julich, West Germany, September,
1985

In-house Short Course - "Current state of the art in the
Beaufort Mackenzie"

J.R. Dietrich

CSPG Short Course "Geology of Jurassic to Pleistocene
Strata, Beaufort-Mackenzie Sea Region"

"A Regional Review of the Hydrocarbon Discoveries in
the Mackenzie Delta-Beaufort Sea Area" (with J.
Dixon), GSC Oil and Gas Forum, Calgary, February
1986

D.A. Leckie

CSPG Distinguished Lecture Tour, Dalhousie
University, St. Francis of Xavier University, Acadia
University, Laval University, University of Ottawa,
November, 1985

CSPG Distinguished Lecture Tour, University of
Manitoba, Lakehead University, McMaster University,
University of Toronto, Concordia University, March,
1986

"Causes of Cyclicity in the Lower Cretaceous Gates
Formation, British Columbia, GSC Oil and Gas Forum,
Calgary, February 1986

R.W. Macqueen

"Scientific Drilling in Sedimentary Basins: An
Overview", presented to Continental Scientific Drilling
in Canada, Ottawa, February, 1986

"Geochemical and Diagenetic Approaches to Canadian
Sedimentary Basins" (with P.W. Brooks, A.E. Foscolos,
L.R. Snowdon), GSC Oil and Gas Forum, Calgary,
February 1986

K.G. Osadetz

"Petroleum Source Rock Reconnaissance of
Saskatchewan (with L.R. Snowdon), GSC Oil and Gas
Forum, Calgary, February 1986

L.R. Snowdon

In-house Short Course - "The Interpretation of
Geochemical Data"

R.A. Stephenson

"Peace River Arch Project - Basement and Crustal
Structure in the Peace River Region (with C. Zelt,
UBC), GSC Oil and Gas Forum, Calgary, February 1986

G.K. Williams

"Some Thoughts on the Tedji Play (Cambrian),
Northwest Territories (with A.P. Hamblin), GSC Oil
and Gas Forum, Calgary, February 1986

Membership on Committees

A.P. Hamblin

Member of CSPG Student/Industry Field Trip
Committee

Member CSPG Graduate Thesis Awards Committee

Member of CSPG '86 Conference Technical Program
Committee

D.A. Leckie

Co-Chairman for 1988 CSPG Core and Field
Conference

Organizing Core Display for Western Canada Coal
Geoscience Forum, November, 1986

Treasurer for Canadian Sedimentology Research Group

Organizing CSPG Field Trip "Cretaceous Depositional
Facies in the Western Interior: The Southern Alberta
Transect", August, 1986

Co-Editor, Foreland Basins and Foldbelts Volume,
Petroleum Basin Series, AAPG (from March, 1986)

R.W. Macqueen

Associate Editor pro tem, Canadian Journal of Earth Sciences (to December, 1985)

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

Member of National Liaison Committee, Canadian Society of Petroleum Geologists (to February, 1986)

Program Chairman, GSC Oil and Gas Forum, Calgary, February, 1986

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, Petroleum Basin Series, AAPG (from March, 1986)

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

Analysis of light hydrocarbons and organic carbon:

	<u>84/85</u>	<u>85/86</u>
Organic Carbon Analysis	1,800	0
Total Carbon	200	0

Extraction and Separation of hydrocarbon fractions:

	<u>84/85</u>	<u>85/86</u>
Extractions	134	97
Distillations	28	78
Separations	70	175
Gas Chromatographic Analysis	150	215

Kerogen Studies:

	<u>84/85</u>	<u>85/86</u>
Isolation	0	16

Source Oil Correlation Studies:

	<u>84/85</u>	<u>85/86</u>
Gasoline Range	335	476
Mass Spectrometry (Faman)	20	0
Capillary GC/MS Analysis	350	600

Pyrolysis:

	<u>84/85</u>	<u>85/86</u>
Rock-Eval	5,775	8,780
Pyrolysis Gas chromatography	150	46

SEM Lab Statistics

	<u>84/85</u>	<u>85/86</u>
Exposures:		
Paleontology Subdivision	499	550
Petroleum	107	100
Regional	-	50
Coal 50	50	
Others (Machine Shop, NEB, etc.)	50	30

Inorganic Geochemistry

	<u>84/85</u>	<u>85/86</u>
XRD Mineral Determinations	5,714	6,000
XRF Analysis	3,075	4,100
Infra-red Analysis	6	50
TGA/DTA	390	500
Atomic Absorption Analysis	36(296)	12(24)*
Low Temperature Ash	98(360)	18(77)*
High Temperature Ash	9(9)	364(364)*
CHN 2160	42(95)*	
Proximate Analysis	218	
Miscellaneous (C, P, S, Moisture, pH)	1480	1879(2718)*

*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 distinctive responsibilities. The Geology of Coal Section conducts stratigraphic, sedimentologic and structural studies which focus on the fundamental geological context of Canadian coal measures. These result in an understanding of paleoenvironments which favoured coal formation and tectonic elements which affected coalification histories in various sedimentary basins.

The Organic Petrology Section directs research toward studies of coal origin with respect to various plant-forming communities relative to syndepositional paleoenvironments, and studies of organic maturation within Canadian sedimentary basins. Research is conducted on 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 provide 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 directs its initiatives 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 according to 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 nearly 19 000 boreholes having an aggregate depth of almost 1 000 000 m. These data reside in 19 computer-processable databases established according to separate coalfields; including 12 coalfields in Alberta, 3 coalfields in British Columbia, 3 coalfields in Saskatchewan and 1 coalfield 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 fundamentally based on these data.

Current coal research requires the support of specialists in geoscience subdisciplines of 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

Significant discoveries and advances in the geology and resource potential of Canada's coal deposits have been made

during the past year. Virtually all of the Subdivision's objectives were met and in many cases were exceeded. Results have profound significance for the exploration, evaluation, development, utilization and management of the nation's coal resources. These results are being effectively publicized through publications, lectures and talks, workshops, poster displays and discussions with geoscientists affiliated with industry, provincial governments and universities. Highlights of these discoveries and advancements are as follows:

1. Coal studies in the northern Yukon and Northwest Territories resulted in the discovery of a 5-metre thick seam of high quality anthracite in the area of the Barn Mountains, Yukon, and identification of an economically significant bitumen occurrence near the Rengleng, N.W.T.
2. Definition of the Cretaceous-Tertiary boundary in new locations of western Alberta will assist coal exploration initiatives by allowing precise correlation between the commercially significant Nevis and Mynheer coal zones, as well as between the Coalspur and Willow Creek formations.
3. Paleoclimatic and paleoecologic research is an essential element to assessing coal potential within a stratigraphic sequence. A new approach to this research has been devised, based on distribution of caliche deposits and associated palynological assemblages in southern Alberta Foothills versus coal-bearing deposits in central Alberta Foothills.
4. Preliminary stratigraphic and sedimentologic observations of the Boulder Creek Formation of northeastern British Columbia indicate that the contained coal beds have neither adequate thickness nor lateral persistence to be commercially significant.
5. Concentrations of trace elements which can affect the utilization potential of coal have been found, in several cases, to be related to geological factors such as depositional environments and coalification histories.
6. A computer program was developed for interactive modelling of geological burial histories in deformed terrains. When compared to actual test data, the predictive modelling tool proved highly reliable. It was subsequently determined that much of the coalification in the commercially significant Kootenay Group of the southern Canadian Rocky Mountains postdates Laramide deformation. Coal rank prediction capabilities have been significantly advanced.
7. Detailed studies of coal rank and geologic structural features in the important coal mining region near Grande Cache, Alberta, showed that coalification mainly pre-dated deformation and ranks have not been significantly changed by local folding and faulting.
8. Studies of organic matter from the Pictou Coalfield of Nova Scotia showed that the best yields from oil shales correspond to high contents of Botryococcus algal matter. Petrographic composition of the coals indicate that most have good liquefaction properties but weaker coking properties.
9. Organic petrology studies pertaining to the Arctic Islands found that the low maturity Carboniferous sediments on Grinnell Peninsula contain thick beds of lacustrine oil shales.

10. A suite of Canadian coals tested by vacuum-pyrolysis showed liquid and gaseous yields vary as a function of reaction temperature along with petrographic composition and rank of feed coals.
11. It was determined that fluorescence patterns on organic materials extracted from various lithotypes including coals, carbonaceous shales, oil shales and source rocks, can be used to determine organic maturation levels, which is particularly significant where other maturation parameters might be absent.
12. A computer program was developed which optimally defines the geometry and aerial extent of coal seams and other correlated units in stratified sequences. The program eliminates previously required manual work, resulting in a reduction of time required to complete a coalfield resource assessment by an estimated fifty per cent.
13. A computer-processable COAL DEPOSIT DATABASE system was developed which, following completion of entry of important resource data, will allow quick access to national coal resource information.

Personnel Notes

The Coal Geology Subdivision consists of 11 scientists, 2 technicians and one secretary.

D.K. Norris retired effective January 10, 1986 after thirty-three years with GSC.

D.W. Gibson, A.R. Cameron and G.G. Smith served for various periods as Acting Head of the Subdivision until October, 1985 when G.G. Smith was appointed Head.

F. Goodarzi was promoted to RES-3 in early 1986.

W.D. Kalkreuth and co-author M. McMechan were awarded the CSPG Medal of Merit for their paper entitled "Regional Pattern of Thermal Maturation as Determined from Coal-Rank Studies, Rocky Mountain Foothills and Front Ranges North of Grande Cache, Alberta - Implications for Petroleum Exploration".

W.D. Kalkreuth acted as thesis advisor for the M.Sc. thesis by M. Hebert, University of Sherbrooke, on pyrolysis characteristics of selected Canadian coals.

F. Goodarzi acted as thesis advisor for the M.Sc. thesis by T. Gentzis, University of Alberta, on petrology of the Hat Creek (B.C.) Deposit No. 2. He also advised on thesis research for students at the universities of Regina, British Columbia, Newcastle (UK), Ankara (Turkey) and Göttingen (W. Germany).

G.G. Smith spent approximately three months evaluating the coal resource potential of the Republic of Niger for the Canadian International Development Agency.

W.D. Kalkreuth returned to ISPG in July after nine months leave of absence spent at the Institute for Petroleum and Organic Geochemistry, Jülich, West Germany.

K. Mottershead returned from maternity leave in late June.

B.D. Ricketts is on leave of absence in New Zealand, from September 1985 to August 1986.

Attendance at Meetings Conferences and Courses

A.R. Cameron

GAC/MAC Meeting, Fredericton, May 1985.

Canadian Coal Petrographers Workshop, Fredericton, May 1985.

GSC Oil and Gas Forum, Calgary, February 1986.

F. Goodarzi

GAC/MAC Meeting, Fredericton, May 1985.

Canadian Coal Petrographers Workshop, Fredericton, May 1985.

GSC Oil and Gas Forum, Calgary, February 1986.

International Paleontological Association - Graptolite Working Group, Copenhagen, August-September 1985.

J.D. Hughes

B.C.-Yukon Chamber of Mines, Annual Meeting, Vancouver, January 1986.

GSC Oil and Gas Forum, Calgary, February 1986.

T. Jerzykiewicz

I.A.S. and S.E.P.M. International Symposium on Foreland Basins, Fribourg, Switzerland, September 1985.

GSC Oil and Gas Forum, Calgary, February 1986.

W.D. Kalkreuth

Second Annual Meeting of Society for Organic Petrology, Houston, November 1985.

GSC Oil and Gas Forum, Calgary, February 1986.

G.G. Smith

CIM Annual General Meeting, Vancouver, April 1985.

OERD Task 2.1 Program Committee Meeting, Ottawa, August 1985.

Alberta Geological Survey-Advisory Committee Meeting, December 1985.

GSC Oil and Gas Forum, Calgary, February 1986.

EMR Staffing Course for Line Managers, Calgary, September 1985.

Special Talks or Lectures

A.R. Cameron

"Distribution of major, minor and trace elements in coals of the Kootenay Group, Mount Allan, Alberta"; GAC/MAC Meeting, Fredericton, May 1985 (with F. Goodarzi).

"Maturation of organic materials in sedimentary basins"; workshop on hydrology and geothermal regimes, ISPG, November 1985.

Three lectures on coal composition and rank evaluation; Organic Petrology Course (organized by F. Goodarzi), ISPG, February 1986.

Co-produced three poster displays for GSC Oil and Gas Forum, Calgary, February 1986.

F.M. Dawson

CSPG Field Trip Leader, "The Ardley Coal Zone of central Alberta"; September 1985.

"GSC energy research and development - coal"; (with G.G. Smith), poster display at GSC Oil and Gas Forum, Calgary, February 1986.

F. Goodarzi

"The use of automated image analysis in organic petrology"; GAC/MAC Meeting, Fredericton, May 1985.

"Pyrolytic carbon in Canadian coals"; Canadian Coal Petrographers Group, Fredericton, May 1985.

"Distribution of major, minor and trace elements in coals of the Kootenay Group, Mount Allen, Alberta"; GAC/MAC Meeting, Fredericton, May 1985.

"Morphology of combusted bituminous and semi-anthracite coals"; Petten, Netherlands, September 1985.

"Progress report on variation in the optical properties of the skeletal materials of graptolites"; International Paleontological Association, Copenhagen, September 1985 (with B.S. Norford - co-author).

"Optical properties of graptolites"; University of Newcastle, England, November 1985.

Coordinator and lecturer in course on Organic Petrology, jointly arranged with ISPG, University of Calgary and University of Regina, January-April 1986.

J.D. Hughes

"A computer-based system for storage and processing of coal exploration data in the development of coalfield models suitable for resource, geological and environmental assessments - Canada's National Coal Inventory"; CSPG Computer Applications Division, June 1985.

"The Geological Survey of Canada's computer-based National Coal Inventory"; Seventh Coal Production and Transportation Meeting, Vancouver, January 1986.

"Modelling borehole data in stratified sequences, by computer"; poster session at B.C.-Yukon Chamber of Mines Annual Meeting, Vancouver; and poster session and talk at GSC Oil and Gas Forum, Calgary, January-February 1986.

"Maturation History of the Kootenay Group in the southern Canadian Rocky Mountains and Foothills"; (with A.R. Cameron), poster session at GSC Oil and Gas Forum, February 1986.

T. Jerzykiewicz

"The Saunders Group in the central Alberta Foothills: A new stratigraphic subdivision and the palynological definition of the Cretaceous-Tertiary boundary"; (co-speaker with A.R. Sweet) at Department of Geology, University of Alberta, Edmonton, April 1985.

"The Saunders Group - A coal-bearing molasse sequence in the Cordilleran Foreland Basin, central Alberta Foothills, western Canada"; poster session at Foreland Basin Symposium in Fribourg, Switzerland, September 1985.

"Stratigraphy, sedimentology and iridium anomaly of coal-bearing Saunders Group (Cretaceous-Tertiary of central Alberta Foothills, Canada)"; at the Geological and Mineralogical Institute of Göttingen University, West Germany, September 1985.

"Coal-bearing formations in Alberta Canada"; at the Geological Institute of the Bergen University, Norway, September 1985.

"The Saunders Group: Late orogenic coal-bearing molasse sequence in central Alberta Foothills"; at the Geological Institute of Bergen University, Norway, September 1985.

"Aspects of clastic sedimentology; Sandbodies from Bohemian Cretaceous Basin, Alpine Molasse Basin and Central Alberta Foothills (Saunders Group)"; at Sedimentology Division CSPG, Calgary, November 1985.

"Caliche in the Paleocene and Upper Cretaceous of southern Alberta; implications for paleoclimate and coal distribution"; (co-author with A.R. Sweet), poster display at GSC Oil and Gas Forum, Calgary, February 1986.

"Cretaceous-Tertiary boundary in Alberta"; (co-author with A.R. Sweet), poster display at GSC Oil and Gas Forum, Calgary, February 1986.

W.D. Kalkreuth

Inkohlungsgrad und petrographische Zusammensetzung von kanadischen Kreidekohlen, insbesondere aus dem Peace River Coalfield, British Columbia, Kanada. 44. Sitzung der Kohlenpetrographischen Arbeitsgemeinschaft, Steinkohlenbergbauverein, Essen, Germany, February 1985.

Anwendung kohlenpetrographischer Methoden bei der Kohlenumwandlung – Rückstände aus der Torfverflüssigung und der Vacuum-Pyrolyse. 44. Sitzung der Kohlenpetrographischen Arbeitsgemeinschaft, Steinkohlenbergbauverein, Essen Germany, February 1985.

Organische Petrologie von kanadischen Ölschiefeln. Gastvortrag, Technische Universität Berlin, Berlin, Germany, May 1985.

Westkanadische Kreidekohlen – Geologie, Petrologie und technologische Eigenschaften. Geologisch – Palaontologisches Colloquium, Freie Universität Berlin, Berlin, Germany, May 1985.

Coal petrological methods applied to the characterization of solid residues from vacuum-pyrolysis and peat-hydrogenation. Studsvik Energiteknik, Department of Fuel Technology, Nyköping, Sweden, July 1985.

Application of coal petrological methods in the evaluation of technological properties of coals and the characterization of solid residues from pyrolysis and liquefaction. Angpanne Föreningen, Division Energisystem, Stockholm, Sweden, July 1985.

Application of coal petrological methods in the characterization of low rank coals, peats and their reaction residues. Statens Landbrukskemiska Laboratorium, Torvavvattningsprojektet, Umeå, Sweden, July 1985.

Thermal maturation and burial history, eastern Rocky Mountains and Foothills of Canada; Geological Survey of Canada Forum; Activities on Oil and Gas in Canada, Calgary, Alberta, February 1986 (with co-authors M. McMechan, A. Cameron and D. Hughes).

Synchronous and Three-dimensional Fluorescence Spectroscopy Applied to Organic Geochemistry. v. 12. International Meeting on Organic Geochemistry, Julich, Germany, September 1985 (poster display with co-author v.d.H. Dick).

Coal rank and structural style, Rocky Mountain Foothills, northeastern British Columbia; Cordilleran Geology and Exploration Roundup, British Columbia and Yukon Chamber of Mines, Vancouver, B.C., January 1986 (poster display with co-author M. McMechan).

Organic Petrology as related to maturation studies and source rock evaluation; Geological Survey of Canada Forum; Activities on Oil and Gas in Canada, Calgary, Alberta, February 1986 (poster display with co-author A. Cameron and F. Goodarzi).

Oil Shales in Canada; Geological Survey of Canada Forum; Activities on Oil and Gas in Canada, Calgary, Alberta, February 1986 (poster display with co-author L. Snowdon and G. Macauley).

Thermal maturation and burial history, eastern Rocky Mountains, Foothills and Plains, northeastern British Columbia; Geological Survey of Canada Forum; Activities on Oil and Gas in Canada, Calgary, Alberta, February 1986 (poster display with co-author M. McMechan).

G.G. Smith

"Role of the mine geologist in an integrated production planning team"; CIM Annual General Meeting, Vancouver, April 1985.

"A comprehensive evaluation of coal resources of the Sheerness Coalfield, Alberta"; formal presentation to Alberta Power Limited, Edmonton, April 1985.

"Coal resources of Canada"; presentation to visiting Coal Mission from the People's Republic of China, CANMET Office, Calgary, June 1985.

"GSC energy research and development – coal"; (with F.M. Dawson), poster display at GSC Oil and Gas Forum, Calgary, February 1986.

Membership on Committees

A.R. Cameron

International Committee for Coal Petrology, member.

International Journal of Coal Geology, editorial board.

Canadian Coal Petrographers Group, chairman.

Management Committee for Coal Combustibility Project of Esso Resources Canada, member.

F.M. Dawson

Coal Group, Canadian Society of Petroleum Geologists, chairman.

ISPG Library Committee, member.

ISPG McConnell Club, chairman.

Organizing Committee, 1986 Western Canada Coal Geoscience Forum, member.

D.W. Gibson

I.G.C.P. Correlation of Coal-Bearing Formations Project 166, national representative.

F. Goodarzi

International Committee for Coal Petrology, member.

Editorial Board of Fuel, member.

Society for Organic Petrology, member.

Canadian Coal Petrographers Group, member.

J.D. Hughes

Technical Committee – Joint Federal-Provincial B.C. Coal Data Collection Project, member.

I.S.P.G. Computer Committee, member.

CSPG Devonian Symposium Organizing Committee, member.

W.D. Kalkreuth

International Committee for Coal Petrology, member.

Society for Organic Petrology, member.

Canadian Coal Petrographers Group, member.

B.D. Ricketts

Bulletin Canadian Society of Petroleum Geologists, associate editor.

I.S.P.G. Library Committee, member.

I.S.P.G. Exhibits Committee, member.

G.G. Smith

OERD Task 2.1 Program Committee, member.

Organizing Committee, 1986 Western Canada Coal Geoscience Forum, chairman.

ISPG Management Subcommittee—Computers, chairman.

Technical Committee - Joint Federal-Provincial B.C. Coal Data Collection Project, member.

Organic Petrology Laboratory

One thousand forty specimens were prepared, nearly all in the form of particulate material in pellets. Sampled materials included coal, kerogen, chemical macerates of sedimentary rocks, bitumens, coke and whole rocks. Approximately 200 specimens required special treatment such as oriented samples of coals and oil shales, graptolites, and various kinds of carbonized material. Microscopic analyses of many of these were also conducted by the technician.

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 every 6 to 8 weeks 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, 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

The Petroleum Resource Appraisal Secretariat role has continued to modify in response to the Department's need for information. Primarily this involved the assumption of a catalytic role in Basin Analysis studies throughout the Survey and the focusing of the results from the Basin Study Teams toward resource assessment. The Sedimentary Basin syntheses are done by staff of the Secretariat.

1. **April - May:** Liaison with other groups regarding petroleum assessment of Boundary Areas. Specifically the areas are Juan de Fuca (Canada -U.S.), Alaska, St. Pierre and Miquelon (Canada -France).
2. **June:** The Secretariat convened a working session of geoscientists in Halifax to begin to make new petroleum estimates for the Jeanne d'Arc Basin, Grand Banks. (Session included scientists from ISPG, AGC, COGLA, NEB.)
3. **July:** Delegates from BGR (German Geological Survey) visited the Secretariat to exchange ideas on assessment methodology.
4. **September:** Worked with PAREX - SOQUIP in Quebec City focusing on geophysics, geochemistry, and resource evaluation methodology as applied to east coast of Canada.
5. **October:** Secretariat had been investigating finding a suitable sedimentary basin which has a long well documented history of exploration. They selected Paris Basin. Elf/Aquitaine visited the Secretariat and brought data in suitable form for analysis with our methodology.
6. **December:** A major study - "Conventional Oil Reserves of Western Canada" was prepared for the Panel in Ottawa.
7. **January:** Secretariat begins to participate in the Advisory Committee of Canadian Energy Research Institute for establishing a supply curve for oil in Province of Saskatchewan.

8. **February:** Participated in the Geological Resources Committee with the Newfoundland Petroleum Directorate in Halifax on oil and gas resources of Jeanne d'Arc Basin.

Initiated scientific appraisal of the several conceptual petroleum plays in Sweetgrass Arch area of southern Alberta/southwest Saskatchewan.

Distributed 700 copies of a summary of results of assessment of Conventional Oil Reserves of Western Canada at the GSC Oil and Gas Forum.

Personnel Notes

The Secretariat currently consists of an Executive Director, three scientists, an engineer and a secretary:

- R.M. Procter - Executive Director
G.C. Taylor - Senior Petroleum Geologist
P.J. Lee - Senior Geologist
- Resource Evaluation Methodology
N.J. McMillan - Senior Petroleum Scientist
- Basin Studies
M. Raicar - Senior Heavy Oil and Enhanced Recovery Engineer
A.G. Foo - Secretary

Attendance at Meetings, Conferences and Courses

Lee, P.J.

Evaluation of Canadian Oil and Gas Properties. University of Calgary. December/85 to April/86.

McMillan, N.J.

Heat and Detachment in Crustal Extension on Continents and Planets. Sedona, Arizona. October 10-12/85.

A delegate as an Observer to CCOP Annual Meeting in Beijing and Guangzhou, China, November/85.

Special Talks or Lectures

Procter, R.M.

"Estimating Canada's Undiscovered Oil and Gas Resources" - talk at Oil and Gas Forum, GSC, Calgary, February/86.

"Estimating Canada's Undiscovered Oil and Gas Resources" - talk at Luncheon Meeting of Canadian Society of Petroleum Geologists, Computer Application Division.

Taylor, G.C.

Report to Panel - Conventional Oil Resources of Western Canada. December, 1985.

Lee, P.J.

Estimating Canada's Undiscovered Petroleum Resources - Computer Application Division of Canadian Society of Petroleum Geologists. February/86.

Gave workshop on petroleum assessment to Suncor (2 days), Arco (1 1/2 days),

Organised petroleum assessment booth for Oil and Gas Forum sponsored by GSC, February, 1986.

McMillan, N.J.

Six months as Acting Head, Petroleum Geology Subdivision, ISPG,

Finalised preparation of "Labrador Stratigraphy" for DNAG volume. Western Canada Petroleum Geology is still underway.

Liaison with research arm of Elf/Aquitaine on

- (a) genesis of grabens and the relationship of the timing to oil generation in them,
- (b) Proterozoic algae project with emphasis on oil generation capacity,
- (c) Synthetic diagenesis programmes,

Liaison with various agencies concerning grabens and their petroleum genesis.

Membership on Committees

Procter, R.M.

ISPG Management Committee to review computer services at ISPG.

International Committee 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

1986 Geochautauqua Organising Committee

McMillan, N.J.

a) NSERC - Oceans Panel. Elected for 3 years

Canadian Society of Petroleum Geologists:

- a) Geolog
- b) Publication and Sales

Editor of Proceedings, Second International Symposium on the Devonian System. Calgary, August, 1987.

Ph.D. Committee of University of British Columbia.

Raicar, M.

EMR Member of Technical Advisory Committees of Computer Modelling Group.

GEOLOGICAL PUBLICATIONS SUBDIVISION

N.C. Ollerenshaw

This subdivision is responsible for communicating the results of the Institute's programs to the federal and provincial governments, their officials and agencies; and to industry, the universities and the general public. 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 and word processing. 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 also 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 36 reports, 54 outside papers and abstracts, 13 open file reports, and 4 maps. Processing of manuscripts involves the selection of critical readers and the evaluation of their reports, scientific editing, copy editing, proofreading and, in many cases, the layout of the publication.

Most maps and illustrations produced by Institute scientists for publication are prepared in the Cartographic Section. To expedite publication, some are now prepared by the scientists themselves with the advice and guidance of Cartographic 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 complex 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 final, camera-ready copy for the printer. Each year, some 30,000 pages are processed. In addition, some 700 letters and memoranda are typed as a special service. ISPG uses a network of 13 Xerox workstations and two microcomputers to process and transfer both copy and data. The acquisition of a phototypesetter in 1985 adds a new and extremely useful dimension to word processing and copy preparation at ISPG.

The Publications and Air Photo Section is the largest, best organized and undoubtedly the most efficient retail outlet of its kind in Western Canada. The increase in sales noted in last year's Annual Report (1984-85) continued in 1985-86 with sales of geological papers and maps increasing by 11 per cent over the previous year, reflecting the temporary resurgence in the western Canadian Oil and Gas Industry.

Personnel Notes

Appointments

J. M. MacGillivray was appointed Assistant Scientific Editor on June 7, 1985.

S. Young joined the Word Processing Centre on December 30, 1985, as Switchboard Operator/Receptionist, after being in a term position for one month.

P. Allen joined the Word Processing Centre in a term position on February 4, 1986.

In August of 1985, L. Machan-Gorham returned to the editorial unit after an absence of 5 months (maternity leave) and having earned the degree of Master of Communications from the University of Calgary.

Resignations

D. Beauregard, an OCE-03 operator, resigned on February 14, 1986 and moved to Ottawa.

C. Brennan, Switchboard Receptionist, resigned on November 29, 1985 to join Bujak Research Limited of Calgary.

Transfer

S. Brennan, an OCE-03 operator, assumed secretarial duties in Victoria, on November 22, 1985.

**Attendance at Meetings,
Conferences and Courses**

N.C. Ollerenshaw

Visit to GID/GSC, Ottawa, 7-10th May, 1985
Visit to GID/GSC Ottawa, 9-11th October, 1985
Association of Earth Science Editors, Annual Meeting,
Lawrence, Kansas, 20-23 October, 1985

J.M. MacGillivray

Canadian Society of Petroleum Geologists' course,
"Canadian Cordilleran Geology, What and How",
Calgary, February 6, 1986.

L. MacLachlan

Visit to USGS, Menlo Park, California, May 30-31, 1985.

W.P. Vermette

Cartographic workshop, OICC, Algonquin, May 5-8,
1985.

J.W. Thomson

Cartographic workshop, OICC, Algonquin, May 5-8,
1985.

B.C. Rutley

Kodak Seminar on Advanced Copy and Restoration,
Edmonton, April 17-19, 1985.

Trade show sponsored by the Professional
Photographers' Association, Calgary, March 16, 1986.

W.B. Sharman

Kodak Seminar on Advanced Copy and Restoration,
Edmonton, April 17-19, 1985.

Trade show sponsored by the Professional
Photographers' Association, Calgary, March 16, 1986.

P. Greener

Siemens telex training, Calgary, October 16, 1985.

Basic Compugraphic training, Vancouver, January 24-
28, 1986.

H. King

Siemens telex training, Calgary, September 23, 1985.

Basic Compugraphic training, Vancouver, January 24-
28, 1986.

A. Seif

Siemens telex training, Calgary, October 28, 1985.

M. Varalta

Siemens telex training, Calgary, September 17, 1985.

S. Brennan

Siemens telex training, Calgary, February 20, 1986.

P. Allen

Xerox 860 training, Calgary, February 10-13, 1986.

Xerox 630 Memorywriter training, Calgary, March 4,
1986.

Siemens telex training, Calgary, February 20, 1986.

J. McCloskey

Siemens telex training, Calgary, October 16, 1985

J. Spirritts

Siemens telex training, Calgary, September 25, 1985

D. Cormier

Siemens telex training, Calgary, September 25, 1985

Membership on Committees

L. MacLachlan

Chairman, I.S.P.G. Exhibits Committee

N.C. Ollerenshaw

Association of Earth Science Editors, Membership
Committee, member.

I.S.P.G. Stratigraphic Nomenclature Committee,
member.

I.S.P.G. Exhibits Committee, member.

B.C. Rutley

I.S.P.G. Exhibits Committee, member.

I.S.P.G. Support Staff Field Trip Committee, member.

W.B. Sharman

I.S.P.G. 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, 1985 – March 31, 1986)**

Scientific Editor's Office

Format	Received	Edited & Approved	To Ottawa or Publisher	Printed
Memoirs	0	1	1	1
Bulletins	7	8	3	3
Papers	2	3	4	3
85- IB	11	11	11	11
86- 1A	9	9	9	9
86- 1B	20	4	0	0
Maps	2	4	10	6
Open Files	15	13	13	13
Outside				
Papers	60	54	54	52
Abstracts	32	32	32	24

Geological Cartography Section

Maps and figures completed by the Cartography Section between April 1, 1985 and March 31, 1986.

	1984-1985	1985-1986
Multicolour maps and section sheets	5	9
Figure illustrations (page)	164	354
Figure illustrations (pocket)	9	7

Manuscripts received

	1984-1985	1985-1986
Multicolour geological maps	7	13
Figure illustrations (page)	349	380
Figure illustrations (pocket)	9	4

Maps and illustrations in progress at March 31, 1986

	1984-1985	1985-1986
Multicolour geological maps	7	3
Figure illustrations (page)	277	199
Figure illustrations (pocket)	10	0

Miscellaneous drafting which averaged approximately 29% of the total drafting time comprised 984 separate items, 410 of which were slides.

Reproduction Services

	1984-1985	1985-1986
Diazo prints	8121	5922
Diazo prints (frame shots)	525	285
Di-chrome	303	243

Photomechanical services

Film (sheets, negatives & positives)	3120	3359
Drafting keys on scribecoat	100	51
Blueline on Cronaflex	14	-
Colour proofs	11	18
Peelcoats	72	125
C-1 prints	17	-
KC-5 prints	1403	1962
Autopositives (multiple exposure)	963	541
Sepia (dry erasable film)	199	126

Photography Section

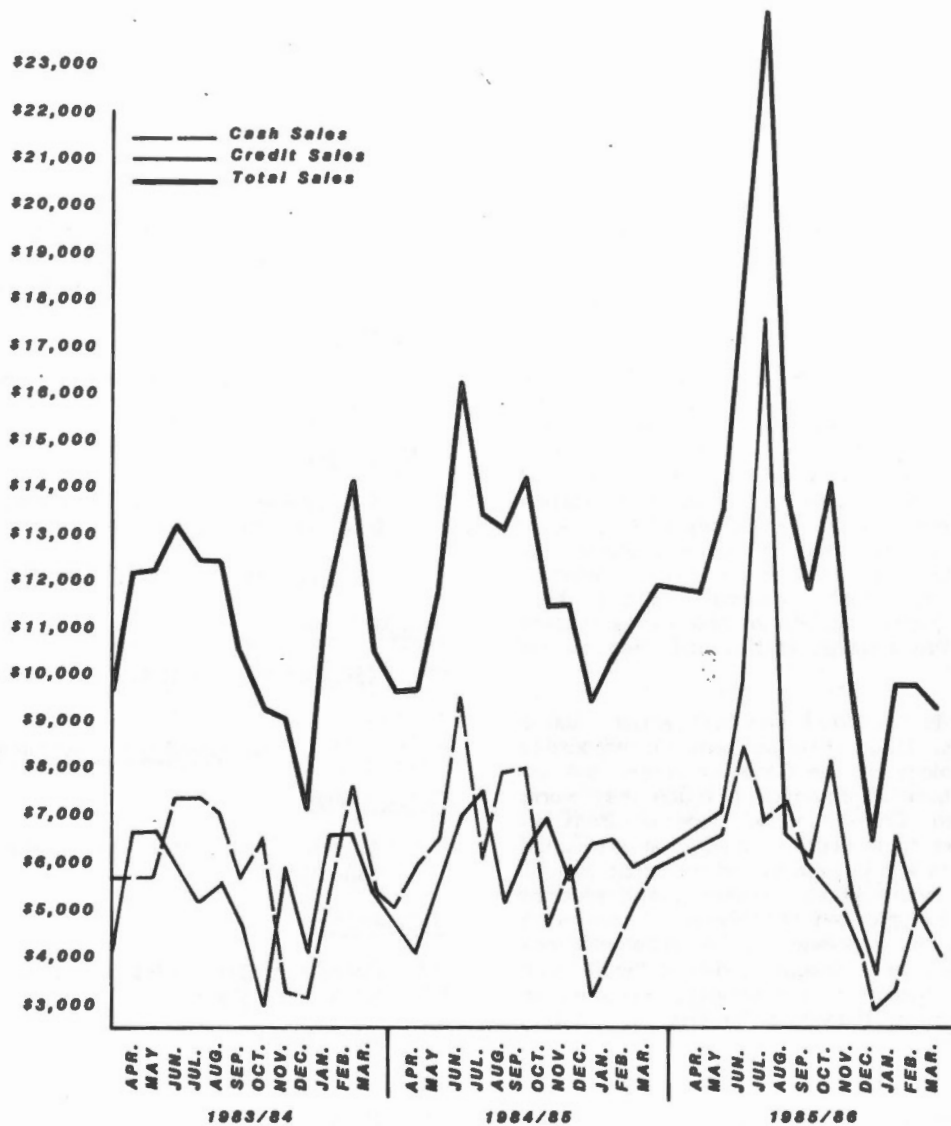
Production during the review years 1984-85 and 1985-86

	1984-1985	1985-1986
Total number of black and white, continuous tone 4" x 5" negatives	1514	1517
Total number of black and white prints	11 566	11 970
Total number of contact proof sheets	895	1184
Total number of 35 mm films (black and white and colour) submitted for processing by staff members	177	244
Total number of black and white 35 mm negative films	170	187
Total number of 35 mm colour slide films	178	197
Total number of colour negatives on file	1141	1960
Total number of colour prints	2728	4065

Publications and Air Photo Section

The sales of materials through this office continued to show an overall increase during the year, boasted by a large order formaps from the Tyrell Museum of Paleontology in July 1985 (see Saks Chart). Sales of maps and publications did decline slightly during the last quarter, but this was mainly due to the annual decrease in Oil Industry field activity during the winter months.

The Publications Office participated in the "Oil and Gas Forum" held at the Convention Centre in February, 1986. As is now known, the Forum was a great success, and we received many enquiries after the forum for publications that were on display. Many of those who attended were previously unaware of the services and materials provided by this office.



Only three charge accounts were closed during the year. A total of thirteen new accounts were opened, bringing the total number of accounts held at this office to 192.

The number of visitors to the office decreased in 1985-86 to 9,167, from 11,083 in the last fiscal year. There was, however, a marked increase in the number of requests received by mail as well as by telephone.

Breakdown of Sales:

	1984-1985	1985-1986
Surveys and Mapping	\$107,450.35	\$118,524.40
National Air Photo Library	9,328.47	8,714.53
GSC Maps	9,890.00	15,005.55
Rock and Mineral Kits	2,941.00	1,516.00
Miscellaneous GSC Materials	820.48	1,710.00
GSC Publications	16,727.54	18,070.30
Mineral Policy Sector	223.35	198.20
Gravity Maps	28.50	20.50
Total	\$147,409.69	\$163,759.48

Breakdown of Accounts

	1984-1985	1985-1986
Credit Sales	\$ 77,774.95	\$ 92,749.25
Cash Sales	\$ 70,508.39	\$ 68,575.33
Received on Account	\$ 76,901.30	95,184.15

Air Photos

A total of 183 orders (150 prepaid) were forwarded to Ottawa during the year. These consisted of:

- 4,851 Black and white contact prints
- 30 ITEK prints
- 25 Colour contact prints
- 78 Flight line index maps
- 85 Black and white diapositives
- 2 Transparencies
- 1 10 x 10 transparency enlargement
- 4 Landsat mosaics
- 14 10 x 10 enlargements
- 4 20 x 20 enlargements
- 35 30 x 30 enlargements
- 14 enlargements to scale

PRECAMBRIAN GEOLOGY DIVISION

J.C. McGlynn, Director

INTRODUCTION

This Division is responsible for all aspects of the bedrock geological framework of the Precambrian Shield. In addition, units of the Division are charged with responsibility for isotope geochronological, petrological and paleomagnetic studies throughout Canada.

The objectives of the Division are: To provide systematic study of the geological framework of the Canadian Shield to standards consistent with the needs for mineral resources discovery and evaluation of future resource potential; to provide isotope geochronology and paleomagnetic studies contributing to consistent correlation and to uniform presentation of the geology of Canada; to provide petrogenetic and metamorphic studies on major rock groups and metamorphic assemblages in Canada, directed toward solution of important problems. Within these objectives, priorities include application and testing of plate tectonic theory to Precambrian studies and deep crustal studies.

The Division is organized into six 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. Special studies in the Division undertake bedrock studies in volcanology, Precambrian stratigraphy and Lower Paleozoic geology of Eastern Canada.

The establishment consists of 62 continuing person-years for indeterminate staff, 11 casual person-years for employment of research assistants and students for summer field work, 6.50 person-years for research scientists and assistants employed on the federal-provincial mineral development agreements and the Gaspé program.

Personnel Notes

F. Marier-Lalonde, Division Administrative Officer, accepted a promotion with the Department of Labour.

J. MacManus was appointed Assistant to the Director of the Division.

R. Bell accepted a permanent draughtperson position with the Department of Defence.

Visiting Fellowships commenced for J. Mortensen in the Geochronology Section, V. Owen with the Newfoundland Mineral Development Agreement and J. Hill with the Nova Scotia Mineral Development Agreement. The Fellowship for N. Culshaw was renewed for a second year.

Dr. Shin-ichi Yoshikura, visiting scientist from Kochi University, Japan spent the year with the Division.

N. Arsenault joined the Division in December as a term word processor.

ADMINISTRATION

Attendance at Meetings, Conferences and Courses

C. Gougeon

Career Advancement Seminar for Women, Ottawa, July.

J. MacManus

Assertiveness Skills, Professional Development Institute, Ottawa, October.

GSC Current Activities Forum, Ottawa, January.

J.C. McGlynn

GSC Current Activities Forum, Ottawa, January.

Membership on Committees

J. MacManus

Ad Hoc committee on Baillie Report on GSC collections.

J.C. McGlynn

Northwest Territories Coordinating Committee on Work in the North.

International Union of Geological Sciences, corresponding member

Canada Safety Code Committee, Member.

GSC Current Activities Forum Committee, chairman.

BEAR-SLAVE SECTION

M.B. Lambert (Head)

Highlights

Major regional mapping projects in the Slave Province continued to investigate the nature of the Thelon Tectonic Zone (TTZ), the boundary between the Slave Province and the Churchill Province. In a southern segment, near Artillery Lake, the boundary is defined by a major shear zone across which there are significant changes in lithology, structural style, metamorphic grade and gravity and magnetic patterns. The zone is characterized by abundant north-northeast trending mylonite zones and parallel bands of upper amphibolite to granulite grade metamorphism. A ductile shear zone subdivides the TTZ into tectonic units having different structural styles. A series of northeasterly trending dextral faults are splays off the master McDonald Fault that transects the southeastern third of the area.

In a northern segment, the Tinney Hills-Overby Lake area, the western side of a major magnetic anomaly marks a fundamental boundary which separates granulites and derived rocks and foliated Proterozoic granites to the east from Slave Province lithologies that have structural trends parallel to the TTZ to the west. The western domain contains metamorphosed basic dykes that are lacking in the eastern domain. A north-northeast fabric overprints both the Proterozoic granites of the eastern domain and the western domain in which it is also associated with folding of the Proterozoic cover (Goulburn Group). The existence of proved Archean structures of TTZ trend invite the interpretation that Proterozoic structures formed along a major Archean feature of similar trend.

In the southern Slave Province, the Great Slave Shear Zone is shown to be a dextral transcurrent structure up to 25 km wide made up of four structural belts. With time, the locus of high strain rate moved outwards from the centre of the shear zone and metamorphic grade decreased from granulite to greenschist facies. The central part of the zone is dextral transpressive whereas the lateral or external parts are dextral transcurrent.

Stratigraphic investigations in the Goulburn Group concluded that the Early Proterozoic Western River and Burnside River Formations represent an initial stable shelf sequence whose outer, southerly edge subsided contemporaneously with arching and subaerial exposure of its interior. Shelf drowning represents the onset of foredeep subsidence subparallel to the trend of the Thelon Tectonic Zone. Arching and subsidence were perpendicular to the tectonic transport direction of intrabasinal nappes, indicating that convergence and uplift along the Thelon Tectonic Zone were probably responsible for foredeep subsidence within the Kilohigok Basin.

In the Fort Resolution area, the Great Slave Shear Zone crosscuts two major plutonic complexes, a granodiorite batholith and white quartz monzonite. In the southeastern Taltson Lake area a prominent fault separates fine-grained gneisses to the east from coarser gneisses to the west. Outliers of Nanocho Group occur as lenses along the fault and as slices overlying and faulted against the western gneisses. In south-central Taltson Lake area scheelite occurs as minor stratabound disseminations and veins within high-grade gneiss remnants in megacrystic granite.

Continued work on the structure of the Asiatic Thrust-Fold Belt in the Bear Province resulted in the construction of a new cross-section, in part computer calculated and restored. This work developed a geometric explanation for some second-order phenomena of thin-skinned belts including "ear" folds associated with box folds, "out of syncline" thrusts and thrusts that die out along axial planes of anticlines.

Structural studies in selected areas of the Wopmay Orogen, Bear Province, showed that the Muskox Lakes synform is a first-order, late-Calderian fold which was probably formed during late, basement-involved shortening and continued uplift of the Calderian metamorphic-internal zone. In the northwestern part of the internal zone, gneisses of Archean age are complexly infolded with amphibolite-grade Proterozoic strata. The contact between the Hepburn Metamorphic Plutonic Belt and the Great Bear Magmatic Zone in this area may be a high-level expression of reactivation of the buried Wopmay Fault. Near the unconformity within the overlying Mid-Proterozoic Hornby Group, the through-going, post Calderian transcurrent fault system was the locus of reactivation, intense alteration and uranium mineralization.

In the western part of Wopmay Orogen, U-Pb zircon dating of volcanic rocks in the Bell Island Group, which unconformably overlies Hottah Terrane and lies unconformably beneath the Great Bear Magmatic Zone, has demonstrated that the main metamorphism and deformation of Hottah Terrane are of pre-Calderian age. It is therefore likely that the Bell Island Group represents a 1.9 Ga continental magmatic arc and overlying marginal basin fill formed on western Slave Craton. The age and composition of the Bell Island rocks confirms the concept that Coronation Margin developed in a back-arc setting.

Field work in the early Proterozoic eastern Cape Smith Belt has documented a network of pre-metamorphic thrust faults that root on a basal décollement localized at the basement/cover interface. The hanging wall and footwall rocks of the décollement display syn-metamorphic high ductile strains over a zone of increasing thickness from foreland to hinterland. The high-strain zone records southward movement of the cover rocks. Pelitic mineral assemblages within the high-strain zone are indicative of metamorphic T of 550°C and minimum P of 5.5 kb.

A study of the Roberts Arm Group, Newfoundland, concluded that the Group encompasses two petrochemical terranes: an alkalic terrane that formed during back-arc spreading followed by a more calc-alkalic terrane which formed about the time of ophiolite emplacement in western Newfoundland.

Work in the Karakorum Himalaya (Pakistan) defined the nature of the Karakorum thrust. Slip on this thrust was synkinematic with at least two "phases" of coaxial deformation of high-grade rocks in the hanging wall. The fault juxtaposes rocks that differ by at least 2 kb and probably 4 kb of metamorphic pressure. The thrust most probably predated the emplacement of the main Karakorum Batholith.

A 1:1,000,000 scale geological compilation map of the Precambrian Shield in the Northwest Territories is completed.

Personnel Notes

J. King joined the Section in June as a research scientist.

R.S. Hildebrand and J. King organized Precambrian High.

F.H.A. Campbell resigned to accept a senior management position with the Surveys and Mapping Branch of Energy, Mines and Resources.

P.F. Hoffman, M. St-Onge and R. Tirrul took part in an international field research project with a transect across the Himalayan Mountains.

J.P. Grotzinger accepted a 3-month term position to perform field work in the Bathurst Inlet area.

Q. Gall, E. Hurdle, D. Lemkow and K. Manser were employed as term research assistants for the Section.

Attendance at Meetings, Conferences and Courses

A. Frith

Geoscience Forum, Yellowknife, NWT, December.

J.B. Henderson

GSC Current Activities Forum, Ottawa, January.

R.S. Hildebrand

Geological Society of America, Annual Meeting, Orlando, Florida, U.S.A., October.

International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), Auckland, New Zealand, January-February.

P.F. Hoffman

Lithoprobe I Workshop, Victoria, B.C., April.

Tectonics and geochemistry of early-middle Proterozoic fold belts, Darwin, Australia, August.

Great Lakes and Hudson Bay Deep Crustal Studies Workshop (GLIMPCE), Madison, Wisconsin, U.S.A., November.

Tectonic evolution of greenstone belts, Lunar and Planetary Institute, Houston, Texas, U.S.A., January.

GSC Current Activities Forum, Ottawa, January.

Western Inter-University Geological Conference, Saskatoon, Saskatchewan, January.

Continental Scientific Drilling in Canada, Ottawa, February.

J. King

Mineralogical Association of Canada, Short Course - Electron Microscopy in the Earth Sciences, Fredericton, New Brunswick, May.

Geological Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

Geological Society of America, Northeastern Meeting, Monticello, New York, U.S.A., March.

M.B. Lambert

International Conference on Mafic Dyke Swarms, Toronto, Ontario, June.

International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), Scientific Assembly, Sicily, September.

GSC Current Activities Forum, Ottawa, January.

Continental Scientific Drilling in Canada, Ottawa, February.

M. St-Onge

Seminaire d'Information (Québec), Québec, November.

GSC Current Activities Forum (poster session), Ottawa, January.

Royal Society of London Discussion Meeting, London, U.K., January.

P. Thompson

Geological Society of London, Current Research in Regional Geology Meeting, London, U.K., November.

Geoscience Forum, Yellowknife, NWT, December.

R. Tirrul

Geological Society of America, Northeastern Section, Lancaster, Pennsylvania, U.S.A., March.

Membership on Committees

A. Frith

TFSS Field Equipment Committee, Chairman.

R.S. Hildebrand

International Geological Correlation Project (IGCP), Working Group 217, member.

International Association of Volcanology and Chemistry in the Earth's Interior (IAVCEI), Working Group on Explosive Volcanism, member.

Geological Association of Canada, Precambrian Division, secretary-treasurer.

P.F. Hoffman

International Lithosphere Program, Working Group 2A (Evolution of Mobile Belts), chairman.

International Union of Geological Sciences, Subcommission on Precambrian Stratigraphy, voting member.

International Geological Correlation Project, Working Group 215, Proterozoic Fold Belts, member.

Royal Society of Canada, nominating committee.

Associate editor: Geology.

Associate editor: Tectonics.

Associate editor: Precambrian Research.

M.B. Lambert

International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), vice-secretary.

P. Thompson

Editorial Board: Journal of Metamorphic Geology.

Special Talks and Lectures

A. Frith

"Geology of Indin Lake Area", Geoscience Forum, Yellowknife, N.W.T., December.

R.S. Hildebrand

Taught 4th year course - Physics of magmas/igneous petrology, Carleton University, Ottawa, Fall.

"Andesite stratovolcanoes of the Cascade Arc", GSC Precambrian High, Ottawa, October.

"Ash-flow calderas", GSC Precambrian High, October.

"Wopmay Orogen, evolution of a 1.9 Ga Cordilleran Margin" and "On the relationship of Kiruna deposits to subvolcanic plutons", United States Geological Survey, Menlo Park, California, U.S.A., January.

"Evolution of sub-stratovolcano plutons and their mineral deposit, Great Bear Magmatic Zone", GSC Precambrian High, Ottawa, March.

P.F. Hoffman

"On accretion of the Precambrian craton of Western Canada", Lithoprobe I Workshop, Victoria, B.C., April.

"Tectonic significance of Archean inliers in Proterozoic Orogens", Darwin, Australia, August.

"Some thoughts on the Slave Province and Thelon Front, N.W.T.", Ottawa, December.

"Simple tectonic model of crustal accretion in the Slave Province granite - greenstone terrain, N.W.T.", Lunar and Planetary Institute, Houston, Texas, U.S.A., January.

"Modes of crustal shortening in Wopmay Orogen, N.W.T.", Western Inter-University Geological Conference, Saskatoon, Saskatchewan, January.

"Crustal accretion in the Slave Province, N.W.T.", Regina, Saskatchewan, January.

"Transect of the N.W. Himalaya-Karakorum, Pakistan", Regina, Saskatchewan; Calgary, Alberta; Saskatoon, Saskatchewan, January.

M.R. St-Onge

"Zoned poikiloblastic garnets: documentation of P-T paths and syn-metamorphic uplift, Wopmay Orogen", GSC, Ottawa, April.

"Eastern Cape Smith Belt: an early Proterozoic thrust-fold belt and basal shear zone exposed in oblique section", GSC, Ottawa, December.

Royal Society of London Discussion Meeting
"Evolution of regional metamorphism during back-arc stretching and crustal shortening in the 1.9 Ga Wopmay Orogen, Canada", London, U.K., January.

"Evolution in pressure temperature and physical space during regional metamorphism in the 1.9 Ga Wopmay Orogen, Canada: A rifting to collisional tectonic setting for metamorphism", McMaster University, Hamilton, Ontario, March.

P. Thompson

"The Thelon Tectonic Zone - a reactivated Archean mobile belt?", GSC Precambrian High, Ottawa and Princeton University, Princeton, New Jersey, U.S.A., April; University of Rennes, Rennes, France, October; University of London, London, U.K., November.

"Polymetamorphism in the Healey Lake area - implications for the Thelon Tectonic Zone", Imperial College, London, U.K., October and Kingston Polytechnic, Kingston, U.K., November.

"Metamorphosed Iron Formations in the Tinney Hills - Overby Lake map area", Yellowknife, NWT., December.

R. Tirrul

"Polyphase deformation in Asiatic Thrust-Fold Belt", Virginia Polytechnical School and the State University, U.S.A., October.

"Excursion through the Karakorum", GSC Precambrian High, Ottawa, December.

Manuscripts Submitted

7 external publications, 11 abstracts, 1 GSC paper; 1 GSC memoir, 9 Current Research reports, 3 open file maps, 1 open file report, 1 book review, 6 A-series maps.

NORTHERN CHURCHILL SECTION

A.N. LeCheminant (Head)

Highlights

New field projects were initiated on a major shear zone exposed along the south shore of Wager Bay and on greenstone-metasedimentary sequences near Rankin Inlet. The first draft of the 1:1 000 000 geological atlas sheet Dubawnt River (NTS 65) was submitted along with a legend-correlation chart, source map index, geotectonic index map and maps and files of geochronological and mineral occurrence data.

Mapping in coastal areas of Wager Bay confirmed the presence of a major east-west striking early Proterozoic ductile transcurrent shear zone that can be traced as an aeromagnetic lineament more the 300 km to the west.

Personnel Notes

G. Jackson and T. Frisch visited the Aldau Shield, USSR, as part of a Canada/USSR scientific and technical cooperation, Theme 1.3.1 - Geology of the ancient cones of platforms.

Attendance at Meetings, Conferences and Courses

T. Frisch

Geological Society of America, Annual Meeting, Orlando, Florida, U.S.A., October.

J.R. Henderson

International Conference on Tectonic and Structural Processes, Utrecht, Netherlands, April

Deformation Mechanisms in Sediments and Sedimentary Rocks, London, U.K., April.

Continental Extensional Tectonics, Durham, England, April.

New York State Geological Association Field Conference, Saratoga Springs, New York, U.S.A., September.

Canadian Tectonics Group, Annual Meeting, Halifax, Nova Scotia, November.

Geological Society of America, Northeast Section, Kiamesha Lake, New York, U.S.A., March.

A. LeCheminant

Geological Association of Canada and Mineralogical Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

International Conference on Mafic Dyke Swarms, Toronto, Ontario, June.

GSC Current Activities Forum, Ottawa, January.

S. Tella

Mineralogical Association of Canada, Short Course - Applications of electron microscopy in earth sciences, Fredericton, New Brunswick, May.

Geological Association of Canada and Mineralogical Association of Canada, Annual Meeting, New Brunswick, May.

GSC Current Activities Forum, Ottawa, Ontario, January.

Continental Scientific Drilling in Canada, Ottawa, Ontario, February.

Dextral shear-sense is indicated by bending to the right of aeromagnetic anomalies into the Wager Bay shear zone and by mesoscopic fabric elements in horizontally lineated vertically dipping mylonites in the 2 km wide north boundary zone. South of the high strain mylonite zone is a belt at least 8 km wide composed of southeast striking mylonites displaced by discrete sinistral ductile shears. The shearing occurred at amphibolite facies conditions and synkinematic granitic rocks filled dilatant zones. North of the shear zone amphibolite grade orthogneiss and supracrustal rocks are intruded by early Proterozoic calc-alkaline I-type plutons of megacrystic granite and granodiorite. K-Th-U radiometric anomalies and occurrence of fluorite and abundant zircon and allanite suggest the granite plutons have high U, Th and REE content.

The Rankin Inlet Group is an (?) Archean greenstone-metasedimentary sequence comprising at least two major cycles of volcanism with intervening turbidite deposition. At Rankin Inlet the sequence forms an east dipping F1 homocline that is folded into a southeast plunging F2 upright syncline. Two structural discordances within the upper volcanic cycle are interpreted as thrusts with opposing vergence that juxtapose rocks of different structural geometry. Migmatitic paragneisses north of Rankin Inlet are believed to be high grade equivalents of the Rankin Inlet Group. A (?) lower Proterozoic orthoquartzite sequence, tentatively correlated with the Hurtwitz Group, is exposed at Rankin Inlet and on Marble Island. The contact with older rocks on Marble Island is a high strain zone interpreted to be a low angle, south verging fault.

Emphasis on granulite facies rocks continued with compilation of a new map of granulite localities of the world, organization of a symposium on granulites, mapping on northwestern Melville Peninsula, and petrologic and geochronological studies. U-Pb zircon geochronology indicates a late Archean age for granulite facies metamorphism south of the Amer mylonite zone. Archean granulite facies rocks of the Soviet Aldan Shield were examined and sampled under terms of the Canada-USSR agreement involving comparison of Precambrian Shield terranes in the Arctic.

Northwestern Melville Peninsula comprises a tonalitic-granodioritic plutonic suite intruded by granite and mafic dykes and overlain by sediments correlated with the 2.9 Ga Prince Albert Group. Shallow dipping slabs of dry basement and wet supracrustals were tectonically stacked and transported to deep crustal levels where they were metamorphosed under upper amphibolite-granulite conditions during the late Archean. During uplift the rising mass was cut by northwest trending mafic dykes. Early Proterozoic amphibolite grade metamorphism of these dykes was accompanied by emplacement of a pegmatite dyke swarm. High-angle faulting and deposition of late Proterozoic clastic sediments preceded mid-Devonian uplift of the Melville Peninsula horst.

Proterozoic Thule Group rocks, Ellesmere Island and Bylot Supergroup rocks, northwestern Baffin Island were probably deposited in a single basin during opening of the Poseidon Ocean at 1.20-1.25 Ga. Stratigraphic analysis of Thule Group sequences indicate easterly sedimentary transport prevailed in southeast Ellesmere Island and southwesterly transport prevailed in western Greenland. Tide-dominated shelf sedimentation was interrupted by intervals of meandering stream sedimentation and plateau basalt volcanism.

J.R. Henderson

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

Canadian Tectonics Group, meeting co-organizer.

S. Tella

GSC Field Equipment Committee, member.

GSC Branch Safety Committee, Division representative - field component.

External member, B.Sc. thesis committee, Queen's University, Kingston, Ontario.

Special Talks and Lectures

T. Frisch

"The Precambrian Shield of Ellesmere and Devon Islands, Canadian Arctic", Institute of Precambrian Geology and Geochronology, Leningrad and Geological Institute, Yakutsk, USSR Academy of Sciences, USSR, August.

J.R. Henderson

"Folding and cleavage formation within Goldenville Formation, Nova Scotia: documentation of cleavage refraction due to flexural flow folding", Utrecht, Netherlands, April.

G.D. Jackson

"The Precambrian Geology of Baffin Island", Institute of Precambrian Geology and Geochronology, Leningrad and Geological Institute, Yakutsk, USSR Academy of Sciences, USSR, August.

A.N. LeCheminant

"Phlogopite in 1.8 Ga lamprophyres and volcanic rocks, Baker Lake region: petrologic indicator and geospeedometer", GSC Precambrian High, Ottawa, April.

"Phlogopite from 1.8 Ga lamprophyres and trachyandesites, District of Keewatin: petrologic implications", Geological Association of Canada and Mineralogical Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

S. Tella

"The significance of high pressure-temperature granulite inclusions in the Tulemalu Fault Zone, District of Keewatin, NWT", Geological Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

Manuscripts submitted

5 external publications, 1 contribution to DNAG volume, 8 abstracts, 5 Current Research reports, 1 open file map, 1 A-series map, 1 GSC paper.

A. Davidson (Head)

Highlights

Continuation of reconnaissance studies in the Grenville Province of Ontario has shown eastward extension of major shear belts previously outlined, and continuity of graphite-bearing gneisses for 100 km between previously known showings near Burk's Falls and at Bissett Creek on the Ottawa River. Geothermobarometric studies confirm pressures in granulites of the Central Gneiss Belt as high as 1100 MPa, compared with 500-600 MPa in the Kingston area of the Central Metasedimentary Belt. Studies along the Grenville front have identified mid-Proterozoic volcanic and granitic rocks that are probably coextensive with similar rocks that underlie mid-continental U.S.A. In addition, detailed structural studies of kinematic indicators have confirmed the northwest thrust-uplift scenario formerly deduced on broader geologic grounds. However, study of the Front near Chibougamau, Quebec, indicates an important sinistral component of displacement along that segment.

In western Superior Province, U-Pb age determinations on detrital zircons in metasediments confirm different ages for Quetico greywacke and 'Seine-type' conglomerate, and thus that these rock units are not facies equivalents.

The Kapuskasing structure zone (KSZ) of the Superior Province is a zone of high-grade metamorphic rocks, postulated to be an overthrust slab of the Archean lower crust. This unique exposure of the third dimension of this ancient craton was examined in LITHOPROBE Phase I in an effort to define the internal architecture of the crust in this area and to understand the processes that have shaped it, from the time of its formation, about 2.7 Ga ago, to the present day, in which associated earthquakes are still known.

Phase I LITHOPROBE studies have been successful in answering many important questions. Major findings include:

1. The crustal cross-section model is probably correct.
2. A thick crustal root occurs beneath the KSZ, possibly isostatic compensation for dense granulites in the upper crust.
3. High-velocity material occurs in the KSZ, suitable for seismic tracing into the contemporary lower crust.
4. A seismic reflector, corresponding to the surface position of the Ivanhoe Lake thrust fault, has been documented to a depth of 16 km.
5. Rocks of the KSZ cooled slowly at depth until at least 2.3 Ga ago and were thrust upward during later events related to orogenic events elsewhere in the Shield.
6. Confirmation of the sense of structural rotation and determination of regional variation paleomagnetically.

Personnel Notes

K.D. Card and A. Davidson have been involved principally with preparation of maps and manuscripts for the Decade of North American Geology volume on the Precambrian Shield, due to be completed in 1986.

S.K. Hanmer spent seven weeks in Ethiopia helping to give a field training course, sponsored by IDRC and UNESCO, for African graduates.

S. Black, S. Marincak and S. Neufeld were employed as term research assistants for the Section.

Attendance at Meetings, Conferences and Courses

K.D. Card

Institute of Lake Superior Geology, Annual Meeting, Kenora, Ontario, May.

International Dyke Conference and Field Trip, Erindale and Northern Ontario, June.

Lunar and Planetary Institute Workshop, Greenland, June-July.

Archean Geochemistry Field Workshop, Wyoming, U.S.A., August.

Ontario Geological Survey Forum, Toronto, Ontario, December.

Lunar and Planetary Institute Greenstone Belt Tectonics Conference, Houston, Texas, U.S.A., January.

Current Activities Forum, Ottawa, January.

A. Ciesielski

Colloque Annual, Ministère d'Énergie et Ressources, Québec, November.

A. Davidson

Friends of Grenville Annual Meeting, Mont Laurier, Quebec, September.

Geological Society of America, Annual Meeting, Orlando, Florida, U.S.A., October.

Great Lakes International Multidisciplinary Program on Crustal Evolution, first general meeting; Madison, Wisconsin, U.S.A., November.

Ontario Geological Survey, Annual Geoscience Research Seminar, Toronto, Ontario, December.

Geological Society of London, 16th annual meeting of Tectonic Studies Group, Southampton, U.K., December.

GSC Current Activities Forum, Ottawa, January.

Canadian Committee on the Dynamics and Evolution of the Lithosphere (CANDEL), Annual Meeting, Ottawa, February.

I.F. Ermanovics

Current Research Forum, Mineral Development Division, Department of Mines and Energy, St. John's, Newfoundland, November.

S. Hanmer

International Conference on Tectonic and Structural Processes, Utrecht University, Netherlands, April.

Canadian Tectonics Group, Halifax, Nova Scotia, November.

Geoscience Forum, Yellowknife, NWT, December.

GSC Current Activities Forum, Ottawa, January.

J. Percival

Kapuskasing Lithoprobe Workshop, Toronto, Ontario, April.

Institute of Lake Superior Geology, Kenora, Ontario, May.

Geological Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

Lunar and Planetary Institute Field Workshop, Nuk, Greenland, June-July.

Organization of meeting, Continental Scientific Drilling, Halifax, Nova Scotia, July.

Archean Geochemistry Field Conference, Landar, Wyoming, U.S.A., August.

Organizational meeting, Great Lakes International Multidisciplinary Program for Crustal Evolution, Madison, Wisconsin, U.S.A., November.

Ontario Geological Survey Geoscience Forum, Toronto, Ontario, December.

Lunar and Planetary Institute Workshop on Tectonic Evolution of Greenstone Belts, Houston, Texas, U.S.A., January.

GSC Current Activities Forum, Ottawa, January.

Workshop in Continental Scientific Drilling in Canada, Ottawa, February.

DOSECC workshop on mid-continental drilling and GLIMPCE organizational meeting, St. Louis, Missouri, U.S.A., February.

Membership on Committees

K.D. Card

International Union of Geological Sciences, Precambrian time-scale subcommittee, corresponding member.

Goldich Medal, Lake Superior Institute, selection committee member.

A. Davidson

Canadian National Committee/International Lithosphere Program (CANDEL).

North American Commission on Stratigraphic Nomenclature.

Geological Association of Canada Editorial Committee.

Mineral Development Agreement Committee, Canada-Ontario.

I.F. Ermanovics

Branch Program Management Committee for the nuclear fuel waste management program - Atomic Energy of Canada Limited.

J. Percival

Kapuskasing Lithoprobe transect co-ordinator.

Organizational committee for Continental Scientific Drilling in Canada.

Executive committee (GSC representative) Great Lakes International Multidisciplinary Program on Crustal Evolution.

Special Talks and Lectures

K.D. Card

"Geology and tectonics of the Archean Superior Province, Canadian Shield", Lunar and Planetary Institute Workshop, Greenland, June.

"Tectonic setting and evolution of late Archean greenstone belts of Superior Province, Canada", Lunar and Planetary Institute Workshop, Houston, Texas, U.S.A., January.

"Geology and tectonics of the Superior Province, Utah Mines Ltd., Seminar, Toronto, Ontario, March.

A. Ciesielski

"Grenville, a new structural approach", part of a Precambrian course given at University of Quebec in Montreal, Quebec, March.

A. Davidson

"Ductile deformation and the development of The Grenville Orogen", Memorial University, St. John's, Newfoundland, April.

Field Excursion, with talk: "Parry Sound-Algonquin geology", State University of New York, Albany, New York, U.S.A., May and University of Michigan, Ann Arbor, Michigan, U.S.A., September.

I. Ermanovics

"The geological program in the nuclear fuel waste management program of Canada", Pinawa, Manitoba, May.

S. Hanmer

"Potential kinematic model for some natural and experimental asymmetrical pull-apart structures", International Conference on Tectonic and Structural Processes, Utrecht University, Netherlands, April.

"The Great Slave Lake Shear Zone: boundary of the Slave Craton, NWT", Geoscience Forum, Yellowknife, NWT, December and GSC Current Activities Forum, Ottawa, January.

J. Percival

"Lithoprobe and the Kapuskasing uplift", Queen's University, Kingston, Ontario, April.

"Metamorphism and plutonism in the Quetico belt, N.W. Ontario", Kenora, Ontario, May.

"Metamorphism and plutonism in the Quetico belt, Superior Province", Nuk, Greenland, June.

"The Kapuskasing Lithoprobe Project" Fredericton, New Brunswick, May.

"An estimate of the amount of displacement on the Kapuskasing-Quetico boundary by geobarometry" Fredericton, New Brunswick, May.

"Lithoprobe-Canada's third dimension", Concordia University, Montreal, Quebec, October.

"The Kapuskasing Uplift: window on the Archean lower crust", University of Wisconsin, Madison, Wisconsin, U.S.A., November.

"Greenstone Belts: their inter-relationships, boundaries and surrounding terranes" (invited keynote presentation), Continental Scientific Drilling in Canada Workshop, Ottawa, February.

Manuscripts submitted

6 'A'-series maps, 1 open file, 2 GSC Papers, 5 Current Research papers, 9 outside publication, 8 abstracts.

SPECIAL PROJECTS SECTION

Highlights

A program was initiated to begin geological mapping and basin synthesis of the Hudson Platform. A short field season was carried out on the first phase of the work in the Hudson Strait using CSS Hudson. Two important findings were forthcoming from the cruise; firstly, the widespread distribution and intensely faulted nature of Ordovician and Silurian terranes the entire length of the Strait and, secondly the definite south-eastward continuation of the Boothia Arch extending across the extreme western end of Hudson Strait from Southampton Island to northern Quebec.

Membership on Committees

B.V. Sanford

Advisory committee on Names for Undersea and Maritime Features to Canadian Permanent Committee on Geographic Names.

Interdepartmental committee to plan and organize a multidisciplinary research program in eastern Canada.

Manuscripts Submitted

3 abstracts, 1 GSC Paper, 4 external publications.

GEOCHRONOLOGY SECTION

O. van Breemen (Head)

Highlights

This year saw the fusion of three major developments which together have brought geochronology in the G.S.C. to the forefront in new techniques and applications. These developments have also placed production on a level which is unique. The new chemistry laboratories are now in routine operation, particle counts are everywhere extremely low and lead contamination blanks are routinely 0.05 Nanograms and as low as 0.02 Nanograms in zircon processing. These low blanks are due to a new design of acid digestion vessels and to the quality of the new ultra-clean laboratory facility.

The production of two batches of new ^{205}Pb spike and development of a practical system for producing more will not only give our group a long term supply but will also benefit the world of geochronology. In one single step, the routine use of ^{205}Pb spike reduced sample size by 67% and the number of necessary mass spectrometer runs by 33%.

The final advance has come from a variable multi-collector retrofit on the mass spectrometer, and associated developments in our laboratories of secondary electron multiplier (SEM) calibration and data gathering software. Not only are the major isotopes of U and of Pb analyzed simultaneously on Faraday cups, but also the tiny common Pb peak on the SEM. At the moment this technique is unique to the G.S.C. Analysis times have dropped from 55 minutes to 10 minutes and as signal is lost, samples ten times smaller are analyzed more accurately. We now count the number of zircon crystals sent to chemistry! Together with greatly improved precision in ages, production has doubled. Laboratory and mass spectrometric advances have also implemented isotopic analysis of trace amounts of Pb in whole rocks and minerals. Common Pb isotope determinations on samples from the Valhalla Complex (southeastern B.C.) demonstrate an upper crustal (Precambrian) component in the lead which has important implications for the genesis of vein mineralization in the region.

Together with further geochronology, a tectonic synthesis has been developed for the Valhalla Gneiss Complex and southern Ominica Belt, including maps and crustal-scale (restored) cross sections illustrating the region's early Tertiary extensional environment - similar to many parts of the Great Basin, U.S.A. The 165 Ma old Nelson Batholith forms a large sheet which travelled eastward across the Valhalla Complex. Near the edge of the Paleozoic continental shelf, many carbonatites have been dated at 350 Ma old.

Volcanic dates in the lowest part of the Great Bear Magmatic Province (District of Mackenzie) are 1901 Ma, equivalent to the age of the Akaitcho Group and clearly older than the main sequence of plutons and volcanics of the Great Bear zone. Within the Thelon Tectonic zone an extensive 2000-1900 Ma magmatic arc has been revealed by U-Pb zircon ages on plutons ranging from the Alberta border to the Arctic Circle. Zircon analyses from the Dubawnt volcanics (District of Keewatin) and associated plutonics west of the Baker Lake area indicate an age of about 1760 Ma, within a basement of 2600 Ma. Volcanic rocks of the Cape Smith belt (Quebec) are as old as 1960 and granites which are syn- to post-tectonic are about 1840 Ma old and form a basis for chronological framework of this Proterozoic belt.

A major U-Pb geochronology study of the eastern Abitibi Belt (Quebec) has been initiated and is helping to resolve the timing of volcanism and plutonism in the area and provide a firm base for tectonic and metallogenic models for the belt. Data collected thus far from the Noranda area indicate that over 10 km of volcanic stratigraphy accumulated in less than 5 million years, at 2700 Ma. Preliminary results from the northern part of the Abitibi Belt suggest that volcanic rocks and associated massive sulphide mineralization in this area are about 20 to 25 Ma older than those in the Noranda area.

In the Cape Breton Highlands (N.S.) the first Grenville inlier has been demonstrated within the Canadian Appalachians. Anorthosites and syenites have been dated in the Grenville Province from Labrador to southern Quebec.

External and internal morphology of zircons from deformed granites in and out of shear zones have been used to provide information about magma origin and mode of emplacement. Irregular and discordant zoning are indicative of interference with crystallizing major minerals. Zircon resorption, regrowth and variations in uranium content have been related to the effects of migrating fluids in the deep crust.

Personnel Notes

A. Martineau resigned his technical position with the Geochronology Section to take a position with a local consulting firm.

R. Theriault joined the Section in the Fall as a term support geologist.

Field Activities

Geological mapping and sample collecting for U-Pb zircon geochronology in the Valhalla Gneiss Complex, southeast B.C.; R. Parrish with S. Carr.

Field excursion to southern Great Basin extensional tectonics; R. Parrish with W.B. Wernicke.

Samples collected for U-Pb zircon geochronology from:

Abitibi Belt, Quebec; J.M. Mortensen with R.I. Thorpe
J.M. Franklin.

Flin Flon area, Manitoba; P. Hunt with T.M. Gordon.

Killarney area, Ontario; O. van Breemen with A. Davidson.

Tinney Hills-Overby Lake (western half) map area (D. of Mackenzie); O. van Breemen with P.H. Thompson and N. Culshaw.

Attendance at Meetings, Conferences and Courses

P. Hunt

Geological Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

W.D. Loveridge

American Geophysical Union, Spring Meeting, Baltimore, Maryland, U.S.A., May.

A. Martineau

Spectra-Physics Training (H.P.L.C. Equipment), Department of Health and Welfare, Tunney's Pasture, Ottawa, January.

R. Parrish

Geological Society of America, Cordilleran Section, Meeting and Field Trip, Vancouver, British Columbia, May.

Cordilleran Roundup Show and Tell, Vancouver, British Columbia, January.

Cordilleran Tectonics Workshop, Vancouver, British Columbia, February.

Paleomagnetism Working Group, Annual Meeting, Pacific Geoscience Centre, Pat Bay, British Columbia, February.

F.B. Quigg

Radiation protection training, Atomic Energy of Canada, Chalk River, Ontario, February.

J.C. Roddick

NATO Workshop on Composition of the Archean Mantle, W. Germany, August.

Finnigan/MAT Users Group Meeting; Geological Society of America, Annual Meeting; Day course on "UNIX in Computer and Geological Applications", Orlando, Florida, U.S.A., October.

R.J.G. Seguin

Radiation protection training, Atomic Energy of Canada, Chalk River, Ontario, February.

R.W. Sullivan

Spectra-Physics Training (HPLC Equipment), Department of Health and Welfare, Tunney's Pasture, Ottawa, January.

O. van Breemen

Geological Society of America, Penrose Conference on "Terranes in the Circum-Atlantic Paleozoic Orogens", Halifax, Nova Scotia, May-June.

Membership on Committees

P. Hunt

GSC Christmas Party Committee.

A. Martineau

GSC Safety Committee

R. Parrish

Deep Seismic Southern Cordilleran Seismic Transect Interpretation Committee.

O. van Breemen

EG-ESS Evaluation Committee, Branch Member.

Special Talks and Lectures

R. Parrish

Extensional tectonics of the southern Omineca Belt, British Columbia", GSC, Vancouver, January; Pacific Geoscience Centre, Pat Bay, February; Precambrian High Series, GSC, Ottawa, February.

J.C. Roddick

"Kambalda Evolution - Pb Isotopic Constraints", NATO Workshop, West Germany, August.

O. van Breemen

"Current Research in U-Pb zircon geochronology", GSC Current Activities Forum, Ottawa, January.

Manuscripts Submitted

11 external publications, 4 GSC publications, 4 abstracts

Laboratory Statistics

Rb-Sr projects 11; samples analyzed 109.
K-Ar age determinations 83.
U-Pb zircon age projects 140; mineral fractions analyzed 422.
Trace lead analyses 34

PALEOMAGNETIC SECTION

W.F. Fahrig (Head)

Highlights

An "A" series map of the diabase dyke swarms of the Canadian Shield was prepared and published. The map provides an age classification for the swarms and is the first such map available for any of the world's shield areas. It compliments a group of papers presented by members of the paleomagnetic section at an International Mafic Dyke Swarm Symposium (Toronto, June, 1986). These papers will be published in a G.A.C. Special Paper along with 30 other papers dealing with mafic dyke swarms from around the world. The Section is involved in editing this volume. The hypothesis, and supporting evidence, that mafic dykes swarms are generally formed in a failed-arm environment during very early spreading was well received as were the various corollaries of this hypothesis.

Nipissing Diabase has long been known to carry two characteristic directions of remanent magnetization (N1 and N2). In paleomagnetic and petrographic study of Nipissing sills and associated rocks from the Englehart and New Liskeard areas, the following conclusions has been reached.

- (1) Nipissing Diabase carries a third characteristic magnetization (N3).
- (2) Although N1 and N3 occur at different sites in a relatively local area, they are never superimposed in the same site.
- (3) A positive baked contact test suggests that N3 is primary.
- (4) Both N1 and N3 are carried by 'fresh' gabbro.

Taken together, these results suggest that there are two or more distinct ages of Nipissing intrusion.

Superposition of two paleomagnetic components, at some sites, N2 and N3 in the Englehart and New Liskeard area, and N1 and N2 in the Gowganda area demonstrates that secondary overprinting has occurred in certain areas.

Personnel Notes

T. West joined the Section in the Fall as a term support geologist.

Attendance at Meetings, Conferences and Courses

K. Buchan and W.F. Fahrig

International Conference on Mafic Dyke Swarms, Erindale College, Mississauga, Ontario, June.

Membership on Committees

W.F. Fahrig

Ph.D. Committee - R. Ernst, Carleton University.

Special Talks and Lectures

K.L. Buchan

"Application of remanent magnetization in diabase dyke contact zones", International Conference on Mafic Dyke Swarms, Mississauga, Ontario, June.

W.F. Fahrig

"The tectonic settings of continental dyke swarms; failed arm and early passive margins", and "The geochemistry of the Mackenzie and Sudbury dyke swarms of the Canadian Shield", International Conference on Mafic Dyke Swarms, Mississauga, Ontario, June.

Manuscripts submitted

5 external publications, 5 abstracts.

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 transformation. Detailed field studies supply material for analysis and provide an opportunity for application of models worked out in the laboratory. The section includes laboratories for the study of rock-forming processes at high temperatures and pressures. The section has also taken responsibility for the bedrock mapping component of the federal-provincial mineral development agreements (MDA).

Highlights

The southern Long Range of Newfoundland consists of four terranes. From northwest to southeast these are Grenvillian basement, paragneisses migmatized and intruded by granite, a sheeted-dyke-gabbro-ultramafic terrane, and a migmatitic gneiss-megacrystic granite terrane. The paragneiss is marked by narrow (25 m) serpentinized ophiolite strips up to 50 km long. The findings suggest the Baie Verte-Brompton 'line' to be a diffuse zone at least 50 km wide in this region (van Berkel and Currie, Canada-Newfoundland MDA).

A regional study of Paleozoic granitic rocks of New Brunswick showed that about 80 percent consist of S type suites. There is little evidence for derivation along a destructive plate margin (e.g. Andean type). The plutons appear to be of several ages, rather than all of Devonian age as previously supposed. A-types and peralkaline granites, both with significant associated mineralization, appear to be much more common than previously supposed (Whalen, Canada-New Brunswick MDA).

Granitoid rocks on the eastern tip of Nova Scotia were intruded subsequent to regional deformation and metamorphism during late ductile dextral deformation which became progressively more brittle. The igneous rocks display a complex intrusion history ranging from biotite tonalite to late leucogranites (Hill, Visiting Fellow, Canada-Nova Scotia MDA).

The Atikonak River massif, southern Labrador is a major new anorthosite-rapakivi granite complex. Zircon dates on charnockitic rocks associated with anorthosite in the Grenville province yield apparent igneous ages from 1140 to 1350 Ma. High precision zircon ages from the Mistastin batholith indicate the span of crystallization time was about 12 Ma (Emslie).

Both the Hollow Fault and the Cobequid Fault bounding the Stellarton basin are dextral. The basin is therefore a classic pull-apart basin, and strata inside the basin are unlikely to have a significant extension outside. The basin developed in Westphalian C time and older sediment dispersal patterns are not affected by it (Yeo, Canada-Nova Scotia MDA).

A new model for the Huronian Cobalt Group of Ontario indicates progressive change from glacial conditions, through feldspathic sandstone deposited in a dry climate, and subsequently silicified by diagenesis, through sabkha-type environment to a shallow marine shelf. The model fits with conventional ideas for formation of sedimentary copper deposits of coastal type (Chandler).

Work in Manitoba and Saskatchewan under the MDA's has led to a stratigraphic division of the Kisseynew gneisses which permits correlation with the adjacent volcanic belts (Ashton). Low pressure metamorphism occurred on the north flank of the Kisseynew belt, with temperatures increasing to the southwest (Gordon and Jackson). Archean rocks in Manitoba exhibit an Hudsonian overprint, in some cases associated with mylonite zones separating blocks with different styles of deformation (Fueten). In the Lynn Lake belt of Manitoba volcanic belts can be recognized by metamorphic cordierite-anthophyllite and cordierite-sillimanite assemblages. Both assemblages contain sulphide mineralization (Froese and Barham). The Lynn Lake region exhibits two ages of plutonism, one dated (U/Pb) at 1871 Ma.

In the Bathurst camp of New Brunswick banded iron formation and red manganese slates are both structural markers, and both are associated with mineralization, but they are not lateral equivalents (van Staal).

Personnel Notes

T.M. Gordon has taken an exchange of work station to the Institute of Sedimentary and Petroleum Geology, Calgary, for 12 months.

M. Fyson, J. Langton and K. Wheatley joined the Section as term support geologists for the federal-provincial mineral development agreements.

Attendance at Meetings, Conferences and Courses

F.W. Chandler

Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

International Meeting, International Geological Correlation Program, Project 160, Ottawa, August.

Geological Survey of Canada/United States Geological Survey conference on resources assessment, Washington, U.S.A., September

Nova Scotia Department of Mines and Energy, Open House, Halifax, Nova Scotia, December.

K.L. Currie

Colloquium on Avalonian Terranes, sponsored by Atlantic Geoscience Society, Amherst, Nova Scotia, January.

T.M. Gordon

NATO Advanced Study Institute on Chemical Transport in Metasomatic Processes, Coutraki, Greece, June.

Manitoba Mineral Resources Division Meeting with Industry, Winnipeg, Manitoba, November.

J. Hill

Canadian Institute of Mining and Metallurgy Conference on Granite-Related Mineral Deposits, Halifax, Nova Scotia, September.

Nova Scotia Department of Mines and Energy Open House and Review of Activities, Halifax, Nova Scotia, November.

J.T. van Berkel

Newfoundland Department of Mines and Energy, Open House, St. John's, Newfoundland, November.

Canadian Tectonics Group, Annual Meeting, Halifax, Nova Scotia, November.

GSC Current Activities Forum, Ottawa, January.

C. van Staal

International Conference of Tectonic and Structural Processes, Utrecht, Netherlands, April.

Geological Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

J.B. Whalen

New Brunswick Department of Natural Resources, Minerals Division, Activities Forum and Poster Session, Fredericton, New Brunswick, November.

G. Yeo

Geological Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

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

Colloquium on Avalonian Terranes, sponsored by the Atlantic Geoscience Society, Amherst, Nova Scotia, January.

GSC Current Activities Forum, Ottawa, January.

Membership on Committees

F.W. Chandler

Geological Society of Canada, organizing committee for the 1986 annual meeting.

T.M. Gordon

Branch Computer Users Committee.

C. van Staal

Committee designing future research for Heath Steele project in New Brunswick, member.

G. Yeo

Atlantic Geoscience Society - Carboniferous Geology Research Group.

Special Talks and Lectures

F.W. Chandler

"Geology of the Early Aphebian copper and gold-bearing Gordon Lake formation", International Geological Correlation Program, Project 160 - Precambrian Exogenic Processes, Ottawa, August.

"Review of GSC participation in Nova Scotia ERDA program", Nova Scotia Department of Mines and Energy, Open House, December.

Informal Lecture on Copper Mineralization in Cobalt Group, to staff of Cogema, Canada Ltd., at Otish Mountains Exploration Camp, Otish Mountains, Quebec, August.

K.L. Currie

"The Avalonian terrane around St. John, New Brunswick", Colloquium on Avalonian Terranes, Amherst, Nova Scotia, January.

T.M. Gordon

Chairman's remarks at NATO Advanced Study Institute on Chemical Transport in Metasomatic Processes, Coutraki, Greece, June.

J.T. van Berkel

"Geology of the Southern Long Range, S.W. Newfoundland", Newfoundland Department of Mines and Energy, St. John's, Newfoundland, February.

C. van Staal

"Structural evolution of the Ordovician Tetagouche" Precambrian High Series, GSC, Ottawa, February.

"Deformation and metamorphism of the Tetagouche Group in the New Brunswick Mines area and its implications for the regional tectonic interpretations" and "Geologic setting and structural evolution of the Brunswick massive sulfide deposits", Geological Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

"Structural analysis of the New Brunswick Mines area", University of Ottawa, Ottawa, November.

G. Yeo

"Stellarton Basin: The Cobequid-Hollow Fault connection", Geological Association of Canada, Annual Meeting, Fredericton, New Brunswick, May.

"Evidence for late Carboniferous dextral movement on the Cobequid-Hollow Fault System and other finds: A progress report", Nova Scotia Department of Mines and Energy, Open House, Halifax, Nova Scotia, November.

"Late Carboniferous tectonics and sedimentation in Stellarton Gap, Nova Scotia", Atlantic Geoscience Society Colloquium, Amherst, Nova Scotia, January.

"Late Carboniferous dextral movement on the Cobequid-Hollow Fault System, Nova Scotia: Evidence and Implications for the Pictou coalfield", GSC Current Activities Forum, Ottawa, January.

Manuscripts submitted

31 GSC reports and papers, 12 external publications, 15 abstracts, 8 open file maps.

A.G. Darnley

This is the final annual report from the Resource Geophysics and Geochemistry Division. Henceforth work previously carried out under the RGG banner may be found in the new Mineral Resources, Geophysics, Terrain Science and Lithospheric and Canadian Shield Divisions. The demise of the division was somewhat unexpected, given the role it has played in introducing innovative rapid geoscientific survey methods on to the Canadian and world scene. The dissolution of RGG has occurred as part of the process of combining the Earth Physics Branch with GSC, effective April 1, 1986 and the decision to distribute the previously concentrated specialized talents amongst geological divisions in order to create multidisciplinary units.

RGG Division was established on January 1, 1972. It was noted at that time (in the GSC 1971-72 Annual Report) that the amalgamation of exploration geophysics and geochemistry reflected a "general trend in applied science towards mission-oriented rather than discipline-oriented research and development". The reorganization taking place in 1986 clearly represents one more step along this road.

The objectives of RGG Division, and the method of achieving them were set out in 1972 and remained essentially unchanged throughout its 14 year history. The results have been sufficiently successful to suggest that the methods should continue to be applied into the future. The purpose of the RGG Division has been "to set standards for and conduct systematic geophysical and geochemical surveys in Canada as an aid to both direct resource appraisal, and mapping and understanding the geology of Canada; to develop and test new geophysical and geochemical methods relevant to regional mapping, resource identification and assessment; to appraise existing methods; and to devise new methods of interpreting and integrating data. The work comprises three stages: research into new methods, and development of the most promising; experimental use and appraisal of the latter under carefully controlled conditions; formulation of specifications for routine application of the best new methods by industrial contractors, and monitoring of contractors' performance. The results of both the second and third stages are continuously fed back into the first so that ideas on new and old methods can be continuously revised."

Fourteen years can be considered a reasonable length of time over which to judge whether objectives have been met, and methods have been suitable. It is appropriate and may be instructive to review some of the achievements during this period, against the changing background of external events which have had a major influence, both positively and negatively. The period has been characterized by a slow decline, which began prior to 1972, in the level of support for ongoing (A-budget) activities, and hence on the ability to launch new lines of long-term research. Scientific knowledge is inherently a growth phenomenon and thrives best at times of economic expansion. The division's major developments in airborne geophysics, which came to full fruition during the period under review, had been initiated by major expenditures in the late 60's. Reconnaissance geochemistry, which required much smaller capital expenditures, began in 1972, as Operation Bear-Slave. Techniques developed in that large scale test survey were modified, and then became routine from 1974 onwards. Potential new developments that were deferred, or in some degree frustrated, by declining resources included the evaluation of TAGA (Trace

Atmospheric Gas Analyser) for airborne geochemistry, the optimization of radar for subsurface exploration, and the introduction of airborne resistivity mapping. In 1972 it might reasonably have been expected that by 1986 the primary aeromagnetic survey of all Canada's land areas would have been completed. Unfortunately that is not the case. Nevertheless there has been substantial progress.

Inevitably there is an element of subjectivity in making a short-list of achievements. The ensuing list gives priority to those achievements which required a substantial team effort, which were by no means certain winners at the time the activity began, and which have since received international commendation.

- the successful development, introduction and general acceptance of reconnaissance geochemical and airborne radiometric surveys as essential components of a national resource data-base.
- the successful development, introduction and general acceptance of the airborne magnetic vertical gradiometer as a detailed geophysical mapping tool.
- the establishment of quantitative standards and standardized procedures as the basis for systematic geoscientific surveys; international adoption of many of these standards and procedures.
- pioneering the introduction of computer-controlled colour plotting for geophysical and geochemical maps, combined with extensive experimentation as to methods of presentation.
- portrayal of the crustal structure of Canada by means of coloured magnetic anomaly maps.
- the development of the high-resolution shallow reflection seismic technique.
- completion of the Athabasca Project, a comprehensive multi-disciplinary investigation and documentation of exploration data pertaining to a major ore district.
- discovery of the Cosmos 954 satellite debris by in-flight recognition of its distinctive gamma-ray signature.

In addition to the above readily documented products there have been:

- substantial contributions to Canadian industry through the transfer of RGG-developed instrumentation and methodology in airborne, ground, borehole and marine geophysics and laboratory mensuration.
- essential support to the development and evaluation of new instrumentation devised by the geophysical and geochemical equipment industry.
- design and supervision of geoscientific aid projects in 12 countries.
- extensive participation in international co-operative R&D projects, most notably those relating to geophysics and geochemistry applied to uranium exploration, but also magnetism, engineering seismic methods, and analytical instrumentation.

- international recognition of GSC's expertise in a wide range of mineral exploration technology, especially airborne and borehole geophysics, and geochemical sampling and quality control.

RGG has focussed its main efforts on satisfying the needs of the mineral exploration industry. Undoubtedly the main impact of RGG has been through its map production. Aeromagnetic maps had been the top priority (and most used) product of the original Geophysics division for many years, although in terms of numbers produced these had been steadily declining from the peak year of 1964 (530,000 km² covered). In RGG the production trend continued downwards, from 230,000 km² surveyed in 1972 to 60,000 km² in 1984 due to steadily increasing costs, a budget which did not keep pace with inflation and a 50% cut in the aeromagnetic budget in 1978. There has been an abrupt (temporary?) reversal in 1985, to 270,000 km², made possible by supplementary funding from three special programs.

The opportunity to launch reconnaissance geochemical and radiometric surveys on a national basis was provided, fortuitously, by the 1973 Energy Crisis, which resulted in a proposal through the Provincial Mines Ministers Conference for a shared-cost Federal-Provincial Uranium Reconnaissance Program (URP), modelled on the earlier Federal-Provincial Aeromagnetic Program. The required techniques had already been developed and were ready and waiting for an opportunity to be applied. Through URP the four years 1975-78 permitted a great leap-forward in national geochemical data production. In 1974 URP received Ministerial approval as a 10 year program, but this did not prevent its termination for economic reasons at the end of FY 78-79. At the time of its cancellation, costs and production were on schedule, and a favourable review by a committee of the Canadian Geoscience Council had just been published.

URP funding supported the first extensive aeromagnetic gradiometer demonstration survey, the acquisition of the first Applicon computer-controlled colour-plotter in Canada (the second in North America), and the first radiometric borehole probe calibration facilities in Canada. Termination of URP was a major blow because URP was providing a much expanded geoscientific data base more directly targetted towards mineral resource assessment than pre-existing survey methods. In retrospect the name of the program should have been changed (to National Resource Reconnaissance) after the second year to reflect its multi-facetted application. Following its cancellation systematic surveys could only be continued at a substantially reduced level until the inauguration of a new series of Mineral Development agreements in 1983. Although these have permitted a significant increase in systematic survey production, (including extensive application of the gradiometer technique by contractors) they have been accompanied by a much increased administrative workload (relative to URP) due to a more complex management hierarchy. The practice whereby the Federal-Provincial Aeromagnetic and Uranium Reconnaissance Programs were planned and budgeted by direct discussion between the Division Chief and Provincial Chief Geologists made for relatively simple, flexible and fast execution of operations, although sometimes with the formal legal agreements, Treasury Board Approval and ministerial signatures following some distance behind.

Total map production during RGG's existence (1972-1986) has been as follows:

<u>Canada</u>	Aeromagnetic	3,319
	Radiometric	2,038
	Geochemical	1,799
	TOTAL	7,156
<u>Overseas (for CIDA)</u>	Aeromagnetic	1,501
	Radiometric	665
	TOTAL	2,166
	COMBINED TOTAL	9,322

This total includes maps at all scales from 1:20,000 to 1:5M, magnetic total field, vertical gradient, and magnetic anomaly maps, 7 gamma-ray spectrometer parameters and up to 15 geochemical elements. (A small number of AEM maps have been included under aeromagnetic total).

Quantitative maps, prepared according to predetermined specifications and standards, provide a data base of long-term if not permanent value, available for a wide variety of purposes, some of which may only become apparent in the light of subsequent discoveries or events.

It was recognized early in the history of the original Geophysics Division that it was quite impossible to satisfy industry's appetite for new maps and at the same time attempt to provide a comprehensive interpretation of the possible geological and economic significance of each map produced. Consequently only a tiny fraction of the maps produced have been interpreted in any detail. Life has been too short! The normal practice has been to provide selected examples of how data can be used, and to describe the principles and processes, and instrumentation involved, so that users will be encouraged to do their own interpretation. Thus, in 14 years the staff of RGG have completed approximately 1200 papers, ranging in size from R.W. Boyle's 584 page Bulletin on Geochemistry of Gold to numerous short (but sometimes highly significant) items in Current Research. The international impact of the work is underlined by the number of RGG publications that have been translated into Chinese.

In retrospect it has been an exciting 14 years, and the work of RGG Division has contributed in a substantial way to changing the types of output that are expected from forward-looking Geological Survey organizations. RGG has been more innovative and entrepreneurial than most government organizations are supposed to be, and I would like to place on record my appreciation of the part played by many present and past members of the Division for making this possible.

An expanded record of RGG total input and output has been prepared as a supplement to this Annual Report.

Attendance at Meetings, Conferences and Courses

A.G. Darnley

Meeting with petroleum industry consortium to discuss Orphan Knoll aeromagnetic survey, Calgary, April 22/23, May 9/10, 1985.

11th International Geochemical Exploration Symposium, Toronto, April 29 and May 2, 1985.

AECL Pinawa, Review of Underground Research Laboratory Program, May 21-23, 1985.

Thailand Mineral Resources Development Project, Project Review Meeting Bangkok, September 8-16, 1985 and January 26-February 4, 1986.

IAEA Meeting on Recognition of Uranium Provinces, London, U.K., September 18-20, 1985.

IMM Conference on High Heat Production Granites, Hydrothermal Circulation and Ore Genesis, St. Austell, U.K., September 22-25, 1985.

Airborne Resistivity Workshop, Ottawa, October 2-3, 1985.

IAEA Advisory Group on Uranium Exploration and Regional Evaluation, Vienna, Austria, October 14-17, 1985.

Joint Industry-Government Drilling Technology Meeting, Ottawa, October 23, 1985.

Ocean Drilling Project, Visit to Vessel, St. John's, Newfoundland, October 30, 1985.

Manitoba and Saskatchewan Provincial Open Houses, Winnipeg and Regina, November 20-21, 1985.

Dahlem Workshop on Resources and World Development, Berlin, January 12-17, 1986.

Prospectors and Developers Convention, Toronto, March 10-12, 1986.

Exploration '87 Organization Meetings, Toronto, May 14, August 22, 1985 and March 5, 1986.

Special Talks and Lectures

A.G. Darnley

"Geophysical and geochemical maps of the Athabasca and Elliot Lake regions". IAEA Meeting, London, U.K.

Chairman's Summary, Closing Discussion Session. IMM Meeting on High Heat Production Granites, St. Austell, U.K.

Opening Remarks, Airborne Resistivity Workshop, Ottawa.

"Resource for nuclear energy". Dahlem Conference, Berlin.

Membership on Committees

A.G. Darnley

Chairman, IAEA Consultants Advisory Group on Uranium Exploration and Regional Evaluation.

Member, Dahlem Workshop on Resources and World Development.

Member, Organizing Committee for Exploration '87.

Co-Chairman, Drilling Technology Workshop.

Member, Scientific Committee, International Meeting on Concentration Mechanisms of Uranium in Geological Environments, C.R.G.U., Nancy, France.

TECHNOLOGY TRANSFER

L.S. Collett

Canada is recognized internationally as a world leader in supplying geophysical instruments and services to the mining and related industries. With the pressures of foreign competition, support of this Canadian industry, is increasingly important.

For the Earth Science Sector, transfer of geophysical technology to industry has been an activity of RGG Division. Funding from the Program for Industry/Laboratory Projects (PILP) is the main support for this activity. Administered by the National Research Council, PILP is designed to assist Canadian companies with projects that take advantage of scientific and engineering knowledge and resources existing within government laboratories. Recently, PILP has been extended to include technology originating within Canadian universities.

During F.Y. 1985/86, seven Earth Science Sector PILP projects were in progress: seismic (4), gravity (1), audio magnetotelluric (1) and sub-penetrating radar (1); and two new projects were under development. Three other projects, supported by the NRC Industrial Research Assistance Program (IRAP) during the year, were related to development of a modular EM system, helicopter EM, and migration of hydrocarbons. NRC has changed the format of the large IRAP-P program to conform to the guidelines of the PILP program, and the IRAP program will continue whilst PILP will be phased out.

Advice is provided to the Natural Sciences and Engineering Research Council (NSERC) on research proposals from universities. Under the NSERC University-Industry Program, now known as Cooperative Research and Development Program (CRD), two projects were supported in the past year: development of piezoelectric exploration technique (UBC), and TURAM (U. of Calgary).

Advice and assistance has also been provided to Supply and Services Canada (Scientific Authority on one project), Formation de Chercheurs et d'Action Concertee (Quebec), AECL, Ontario Geological Survey's Exploration Technology Development Fund (Committee Chairman), the Canadian Electrical Association (Montreal), the Alberta Research Council and the Ontario Research Foundation. During the year numerous agencies, university members and industrial companies have sought information on the availability of government R&D grants.

REGIONAL GEOPHYSICS SUBDIVISION

P.J. Hood

The primary objective of the Regional Geophysics Subdivision is to improve the understanding of the geological framework of Canada and to facilitate mineral exploration and development programs by providing a regional framework of basic geophysical data. Emphasis is placed upon magnetic methods. The Subdivision develops new survey instrumentation and techniques, conducts experimental surveys, devises new techniques for the

computer treatment, presentation and interpretation of resultant data, prepares specifications for surveys execution, and supervises the publication of results. Geological interpretations of other results are provided to the extent possible with available staff. There are no personnel changes in 1985/86.

The Regional Geophysics Subdivision consists of four sections: Contract Aeromagnetic Surveys, Experimental Airborne Operations, Geophysical Data Processing and Magnetic Geophysical Interpretation.

Highlights

Contracted aeromagnetic surveys reached an all time peak in dollar value in FY 85/86. Seven more contracts were issued; two of these were funded under the Boundary Dispute program, one was a combined offshore aeromagnetic survey with five Calgary-based oil companies to survey a large area east of Newfoundland in the vicinity of the Orphan Knoll. The remaining four contracts were for aeromagnetic gradiometer surveys in Nova Scotia, New Brunswick, the Gaspé Peninsula of Quebec, Manitoba and Saskatchewan. The total line kilometrage flown in these surveys was 396,618 line kilometres.

A trigonal (three sensor) gradiometer system was installed on the GSC Queenair aircraft in the Spring of 1985 and test flown in the Carleton Place area which had been previously surveyed with the two-sensor gradiometer system. It is clear from the test survey results that measurable gradient signals in two directions, vertical and transverse can be measured simultaneously using a short-base system and that the required compensation for all three sensors can be achieved.

A total of 18 aeromagnetic maps were published during the fiscal year. These included seven 1:50,000 total

field, seven 1:50,000 vertical gradient, and four 1:1,000,000 magnetic anomaly maps in the National Earth Science Series. A coloured Applicon first draft of the nucleus of the Magnetic Anomaly Map of North America has been assembled for the DNAG project and was presented to the map committee at the SEG meeting in Washington in October 1985.

During the year seven more aeromagnetic contracts were issued to bring the total number of active contracts to seventeen. Of the new contracts, the largest was a 128,119 line km aeromagnetic survey of the Orphan Knoll offshore area east of Newfoundland carried out in co-operation with five Calgary-based oil companies led by Chevron. The survey was noteworthy as being the first aeromagnetic survey in the world in which the satellite-based Global Positioning System was utilized as a prime navigation aid. It was also carried out in the record time of 63 days. Two of the other new offshore surveys were funded under the Boundary Dispute program.

Approximately 4,560 line km were flown in northern Baffin Island to complete the 64,085 line km survey awarded to Geoterrex in 1984. The compilation of the maps is in the final stages and will be printed in the Summer of 1986.

The flying component of the 82,000 line km survey of the Beaufort Sea and northern Yukon awarded to Questor Surveys on February 12, 1985 was completed on September 29, 1985. The PCSP Decca navigation system was used over the water as the prime navigation aid; visual flight path recovery was utilized over land. The diurnal variation throughout the survey was generally quite active as would be expected due to its position with respect to the auroral zone. This has caused the quality of the aeromagnetic survey results to be degraded somewhat and this is also reflected in the smoothness of the contours on the resultant maps.

Contract Aeromagnetic Surveys

The status of contract aeromagnetic surveys is summarized in Table 1.

Table 1

<u>Contract</u>	<u>GSC Project</u>	<u>Type of Survey FW=Fixed Wing H=Helicopter</u>	<u>Contract Issued</u>	<u>Contractor</u>	<u>Kilometres flown in 1985/86</u>
N. Baffin Island	840040	FW-Single Sensor	5/4/84	Geoterrex	4,560
Beaufort Sea-N. Yukon	840074	FW-Single Sensor	12/2/85	Questor	56,255
Laurentian Channel	850060	FW-Single Sensor	12/7/85	Kenting	85,853
Orphan Knoll, Newfoundland	850065	FW-Single Sensor	4/7/85	Geoterrex/ Kenting	128,119
Queen Charlotte Is., B.C.	840067	FW-Single Sensor	11/6/85	Sander	35,730
Newfoundland, Victoria Lake	840073	FW-Gradiometer	17/12/84	Questor	9,172
Nova Scotia, Liverpool	840072	H-Gradiometer	18/12/84	GSi	0
Nova Scotia, Dalhousie	840072	H-Gradiometer	7/8/85	Aerodat	16,233
New Brunswick, Tétagouche River	840071	FW-Gradiometer	17/12/84	Questor	0
New Brunswick, Grand Falls	840071	H-Gradiometer	19/7/85	GSi	13,202
Quebec-Gaspé	840070	H-Gradiometer	21/9/84	GSi	0
Quebec-Gaspé	840070	H-Gradiometer	5/6/85	Sander	11,700
Quebec-E. Townships	840069	FW-Gradiometer	31/8/84	Kenting	0
Manitoba-Issett Lake	840068	FW-Gradiometer	18/9/84	Kenting	0
Manitoba-Sherridon-Moose L.	840068	FW-Gradiometer	24/9/85	Kenting	17,061
Saskatchewan-May Lake	840068	FW-Gradiometer	18/9/84	Kenting	0
Saskatchewan-Amisk Lake	840068	FW-Gradiometer	24/9/85	Kenting	18,787

					396,618

The Laurentian Channel survey south of Newfoundland was awarded to Kenting on July 12, 1985. The crash of one of the two Piper Navajo survey aircraft on July 21 resulted in the loss of 3 lives. The aircraft was replaced and on-site by August 26. This tragedy illustrates the need to utilize AGS contractors with substantial capabilities. The flying of this 85,853 line km survey was completed on September 27 using Loran C as the prime navigation aid.

Offshore Queen Charlotte Islands survey was awarded to Sander Geophysics on June 11, 1985. The 35,730 line km survey was completed on September 29 using Loran C as the prime navigation aid. Much of the resultant data collected has not met GSC specifications because of the substandard performance of the contractor's in-house designed magnetometer system, consequently much re-flying of the survey lines has been required.

The remaining four new surveys were aeromagnetic gradiometer surveys carried out under the Mineral Development Agreements in Nova Scotia, New Brunswick, the Gaspé Peninsula of Quebec and a combined survey in Manitoba and Saskatchewan and these are listed in Table 1. Only the latter survey was a fixed-wing vertical gradiometer survey; the other three surveys were carried out using helicopter-borne towed bird systems.

The aeromagnetic survey program experienced considerable difficulties in receiving delivery of acceptable final end products (printed contour maps and digital magnetic tapes) from the various contractors by the dates specified in the contracts. GSC inspectors have noted a marked decrease in the standard of excellence of aeromagnetic end products and much of the compilation work has had to be returned to the contractors for reworking of the data. This is due in part to the fact that the value of aeromagnetic survey contracts issued was at an all time high in FY 85/86 so in a number of cases the (aeromagnetic compilation) resources of the companies were strained. It was also due in part to the fact that a downsizing exercise has been carried out in most companies over the past two years with the consequent release of senior experienced personnel due to the demand for other types of (more profitable) airborne geophysics being minimal in the past several years. The prices bid on the aeromagnetic survey contracts are very competitive - much too competitive for a healthy industry. However but for the GSC aeromagnetic survey contracts it is apparent that a number of contractors would have gone bankrupt by now.

Queenair Aeromagnetic Gradiometer Project

The transverse and upper boom were installed on the Queenair aircraft in the spring of 1985 to produce a trigonal configuration. Three high sensitivity self orienting magnetometer systems and three nine-term CAE compensator systems were installed in the three booms. Several compensation flights were made to reduce the aircraft magnetic interference to a minimum value. Then from June 11 to June 25, a small, 348 line km, airborne survey was flown in the Carleton Place area using Ottawa, as the base of operations. The resultant data contained both vertical and transverse magnetic gradient information. It is clear from the data that gradient signals in two directions, vertical and transverse, can be measured using a short base gradiometer system and that it is possible to effectively compensate all three cesium-vapour magnetometer sensors to provide the sensitivity required.

The single lower boom, high sensitivity survey system, was then re-installed on the Queenair aircraft

after June 25 and carefully compensated for magnetic interference. Subsequently four high sensitivity surveys were flown using Loran C as the prime navigation aid with the exception of the first one where photo mosaics were used as follows:-

- a. Ontario profile lines (6,195 line km) based in Kapuskasing, Ontario for the levelling of the Magnetic Anomaly Map of Canada.
- b. Lake Erie (18,993 line km) based in Windsor, Ontario, the 1985 survey completes the aeromagnetic survey of Lake Erie.
- c. Lake Simcoe, Ontario (2,273 line km) based in Collingwood, Ontario.
- d. Georgian Bay, Ontario (21,842 line km) based in Collingwood, Ontario.

The total line km flown on survey by the GSC Queenair aircraft in 1985 was 41,500.

At the end of the survey season the aircraft and the flight crew returned to Ottawa. Instead of installing the new survey data acquisition package and test flying it, the Sonotek automatic compensation system was installed in the Queenair and flight tested numerous times. The results, although encouraging, were not as good as could be achieved with the CAE, 9 term compensator. The best figure of merit obtained for the Sonotek system was 1.14. The average figure of merit for the CAE system was 0.6. Further tests of the Sonotek automatic compensator system are scheduled for this coming spring after the manufacturer has made some improvements and modifications.

The new computer controlled data acquisition system is about 90% complete. Some improvements are being made to the chassis itself and a final card was redesigned. This modified card could not be completed in this reporting period because of financial difficulties in the division. The programs to operate the whole system have been written and bench tested with the system and found to be working properly.

Prior to the start of the 1985 field season a studio-quality video camera system with recorder and CRT monitor were installed in the Queenair aircraft for flight recovery purposes. Although a 35 mm flight path film camera was also operated, it is clear that the resolution of the video camera is sufficiently good for the purpose intended. Accordingly a decision has been made for the 1986 field season to dispense entirely with the 35 mm flight path film camera and utilize only the imagery recorded by the video camera.

The statistics for map products resulting from the Queenair project that were published during the year are given in Table 2.

Compilation of the 1984 surveys of Lake Ontario, the Lake of the Woods and the Albern area in B.C. and the 1985 survey of Lake Simcoe have been completed. The 1984 survey of Lake Ontario has been levelled.

In the compilation of the Queenair data, most of the digital aeromagnetic data compilation systems have now been converted from operation on the more expensive EMR Cyber computer to the new VAX 11-780 which is the computer commonly used throughout the airborne geophysical survey industry.

Table 2

<u>Maps Published</u>	<u>Scale</u>	<u>Total Field</u>	<u>Gradiometer</u>
1. Guysborough County, Nova Scotia	1:50,000	5	5
2. Buchans/Badger Area, Newfoundland	1:50,000	2	2
		--	--
TOTALS		7	7

Magnetic Anomaly Map of North America

Both the 1984 and 1985 tie line data obtained by the Queenair was utilized to adjust the magnetic anomaly data in south central Canada which appeared anomalously low. Digitizing and editing of the offshore areas in the Atlantic and Pacific Oceans received from J.R. Heirtzler, the coordinator on the North American Map Committee for marine data on January 30, 1985 is in progress under existing contracts. The Arctic data has been adjusted for tilt along the Davis Strait based on the tie line flown by the NAE Convair aircraft. The counterminous US and Alaska digital data has been received from the USGS and has been plotted along with the Canadian data to form the nucleus of the North American map around which all other data will be fitted.

Ocean Aeromagnetic Project

The tracing of the axial dyke system in the Nares Strait between Ellesmere and Greenland was continued in April 1985 using the NAE Convair aircraft and extended further south. Two tie lines were also flown between Newfoundland and the southern tip of Greenland to support the compilation of the Magnetic Anomaly of North America. Additional coverage was obtained across the southern part of the Greenland Ice Cap using funding supplied by the Geological Survey of Greenland.

The aeromagnetic tie line survey of the Caribbean commenced in November 1984 was completed in March 1986. A complete grid network now exists for the Caribbean which will be utilized in the compilation of the first and future editions of the Magnetic Anomaly Map of North America.

Magnetic Interpretation

John Broome continued his development of IBM-PC and VAX software for the presentation and interpretation of aeromagnetic data. He has developed a microcomputer-based workstation whose software includes a 2.5 dimensional modelling program, a colour display and enhancement program, and a shaded-relief program allowing real-time variation of the illumination direction.

An interpretation of the aeromagnetic vertical gradient maps in the Buchans area of Newfoundland by L.J. Kornik has revealed a complex structural pattern within the Topsails intrusions and intrusive features related to their intrusion into the surrounding volcanic rocks. L.J. Kornik carried out a month's field work in the Buchans area during July 1985 collecting geological data and samples to help in the geological interpretation of the aeromagnetic features present in these maps. The Topsails intrusion in the Buchans area is a high level granitic intrusion composed of many phases to the intrusion. Sub-aerial volcanic activity is abundant in the granitic intrusions.

The interpretation of aeromagnetic data in the Abitibi greenstone belt indicates that the greenstones (folded metamorphosed volcanics and sediments) reach their greatest depth (13 km ±) in the southern part of the belt with exposed granite batholiths down to nearly 10 km (from gravity). The great Abitibi dyke extends to at least the bottom of the greenstone sequence. These results were presented by E.J. Schwarz at the Canadian Geophysical Union Annual Meeting in Calgary and the Mafic Dyke Conference in Toronto.

Asbestos Initiatives Program - Eastern Townships, Quebec

The results of a reconnaissance IP survey near Sutton were open filed (OF 1151). A large in-strike conductivity anomaly was found while testing Hadrynian sediments in which pockets of metallic sulphides were known to occur.

Attendances at Meetings, Conferences and Courses

J. Broome

Attended Remote Sensing for Exploration Geology Conference in San Francisco in April 1985 and exhibited examples of enhanced aeromagnetic maps at a poster session.

Attended the Computer Applications in Mining Exploration Meeting in Toronto from January 13-15, 1986 and the GSC Forum in Ottawa and demonstrated his microcomputer-based data presentation and interpretation workstation. A poster session showing enhanced aeromagnetic and radiometric data from eastern Nova Scotia was also presented at the two meetings.

S.D. Dods

Attended the following conferences NCGA exposition in Dallas, Texas from April 15-18, 1985; Computer Applications in Mining Exploration in Toronto from January 13-15, 1986, the GSC Forum in Ottawa from January 22-24, 1986.

P.J. Hood

Attended the annual GAC meeting in Fredericton, New Brunswick from May 15-17, 1985. With S.J. Haynes presented a paper entitled "Application of airborne gradiometry to gold exploration, eastern Nova Scotia".

Attended the IAGA meeting in Prague, Czechoslovakia from August 4-17, 1985. Presented three papers at the meeting. The first paper co-authored with D.J. Teskey was entitled "Use of the IGRF in the production of Canadian magnetic anomaly maps". The

Special Talks and Lectures

J. Broome

Presented introductory geophysics lecture with K.L. Ford for 4th year remote sensing course at Carleton University on aeromagnetic interpretation.

P.J. Hood

Presented a talk at the Ministry of Metallurgical Industries, Peking, China on October 19 entitled "State of the art in mining geophysics".

Presented the following series of lectures to the Geophysical Prospecting Company in Baoding, Hebei Province, China

October 22: Trends and developments in mining geophysics.

October 24: Airborne geophysical surveying in rugged terrain.

October 25: Aeromagnetic gradiometry.

October 26: Geophysical prospecting for gold.

Presented a public lecture at the Department of Mineral Resources, Bangkok, Thailand on November 19 entitled "Airborne geophysical surveys: their practical application in Canada and Thailand to mineral exploration".

Memberships on Committees

P.J. Hood

Co-Chairman, Magnetic Anomaly Map of North America Committee, DNAG Project, Geological Society of America.

Chairman, Working Group I-4 (Magnetic Anomalies - Land and Sea), Division 1, International Association of Geomagnetism and Aeronomy.

E.J. Schwarz

Associate Editor, Geoscience Canada.

Professeur Invite de Geophysique Appliquee, Ecole Polytechnique de Montreal.

D.J. Teskey

Associate Member, Magnetic Anomaly Map of North America Committee, DNAG Project, Geological Society of America and Co-Chairman of its Magnetic Data Exchange Format Subcommittee.

Subdivision Productivity

18 Aeromagnetic Maps
7 Outside Publications
12 Abstracts of Formal Talks
1 Open File
6 Poster Sessions

second co-authored with Margaret Bower and D.J. Teskey was entitled "Displacement along the Nares Strait: evidence from low-level aeromagnetic survey data". The third paper co-authored with D.J. Teskey was entitled "Long wavelength magnetic anomalies of the Canadian Precambrian Shield". As Chairman of Working Group I-4 - Magnetic Anomalies (Land and Sea), P.J. Hood presented his committee's report at the Reporter Review session. Working Group I-4 are sponsoring two symposia at the 1987 IUGG meeting in Vancouver.

Attended the SEG meeting in Washington, DC from October 6-10, 1984 and co-convoked a meeting of the Committee for the Magnetic Anomaly Map of North America.

Attended the GSC Forum in Ottawa from January 22-24, 1986. Presented a paper co-authored with D.J. Teskey entitled "Helicopter-borne aeromagnetic gradiometer surveys: a progress report".

E.J. Schwarz

Attended the CSEG meeting in Calgary, Alberta from May 7-10, 1985. Presented two papers; the first was co-authored with L. Losier and was entitled "Interpretation of geophysical data for the Abitibi Greenstone Belt". The second paper presented was co-authored with B.S. Daudier and was entitled "An iterative system for the inversion of magnetic and gravity data over layered structures".

Attended the International Conference on Mafic Dykes Swarms at the Erindale Campus in Mississauga from June 4-7, 1985. Presented two papers; the first was co-authored with P.J. Hood and D.J. Teskey entitled "Magnetic expression of Canadian diabase dykes". The second paper presented was co-authored with K.L. Buchan and was entitled "Applications of remanent magnetization in dyke contact zones".

D.J. Teskey

Attended the International Meeting on Potential Fields in Rugged Topography in Lausanne, Switzerland from July 30 to August 2, 1985. Presented two papers co-authored with P.J. Hood entitled "Aeromagnetic gradiometer surveys in mountainous terrain" and "Regional aeromagnetic surveys of mountainous terrain".

Attended the SEG meeting in Washington, DC from October 6-10, 1985. Attended the committee meeting for the Magnetic Anomaly Map of North America.

Attended the Computer Applications in Mining Exploration Meeting in Toronto from January 13-15, 1985 to present a poster session displaying end products from the aeromagnetic survey program.

Attended the GSC Forum in Ottawa from January 22-24, 1985 and presented (with S.D. Dods) a poster session displaying the new coloured pixel magnetic anomaly map of Canada at the 1:2,500,000 scale.

Attended the ISPG Forum in Calgary in February 1986 to display the new pixel version of the 1:5,000,000 Magnetic Anomaly Map of Canada. The same map was also displayed at the Forum in Vancouver in January and at the Prospectors and Developers Meeting in Toronto in March 1986.

RESOURCE GEOCHEMISTRY SUBDIVISION

E.H.W. Hornbrook

The objective of this Subdivision is to undertake research, develop, apply and evaluate methods of geochemical exploration for a variety of purposes; systematic data are gathered from a variety of sampling media and analytical techniques in order to assist the mineral exploration industry, government assessment of resources, and general geological mapping. Many of the data are also relevant to topical environmental and health problems. These data gathering activities are complemented by research on geochemical processes; by development of new methods of mineral exploration and resource appraisal; by study of new analytical techniques and geochemical instrumentation; and by software development to facilitate interpretation.

Highlights

The Subdivision was involved in Federal-Provincial Mineral Development Agreements with Newfoundland, Nova Scotia, New Brunswick, Ontario, Manitoba, Saskatchewan and the Yukon Territory. Regional geochemical surveys were carried out in all provinces and the Yukon except Ontario where the involvement was in the planning of the 4-year geochemical program. Joint regional surveys were also carried out in British Columbia under "Joint Letters of Agreement". All 1985 regional geochemical data will be published in open file releases early in fiscal 1986/87. Orientation and follow-up geochemical studies were carried out in Newfoundland (Labrador), Nova Scotia, New Brunswick, Manitoba and Saskatchewan and results are being released in various papers, posters and oral presentations.

Early in 1985 the results of 1984 regional geochemical surveys were released in 8 Open Files comprising 150 geochemical maps. The release of the gold data in Saskatchewan, the first regional scale gold release, led to a staking rush in the La Ronge - Reindeer Lake - Flin Flon area. Regional geochemical surveys are carried out by E.H. Hornbrook, P.W.B. Friske, J.J. Lynch, N.G. Lund, A. Galletta, B. Elliott and M. McCurdy.

Preliminary litho-geochemical and petrographic studies by S.B. Ballantyne of lode gold deposits and their associated gold placers in the Atlin Terrane of British Columbia have identified the distinctive elemental associations of Au, Bi, Sb, Te and As which also occurs in the adjacent Whitehorse trough. Since the epithermal-mesothermal gold mineralization has a definite structural affinity, it is suggested that this elemental assemblage transcends terrane boundaries due to extensional strain tectonics.

A cost effective method of installing groundwater piezometers during reverse circulation and casing advancement overburden drilling has been developed by Dr. D.R. Boyle. The first application will be on the joint GSC - ESSO Minerals research program for gold exploration in heavy drift covered areas of northern Quebec.

By studies at a number of deposits, Dr. E.M. Cameron has shown that major Archean gold mineralization is derived from oxidized magmatic-hydrothermal fluids. Areas that may contain gold mineralization may now be recognized by the mineralogy of granitic rocks that reflect crystallization from an oxidized melt.

W. Dyck's initial studies have shown that He and Rn determinations in sea water show a slight increase in the vicinity of hydrothermal sea floor vents. With increased Rn sensitivity and precision, He and Rn have the potential for successful detection of hydrothermal vents in seafloor studies. The portable He analyser under development by AlphaNUCLEAR was not completed on schedule due to design problems.

The automated procedure for catchment basin analysis and production of stream sediment geochemical leaf-maps to provide for advanced level interpretation has been completed and published by D.J. Ellwood.

Improved data analysis techniques (statistical models, computer aided drafting) were integrated into the "IDEAS" program by Dr. R.G. Garrett with the help of a Co-op student.

Four members of the Subdivision have participated on cruises off the west coast for the Seafloor Hydrothermal Program. During Dr. W.D. Goodfellow's cruise on the Parizeau to Juan de Fuca ridge, a significant discovery of sulphides was made while sampling a large (60 m high by 400 m wide) mound above 300 - 400 m of pelagic sediments. This setting is unique with respect to other ocean bed discoveries due to the bedded character of the sulphides and location in a sedimentary environment.

A secondary zinc deposit in the Selwyn Basin, at present unknown to the mineral exploration industry, that is similar to the secondary zinc zone overlying the Howards Pass Pb-Zn deposit was discovered and confirmed by Dr. W.D. Goodfellow during geochemical follow-up studies.

A number of highlights have been achieved by G.E.M. Hall and the staff of the geochemical analytical laboratories. These would include:

The Sciex Elan Inductively Coupled Plasma - Mass Spectrometer, acquired in March 1985, is fully operational. Methods have been developed by Dr. D.C. Gregoire for the determination of boron and boron isotope ratios in a variety of sample types. To date, boron concentration and isotope ratios have been obtained for tourmalines, coemanites, gypsum, anhydrite, conodonts, ashed plant material, hydrothermal vent and sea waters and sulphidic core samples obtained in the vicinity of undersea hydrothermal vents.

On the recently acquired Inductively Coupled Plasma - Emission Spectrometer a new method to determine boron in solids (and water) has been put into routine production and has been extended to include Mo, W, V and Cr in selected samples.

The detection limit for Mo and W in rocks, soils and sediments has been lowered from 2 - 5 $\mu\text{g g}^{-1}$ to 0.1 $\mu\text{g g}^{-1}$ by a novel separation technique followed by measurement by ICP - mass spectrometry. The application of the electrothermal vapouriser, designed by Dr. Chang Park, is and will have dramatic impact on lowering detection limits by the ICP-MS.

The determination of As, Sb, Se, Te and Bi in sulphide-bearing samples has been improved to eliminate interferences in the hydride/AA measurement by a separation procedure using $\text{La}(\text{OH})_3$. Detection limits are in the range 0.1 - 0.4 $\mu\text{g g}^{-1}$.

Tin has now been measured to 0.2 $\mu\text{g g}^{-1}$ dry weight in vegetation samples by hydride/AA.

In October, 1985, sulphide mounds with attendant stringer and hydrothermal alteration pipe were observed for the first time in a modern ocean floor environment. The occasion was an international expedition, in which Dr. I.R. Jonasson participated, using Atlantis II and the submersible ALVIN, to the Galapagos Rift Zone. The cruise was a joint NOAA - GSC - Universities venture. The find is most significant in that it permits ocean ridge deposits to be studied multidimensionally and offers an excellent opportunity to investigate the nature of ore-forming fluids and their interactions with host rocks.

Two of the three International Geochemical Reference Standards (stream and lake sediments) produced by J.J. Lynch are in the process of evaluation of characterization data while the third standard (soils) is collected and 50% prepared and bottled.

Several new auriferous regions were discovered by surveys under the direction of Dr. Y.T. Maurice in the Eastern Townships, including an area to the north of Thetford Mines and one to the east of Lac Megantic. Gold was found to be distributed in long narrow dispersal trains, in some cases over 100 km long, parallel to the direction of glaciation.

Personnel Notes

The retirement of Dr. R.W. Boyle on May 31, 1985 marks the end of a special era for geochemistry at the Geological Survey that began with his employment in 1952. Dr. Boyle has played a key role in the development and acceptance of principles of geochemical exploration not only in Canada but throughout the world. His legacy to the Subdivision is to maintain the high quality of work in geochemical research and methodology development that he did throughout his career.

H.R. Schmitt joined the Subdivision as a Mineral Agreement Survey geochemist for the duration of the Federal-Provincial Agreements. Rolf, who obtained his BSc in geology and MSc in resource management from UBC, has had several years experience in industry and with the British Columbia Ministry of Energy, Mines and Petroleum Resources. His initial assignments at the GSC will include supervision and monitoring of regional stream and lake surveys and orientation studies on gold in the surficial environment.

Dr. C.E. Dunn joined the Subdivision as a Research Scientist in December, 1985 to undertake R & D efforts focussing on the development and application of biogeochemistry to the exploration for mineral resources. Colin, who obtained his doctorate in geology/geochemistry from London University in 1972, joined the Saskatchewan Geological Survey working on sedimentological and stratigraphic problems before returning to geochemical studies in the mid-seventies. His experience in biogeochemical research and recent gold studies will be of benefit to the Subdivision.

Dr. N. de Silva joined Resource Geochemistry Subdivision as an analytical chemist in February. He obtained his PhD in analytical chemistry from the Trace Analysis Research Centre, Dalhousie University, Halifax in 1981. Before joining GSC, he was working as a Research Associate at the Atlantic Regional Laboratory of National Research Council of Canada. Nimal's R & D efforts will be focussed mainly on the development of automated preconcentration and solvent extraction methods for water analysis and the sample introduction aspects in analytical spectroscopy.

Dr. Chang Park joined the Geochemistry Laboratories Section of the Resource Geochemistry Subdivision on a Visiting Fellowship in October. Chang recently received his doctorate from the University of Toronto, Aerospace Institute, where he studied the instrumental design of an inductively-coupled plasma-mass spectrometer (ICP-MS). At the GSC, Chang will continue development and application of his thesis subject, electrothermal vapourisation coupled to the ICP-MS or the "Elan" as it is now known by its commercial manufacturer, Sciex, Ontario.

Dr. Y.T. Maurice remains seconded for most of his time to the Director General's office as coordinator of the GSC's participation in the Gaspé - Lower St. Lawrence Development Plan.

Attendance at Meetings, Conferences and Courses

S.B. Ballantyne

11th International Geochemical Exploration Symposium, Toronto, May 1985.

CIM Geology Division Granite-Related Mineral Deposits - Geology, Petrogenesis and Tectonic Setting Symposium, Halifax, September 1985.

Cordilleran Geology and Exploration Round-up, Vancouver, January 1985.

54th Annual Prospectors and Developers Association Annual Meeting, Toronto, March 1985.

D.R. Boyle

GAC Newfoundland Branch Meeting on Hydrology and Mineral Deposits, St. Johns, March - April 1985.

Concentration Mechanisms of Uranium in Geological Environments Conference, Nancy, France, October 1985.

E.M. Cameron

11th International Geochemical Exploration Symposium, Toronto, May 1985.

GAC Annual Meeting, Fredericton, May 1985.

Isotopes in the Sedimentary Cycle Conference, Obernai, France, July 1985.

W. Dyck

11th International Geochemical Exploration Symposium, Toronto, May 1985.

D.J. Ellwood

Computer Applications in Mineral Exploration, 1986, Toronto, January 1986.

P.W.B. Friske

11th International Geochemical Exploration Symposium, Toronto, May 1985.

Review of Activities (1985), Department of Forests, Mines and Energy, Province of New Brunswick, Fredericton, November 1985.

Geoscience Research Seminar and Open House '85, Ontario Geological Survey, Toronto, December 1985.

R.G. Garrett

11th International Geochemical Exploration Symposium, Toronto, May 1985.

Commonwealth Science Council Training Workshop on Geochemical Exploration in Tropical Terrains, Kingston, Jamaica, July 1985.

Joint GSC-USGS Workshop on Prospects for Mineral Resource Assessment in 1985, Leesburg, Virginia, September 1985.

W.D. Goodfellow

The Genesis of Stratiform Sediment-Hosted Pb-Zn Deposits, Stanford University, Palo Alto, California, June 1985.

Isotopes in the Sedimentary Cycle, Strasbourg, France, July 1985.

Current Activities Forum, GSC, Ottawa, January 1986.

A Symposium on the Juan de Fuca Ridge System, GAC Vancouver, March 1986.

Joint GSC-USGS Working Group on Offshore Studies Field Trip to Massive Sulphide Deposits in Newfoundland, May 1985.

D.C. Gregoire

27th Rocky Mountain Conference on Spectroscopy, Denver, Colorado, July 1985.

Spectroscopy Society of Canada Workshop on Applications of Inductively Coupled Plasma - Mass Spectrometry, Toronto, October 1985.

G.E.M. Hall

11th International Geochemical Exploration Symposium, Toronto, May 1985.

12th Annual Meeting of the Federation of Analytical Chemistry and Spectroscopy Societies, Philadelphia, PA, October 1985.

E.H.W. Hornbrook

11th International Geochemical Exploration Symposium, Toronto, May 1985.

International Symposium on Acidic Precipitation; Muskoka, September 1985.

Geoscience Seminar and Open House '85, Ontario Geological Survey, Toronto, December 1985.

Current Activities Forum, GSC, Ottawa, January 1986.

I.R. Jonasson

International Volcanological Congress, Auckland, New Zealand, February 1986.

J.J. Lynch

Computer Applications in Mineral Exploration, Toronto, January 1986.

Y.T. Maurice

Seminaire d'Information sur les Activités du Ministère de l'Énergie et des Ressources, Quebec City, November 1985.

Current Activities Forum, GSC, Ottawa, January 1986.

H.R. Schmitt

Gold in the Western Shield Symposium, Saskatoon, September 1985.

Manitoba Geoscience Forum, Winnipeg, November 1985.

Saskatchewan Geoscience Forum, Regina, November 1985.

Memberships on Committees

S.B. Ballantyne

Chairman, Technical Session, 11th International Geochemical Exploration Symposium.

C.E. Dunn

Associate Editor, Bulletin of Canadian Petroleum Geology.

Associate Editor, Applied Geochemistry.

Reviewer, Journal of Geochemical Exploration.

D.J. Ellwood

Member, Departmental Computer Users Committee.

R.G. Garrett

Co-chairman (Program), 11th International Geochemical Exploration Symposium.

Councillor, Association of Exploration Geochemists.

Member, Editorial Board, Journal of Geochemical Exploration.

Member, Organizing Committee for Exploration '87, Toronto.

Secretary-Treasurer (past, 1984-86), COGEO DATA.

W.D. Goodfellow

Councillor, Association of Exploration Geochemists.

Chairman, Two Technical Sessions, 11th International Geochemical Exploration Symposium.

Member, IGCP number 119, "Rare Events in Geology".

G.E.M. Hall

GSC Representative, Management Committee of the Ottawa - Carleton - GSC Shared Isotope Facility.

E.H.W. Hornbrook

Chairman, Technical Session, 11th International Geochemical Exploration Symposium.

I.R. Jonasson

Member, Research Scientist Executive Committee.

J.J. Lynch

Member, ad hoc Committee to Consider Baillie Report.

Y.T. Maurice

Member, Executive Committee for the Gaspé - Lower St. Lawrence Development Plan.

Member, Board of Directors of the Mineral Exploration Research Institute in Montreal.

Special Talks and Lectures

D.R. Boyle

"Groundwaters - Their Role in the Formation and Discovery of Mineral Deposits". Paper presented at the GAC Newfoundland Branch Meeting on Hydrology and Mineral Deposits, St. John's, March 1985.

"Precipitating Mechanism for Saleeite-Autunite-Ningyoite Mineralization in Sedimentary Host Rocks". Paper presented at the Concentration Mechanisms of Uranium in Geological Environments Conference, Nancy, France, October 1985.

E.M. Cameron

"Archean Gold Mineralization and the Sulphide Cycle". Paper presented at the GAC Annual Meeting, Fredericton, May 1985.

"Occurrence and Geochemistry of Anhydrite in the Hemlo Basin". Paper presented at the GAC Annual Meeting, Fredericton, May 1985.

"Pyrite of Distinctive Isotopic Composition Associated with the Hemlo Gold Mineralization". Paper presented at the 11th International Geochemical Exploration Symposium, Toronto, May 1985.

"An Unusual Sulphate-Rich Greenstone in the Archean of the Canadian Shield". Paper presented at the Isotopes in the Sedimentary Cycle Conference, Obernai, France, July 1985.

"Archean Sulphur Cycle". Special talk given at University of Ottawa, Ottawa, October 1985.

C.E. Dunn

"Gold and Other Metals in the Vegetation of Canada's Northern Forests: Exploration Clues". Special talk given at Carleton University, Ottawa, January 1986.

R.G. Garrett

"Field Sampling Designs and Procedures" and "Management, Analysis and Display of Geochemical Data". Special talks given at the Commonwealth Science Council Training Workshop on Geochemical Exploration in Tropical Terrains, Kingston, Jamaica, July 1985.

"Geochemical Abundance Models: An Update 1975 to 1984". Special talk given at the Joint GSC-USGS Workshop on Prospects for Mineral Resource Assessment in 1985, Leesburg, Virginia, September 1985.

"Regional Geochemical Surveys in Canada, Brasil and Thailand". Special talk given at a Seminar, Geological Department, University of West Indies, Mona, Jamaica, January 1986.

W.D. Goodfellow

"Geology and Geochemistry of the Howards Pass Pb-Zn Deposits, Yukon: Constraints on Metal Source, Transportation and Concentration". Paper presented at the Genesis of Stratiform Sediment-Hosted Pb-Zn Deposits, Stanford University, June 1985.

"Stratified Oceans Discerned by $\delta^{34}\text{S}$ Secular Trends: Implications for the Formation and Preservation of Sedimentary Pb-Zn Deposits". Paper presented at the Isotopes in the Sedimentary Cycle Symposium, Strasbourg, France, July 1985.

"Anoxic Oceans and Stratified Sulphide Deposits, Selwyn Basin, Yukon and N.W.T.". Special talk given at the USGS, Reston, Virginia, November 1985.

"Evidence for the Bolide Impact at the Frasnian - Famennian Boundary". Special talk given at the USGS, Reston, Virginia, November 1985.

"Massive Sulphides Discovered in a Sedimented Rift Valley Northern Juan de Fuca Ridge: Geological Setting, Mineralogy and Geochemistry". Paper presented at Geoscience Activities Forum, GSC, Ottawa, January 1986.

"Mineralogy and Geochemistry of Sulphide Discovered in Middle Valley, Northern Juan de Fuca Ridge". Special talk given at the Friends of Juan de Fuca Organizational meeting, Vancouver, March 1986.

D.C. Gregoire

"The Determination of Boron Isotope Ratios in Geological Materials by Inductively-Coupled-Plasma Mass Spectrometry". Paper presented at the Spectroscopy Society of Canada Workshop on Applications of Inductively Coupled Plasma - Mass Spectrometry, Toronto, October 1985.

"Metallogenesis and Anoxic Basins". Special talk given at Melbourne University, Melbourne, Australia, February 1986.

"Géochimie des Minéraux Lourds en Estrie". Paper presented at the Séminaire d'Information sur les Activités de la Direction Générale de l'Exploration Géologique et Minière du Ministère de l'Énergie et des Ressources, Québec City, November 1985.

Subdivision Productivity

21	Outside Publications
7	GSC Papers
13	Abstracts for Formal Talks
17	Open Files
	8 OF @ 250,000 scale, 145 maps, 149,300 km ²
	2 OF no maps
	10 OF @ 50,000 scale, 150 maps, 8,700 km ²
17	Poster Sessions
11	Oral Presentations

RESOURCE GEOPHYSICS SUBDIVISION

K.A. Richardson

The objective of the Resource Geophysics Subdivision is the development, demonstration, and evaluation of nuclear, electrical and seismic methods of geophysics, and the application of these methods to mineral exploration, geologic mapping and engineering geology, in airborne, surface, borehole and marine environments.

The Subdivision develops new instrumentation both inhouse and in cooperation with industry, and devises new techniques for more efficient acquisition and interpretation of field data. Experimental surveys are conducted to demonstrate new developments and their application. Calibration facilities are designed, constructed and maintained for use by industry, academic and government agencies; advice is provided to users of the facilities in order to improve the standardization of geophysical measurements.

The Resource Geophysics Subdivision consists of five sections: Radiation Geophysics, Borehole Geophysics, Terrain Geophysics, Instrumentation R & D, and Technical Services, and a Special Projects Group that supports new technology development and nuclear fuel waste management programs.

Highlights

Airborne geophysical operations were primarily directed toward Mineral Development Agreements in Nova Scotia, New Brunswick and Newfoundland. Approximately 34,000 line km of gamma-ray, VLF-EM and magnetic data were acquired. Development work on the presentation of 3-component radioelement maps and VLF data continued; the first 1:5,000,000 scale radioactivity map of Canada was completed and shown at the Current Activities Forum in January '86; publication of colour radioelement maps began with eight 1:50,000 sheets from northern Labrador. A total of 136 geophysical series maps was completed for publication during the year.

In March '86, in cooperation with Environment Canada, U.S. Atmospheric Environment Service and Army Corps of Engineers, a gamma-ray survey of the Lake Superior Basin was flown, to measure snow water equivalent for control of water level in the lake.

Engineering work on design of wing tanks for Skyvan, to extend aircraft range from 4 hours to 6 1/2 hours, was completed. This will permit the aircraft (when construction and installation are complete in '87 or '88) to survey areas with increased efficiency. Update of the data acquisition system for the Skyvan (and same system for borehole logging truck) was nearly completed, for testing in logging truck in summer '86.

R.L. Grasty spent 1 month in England working with Hunting Geology & Geophysics, using data collected on a United Nations project in Malawi, and successfully developed a new method for correcting airborne gamma ray data for atmospheric radioactivity. This will be particularly useful to Canadian contractors on foreign contracts (such as Thailand) where extreme background variations occur, and there are insufficient lakes for monitoring these changes.

As a result of follow-up work on radioactive anomalies delineated by GSC's airborne survey programs visible gold has been found in specimen material collected last summer by RGG staff in the District of Keewatin. Some claim staking has recently taken place in this area after it was outlined as potentially gold bearing at the 1985 GSC Current Activities Forum. The new information was subsequently published in GSC Current Research. Under the Nova Scotia MDA, follow-up of gamma ray surveys in the Musquodoboit area delineated various phases of the composite granitic terrane to the use of radioelement distribution maps as a guide to the concentration of tin, tungsten, and beryllium associated with granites.

In October GSC held a Workshop on Airborne Resistivity Mapping which was attended by 143 people from 15 countries. The workshop investigated the state-of-the-art and explored new applications of AEM in a time of industry distress. Plans for application of airborne EM to overburden mapping on the Ontario MDA (86/87) were developed, and ground electrical measurements were made over a new EM calibration/test range in the Val Gagne area.

Borehole logging experiments with IP and resistivity techniques tested a series of different electrode materials and logging parameters. Gamma-gamma density logging was applied successfully at Larder Lake, to distinguish conductors that are due to clay, graphite, and gold-sulphide deposits.

A new gamma-gamma spectral logging probe was finally completed and delivered by AECL, and testing began to determine optimum operating parameters for this new logging technique which is aimed at developing a method for in-situ assaying.

Under the Newfoundland MDA a suite of logging techniques was applied at the Daniels Harbour (Newfoundland Zinc Co.) property as an aid to future exploration and development work.

Major progress was made on installation of calibration facilities for coal density logging on the ISPG site in Calgary. Site problems prevented completion of the operation before freeze-up; finishing of the Calgary facility and final landscaping of the similar Dartmouth facility will be done in 1986.

A requirement arose in the Radwaste program to measure diffusion coefficients of rock core samples by recording changes in ion content at one end of a sample due to diffusion through it of ions from a solution in contact with the other end. Each measurement requires weeks for completion. A unique microprocessor controlled data acquisition system was designed by the Instrumentation R&D Section (C. Gauvreau) which records data from multiple sensors, allowing several experiments to be run simultaneously, and stores data in non-volatile bubble memory. Extensive software was developed to provide rapid computation of diffusion coefficients and computer generated plotting of the results. AECL are seeking an arrangement for their use of the design.

Seismic reflection work was carried out on the Arctic Ice Island project; 70 km of data were acquired, providing information on the sedimentary section of the Arctic coastal plain off Narsen Sound. On the ice in Loughheed Basin area, 3 km of data were acquired to map near seabottom structure of unconsolidated materials, in cooperation with AGC's NOGAP program.

Under the Nova Scotia MDA 120 km of marine multichannel seismic data were recorded off the west coast of Cape Breton to map structure of coal bearing sedimentary formations, and 12 km of data were obtained to test the method in the Cumberland Basin. Excellent results were obtained in both of these investigations.

Shallow seismic reflection tests near Matheson, Ontario, in cooperation with OGS, were directed toward overburden mapping, combined with geochemical sampling for gold prospecting; and experiments in the Fraser Delta, B.C., were part of a study coordinated with PGC and Simon Fraser University.

Seabottom refraction testing with a deep-towed eel were carried out on CCGS Nahidik in the Beaufort to detect shallow sub-seabottom permafrost.

GSC scientists in cooperation with USGS, and the state Geological Surveys of Kansas and New Jersey, conducted a comparative study of seismic sources at sites in New Jersey, in October, 1985. Several companies participated in the evaluation of a number of different sources ranging from hammer sources, shot gun and machine gun sources to large accelerated weight drops.

In February shallow seismic reflection studies were carried out at the Asian Institute of Technology, Bangkok, Thailand, sponsored by the International Development Research Centre (J.A.M. Hunter, S.E. Pullan). The work consisted of initiating shallow seismic reflection surveying, using techniques developed at GSC, for detailed mapping of groundwater aquifers. As well, a two week course on shallow seismic techniques was conducted, with 16 students coming from various S.E. Asian countries.

During the year the Instrument Development Shop completed 169 work orders, with the work distributed among the Divisions as follows:

RGG	32.6%
Prec	25.3%
EGM	14.2%
TS	10.4%
GID	6.0%
ISPG	1.7%
Admin & Other	1.1%
Emergency Repair & Maintenance	8.7%

Products of the shop included an Electrothermal vaporizer for the ICP spectrometer which is being considered for a patent, a self-timed and illuminated thin section holder for the SEM which may be licensed to the manufacturer of the SEM, and hydrofluoric acid dispensers which resulted in a Suggestion Award to the client.

Personnel Notes

D.C. Gresham resigned in December, 1985, to join Paterson, Grant & Watson Ltd., in Toronto.

D.S. Bromley joined the Subdivision in May, 1985, to carry out seismic investigations under the Nova Scotia Mineral Development Agreement.

A.V. Dyck returned to GSC in September, 1985 after spending a year teaching at Queen's University on an exchange agreement.

J.F. Bourillet completed a 14-month term under the French-Cooperant program and returned to France in December, 1985.

Attendance at Meetings, Conferences and Courses

D.S. Bromley

Nova Scotia Dept. of Mines and Energy Open House, Halifax, November 27-28, 1985.

K.L. Ford

Institution of Mining & Metallurgy Conference on High Heat Production Granites, St. Austell, Cornwall, England, September 22-25, 1985.

New Brunswick Dept. of Forests, Mines & Energy Open House, Fredericton, November 26, 1985.

Nova Scotia Dept. of Mines and Energy Open House, Halifax, November 27-28, 1985.

International Geochemical Symposium, Toronto, April 28 - May 2, 1985.

J.A. Grant

North American Data General Users' Group Annual Meeting, Boston, Massachusetts, August 26-30, 1985.

J.A.M. Hunter

Society of Exploration Geophysicists Annual Meeting, Washington, D.C., October 6-10, 1985.

AGID International Geological Correlation Programme Workshop & Training Course on Economic Geology, Tectonics, Sedimentary Processes and Environment of the Quaternary in Southeast Asia, Haadyai, Thailand, February 3-7, 1986.

P.G. Killen

Society of Professional Well Log Analysts Annual Meeting, Dallas, Texas, June 18-20, 1985.

Continental Drilling in Canada Meeting, Ottawa, January 21-23, 1986.

C.J. Mwenifumbo

Society of Professional Well Log Analysts Annual Meeting, Dallas, Texas, June 18-20, 1985.

Newfoundland Dept. of Mines and Energy Open House, St. Johns, November 6-7, 1985.

J.G. Palacky

Workshop on Airborne Resistivity Mapping, Ottawa, October 2-3, 1985.

Ontario Geological Survey Geoscience Research Seminar, Toronto, December 4-5, 1985.

S.E. Pullan

Society of Exploration Geophysicists Annual Meeting, Washington, D.C., October 6-10, 1985.

AGID International Geological Correlation Programme Workshop & Training Course on Economic Geology, Tectonics, Sedimentary Processes and Environment of the Quaternary in Southeast Asia, Haadyai, Thailand, February 3-7, 1986.

K.A. Richardson

Newfoundland Dept. of Mines and Energy Open House, St. Johns, November 6-7, 1985.

Ontario Geological Survey Geoscience Research Seminar, Toronto, December 4-5, 1985.

Prospectors and Developers Association Annual Meeting, Toronto, March 10-12, 1986.

R.B.K. Shives

New Brunswick Dept. of Forests, Mines & Energy Open House, Fredericton, November 26, 1985.

Nova Scotia Dept. of Mines and Energy Open House, Halifax, November 27-28, 1985.

A.K. Sinha

Society of Exploration Geophysicists Annual meeting, Washington, D.C., October 6-10, 1986.

V.R. Slaney

First Atlantic Canada Symposium on Remote Sensing and Geographic Information Systems, Lawrencetown, N.S., August 16-17, 1985.

Basement Tectonics Symposium, Santa Fe, New Mexico, September 16-20, 1985.

Geosat Committee Meeting, Flagstaff, Arizona, November 4-8, 1985.

Special Talks and Lectures

L.S. Collett

"Development of the airborne EM techniques." Workshop on Airborne Resistivity Mapping. Ottawa, October 2-3, 1985.

A.V. Dyck

"Are diffusion effects really observable in drill-hole electromagnetic survey data?" 55th Annual Meeting of the Society of Exploration Geophysics, Washington, D.C., October 6-10, 1985.

K.L. Ford, R.N.W. Dilabio, and A.N. Rencz

"Preliminary results of multidisciplinary studies around the recently discovered Allan Lake carbonatite, Algonquin Park, Ontario." Association of Exploration Geochemists - 11th International Geochemical Exploration Symposium, April 28 -May 2, 1985, Toronto.

R.M. Gagne, S.E. Pullan, and J.A. Hunter

"A shallow seismic reflection method for use in mapping overburden stratigraphy." National Well Water Association Conference on Surface and Borehole Geophysical Methods.

John A. Grant

"Designing and writing interactive programs using AOS CLI switches and arguments." North American Data General User's Group Meeting, Boston, Massachusetts, August 26-29, 1985.

J.A. Hunter, S.E. Pullan, R.A. Burns, R.M. Gagne, and R.L. Good

"The optimum offset shallow reflection technique - case histories." 55th Annual Meeting of the Society of Exploration Geophysicists. October 6-10, 1985.

P.G. Killen

"A series of 5 lectures on Geophysics at GSC, Borehole Logging and Calibration." CSIRO, Division of Mineral Engineering, Melbourne, Australia, November 19 - December 5, 1985.

"Calibration and testing of logging tools for mineral exploration." Geological Survey of South Australia, Adelaide, Australia, December 9, 1985.

"Continental scientific drilling: standards and calibration for quantitative borehole logging measurements." Continental Scientific Drilling in Canada Meeting, Ottawa, February 5, 1986.

C.J. Mwenifumbo

"Borehole geophysics in exploration for gold." Society of Professional Well Log Analysts - Annual Meeting, Dallas, Texas, June 18-20, 1985.

E.J. Norminton, and S.E. Pullan

"Engineering seismic reflection software for the Apple microcomputer." 55th Annual Meeting of the Society of Exploration Geophysicists, Washington D.C., October 6-10, 1985.

G.J. Palacky

"Physical & geological basis of resistivity mapping." Workshop on Airborne Resistivity Mapping, Ottawa, October 2-3, 1985.

"Airborne Resistivity Mapping." Earth Physics Branch Seminar, Ottawa, November 1985.

"New applications for airborne electromagnetics." Ottawa Mineral Exploration Group Meeting, Ottawa, February 25, 1986.

S.E. Pullan and H.A. MacAulay

A new source for engineering seismic surveys. Annual Meeting of the Society of Exploration Geophysicists, Washington, D.C., October 6-10, 1985.

A.K. Sinha, L.E. Stephens, and D. Gresham

"Mapping of sedimentary formations in southern Ontario by electromagnetic techniques." Annual International Meeting of the Society of Exploration Geophysicists, October 6-10, 1985, Washington, D.C.

"Quantitative interpretation of ground VLF-EM data as applied in the Canadian Nuclear Fuel Waste Management Program." American Geophysical Union Fall Meeting, San Francisco, December 9-13, 1985.

V.R. Slaney

"The Radarsat Project." Earth Physics Branch Seminar, Wednesday, October 23, 1985.

Membership on Committees

J.M. Carson

Member, Ad Hoc Advisory Committee for Minerals Technology Program, Sir Sanford Fleming College.

L.S. Collett

Member, IRAP Selection Committee National Research Council, Branch Representative.

Chairperson, Ontario Exploration Technology Development Fund, Ontario Geological Survey, BILD Program.

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

A.V. Dyck

Associate Editor, Borehole Geophysics, for "Geophysics".

J.A.M. Hunter

Member, Permafrost Subcommittee of N.R.C.

Member, U.S. Committee on Permafrost, Polar Research Board.

Chairman, Engineering & Groundwater Committee, Society of Exploration Geophysicists.

Chairman, Engineering Seismograph Digital Standards Subcommittee, Society of Exploration Geophysicists.

Editor for "Geoexploration".

Editor, Engineering Geophysics, for "Canadian Geophysical Bulletin".

P.G. Killeen

Member, IAEA Advisory Group on Nuclear Techniques for Coal Exploration & Exploitation.

President, Minerals & Geotechnical Logging Society of Professional Well Log Analysts.

Chief Scientific Investigator, IAEA research programme in Nuclear Borehole Logging Techniques.

G.J. Palacky

Associate Editor, International Scientific Advances, for Geophysics.

A.K. Sinha

Member, Reviews Committee, Society of Exploration Geophysicists.

V.R. Slaney

EMR Representative - Geosat Committee.

Member, Nova Scotia Land Survey Institute Remote Sensing Review Committee.

Subdivision Productivity

136 Maps	133 radiometric maps 2 VLF-EM maps 1 Radioactivity Map of Canada (included in: 19 Geophysical Series & 2 Open Files)
9 GSC Reports	4 GSC papers 4 Current Research 1 Open File
12 Outside Publications	
7 Abstracts of Formal Talks	

TERRAIN SCIENCES DIVISION

J.S. Scott, Director

Introduction

Responsibilities of the Division are provision of geoscientific data and interpretive information on the surficial geology and geomorphic processes of the Canadian landmass and for such geotechnical aspects of surficial and bedrock materials as may have a bearing on use of the terrain for various purposes. Management responsibility for and provision of administrative services to the EMR co-operative program with Atomic Energy of Canada Limited for Nuclear Fuel Waste Management is also centered within the Division.

The objectives of the Division are: to provide a systematic coverage of surficial geology of the Canadian landmass consistent with the information requirements for effective use of the terrain and for the interpretation of Quaternary and Holocene geological events; to acquire an understanding of past and present geomorphic processes; to identify and assess the occurrence and magnitude of natural terrain hazards; to provide geoscience information to assist in the use, maintenance and restoration of the physical environment; and to provide 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 four sections. Regional Projects Section activities are directed largely toward geological investigations of the nature, origin and distribution of unconsolidated deposits and landforms, to provide geological maps of the areas investigated and to establish the stratigraphic and environmental history. Paleocology and Geochronology Section is responsible for paleontological and paleoecological investigations of Quaternary fossil materials as an aid to stratigraphic correlation and determination of paleoenvironments and for the provision of ^{14}C dates on various organic materials. Sedimentology and Mineral Tracing Section is concerned with defining the mechanisms of glacial dispersal of bedrock components in glacial drift and with the determination of its geochemical characteristics. Geomorphic Processes and Engineering Geology Section is concerned with the study of active geomorphological processes with emphasis on the permafrost environment, but including studies of terrain hazards in various regions of southern Canada. This Section is also responsible for studies of the engineering characteristics of geological materials for engineering or terrain use purposes. Current activities include contributions to the Nuclear Fuel Waste Management Program.

During the final quarter of the fiscal year the organization of the Division was significantly influenced by the merger between Earth Physics and Geological Survey Branches and by transfer to the Division of the Glaciology Section from the Polar Continental Shelf Project (PCSP). With the inclusion in the Division of the Terrain Geophysics Section from Resource Geophysics and Geochemistry Division,

Permafrost Research Group from Earth Physics Branch and Glaciology Section from PCSP the Division initiated a reorganization into subdivisions to become effective 1 April 1986.

During the year the scientific program of the Division was substantially affected by involvement in special programs including federal/provincial mineral development agreements in Newfoundland, Nova Scotia, New Brunswick and Manitoba, programs to encourage mineral exploration in Gaspé and Eastern Townships of Quebec and northern terrain research funded through the Office of Energy Research and Development. The aggregate of funding for these special programs represented approximately 60 per cent of the total O&M funding allocated to the Division.

The Canadian Geoscience Council ad hoc Committee on Quaternary Engineering Geology, chaired by Professor M. Church, U.B.C., completed its examination of Divisional products and user requirements in Quaternary and engineering geology. A preliminary report of the findings, conclusions and recommendations of the Committee was received in September. The Committee placed emphasis on the importance of Quaternary geology maps to various user groups and the high value placed by these groups on formal publications of the Division. Recommendations included, inter alia, greater use of remote sensing techniques and applications of new technology for both data acquisition and dissemination of users. The Committee's final report, expected during the year, has been delayed until the spring of 1986.

At the end of the report-period the staff comprised 1 Research Manager, 31 Research Scientists, (3 terms) 21 Physical Scientists (9 terms), 10 technical support (2 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: 4 GSC Reports; 13 Maps; 3 Open Files; and 22 contributions to Current Research. In addition 36 papers and 23 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 is one Staff Scientist who carries out research and provides advice to the Branch and other Departments on marine geoscience programs.

Personnel Notes

Division Headquarters consists of a permanent staff of 1 Research Manager, 1 Research Scientist, 2 Physical Scientists, and 6 support staff.

Attendance at Meetings, Conferences and Courses

B.R. Pelletier

Presented a poster session at the Geological Association of Canada Annual Meeting, Fredericton, May 1985.

Sedimentology Workshops, Terrain Sciences Division, Ottawa, Spring to Fall 1985.

Presented a poster session at the Workshop on Arctic Land-Sea Interaction, Halifax, November 1985.

1986 Current Activities Forum, Ottawa, January 1986.

J.S. Scott

Geological Society of America Annual Meeting, Orlando, Florida, October 1985.

Membership on Committees

J.A. Lowdon

Departmental Steering Committee for Review of the EG-ESS Standards, Branch Representative

B.R. Pelletier

Maritime Sediments and Atlantic Geology, Associate Editor

Advisory Committee on Undersea Features Names, Member

Working Group Marine Atlases for Canada, 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 (85-86)

Special Talks or Lectures

B.R. Pelletier

'Canadian marine geology' to the Canadian Hydrographic Service: Cartographers, Ottawa, September 1985; and to the Hydrographers, November 1985.

J.S. Scott

'Canada's mineral, forest and fisheries resources' to Course XXXIX at the National Defence College, Kingston, Ontario, October 1985.

Quaternary Discussion Group

Under the Chairmanship of J.R. Bélanger the following papers were presented during April 1985 to March 1986.

Dr. J.J. Clague, Terrain Sciences Division, GSC, Vancouver -- Quaternary geology of the Queen Charlotte Islands.

Dr. D.N. Proudfoot, Terrain Sciences Division, GSC, Calgary -- A model for glacial sedimentation in southeast Alberta.

Dr. D.N. Proudfoot, Terrain Sciences Division, GSC, Calgary -- A prairie landform - facies model: is it a practical tool?

Dr. M. Rappol, Terrain Sciences Division, GSC, Ottawa -- Till structure and genesis in the Netherlands.

Dr. S.A. Edlund, Terrain Sciences Division, GSC, Ottawa -- Modern arctic vegetation and its congruence with arctic summer climate.

Dr. S.G. Evans, Terrain Sciences Division, GSC, Ottawa -- Rockslides in the Canadian Cordillera evaluating damage scenarios.

Dr. D.N. Proudfoot, Terrain Sciences Division, GSC, Calgary -- Correlation of Wisconsinan sediments between southeast Alberta and southwest Saskatchewan.

Dr. D.A. St-Onge, Terrain Sciences Division, GSC, Ottawa -- Early Holocene downwasting of the continental ice sheet in the Coppermine River region: a paleogeographic reconstruction.

Dr. J.S. Scott, Terrain Sciences Division, GSC, Ottawa -- Seepage problems with the Colorado Dike, Colbun Project, Chile.

Dr. J. Brigham-Grette, University of Alberta, Edmonton -- Late Cenozoic transgressions on the arctic coastal plain of Alaska.

Mr. H. Thorleifson & Mr. P. Wyatt, Terrain Sciences Division, GSC, Ottawa -- Quaternary stratigraphy of the central Hudson Bay lowlands, northern Ontario.

Dr. E. Larsen, Geological Survey of Norway, Norway -- Weichselian stadial and interstadial stratigraphy in western Norway and adjacent seas.

REGIONAL PROJECTS SECTION

R.J. Fulton and D.A. St-Onge (Heads)

The prime objectives of the Regional Projects Section are to provide a Canada-wide inventory of surficial materials and landforms and to establish the stratigraphy and environmental history of Quaternary deposits. 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 and to furnish an understanding of the genesis

of deposits and landforms. Terrain and surficial geology information is required 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.

Highlights

Within the framework of the lower St. Lawrence and Gaspé federal-provincial mineral agreement, mapping of the surficial geology of the Gaspé Peninsula at 1:50 000 scale was completed during summer 1985 by Terrain Sciences assisted by a private firm under contract. Compilation of the Quaternary map of the peninsula at 1:250 000 scale is in progress. In the same program a major research project (contract) under the direction of P. David (U. de M.) was initiated in north-central Gaspé. Its main objectives are a detailed study of the McGerrigle boulder train and associated deposits with emphasis on glacial transport conditions, and till stratigraphy and geochemistry. G. Prichonnet (UQUAM) completed a glacial transport study in the Mont-Joli area.

A till sampling and glacial transport project (contract) was undertaken by M. Bouchard (U. de M.) and assistants in a vast area between Hudson Bay and Ungava Bay where Monopros Ltd. was conducting an orientation survey based on the sampling of surficial sediments. Sample analysis is in progress.

Field work in the Abitibi area of eastern Ontario and western Quebec west of the Harricana Moraine confirmed the existence of two major widespread directions of ice-flow (W and SSW) prior to the last flow to the SE during final deglaciation. Cross-striations and other features at over 100 sites supply the regional evidence to the stratigraphic data obtained from open pit mines in the Timmins area and the Selbaie mine in Quebec. These new data may explain several transport "anomalies" in tills west of the Harricana Moraine.

Some of the till samples from northern Manitoba, submitted for geochemical analysis, have yielded relatively high gold concentrations in the fine matrix fraction. Because directions and distances of glacial transport are known from regional mapping and reconstructions of the Quaternary geologic history, the probable source rocks are known. Further details were provided in a paper by L.A. Dredge and E. Nielsen in Current Research, Part A, Geological Survey of Canada, Paper 86-1A, p. 779-782.

During Quaternary mapping of Prince of Wales Island important stratigraphic sections were discovered near Cape Hardy. These expose tills and fossiliferous glaciomarine sediments from two glaciations separated by interglacial fluvial gravels, capped in places by a well developed paleosol with intact Ah horizon. Numerous samples of driftwood, whalebone, and shells were collected to

define local relative sealevel histories and further explore the possibility of postglacial faulting in the area.

Investigation of very light rotary, fluid circulation drilling techniques applied to stony frozen ground was resurrected this year after a lapse of a decade. Equipment was deployed on three programs, two requiring instrument installation and the third to provide stratigraphic control for a geophysical survey. In each case, results surpassed expectations in terms of depth, core quality and recovery and hole stability. Two factors contributing to this success were (1) a recognition of the limitations of very light equipment and resultant realistic job specifications, and (2) close drill fluid control. These results suggest that this may be an excellent method to provide third dimension information where sections are not available.

D.A. Hodgson took advantage of base camp facilities provided by ISPG to examine deposits of western Melville Island. The first clear evidence in the western Queen Elizabeth Islands of the following two glacial events was found: 1. Inundation of the entire area by continental ice bearing igneous erratics at an as yet undated time; 2. Wasting of an ice cap (at least 10^4 km^2) of Late Wisconsinan age. The form and age of the latter ice cap will be better defined after contemporary glaciolacustrine and marine deposits are dated.

Renewed investigations within the thermokarst terrain (Thaw Lake) at the large glaciomarine fan northeast of Cambridge Bay, Victoria Island, N.W.T. were carried out by D.R. Sharpe (stratigraphy and groundwater), F.M. Nixon (drilling) and L.D. Dyke (geophysics). This is part of a continuing program to investigate the origin, modern processes and periglacial significance of active thermokarst erosion of the glaciomarine deposits. Preliminary investigations of the ice by oxygen-isotope suggest that glacial age ice may be present. At the same time large cavities in the thick ground-ice below concentric crevasse features around "thaw"-lake suggest possible groundwater connection with it. The origin of these openings is not known. Stratigraphic studies revealed sorted, sand "clasts" within a fine glaciomarine diamict. Their occurrence support a subaqueous debris-flow origin for diamictons and this serves to limit the extent of known subaerial reworking of the fan by thaw-erosion. The drilling results confirmed the distribution of thick fine diamicton with occasional sand clasts. The sediment logging and ice content of these sediments will assist in the interpretation of a variety of geophysical "features" that relate to ice-rich and ice-poor sediment and to cavity occurrence in the ground ice system.

Several scientists have been involved in the preparation of guidebooks for 9 of the 23 field trips being planned for the XII Congress of the International Union for Quaternary Research. The meeting will be held in Ottawa between July 31 and August 9, 1987. Field trips will be held in various parts of the country both before and after the meeting. The guidebooks provide major syntheses of the Quaternary geology of many areas.

Preparation continued on the Quaternary Volume for the new Geology of Canada series. This Volume is a contribution for the Decade of North American Geology Series and in addition to covering Canada will contain a section prepared by Danish geologists on the Quaternary of Greenland. The Volume, being compiled by about 50 scientists both inside and outside the Geological Survey of Canada, presents a description of the Quaternary geology of Canada and Greenland and includes several chapters that discuss the interplay between Quaternary deposits and processes and man. The first draft has been reviewed and the final draft should be completed before the 1986 field season. A surficial materials map of Canada, scale of 1:5M, is being prepared as a companion piece for the Quaternary Volume. It will be the first map to show the nature of surface materials of all of Canada. The map is about 2/3 completed.

Quaternary geology studies continue in the central part of the Fraser River basin, British Columbia. Field mapping has been completed in two of the four 1:250 000 map areas which are included in this long term project and considerable stratigraphic data have been gathered from the extensive deposits exposed along the Fraser River. Detailed sedimentological studies have been carried out in lake sediments that underlie till in the Quesnel area. These deposits are significant because they are the locus of many of the large landslides which occur in the region.

Backhoe pits were excavated in several hollows in hummocky moraine in the Cypress map area of southwestern Saskatchewan. The main purpose of this stratigraphic work was to search for proof that parts of this area were not ice covered during the last glaciation. Unfortunately nothing was found which indicated southern parts of the area were deglaciated at a significantly different time from more northerly areas. This work did however turn up a peat bed which will provide paleoenvironmental information on the early Holocene of this region.

Stratigraphic studies were conducted in and adjacent to the South Saskatchewan River valley in an area straddling the Alberta-Saskatchewan boundary. The purpose of this work was to correlate Wisconsinan stage stratigraphy of the Medicine Hat area with that of adjacent Saskatchewan. Preliminary results of this work indicate that the Prelate soil, which was studied by P. David in the general area of Leader, Saskatchewan is a marker horizon of regional significance and may correlate with the Evilsmelling band which was described in the Medicine Hat area by A.M. Stalker.

Personnel Notes

The Regional Projects Section consists of a permanent staff of 12 Research Scientists, and 4 Physical Scientists. The Section also supported 4 EMR Research Agreements.

D.N. Proudfoot of the Department of Geology, University of Alberta, continued work on problems related to characterization of tills in southwestern Saskatchewan as a Visiting Fellow.

Attendance at Meetings, Conferences and Courses

J.J. Clague

Canadian Quaternary Association Symposium, Lethbridge, Alberta, August 1985.

S.A. Edlund

Presented a paper at the 1985 Arctic Science Conference, Fairbanks, Alaska, September 1985

Presented a paper at the Climate Change Impacts for the Canadian Arctic, Geneva Park, Ontario, March 1986.

R.J. Fulton

Presented a poster at the Cordilleran Division of the Geological Society of America, Vancouver, May 1985.

Eastern Friends of the Pleistocene, northern New Jersey, May 1985.

Presented a poster at the 1986 Current Activities Forum, January 1986.

D.R. Grant

5th Coral Reef Congress and Field Conference IGCP Project 200 (Sea Level), Tahiti, May-June 1985.

Presented a paper at the 14th Arctic Symposium, Halifax, November 1985.

Presented a poster at the 1986 Current Activities Forum, January 1986.

D.A. Hodgson

Presented a poster at the 14th Arctic Workshop Symposium, Halifax, November 1985.

O.L. Hughes

Canadian Quaternary Association Symposium, Lethbridge, Alberta, August 1985.

R.W. Klassen

Presented a paper at the Canadian Quaternary Association Symposium, Lethbridge, Alberta, August 1985.

F.M. Nixon

Ontario Association of Geomorphologists Symposium on New Instrumentation and Techniques, Mississauga, Ontario, April 1985.

D.A. St-Onge

Presented a paper at the Réunion annuelle de l'ACFAS, Chicoutimi, May 1985.

Delivered Presidential Address at the Geological Association of Canada, Fredericton, May 1985.

Presented a paper at the Canadian Quaternary Association Symposium, Lethbridge, Alberta, August 1985.

Presented a paper at the First International Conference on Geomorphology, Manchester, England, September 1985.

D.R. Sharpe

Presented a paper at the Geological Society of America North-Central Sectional Meeting, Dekalb, Illinois, April 1985.

A.M. Stalker

Canadian Quaternary Association Symposium, Lethbridge, Alberta, August 1985.

J-S. Vincent

Presented a paper at the Geological Association of Canada, Annual Meeting, Fredericton, May 1985.

Presented a paper at the 14th Arctic Workshop, Halifax, October 1985.

Membership on Committees

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

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

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

N.R. Gadd

Conseil Scientifique, Géographie physique et Quaternaire, Member

D.R. Grant

INQUA Commission on Quaternary Shorelines, President

NRC Canadian National Committee for INQUA, Secretary

IGCP Project 200, Executive Board Member

North American Working Group of the IAG Commission on Recent Crustal Movements, Member

D.A. St-Onge

Geological Association of Canada, President 84/85

Royal Canadian Geographical Society, Vice President; Research Committee, Editorial Committee and Massey Medal Committee, Member

INQUA '87, Organizing Committee, Vice President

Comité d'Honneur de la Fondation ACFAS, membre

D.R. Sharpe

Canadian Quaternary Association, Council Member

A.M. Stalker

Canadian Quaternary Association, Past Chairman

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

Géographie physique et Quaternaire, Rédacteur adjoint

Special Talks or Lectures

J.J. Clague

'Distinguishing diamictos from central interior British Columbia, problems in distribution' at the Glaciogenic Sedimentology Workshop, Ottawa, April 1985.

'Pandemonium Creek rock avalanche' at the Cordilleran Slope Hazards Workshop, Simon Fraser University, Burnaby, B.C., February 1986.

'Soils-vegetation-climate patterns in the Queen Elizabeth Islands' at the (1) Institute of Arctic Biology, University of Alaska and (2) Institute of N. Forestry, Fairbanks, Alaska, and at the (1) University of Alaska-Anchorage & Anchorage Community College and (2) Alaska Rare Plant Society, Anchorage, Alaska, October 1985.

'Arctic vegetation' at the Manotick Horticultural Society, Manotick, March 1986.

PALEOECOLOGY AND GEOCHRONOLOGY SECTION

W. Blake, Jr. (Head)

A major portion of the work of the Paleoeology and Geochronology Section is of a laboratory nature, but specialized field studies, such as the coring of lake sediments, are carried out by staff members. In 1985 field work was undertaken in: Newfoundland, Nova Scotia, New Brunswick, Ontario, Yukon Territory and Ellesmere Island, N.W.T., as well as in New York State and Alaska. These field investigations, together with laboratory studies of previously collected samples, have provided additional information on past environments throughout Canada and the neighbouring U.S. Because the analyses of fossil diatoms, insects, marine invertebrates, pollen, seeds and wood are often coupled with radiocarbon age determinations, an appreciation is being gained of the rates at which the environment is changing and of the rates at which processes are occurring.

Highlights

Field work for the Yukon Refugium Project, a major interdisciplinary study in which the Section participates (especially with regard to fossil insects, plant macrofossils, and radiocarbon dating) was essentially completed in 1981. However, the discovery of a new and important tephra layer necessitated additional field work and collecting in 1985. This research effort has involved GSC staff members as well as personnel from the National Museum of Man, the National Museum of Natural Sciences, the University of Alberta, the University of Minnesota, the University of Alaska, and the U.S. Geological Survey. A book entitled "Paleoecology of Beringia", summarizing many of the studies made, was published by Academic Press in 1982, and in 1985 exposures along the Yukon coast on both sides of the border were examined by a joint Canadian/U.S. group. Paleoeological analysis and dating of the collections continues.

A second major interdisciplinary study, the Cape Herschel Project, is concerned with the glacial history of east-central Ellesmere Island and the adjacent coasts of northwest Greenland. Related studies include fluctuations of sea level, botany, rock weathering, water chemistry, marine invertebrates, climatic changes (as deduced from the record of pollen, diatoms, other algae, and invertebrates preserved in lake sediments), and the development of boulder barricades and geomorphic processes occurring at the present coast. In

addition to GSC personnel, participants have come from the University of Helsinki, the University of Copenhagen, Greenland Botanical Survey, Norsk Polarinstitut, Scarborough College (University of Toronto), Sir Sanford Fleming College, Memorial University of Newfoundland, McMaster University, Queen's University, and the Alberta Geological Survey. The geological and botanical studies complement archeological investigations which have been carried out in the area by the Arctic Institute of North America.

Another area of emphasis involves palynological studies over a broad area extending from the Great Lakes to the Maritime Provinces and Newfoundland. The palynological studies are coupled with studies of plant macro-fossil and fossil arthropods, and significant horizons are dated by the radiocarbon method. A detailed knowledge of vegetation and climatic history is emerging from these investigations, including the recognition of events which correlate with the Allerød/Younger Dryas climatic oscillation in Europe. In addition, cross-checking of radiocarbon dates on marine and terrestrial materials may be possible. One of the chief aims of the project is to resolve chronological problems between the Champlain Sea, which formerly occupied the Ottawa-St-Lawrence Lowland, and the Great Lakes area.

With regard to diatoms, a major study has compared surface snow samples from several Arctic ice caps with precipitation (rime frost and snow) collected nearer to sea level along the east coast of Ellesmere Island. All samples contained diatoms, including marine species. In the ice cap samples the presence of marine diatoms is indicative of long distance transport.

The Radiocarbon Dating Laboratory, now in its 26th year of operation, has completed more than 4200 age determinations on a variety of organic materials -- wood, peat, gyttja, shells, bone, antler, horn, ivory, charcoal, and hair. These age determinations bear on problems such as the time of deglaciation, the rate of sedimentation in lakes, the rate at which peat deposits are building up, the time that landslides occurred, or the time that selected areas emerged from the sea. In some localities it has been possible to bracket the time of glacial advances. Results of the dating program are published annually in the GSC Paper Series; List XXV has now appeared and List XXVI is in preparation. Laboratory research is being conducted into the problems of: (1) dating sediments from hard water lakes, and (2) obtaining more reliable ages on bones by improving pretreatment techniques.

Continuation of the program of radiocarbon dating by accelerator mass spectrometry (AMS) has contributed to more precise chronological studies in several parts of the country. Age determinations on milligram-sized samples have been obtained on a variety of materials from the IsoTrace Laboratory, University of Toronto. Materials analyzed include wood, moss, shell, bone, spruce needles, the chitinous covering on pelecypod shells, and microtine fecal pellets.

Personnel Notes

The Paleocology and Geochronology Section consists of a permanent staff of 5 Research Scientists, 2 Physical Scientists, and 2 Technicians. In addition, 2 Physical Scientists work in support positions. The Section also supported 4 contracts and 4 EMR Research Agreements.

Attendance at Meetings, Conferences and Courses

T.W. Anderson

Presented a paper at the Annual Meeting of the Geological Association of Canada, Fredericton, New Brunswick, May 1985.

W. Blake, Jr.

Presented a paper at the 12th International Radiocarbon Conference, Trondheim, Norway, June 1985.

Presented a poster at the 4th International Symposium on Paleolimnology, Ossiach, Carinthia, Austria, September 1985.

Workshop on Airborne Resistivity Mapping, G.S.C., Ottawa, October 1985.

J.V. Matthews, Jr.

Meeting on Global Change organized by The Royal Society of Canada, Ottawa, December 1985.

R.J. Mott

Annual Meeting of the Geological Association of Canada, Fredericton, New Brunswick, May 1985. Field trip co-leader.

Presented a paper at the 1986 Current Activities Forum, Ottawa, January 1986.

Membership on Committees

T.W. Anderson

National Research Council Peat Forum, Member

Geological Survey of Canada Radiocarbon Dating Committee, Member

W. Blake, Jr.

American Quaternary Association, Councillor 1982-1986

Fellows Committee, Arctic Institute of North America, Calgary, Chairman

Geological Survey of Canada Radiocarbon Dating Committee, Chairman

Divisional Committee for EMR Research Agreements, Member

Ph.D. Thesis Committee for M. Krawetz, Department of Geography, McMaster University, Hamilton, Member

J.V. Matthews, Jr.

Biological Survey of Canada, Scientific Advisory Board, Member

Climate Planning Board, Member

Canadian Committee on Climatic Fluctuations and Man, Member

Task Force on Proxy Climate Data (of CCCF), Chairman

R.J. Mott

Branch Safety Committee, Member

Laboratory Statistics

Paleocology

1. Samples processed

Diatom samples	
samples processed	7
filters prepared	28
slides prepared	28
diatoms counted	7764
Palynological	312
Wood treatments	211

2. Reports completed

Fossil Arthropod	13
Palynological	7
Plant Macrofossils	17
Wood	103

Geochronology

3. Determinations completed

Conventional radiocarbon ages (GSC)	
Geological samples	182
Geochemical samples	6
¹³ C/ ¹² C ratios	149
(University of Waterloo - contract)	
AMS radiocarbon ages (IsoTrace)	33
(University of Toronto - contract)	

SEDIMENTOLOGY AND MINERAL TRACING SECTION

W.W. Shilts (Head)

The primary task of the Section is to provide information on the physical and mineralogical-chemical properties of glacial and associated surficial sediments of Canada. Research is aimed at providing basic data on regional variations in drift properties and at developing techniques of using drift composition to aid in prospecting or evaluation of environmental or geotechnical problems. In addition, members of the Section do basic research on glacial and lacustrine sedimentation and map surficial sediments where necessary to support sedimentological, geochemical, or remote sensing activities.

The Sedimentology-Engineering Geology Laboratories are administered within this Section. These Laboratories provide research facilities and analyses as well as preparation of samples for Terrain Sciences Division staff and for other scientists within and outside of the Geological Survey.

Highlights

Sampling and mapping of the surficial deposits of the Miramichi Highlands was begun in 1985. Detailed studies of the relationship of the widespread preglacial regolith to overlying glacial deposits were carried out in trenches dug for mineral exploration and for study of effects of the 1982 Miramichi earthquake. Till that is virtually indistinguishable from the regolith was identified as a major exploration problem. The glacial history of the northwestern part of the province was studied by mapping dispersal patterns, till fabric, and striations as well as through stratigraphic and sedimentological studies of sections exposed in St. John River valley. A significant and long-lived ice cap centered on New Brunswick has interacted in complex ways at various times with glaciers flowing southward from the Canadian Shield. Clarification of these interactions is essential to efficient interpretation of exploration data.

Under the Manitoba MDA project, airphoto compilation and till sampling continued to provide a detailed surficial geology base and reconnaissance till geochemistry data for northwestern Manitoba. Reconnaissance surficial mapping and aggregate inventory continued in eastern Manitoba. Preliminary work on the geochemistry of modern lake sediments in the Lake Agassiz basin indicates that Lake Agassiz clays are major components of most lake floors and the clays are readily recycled into the modern sediments through shoreline erosion.

Analysis of archived organic materials from the Timmins area indicates the presence of a widespread interstadial unit of probable mid-Wisconsinan age. The provenance of tills below this unit will become a subject of an Ontario MDA study, because mineral exploration in this region relies heavily on till geochemistry.

Study of gold spheres found in museum collections indicates that many of them are probably man-made melt droplets and that they are a worldwide contamination problem in placer gold specimens. A few are still suspected to be low-temperature chemical precipitates.

Gold grains from surficial sediments in Canada are being studied by SEM-microprobe methods to determine the extent of damage by either clastic transport or groundwater corrosion and to match their compositions to their probable sources.

Studies of drift composition and glacial history have been continued in the area of the Central Mineral Belt, Labrador, as part of the Canada-Newfoundland MDA. The work has indicated a complex history of ice flow related to evolution of previously unknown dispersal centres within the Laurentide Ice Sheet. Patterns of glacial dispersal

associated with the varied phases of ice flow have been established by examination of indicator erratics and by geochemical analysis of till, and dispersal trains at scales from regional (100's of km) to detailed (100's of m) have been defined. The work provides a basis for the use of drift prospecting techniques in mineral exploration.

Twenty-six 11 cm-diameter holes were drilled to bedrock in and adjacent to the Chaudière Valley using refraction seismic data for guidance. Detailed logging of the continuous core recovered from these holes, combined with study of previously undescribed stratigraphic sections has confirmed the general glacial stratigraphy previously proposed for this region. The buried gold-bearing strata of the Beauceville region were drilled in detail. These highly oxidized strata were interpreted to comprise a preglacial regolith/alluvial complex that was partially reworked by glaciers but was largely preserved in the Rivière Gilbert valley of the St. Simon-les-Mines area.

Compilation and interpretation of regional geochemical and mineralogical data collected over the past 25 years in the Eastern Townships was carried out under contract. Data of use in evaluating the potential effects of acid rain on the region were also mapped. Geologically interesting anomalies for arsenic, tin, and uranium will be investigated further in 1986.

Sonar surveys were carried out in support of university and divisional research in British Columbia, Ellesmere Island, Manitoba, Labrador, Alberta, and Ontario. Particular emphasis was placed on developing late glacial sedimentation models and on relating signs of sediment disturbance to neotectonic events. More deep boreholes were drilled in Lake Doré, Ontario, Lake Megantic, Québec and in Lac Deschênes, Québec/Ontario to provide ground "truth" for various types of sonar records.

Compilation of airphoto mapping of the western Canadian Shield continued and maps emphasizing one or another of several types of glacier bedforms were prepared. The airphoto interpretation, though not to standards of conventional field mapping projects, provides accurate representation of 70% to 90% of the glacial geology that could be mapped using present field techniques at a very low cost.

Sampling of glacial sediments for the acid rain program was completed between Huntsville, Ontario and Georgian Bay. Many geochemical and mineralogical parameters have been measured that will allow a unique comparative study with similar parameters measured on lake waters and sediments from the same region.

A detailed study of the sedimentary facies and environments of deposition of a series of glaciofluvial deposits in the area north of Gananoque, Ontario was completed and the results submitted to Canadian Journal of Earth Sciences for consideration for publication.

Regional studies of the Quaternary stratigraphy of the Ontario part of the Hudson Bay Lowlands were continued along the Severn, Winisk, and Matagami-Abitibi rivers. Thermoluminescence, amino acid, and

C14 accelerator dating results continue to support the concept that Hudson Bay was open about 40 000 and 75 000 years ago.

Contracts aimed at (1) quantifying the Acid Neutralizing Capacity (ANC) of glacial sediments, (2) defining the role of gases generated in lake bottoms in modifying cation distributions, and (3) summarizing and explaining the geochemical and mineralogical characteristics of till in the Estrie-Beauce region of Quebec were completed. Results of these projects are in preparation for publication.

Over the past year the SIR data bases used by the Section have added a significant number of variables and the number of project specific data bases has doubled. Plotting programs for striations and geochemical data have reached a stage of regular use for data compilation and display. The fence data display package is nearly finished testing and is now starting regular use.

Personnel Notes

The Sedimentology and Mineral Tracing Section consists of a permanent staff of 5 Research Scientists, 2 Physical Scientists, and 5 Technicians. In addition, 1 Research Scientist, 6 Physical Scientists and 2 Technicians work in support positions. The Section also supervised 11 contracts, and supported 4 Ph.D. and 2 M.Sc. theses.

Attendance at Meetings, Conferences and Courses

J.D. Adshead

Presented a paper at the American Geophysical Union, San Francisco, December 1985.

J.R. Bélanger

Presented a paper at the 1986 Current Activities Forum, Ottawa, January 1986.

R.N.W. DiLabio

Presented a paper at the International Geochemical Exploration Symposium, Toronto, April 1985.

Presented a poster display at the Manitoba Department of Energy and Mines Current Activities Forum, Winnipeg, November 1985.

Ontario Geological Survey Current Activities Forum, Toronto, December 1985.

Presented a poster display at the 1986 Current Activities Forum, Ottawa, January 1986.

I. Kettles

Presented a poster display at the Association of Exploration Geochemists Annual Meeting, Toronto, April 1985.

Presented a poster display at the Muskoka Acid Rain Conference, Muskoka, Ontario, September 1985.

Ontario Geological Survey Open House, Toronto, December 1985.

R.A. Klassen

Presented a paper at the International Geochemical Exploration Symposium, Toronto, May 1985.

Presented a paper at the Geological Association of Canada Annual Meeting, Fredericton, May 1985.

Newfoundland Department of Mines and Energy Open House Forum, St. John's, November 1985.

Presented a paper at the 1986 Current Activities Forum, Ottawa, January 1986.

W.W. Shilts

Presented a poster display at the Association of Exploration Geochemists Symposium, Toronto, May, 1985.

Presented a poster display at the Muskoka Acid Rain Conference, Minett, Ontario, September 1985.

Presented a poster display at the 1986 Current Activities Forum, Ottawa, January 1986.

Presented a poster display at the Exploration Round-up, Vancouver, February 1986.

Presented a poster display at the Prospector's and Developer's Association, Toronto, March 1986.

Membership on Committees

J.M. Aylsworth

Terrain Sciences Map Legend Committee, Member

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

R.N.W. DiLabio

Terrain Sciences Division Display Committee, Member

11th International Geochemical Exploration Symposium, 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

J.R. Bélanger

'Drift prospecting and remote sensing' at Concordia University, Montreal, March 1986.

R.A. Klassen

'Glacial history of Bylot Island' to staff and graduate students of Lehigh University, Bethlehem, Pennsylvania, February 1986.

W.W. Shilts

Two talks (1) 'Erosion and glacial sedimentation -- configuration and history of Laurentide Ice Sheet' and (2) 'Glacial and periglacial environments in Canadian Arctic' at the University of Sherbrook, Sherbrook, April 1985.

'Geology of Laurentide Ice Sheet' to the Ottawa Glaciology Discussion Group, Ottawa, April 1985.

Two talks (1) 'Geology of Laurentide Ice Sheet' and (2) 'Acid Rain' at DePauw University, Greencastle, Indiana, October 1985.

'Geology of Laurentide Ice Sheet' at Waterloo University, Waterloo, April 1985, and at the University of Windsor, Windsor, May 1985.

'Geological models for the configuration and history of the Laurentide Ice Sheet' to the Logan Club, Ottawa, October 1985.

'Geochemistry of Appalachian tills of southeastern Quebec' at the Ministère de l'énergie et des ressources open house, Quebec, November 1985.

'Geology of Laurentide Ice Sheet' to G.S.C. personnel, Vancouver, February 1986.

Laboratories

Physical Sedimentation Laboratory, Tunney's Pasture

Yearly Report

	<u>No. of Samples</u>
Freeze Drying	1485
Complete Sieve & Pipette	290
Gravel-Sand-Silt-Clay	1150
Hygroscopic Moisture Content	1185
Atterberg Limits	103
Calcite/Dolomite Ratio	13
Natural Water Content	60
Soil Colour Determination	600

Drift Chemistry and Mineralogy Laboratory

This Laboratory operated at 2/3 strength for part of the year. Much effort is expended by both laboratories in maintaining a drift sample reference collection and computer file for rapid location of samples for further analyses.

Production Summary

	<u>No. of Samples</u>
Clay separations (for chemical analysis)	2470
Dry sieving to <64µm (for carbonate and trace element determination)	2160
Carbonate/non-carbonate carbon determinations (Leco carbon analyzer)	1320
Heavy mineral separations	6
Grinding of coarse fractions (for chemical analysis)	130
Clay slide mounts for XRD	100
Samples & splits coded and archived	7800

GEOMORPHIC PROCESSES AND ENGINEERING GEOLOGY SECTION

J.A. Heginbottom (Head)

The task of the Geomorphic Processes and Engineering Geology Section is to provide information on the nature and occurrence of geomorphic processes and on the engineering characteristics of geological materials in Canada, including the continental shelves. Particular emphasis is placed on processes of the permafrost environment of northern Canada, and on studies related to landslide hazards. Advice is provided on the implications of development proposals on the physical environment. The work of the Section also includes studies related to resource development in the mountains of western Canada and studies of fluvial processes. Facilities available in the Section include a research cold room.

Highlights

Completion of the first phase of a project to examine the impact of construction of the Norman Wells to Zama Lake pipeline on the geological environment of the upper Mackenzie Valley. This work was supported in part by O.E.R.D.

Participation in a geotechnical field drilling program on Richards Island, N.W.T., in conjunction with Indian and Northern Affairs Canada. The work, which included logging of geotechnical and geocryological characteristics of subsurface materials, was in preparation for a program to test the efficacy of ground probing radar geophysical surveys for the delineation of bodies of ground ice, to be done in 1986-87. This work was supported in part by O.E.R.D.

Continuation of a survey of geotechnical and geocryological conditions along the land-side of the coastal zone of the Beaufort Sea. This work was supported in part by O.E.R.D. and in part by N.O.G.A.P.

Continuation of a project to examine the influence of flooding on the take-up of heavy metals by trees.

Continuation of a project to study periglacial geomorphic processes in the vicinity of Cambridge Bay, Victoria Island. Work during the year included study of the distribution of ice in the active layer and its variation during the summer thaw season; and preliminary drilling and geophysical study of an area of thermokarst.

Evaluation of the potential for both shallow slope movements and deep-seated movement of the rock mass of Parliament Hill, Ottawa. The conclusion is that while shallow slope movements are continuing to occur, the geological conditions of the rock mass are such that no major movements are anticipated.

Examination of landslide characteristics of metamorphic terrains in the Columbia Mountains, B.C., landslides in glaciolacustrine deposits in central British Columbia, and geotechnical aspects of moraine dams in the Selkirk and Coast Mountains, B.C.

Comparison of laboratory data on the acoustic transmission properties of seabed sediments from the southern Beaufort Sea with field data obtained from a sonic cone penetrometer, as part of a program to evaluate the use of the SCPT for in-situ tests of materials to determine their geotechnical characteristics. This work was supported in part by O.E.R.D.

In co-operation with staff of RGG Division, the installation of 10 ground temperature cables in shallow waters of the southern Beaufort Sea, in an area studied previously. Preliminary results indicate a substantial body of shallow permafrost immediately adjacent to the shore. This work was supported in part by O.E.R.D.

Completion of a report on physical and geotechnical observations on land reclamation of open pit mines, Alberta and B.C., and completion of a project on the environmental assessment of coal resource development, Canadian Cordillera, commenced in 1977.

Completion of a project to examine the hazard associated with debris flows in the Rocky Mountains, Alberta.

Continuation of a study of Quaternary geology and terrain conditions in the Logan Mountains, Yukon-N.W.T. Work in 1985-86 included completion of field work in the Tay River map area (105 K), investigation of Eocene basalts in the Finlayson Lake map area (105 G) and completion of a terrain inventory map of the Finlayson Lake map area (105 G).

Completion of a report comprising contributions to a joint Canadian-American workshop on correlation of Quaternary deposits and events around the Beaufort Sea. The report is to be released as a GSC Open File.

Personnel Notes

The Geomorphic Processes and Engineering Geology Section consists of a permanent staff of 4 Research

Scientists, 2 Physical Scientists and 1 Technician. In addition, 1 Physical Scientist works in a support position. The Section also supervised 4 contracts and 4 EMR Research Agreements.

Attendance at Meetings, Conferences and Courses

S.G. Evans

81st Annual Meeting, Cordilleran Section, Geological Society of America, Vancouver, May 1985.

7th Annual Slope Hazards Investigation Trip, Vancouver, October 1985.

Presented a paper at the 1986 Current Activities Forum, Ottawa, January 1986.

D.G. Harry

Presented a paper at the Workshop on Research Methods in Geomorphology, Toronto, April 1985.

Presented a paper at the 14th Arctic Workshop, Halifax, November 1985.

Permafrost Workshop, Edmonton, November 1985.

J.A. Heginbottom

Presented a paper at the First International Conference on Geomorphology, Manchester, England, September 1985.

International Permafrost Association Executive Committee, Oslo, Norway, September 1985.

Joint Quaternary Research Association (UK)/IGU Periglacial Commission Symposium on Periglacial Processes and Landforms in Britain and Ireland, Manchester, England, September 1985.

Workshops on Offshore Permafrost and Permafrost Geophysics, Edmonton, November 1985.

Permafrost Subcommittee and Working Groups, Edmonton, November 1985.

CNC International Permafrost Association, Edmonton, November 1985.

P.J. Kurfurst

38th Canadian Geotechnical Conference, Edmonton, September 1985.

Membership on Committees

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

J.A. Heginbottom

Permafrost Subcommittee, NRC Associate Committee on Geotechnical Research, Member

Working Group on Ground Ice, International Commission on Snow & Ice, Member

Commission on the Significance of Periglacial Phenomena, International Geographical Union, Corresponding Member

Terrain Sciences Division Display Committee, Chairman

EMR Permafrost Committee, Member

L.E. Jackson

International Conference on Palynology 1984, Member; Organizing Committee, Member; Field Trips Subcommittee, Chairman

P.J. Kurfurst

Underground Research Laboratory Project Management Committee, Member

Subcommittee on Marine Geotechnical Engineering, NRC Associate Committee on Geotechnical Research, Member

Underground Research Laboratory Site Evaluation Subcommittee, Chairman

Committee on Needed Research for Northern Pipelines, Member

NEP Subcommittee on Canadian Facility for Controlled Environmental Research and Testing, Member

Executive Committee, Engineering Geology Division, Canadian Geotechnical Society, Member

Special Talks or Lectures

S.G. Evans

Four lectures on 'Landslides in the Canadian Cordillera' to graduate students in geotechnical engineering, University of Alberta, Edmonton, November-December 1985.

'The engineering geomorphology of Big Slide, British Columbia' to the Edmonton Geotechnical Society, Edmonton, Alberta, November 1985.

'Catastrophic processes in glacier forelands' to the Department of Geology and the Graduate Seminar in Geotechnical Engineering, Department of Civil Engineering, University of Alberta, Edmonton, November-December 1985.

D.G. Harry

'Geomorphic role of ground ice' and 'Periglacial landscape evolution, Arctic Canada' to faculty and students, Department of Geography, University of Western Ontario, London, November 1985.

P.J. Kurfurst

'GSC: Current Research, needs and goals in the field of acoustic properties' at the Atlantic Geoscience Centre, Halifax, June 1985.

'Marine geotechnique and permafrost' to Chinese Engineering Geology Delegation, Ottawa, November 1985.

STAFF LIST

(to March 31, 1986, as supplied by reporting units)

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Regional Reconnaissance

Blakeney, C.P.
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Eastern Petroleum Geology

Ascoli, P.
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Mathematical Applications in Geology

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Regional Mineral Resource Assessment

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