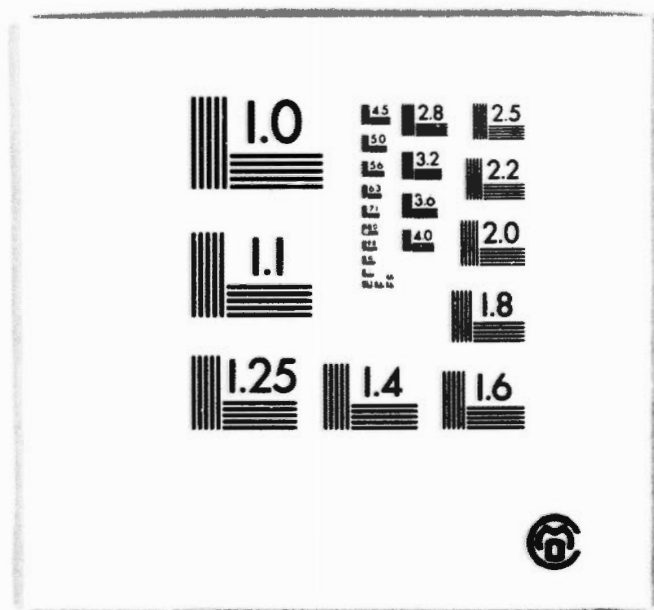


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**LE CONSEIL CANADIEN
DES SCIENCES
DE LA TERRE**

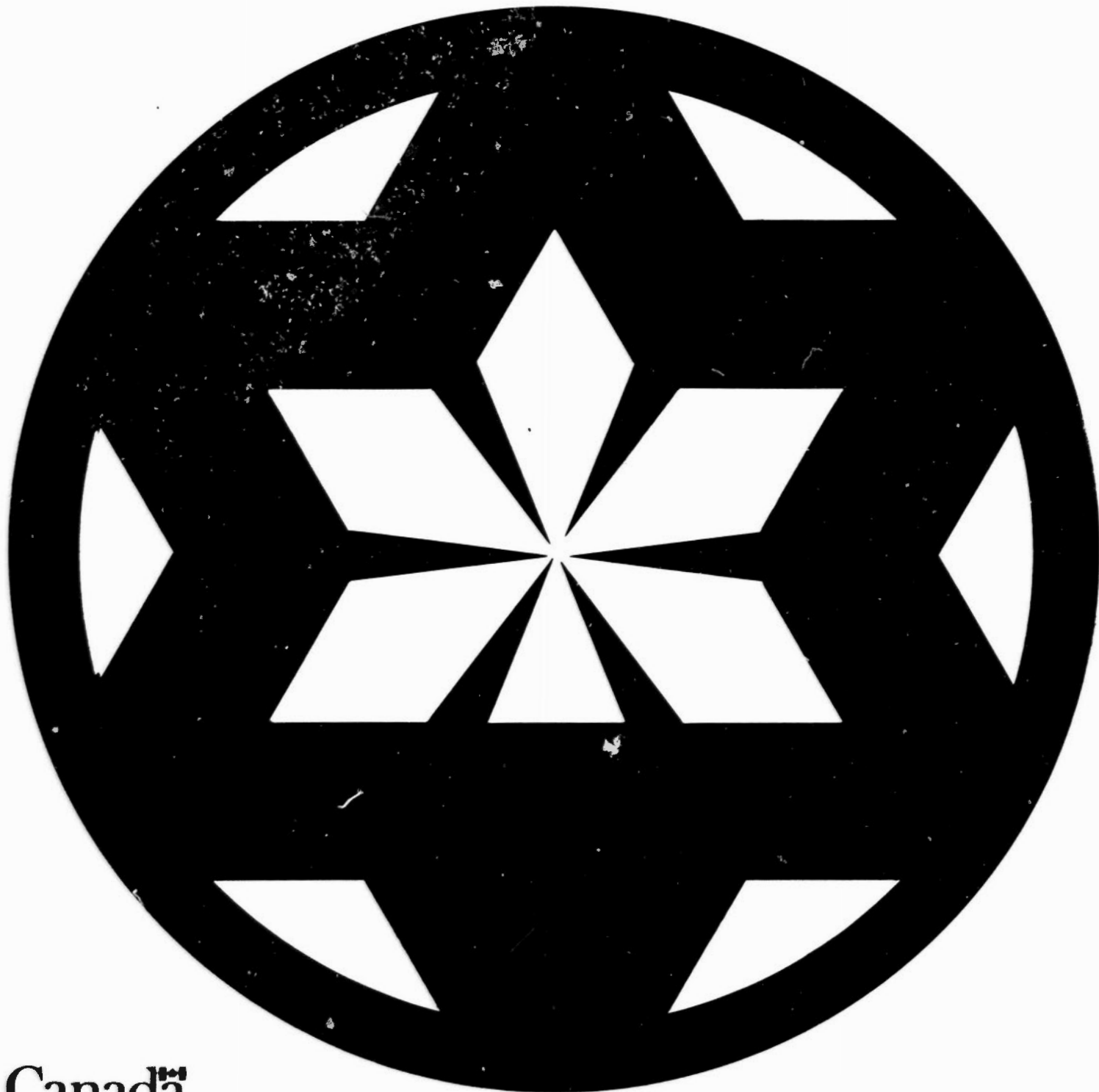
Publié par la Commission
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Étude 80-6, partie 1

**LES SCIENCES DE LA TERRE
AU CANADA, 1979**

Partie 1: La géologie et la
géophysique dans les
universités canadiennes

E.R.W. Neale et J.E. Armstrong



Canada

ANNEXE 2A
UNIVERSITÉS QUI ONT DÉCERNÉ DES DOCTORATS EN
GÉOLOGIE ET GÉOPHYSIQUE.

GEOLOGISTS

Canadian Universities

1. Alberta	6
2. British Columbia	6
3. Carleton	1
4. Dalhousie	2
5. Ecole Polytechnique	1
6. Laval	5
7. Manitoba	2
8. McGill	28
9. McMaster	12
10. Memorial	2
11. Montreal	2
12. New Brunswick	2
13. Ottawa	2
14. Toronto	18
15. Waterloo	1
16. Western Ontario	7
TOTAL	97 (27.2%)

United States Universities

1. Brown	3
2. California at Berkley	12
3. California at Davis	1
4. California at Los Angeles	2
5. California Inst. of Tech.	3
6. Chicago	5
7. Cincinnati	2
8. Colorado	2
9. Columbia	5
10. Connecticut	1
11. Cornell	2
12. Harvard	4
13. Illinois	7
14. Indiana	2
15. John's Hopkins	4
16. Kansas	3
17. Massachusetts Inst. Tech.	13
18. Michigan	5
19. Michigan State	1
20. Minnesota	2
21. New York University	1
22. Northwestern	2
23. Oklahoma	1
24. Pennsylvania	1
25. Pennsylvania State	1
26. Pittsburgh	1
27. Princeton	15
28. Purdue	2
29. Rennseler Polytechnique	1
30. Southern California	1
31. Stanford	6
32. Suny (Binghamton)	2
33. Washington	2
34. Western Reserve	1
35. Wisconsin	3
36. Yale	8
TOTAL	130 (36.5 %)

United Kingdom Universities

1. Aberdeen	1
2. Birmingham	2
3. Cambridge	11
4. Durham	2
5. Edinburgh	7
6. Glasgow	6
7. Leeds	1
8. Leicester	1
9. Liverpool	7
10. London	18
11. Manchester	9
12. Newcastle	2
13. Nottingham	1
14. Oxford	5
15. Queens (Belfast)	1
16. Reading	6
17. Sheffield	1
18. Southampton	1
19. Wales	5
TOTAL	87 (24.5%)

Other World Universities

1. Adelaide (Australia)	1
2. Australian National Univ.	8
3. Bordeaux (France)	1
4. Brussels (Belgium)	1
5. Capetown (South Africa)	1
6. Clermont-Ferrand (France)	1
7. Charles (Czechoslovakia)	2
8. Copenhagen (Denmark)	1
9. Geneva (Switzerland)	1
10. Innsbruck (Austria)	1
11. Jladalpur (India)	1
12. Krakow (Poland)	1
13. Latvia	1
14. Leiden (Netherlands)	1
15. Lund (Sweden)	1
16. Munich (West Germany)	2
17. Neuchatel (Switzerland)	1
18. New South Wales (Australia)	1
19. Otago (New Zealand)	2
20. Paris (France)	1
21. Parma (Italy)	1
22. Queensland (Australia)	1
23. Stuttgart (West Germany)	2
24. Toulouse (France)	2
25. Trinity (Ireland)	1
26. Tübingen (West Germany)	2
27. West Berlin (W. Germany)	1
28. Witwatersrand (S. Africa)	1
29. Zurich (Switzerland)	2
TOTAL	42 (11.8%)

SUMMARY OF GEOLOGY PROFESSORS

Ph.D.'s from Canadian Univ.	97
Ph.D.'s from U.S.A. Univ.	130
Ph.D.'s from U.K. Univ.	87
Ph.D.'s from elsewhere	42
TOTAL	356
Geologists without Ph.D. degree:	14

GEOPHYSICISTS

Canadian Universities

1. Alberta	4
2. British Columbia	12
3. Dalhousie	1
4. Laval	1
5. Manitoba	2
6. McGill	5
7. McMaster	1
8. Saskatchewan	3
9. Toronto	15
10. Western Ontario	

United States Universities

1. California at Berkley	2
2. California at L.A.	1
3. California at San Diego	1
4. California Inst. of Tech.	1
5. Mass. Institute of Tech.	2
6. Princeton	2
7. Saint Louis	1
8. Utah	3
TOTAL	13 (17%)

United Kingdom and other non-North American

1. Adelaide (New Zealand)	1
2. Australian National	2
3. Cambridge (U.K.)	4
4. Charles (Czechoslovakia)	1
5. Cologne (West Germany)	1
6. Leeds (U.K.)	2
7. London (U.K.)	2
8. Oxford (U.K.)	1
9. Tohoku (Japan)	1
10. Utrecht (Holland)	1
11. Witwatersrand (South Africa)	1
TOTAL	17 (22%)

SUMMARY OF GEOPHYSICS PROFESSORS

Ph.D.'s from Canadian Univ.	47
Ph.D.'s from U.S. Univ.	13
Ph.D.'s from United Kingdom and other non-North American Univ.	17
TOTAL	17

FOOTNOTES

1. Total number of geologists and geophysicists employed by Canadian universities: 464.
Total number of geologists and geophysicists accounted for in this table: 433.
Information was not available on 31 or approximately 6.7%.
2. The doctorate degrees do not accurately represent the number of Canadians on the staffs as prior to the 1970's many Canadian graduates went to the U.S.A., U.K., and Australia for their doctorate degrees. Listed below are two representative groups of universities indicating where the staff obtained their first and final degree.
 - a) Three western universities, British Columbia, Calgary and Saskatchewan
Total staffs 57
Bachelor's degree
Canadian 26
U.S.A. 13
U.K. 10
Elsewhere 8
Doctorate degree
14
27
9
7
3. The great majority of professors hired from outside of Canada are now Canadian citizens.
4. To demonstrate the cosmopolitan training of our staffs, contrast with the 7 campuses of the University of California with an academic staff of 187, only 25 obtained their doctorates outside the U.S.A.

ANNEXE 2B
ÉQUIPEMENT PRINCIPAL DANS TROIS DÉPARTEMENTS,
ALBERTA, 1979

a) Research Equipment

Mass spectrometers MS10, MM6, MM30B and home-built 6-inch machine. Access to 7 other mass spectrometers which are used on a shared basis.

Argon fusion system
Rb, Sr, U and Pb SMD laboratories.

ARL EMX Microprobe
ARL SEMQ Microprobe
Various electronic testing equipment

2 X-ray diffraction units
2 Manual XRF units
1 Philips Pailred single crystal diffractometer
2 Gamma ray spectrometers

1 Sieve shaker and ultrasonic sieve
1 Rock splitter
4 Rock saws
2 Jaw crushers
4 Rock grinders
2 Thin section grinders
4 Rock polishers
3 Swing mills
1 Wilfley table
2 Frantz separators

1 30 kilobar press
1 5 kilobar internally heated pressure vessels
6 cold seal bonds
Several 1 atmosphere furnaces and all appropriate pressure controlled equipment

Fully equipped chemical analytical laboratory capable of doing ultra-clean analytical work
2 Beckman ASS units
2 Perkin Elmer ASS units
1 Perkin Elmer flame photometer

93 Stereo microscopes
66 Reflective light microscopes
57 Polaroid microscopes
Microscopes include 3 Zeiss Universal Vickers hardness testing equipment, heating and freezing fluid inclusion stages with television screen

5 Drafting tables
1 Theodolite light
2 Stereo plotters
2 Microfilm readers
10 Electric typewriters
Numerous programmable calculators
5 Terminals including graphics display unit
10 Cameras
3 Polaroid cameras
1 16 mm camera
2 Enlargers
1 Photographic dryer
Floodlight unit
Magnetometer
1 Soil moisture meter
1 Water current meter
1 Water level recorder
2 Seismometers
1 Mobile auger
1 GSC sample drill
3 Trail bikes
3 Inflatable boats
2 Canoes
4 Outboard motors
1 Trailer

Question

(b) Do you charge time on any of this equipment against research grants? No.

Question

(c) Do you charge outsiders for the use of it? Yes.

Institute of Earth and Planetary Physics
University of Alberta, November, 1978

1. Mass spectrometers

Unit	Manufacturer	Funding	Replacement Cost	Status	Use
M.S 1	In Dept of Physics	U. of A.	*\$75,000	Under construction	C,O
M.S 2	"	\$25,000 NRC CAP (Cumming)	*\$75,000	Recently upgraded	Rb (Sr)
M.S 3	"	NRC \$25,000 (Krouse)	*\$75,000	Obsolete	C,O
M.S 4	"	NRC CAP (Cumming) \$25K	*\$75,000	Being rebuilt	U,Pb
MM30	V.G. Micromass	NRC CAP (Lambert) \$142K	\$142,000	2 yr. old	U,Pb Sr
MM602D	"	\$32K	\$32K	2 yr. old	H/D

*In-house rebuilding costs.

2. Seismology

(1) SEISMIC DATA LINK (Funding U. of A.)

This is situated in the Edmonton (EDM) Observatory (U. of A. property) and contains Energy, Mines and Resources Seismic Analog Earthquake recording system with 3 long period and 3 short period instruments. The telemetry and digital recording system is University capital equipment. This includes Analog to Digital converter, multiplexer, amplifiers, 2 radio repeaters (RCA-54A), 6 helicorders, a PDP 11/20 computer with 28,000 word memory, 2 magnetic tape formats, 5 tape driver. Mixed age but all parts good for about 3 years.

Value ~\$200,000

(2) TRIPARTITE SEISMIC ARRAY SYSTEM (Funding NRC-negotiated development grant) (Earthquake recording)

9 Systems - Recording system 5-7 years old, nearly obsolete; seismometers and trailers still useful.

New Value ~\$45,000
(but now obsolete except seismo-meters etc. (\$15,000))

(3) PEACE RIVER SEISMIC ARRAY SYSTEM (NRC Funding) Obsolete Value when new ~\$20,000

Above items (2) and (3) being replaced by

(4) SEISMIC TELEMETRY SYSTEM - 3 stations (Earthquakes)

(Funding NRC and U. of A.) ~\$30,000

(5) EVENT DETECTING SYSTEM - 20 stations

(Funding NRCO ~\$30,000

(Items (3) and (4) have been purchased and are being built now.

(6) SEISMIC CRUSTAL REFLECTION RECORDERS

(Funding U.S. Air Force)

(Obsolete but can be used with much maintenance).

Parts of this are 7 to 15 year sold. (Part of U.S. Air Force grant for crustal studies).

Old Cost ~\$50,000

(7) TEST EQUIPMENT (Funding U. of A.)

Tectronix oscilloscopes, function generators, meters, etc. Value (fairly new) 15,000

(8) FIVE TERMINALS for access to University computer and playback of field tapes

Value (fairly new) 15,000

(Funding U. of A. and NRC)

(9) GEODETIC SURVEY EQUIPMENT

Value (new) 12,000

(Funding U. of A.)

3. Magnetometer arrays

No.	Unit	Manufacturer	Funding	Replacement Cost	Status	Use
25	Gough-Reitzel magnetometer	In Dept. of Physics	U. of A. + NRC operating + \$6,000 capital	\$75,000	Serviceable, being upgraded	Magnetometer arrays
8	As above	As above NRC operating	U. of A. +	\$24,000	Under construction	As above

4. Paleomagnetism and Rock Magnetism

Magnetically shielded room	In Dept of Physics	NRC capital + U. of A.	\$30,000	Operational	Thermal demagnetization of paleomagnetic specimens; field-free storage
Cryogenic magnetometer	Superconducting Technology Inc. California	Alberta/Canada ERRF	\$33,000	On order	Cretaceous magnetostratigraphy
Spinner magnetometer 1	Digico, England	NRC capital +U. of A.	\$35,000	Operational	General paleomagnetic measurements; low and high temperature investigations
Spinner magnetometer 2	Schonstedt	U. of A.	\$20,000	Operational	General purpose; good for fragile specimens
Spinner magnetometer 3	P.A.R.	\$9,000 in 1966 U. of A.	—	Operational (but tends to be held in reserve)	General purpose measurements
Anisotropy of susceptibility magnetometer	Dept. of Physics	U. of a. + NRC opetating	\$25,000	Operational	rock fabric studies
High temperature vibrating sample magnetometer	Dept. of Physics	U. of A. + NRC operating	\$40,000	Operational	Room and high temperature measurements of magnetization

Major Equipment, Department of Geological Sciences, U.B.C.

Equipment	Purpose type of research	How financed	Date purchased	Replacement value	Maintenance cost per year	Life expectancy	Breakdown time per year
Microprobe		Special grant	1975	\$200,000	\$4,000	20 yr?	20 weeks
Mass Spectrometer	Isotope	Special grant	1973	\$200,000	\$800	20 yr	1 week
X-ray Fluorescence		Special grant	1976	\$80,000	\$800	20 yr	2 weeks
X-ray Diffractometer		Department funds and special grant		\$90,000	\$800	20 yr	2 weeks
X-ray Spectrometer		Grant	1976	\$80,000	\$800	20 yr	2 weeks
Ultraphot	Optical	Department funds and grant	1968	\$25,000	\$300	15 yr	5-10 days
Ultraphot	Optical	Grant	1969	\$20,000	\$50	15 yr	--
Lathe	Research equip. manufacture	Department funds	1978	\$18,000	\$100	30 yr	2-10 days
Maho Milling Machine	Research equip. manufacture	Department funds and grants	1970	\$22,000	\$100	25 yr	1 week
Truck	Field Trips/Field Work/ Runabout	Department funds	1978	\$13,000	\$500	10 yr	1 week
Press (HJG)	Experimental petrology	NRC	1976-8	\$15,000	\$1000	10 yr	2 weeks
Press (JVR)	Experimental deformation	NRC	1970	\$15,000	\$1000	10 yr	2 weeks

1. Charging of operating costs of microprobe, XRF, XRD equipment to users inside and outside the University.

Non-U.B.C. users

\$50.00 per hour, plus film costs

Discussion centred around the need to defray operating and maintenance costs, and the need to charge outside users enough so as not to compete unfairly with any available commercial supplier of the same or similar service. After considerable discussion, the following rates were agreed upon.

XRD Departmental users	\$ 3.00 per hour, diffractometer \$ 5.00 per run, powder cameras
Non-U.B.C. users (contracts, etc)	\$20.00 per hour, or \$10.00 per diffractometer chart plus film costs
XRF Departmental users	\$ 3.00 per hour
Non-U.B.C. users	\$20.00 per hour, user supplies materials and manpower
SEMO	Departmental users
Normal working hours	\$20.00 per hour (help available)
Weekends, nights	\$10.00 per hour (permission required)
Undergrad theses	3 hours free, with supervisor's permission

Definition: A non-U.B.C. user is any person, including students, staff, and faculty of U.B.C. who uses instruments to provide results for a person or group outside of the University.

Billing: The user will be billed by the Department for the time used at the above rates. If the user is acting as agent for someone else then that user can collect the amount due privately but it is the user who is financially responsible for the bill.

Under present arrangements, Mary Malcolm will handle invoicing, collecting, and deposit of payment in the proper account.

Cheques may be made payable to the University of British Columbia, and mailed or given to Mary Malcolm.

Accounting of chargeable time used will be attended to by G. Georgakopoulos.

2. Charging rates for Departmental services (E. Montgomery)

Trucks - 20¢ per mile
Thin sections - \$3.75

ANNEXE 3A
DIVERSITÉ DU 1^{er} CYCLE EN GÉOLOGIE ET GÉOPHYSIQUE
DANS LES UNIVERSITÉS CANADIENNES

<u>University and Departments</u>	<u>Undergraduate Degrees in Geology and Geophysics</u>	<u>Duration (in years)</u>
(1) Acadia: Wolfville, N.S. Geology	B.Sc. (pass) and B.A. (pass) in geology B.Sc. and B.A. honours in geology B.Sc. (specialized) in geology	4 4 4
(2) Alberta: Geology, Physics, and Zoology	B.Sc. honours and specialization in geology B.Sc. honours and specialization in geophysics B.Sc. concentration in geology B.Sc. honours and specialization in geology and geophysical B.Sc. honours and specialization in geophysics in geophysics	4 4 3 4 4 4
(3) Brandon: Brandon, Manitoba Geology	B.Sc. major in geology B.Sc. specialist in geology	3 4
(4) British Columbia: Vancouver, B.C. Geological Sciences, Geophysics and Astronomy Geography	B.Sc. major in geology B.Sc. major in geophysics B.Sc. honours in geology B.Sc. honours in geology and geography B.Sc. honours in physics and geophysics B.Sc. honours in physics and geophysics B.Sc. honours in geology and geophysics	4 4 4 4 4 4 4
(6) Calgary: Calgary, Alberta Geology and Geophysics	B.Sc. major in geology B.Sc. honours in geology B.Sc. major in geophysics B.Sc. honours in geophysics	4 4 4 4
(7) Carleton: Ottawa, Ont. Geology, Chemistry and Physics	B.Sc. major in geology B.Sc. honours in geology B.Sc. honours in biology and geology B.Sc. honours in chemistry and geology B.Sc. honours in geology and physics	4 4 4 4 4
(8) Concordia: Montréal, Québec Geology (Note: admission to all Quebec universities for Québec students follows graduation from CEGEP. The CEGEP's have replaced the old first year university programs.)	B.Sc. major in geology B.Sc. honours in geology	3 3
(9) Dalhousie: Halifax, N.S. Geology	B.Sc. major in geology B.Sc. honours in geology	4 4
(10) École, Polytechnique: Montréal, Québec Dept. de Génie Minéral	B.Sc. A. en génie géologique	4
(11) Guelph: Guelph, Ontario Land Resource Science	B.Sc. general program in earth science B.Sc. honours program in earth science	3 4
(12) Lakehead: Thunder Bay, Ontario Geology	B.Sc. general program in geology B.Sc. honours program in geology	4 4
(13) Laurentian: Sudbury, Ontario Geology, Chemistry and Physics	B.Sc. general program in geology B.Sc. honours program in geology B.Sc. honours in chemistry and geology B.Sc. honours in physics and geology	3 4 4 4

University and Departments	Undergraduate Degrees in Geology and Geophysics	Duration (in years)
(14) Laval: Québec City, Québec Géologie	B.Sc. en géologie B.Sc. A. en genie géologique	3 4
(15) Manitoba: Winnipeg, Manitoba Earth Sciences	B.Sc. general earth sciences B.Sc. earth sciences major B.Sc. honours geology option B.Sc. honours research option B.Sc. honours geophysics option includes geophysics exploration earth physics options B.Sc. in engineering geological engineering	3 4 4 4 4 4 4
(16) McGill: Montréal, Québec Geological Sciences and Mining Engineering	B.Sc. major in geological sciences B.Sc. honours in geological sciences B.Sc. honours in solid earth geophysics	3 3 3
(17) McMaster: Hamilton, Ontario Geology, Chemistry and Geography	B.Sc. pass geology B.Sc. major geology B.Sc. honours geology B.Sc. honours chemistry and geology B.Sc. honours geography and geology	3 4 4 4 4
(18) Memorial: St. John's, Nfld. Geology, Physics and Biology	B.Sc. general in geology B.Sc. honours in geology B.Sc. major in geology and geophysics B.Sc. honours in geology and geophysics B.Sc. honours in geology and biology B.Sc. major in geophysics B.Sc. honours in geophysics	4 5 5 5 5 4 5
(19) Université de Montreal: Montréal, Québec Géologie	B.Sc. spécialisé en géologie	3
(20) Mount Allison: Sackville, N.B. Geology	B.Sc. major in geology B.Sc. honours in geology	3 or 4 4
(21) New Brunswick: Geology	B.Sc. major in geology B.Sc. honours in geology	4 4
(22) Ottawa: Ottawa, Ontario Geology	B.Sc. major in geology B.Sc. honours in geology	4 4 or 5
(23) Université de Québec: Chicoutimi, Québec Chicoutime Sc. appliquees, Module des Sciences de la terre	B.Sc. A. en genie géologique	4
(24) Université de Québec: Montréal, Québec Sciences de la terre	B.Sc. en géologie	3
(25) Queen's: Kingston, Ontario Geological Sciences, Chemistry and Physics	B.Sc. major in geological science B.Sc. honours in geological sciences B.Sc. honours in geological sciences B.Sc. honours in geological sciences	3 4 4 4

<u>University and Departments</u>	<u>Undergraduate Degrees in Geology and Geophysics</u>	<u>Duration (in years)</u>
	B.Sc. honours, major concentration in geological sciences	4
	B.Sc. honours, major concentration in geological sciences and chemistry	4
	B.Sc. in geological engineering option 1 mineral resources exploration option 2 engineering geology, environmental engineering option 3 applied geophysics	4
(26) Regina: Regina, Saskatchewan Geological Sciences, Chemistry and Physics	B.A. major in geology	3
	B.Sc. major in geology	3
	B.A. honours in geology	4
	B.Sc. honours in geology	4
	B.Sc. major in applied geophysics	4
	B.Sc. major in chemical geology	3
	B.Sc. honours in chemical geology	4
(27) Royal Roads Military College: Esquimalt, B.C. Physics	B.Sc. honours in marine geophysics	4
	B.Sc. general program in marine geophysics	4
(28) Saskatchewan: Saskatoon, Saskatchewan Geological Sciences	B.Sc. general major in geology	3
	B.Sc. advanced major in geology	4
	B.Sc. honours in geology	4
	B.Sc. honours in geophysics	4
	B.Sc. advanced major in geophysics	4
	B.E. geological engineering	4
	B.E. geological engineering (geophysics option)	4
	B.E. = bachelor of science in engineering)	
(29) St. Francis Xavier: Antigonish, N.S. Geology	B.Sc. general in geology	4
	B.Sc. major in geology	4
	B.Sc. honours in geology	4
(30) St. Mary's: Halifax, N.S. Geology	B.Sc. major (pass) in geology	4
	B.Sc. honours in geology	4
(31) Toronto: Geology Biology Chemistry and Physics Physics Civil Engineering, Metallurgy, and Material Science	B.Sc. general major in geology	3
	B.Sc. specialist major in geology	4
	B.Sc. specialist major in palaeontology	4
	B.Sc. specialist major in chemistry and geology	4
	B.Sc. specialist major in geology and physics	4
	B.A.Sc. geological engineering and applied science	4
	(a) mineral exploration option. (b) mineral engineering option. (c) geotechnical engineering option.	
(32) Victoria: Victoria, B.C.	B.Sc. general program in physics	4
	B.Sc. major in physics	4
	B.Sc. honours in physics	4
	Co-op program available	4
	All above have electives in geophysics	
(33) Waterloo: Waterloo, Ontario Earth sciences	B.Sc. honours in earth sciences	4
	B.Sc. honours in earth sciences Co-op program	5
	B.Sc. honours in science, earth sciences major	4
	B.Sc. major in earth sciences	3 or 4
	The Co-op program has two options namely geology option and geotechnical option	

<u>University and Departments</u>	<u>Undergraduate Degrees in Geology and Geophysics</u>	<u>Duration (in years)</u>
(34) Western: London, Ontario Geology, Geophysics and Chemistry	B.A. concentration in geology B.Sc. general program in geology B.Sc. general program in chemistry and geology B.Sc. honours in geology B.Sc. general program in geophysics B.Sc. honours in geophysics (a) physical option (b) geological option	3 3 3 4 3 4 4
(35) Windsor: Windsor, Ontario Geology, Biology and Geography	B.Sc. general program in geology B.Sc. honours in geology B.Sc. honours in geology and biology B.Sc. honours in geology and geography B.A.Sc. in geological engineering	3 4 4 4 4
(36) York: Downsview, Ontario Earth and Environmental Science Program	B.Sc. specialized honours in earth sciences B.Sc. honours in earth science and environmental science B.Sc. honours in physics and earth science B.Sc. honours in applied computational and mathematical science and earth science	4 4 4 4

ANNEXE 3B
PROGRAMMES TYPES DE 1^{er} CYCLE EN GÉNIE

Queen's University
Mineral Resources Option

University of British Columbia
Mineral Exploration (Mining Option)

2nd year

Physical Chemistry
Analytical Chemistry
Strength of Materials
Descriptive Geometry
Crystallography
Mineralogy & Petrology
Earth History, Time &
Stratigraphy
Physics of the Earth
Chemistry of the Earth
Differential Equations
Probability & Applied
Statistics

Technology and Society
Mechanics of Solids
Materials Science
Fluid Mechanics
Plane Surveying
Intro. to Computers and
Programming
Intro. to Mineralogy and
Petrology
Stratigraphy and Structure
Sedimentology
Elem. Statistics
Differential Equations ii
Series and approximation
Methods

3rd year

Principles of Economics
Applied Plane Surveying
Soil Mechanics
Field Methods
Structural Geology I
Optical Mineralogy and Petrology
Groundwater Hydrology
Fossil Fuels
Rock Properties I
Elements of Mineral Engineering

Engineering Communication
Effective Technical Reporting
Structural Geology
Sedimentation
Introductory Field School
Mineral Resources &
Exploration
Energy & Water Resources
Introduction to Petrology
Terrain Analysis
Ore Petrology

INTRODUCTION TO GEOLOGY AND GEOPHYSICS

3rd year

Hydrogeology
Introduction to Mining

4th year

Professional Engineering Practice
Thesis
Mineral Deposits
Sulfide Mineralogy and
Mineralogography
Petrology
Field Geology
Applied Physics of the Earth
Introduction to Valuation
Introduction to Rock Mechanics
and electives

Senior Field School
Geological Engineering Thesis
Introduction to
Applied Geophysics
Metallogeny and
Mineral Exploration
Geochemistry of Ore Deposits
and Mineral Exploration
Exploration Geochemistry
Mine Valuation and Finance
Economics of the Mineral Industry
and electives

ANNEXE 3C

SOMMAIRE DES RÉPONSES RELATIVES AU QUESTIONNAIRE ENVOYÉ AUX COMPAGNIES MINIÈRES ET D'EXPLOITATION MINÉRALE

Questionnaire

Dear Sir,

The Canadian Geoscience Council has set up a committee under the chairmanship of Dr. John E. Armstrong to do a study of the Status of Geoscience in Canadian Universities. Important aspects of that study include an assessment of career preparedness of recent and current graduates, an assessment of whether appropriate numbers of students are graduating in various subdisciplines, and a review of research emphasis and the degree of research collaboration between individual faculty members and others. The enclosed questionnaire is intended to obtain opinions on these and related topics from people in industry who employ and supervise geoscientists. I would much appreciate it if you would return it to me after completion by the member or member of your staff most directly concerned with the hiring and evaluating of geoscientists and with industry - university research and research co-operation. Additional copies of the questionnaire are available on request.

Yours truly,

P.L. Money
Chief Geologist
Canadian Exploration,
Texasgulf Inc.

CANADIAN GEOSCIENCE COUNCIL STUDY OF THE STATUS OF GEOSCIENCE IN CANADIAN UNIVERSITIES QUESTIONNAIRE FOR INDUSTRY (EXCLUSIVE OF OIL AND GAS)

1. Company
2. Division and/or Department
3. Names(s) and title(s) of staff members completing questionnaire
4. Main function(s) of geoscientists in division and/or department
 - Mine geology - metals
 - non-metallic except coal
 - coal
 - Exploration - metals
 - non-metallic except coal
 - coal
 - Other(s) (specify)
5. Commodities and/or deposit types of major interest
6. Number of geoscientists on permanent staff with university or equivalent training

Academic Level

	B.A.Sc. or other Engineering degree	B.Sc or other Non-engineering degree	M.A.Sc.	M.Sc.	Ph.D.	"Equivalent Training"
Geology						
Geophysics						
Geochemistry						
Other (Specify)						

7. (a) At what academic level(s) do you currently prefer to hire geoscientists?
(b) Has this changed recently? If so, when and in what way?
(c) If you have hired at levels other than those you prefer within the past 5 years please list and explain why (e.g. exceptional individual(s), nobody available at preferred level, etc.).
8. (a) Have you found it necessary to hire geoscientists educated outside of Canada because people with suitable qualifications educated in Canada were not available?
(b) If yes, in what field(s) of specialization and at what academic level?
9. In which subdisciplines are Canadian universities producing too many graduates (specify academic levels)?
10. In which subdisciplines are Canadian universities producing too few graduates (specify academic levels)?
11. Judging from staff members and temporary employees hired within the past 5 years what aspects of training generally require improvement (specify academic level and subdiscipline)?
12. If in the previous question you have recommended additional training what adjustments in university programs would you recommend to accomodate such training.
13. List Canadian universities you are familiar with which in your opinion currently offer outstanding/superior/adequate/poor training of geoscientists. Specify academic level and subdiscipline.
14. (a) Have any of your staff carried out joint research projects with university staff within the past 5 years?
(b) If yes, with whom and at what university?
15. Has your company recently sponsored research projects or studies at any Canadian universities? If so, where and of what type?
16. In the past 5 years has your company helped to provide thesis topics at Canadian universities? If yes, at what academic level(s) and university(s).
17. What areas or topics of geoscience research require more work or work of better quality at Canadian universities?
18. What should be the balance in Canadian university research in geosciences amongst field-oriented, laboratory-oriented, the theoretical studies?
19. In your opinion is this balance usually achieved? If not, what is overemphasized?
20. Comments

Summary of responses from Mineral Exploration and

Mining companies

Dr. P.L. Money, a member of the Geoscience Council of Canada Committee established to study the Status of Geoscience in Canadian Universities sent a detailed questionnaire to more than 150 mineral exploration, mining, and mineral consulting companies seeking their views on the education of geoscientists by Canadian universities. The questionnaire and the accompanying letter are attached to this summary. Twenty questions were asked. 150 companies replied and all answered questions 1 to 6. The names of the companies replying are attached to this summary.

Synopsis of answers to questions 4 to 6.

(a) Total number of employers	150
(b) Total number of geoscientists employed	1210
(c) Type of employer	
1) Mineral exploration companies	61
2) Mining companies with large exploration program centred at mine	6
3) Mining companies with a small local exploration program	17
4) Mining companies without exploration program	55
5) Consulting geoscientist firms	11

(d) Education level of employees in above 5 groups

	B.Sc.	B.A.Sc.	M.Sc.	M.A.Sc.	Ph.D.	Equivalent Training
1.	384(45.3)	124(14.4)	163(19.2)	35(4.1)	103(12.1)	42(4.9)
2.	59(63.5)	17(18.2)	6(6.4)	1(1.1)	4(4.4)	6(6.4)
3.	33(36.3)	25(27.5)	9(9.9)	3(3.3)	3(3.3)	18(19.7)
4.	55(49.5)	32(28.3)	8(7.3)	3(2.9)	2(1.8)	11(9.9)
5.	19(29.7)	18(29.1)	6(9.4)	2(3.1)	18(29.1)	1(1.5)
Total	550(45.5)	216(17.8)	192(15.9)	44(3.6)	130(10.7)	78(6.4)

(e) Categories of employees

Geologists	1122
Geophysicists	54
Geochemists	14
Others	20

Summary of answers made to questions 7 to 20 employers in categories 1,2, and 5, who are mainly concerned with mineral exploration.

These 3 categories total 78 employers and employ 1008 of the geoscientists.

Question 7: At what academic level(s) do you currently prefer to hire geoscientists.

(a) B.Sc.	15
(b) B.A.Sc.	7
(c) M.Sc.-M.A.Sc.	8
(d) B.Sc.-B.A.Sc.-M.Sc.-M.A.Sc.	25
(e) Ph.D.	4
(f) All levels	9
(g) No answers	10
	78

Question 8: Have you found it necessary to hire geoscientists educated outside of Canada

Very few yes answers were received to this questions. The great majority of companies prefer to employ Canadians. Several stated that they thought British and European geoscientists were better trained. About a dozen companies said: occasionally they had to seek specialists from outside Canada. Three companies stated they hired non-North American geoscientists because they were willing to work for lower salaries.

Question 9: In which subdisciplines are Canadian universities producing too many graduates
(includes multiple answers)

- | | |
|--|----|
| (a) B.Sc. geology, without specialities | 5 |
| (b) B.Sc. geology, laboratory and theoretically oriented | 3 |
| (c) B.Sc. economic geology | 2 |
| (d) B.Sc. geology and geophysics, overspecialized | 2 |
| (e) B.A.Sc. geological engineer | 1 |
| (f) B.Sc. environmental studies | 3 |
| (g) B.Sc. geochemistry | 2 |
| (h) Ph.D.'s most subdiscipliies | 3 |
| (i) No answers | 60 |

In contrast to question 10, these answers seem to indicate many of those who replied are out of touch with the job opportunities for geoscientists.

Question 10: In which subdisciplines are Canadian universities producing too few graduates
(includes multiple answers)

- | | |
|---|----|
| (a) B.Sc. to Ph.D. exploration geophysicists | 9 |
| (b) M.Sc. to Ph.D. exploration geochemists | 4 |
| (c) B.Sc. to M.Sc. coal geologists | 3 |
| (d) B.Sc. to M.Sc. economic geologists | 4 |
| (e) B.Sc. to M.Sc. field, mining, and exploration geologists | 5 |
| (f) B.A.Sc. and B.Sc. mining engineers and geological engineers | 9 |
| (g) B.Sc. to Ph.D. pleistocene geologists | 5 |
| (h) No answers | 46 |

Question 11: What aspects of university training in the geosciences require improvements
(includes multiple answers)

- | | |
|--|----|
| (a) Improvement needed in ability to express oneself in basic and technical english, both in report writing and orally. Several francophone companies had the same complaint regarding french. | 23 |
| (b) Most graduates at all levels have no understanding of business and finance, particularly mining economics. For example few know what 'ore' is. | 18 |
| (c) Many graduates need more preparation in field geology, included here is basic geological mapping, surveying, drafting, and presentation of data. | 16 |
| (d) Practical or applied goephysics, especially the geological interpretation of geophysical data. | 12 |
| (e) Practical application of most course work to exploration and mining geology, particularly true of many courses in economic geology. | 9 |
| (f) Exploration and theoretical geochemistry. | 8 |
| (g) More petrography and identification of rocks and minerals in the field. | 7 |
| (h) Glacial (Pleistocene geology). | 6 |
| (i) Structural geology especially in the field. | 6 |
| (j) Computer processing and geostatistics. | 3 |
| (k) Basic sciences. | 3 |
| (l) No answers. | 14 |

Question 12: If in question 11 you have recommended improvement in university geoscience programs what adjustments would you recommend to accomodate such changes.
(includes multiple answers)

- (a) Improve english with special courses in technical writing. If this is not possible give more essay type exams and exercises and grade them at least 50% on their English (included would be organization and writing style, spelling and in particular grammar). Also include in some courses oral dissertations by students with professor and fellow students acting as critics. 14
- (b) Include at least one course in business and finance and if possible it should be a special course slanted towards the development of nonrenewable resources. B.W. Mackenzie of Queen's department of Geological Sciences gives such a course. Outside speakers from industry and finance could be an integral part of such a course. 8
- (c) More emphasis could be placed on field-oriented geology by reducing some laboratory-oriented courses. Also by employing more staff members whose major interest is in field geology. Another suggestion is that field schools could be extended to 4 weeks or more and should include instrumentation, geochemistry, and geophysics. Still other suggestions include the following: (1) make 3-6 months field work with government surveys or industry compulsory before graduation, this would include a summer essay based on field work. (2) encourage the Geological Survey of Canada and Provincial Surveys to step up their student employment programs. 11
- (d) At least one course should be compulsory in exploration geophysics. 4
- (e) Economic and mining geology. Staff should be hired on a full time basis only after they have had 5+ years experience in industry. Another possibility would be to arrange an exchange system in which industry or government geologists could teach at a university and university geologists could spend up to a year in industry or government. If neither the above suggestions is feasible industry and government geologists could be employed on a part-time basis. Medical and law schools do this on a major scale with their own professionals. Some samples of this in geology already exist to name a very few: Holmes at Toronto, Patton at U.B.C., Toth at Calgary and Brown at Victoria.
- (f) At least one course in exploration geochemistry should be compulsory. 2
- (g) Descriptive mineralogy and petrography should be re-emphasized. 4
- (h) At least one course in Pleistocene (glacial) geology should be compulsory in a country at least 95% glaciated. 4
- (i) Field structural geology should be a compulsory part of all training. 3
- (j,k) These are minor complaints and no solutions were proposed.
- (l) General statements concerning solutions to improve the geology programs include the following: 10
 - (1) Screen out unqualified students and add course load to remainder.
 - (2) Increase number of compulsory courses and decrease the options.
 - (3) Eliminate the exotic courses and substitute basic courses and field-oriented courses.
 - (4) Add one year to undergraduate program as is now done in Waterloo, the extra year for practical training.
 - (5) Increase work load of faculty by cutting back on their research and consulting.
 - (6) As will be seen in question 18 most companies believe: there is too much emphasis placed on laboratory and theoretical- oriented courses and not enough emphasis on basic geology and field-oriented courses. This is especially true with graduate students where many of them overspecialize and become carbon copies of their professors.
 - (7) Students should be taught to think geologically and not to regurgitate their textbooks and professors only. Could be done with much wider use of seminars.
- (m) No answers. 34

Footnote to Questions 11 and 12 (J.E.A.):

Most departments that offer degrees in geological engineering either are oriented towards the mining industry, or have options that are mining oriented. In these cases many of the inadequacies referred to in questions 11 do not apply. To a large extent, although not entirely, the criticism concern B.Sc. degrees offered by Science and Arts and Science faculties. In particular they apply to the major and general programs and to a much lesser extent to the honours programs. They reflect a general trend across Canada in which the compulsory course contact has been reduced and the optional course program increased. Some of the mining exploration and mining companies refer to this as the buffet or smorgasbord system of university education. Some of our departments have eliminated the honours program and others have eliminated the honours thesis or made it optional, many companies consider this retrogressive.

The writer has studied the curricula at the 6 anglophone universities that grant degrees in geological engineering, which are British Columbia, Saskatchewan, Manitoba, Toronto, Queen's, and Windsor. He has noted the following compulsory courses in these 6 schools.

(a) Technical writing and reporting	3
(b) Surveying	5
(c) Computer programming	5
(d) Mining economics, business, finance	6
(e) Statistics	3
(f) Mineral deposits and economic geology	6
(g) Mineral exploration	2
(h) Exploration geophysics	2
(i) Exploration geochemistry	2
(j) Drafting and graphics	5
(k) Field courses and trips	6
(l) Introduction to mining	2

Where they are not compulsory most are normally available, as electives, the exceptions are (a), (g), (i), and (l).

In the course of the writer's travels he had the opportunity to talk to many undergraduate students, many of them mentioned several areas in need of improvement that I have catalogued for mining and mining exploration companies, although I am sorry to say none mentioned the need to improve their english. The engineering students as a group were less critical of their curricula. I also obtained the impression that the majority of undergraduates in geoscience are prepared to accept a heavier course load and tougher grading. To bear this out the enrolment in engineering geology is increasing faster than in science. The compulsory course load is much heavier in engineering than in science.

Question 13: List Canadian universities you are familiar with which in your opinion currently offer outstanding/ superior/ adequate/ poor training of geoscientists. Specify academic level and subdisciplines.

The replies are summarized below.

41 companies answered this question, 37 did not answer the question

University Geology Department only	No. of Ratings Does not include departments with less than 5 ratings	Point Average	
1. Western Ontario	18	3.0	
2. Memorial	10	2.8	
Waterloo	6	2.8	
3. Toronto	20	2.7	
McGill	15	2.7	
4. Queen's	30	2.6	
Carleton	6	2.6	
5. Ecole Polytech	5	2.4	outstanding - 4 points
Laval	7	2.4	superior - 3 points
Manitoba	5	2.4	adequate - 2 points
6. Saskatchewan	5	2.2	poor - 1 point
British Columbia	27	2.2	
McMaster	5	2.2	
Chicoutimi	5	2.2	
7. Alberta	5	2.0	
Calgary	5	2.0	
University of New Brunswick	5	2.0	

These ratings are primarily for B.Sc. degrees in Science departments with no distinction between honours and general degree. Graduates with engineering degrees were generally rated higher. Master degrees normally rated about 0.3 points higher and doctorate degrees about 0.8 points higher.

Question 14: Have any of your staff carried out joint research projects with university staffs in the past 5 years.

Twenty-two companies replied yes and 56 no. The following universities were named: Alberta (1), British Columbia (3), Carleton (1), École Polytechnique (2), Laurentian (1), Laval (1), McGill (2), Memorial (1), New Brunswick (2), Quebec-Chicoutimi (1), Queen's (2), Saskatchewan (1), Toronto (5), Waterloo (1), Western (1), Imperial College (1), Pennsylvania State (2), Michigan Tech. (1), Univ. of California in Los Angeles (1), and Australian National University (1).

Question 15: Has your company recently sponsored research projects or studies at any Canadian universities?

Twenty three companies replied yes and 55 no, however several of the latter indicated a willingness to do so. The following universities were named as beneficiaries of grants: British Columbia (4), Calgary (1), Carleton (1), École Polytechnique (1), Laurentian (1), McGill (2), Memorial (1), Queen's (5), Saskatchewan (1), Toronto (5), Waterloo (1), Western (5), Royal School of Mines (1) and unnamed (4).

Grants were made in the following subdisciplines

(a) Economic Geology	14
(b) Geophysics	4
(c) Geochemistry	3
(d) Mineralogy and Petrology	2
(e) Geostatistics	1
(f) Unnamed	14

Question 16: In the past 5 years has your company helped to provide thesis topics at Canadian universities?

Forty seven companies indicated they had helped to provide 137 thesis topics as listed below. Twenty one companies replied they had not helped to provide thesis topics.

	<u>B.Sc. or B.A.Sc.</u>	<u>M.Sc. or M.A.Sc.</u>	<u>Ph.D.</u>	<u>Total</u>
Alberta	1	2	1	(4)
British Columbia	8	3	3	(14)
Calgary	-	1	-	(1)
Carleton	2	3	4	(9)
Dalhousie	1	-	-	(1)
École Polytechnique	-	2	-	(2)
Laurentian	1	2	-	(3)
Laval	-	1	1	(2)
Manitoba	1	2	2	(5)
McGill	1	3	1	(5)
McMaster	-	1	1	(2)
Memorial	-	2	2	(4)
New Brunswick	-	1	1	(2)
Ottawa	1	-	-	(1)
Québec à Chicoutimi	-	2	-	(2)
Queen's	4	12	6	(22)
Saskatchewan	1	1	-	(2)
Toronto	3	7	3	(13)
Waterloo	3	-	-	(3)
Western Ontario	6	11	4	(21)
Unnamed Canadian Universities	3	7	5	(15)
Universities outside Canada	-	2	2	(4)
	36	65	36	137

Question 17: What areas or topics of geoscience require more work or work of better quality at Canadian universities.

Thirty five companies made suggestions 43 did not. The topics are summarized below, many multiple answers were received.

(a) Mineral and ore deposits including metallogeny.	11
(b) Exploration techniques including applications of geophysics and geochemistry as applied to search for ore deposits.	9
(c) Field geology, particularly structural and petrographic studies	8
(d) Applied research, no enlargement on this statement.	8
(e) Coal geology.	3
(f) Quaternary geology, especially application to mineral search.	3
(g) Miscellaneous suggestions.	5

Some of the more interesting suggestions and comments on research are quoted below.

1. "Studies in which the graduate students have greater involvement with field aspects on projects, and do not spend a number of years as technicians producing much data of little or no practical use. In many universities, the graduate students do not even become involved in the operation of the equipment from which these data are obtained."
2. (a) "Much more emphasis needs to be placed on the distribution of ore and alteration minerals in rocks of ore deposits where they are treated and studied in the petrologic context of the whole rock."
 (b) "There is a crying need for solution geochemistry research not only related to processes of ore formation but also rock diagenesis, metamorphism, etc. Work in this area could revolutionize our understanding of geology, and it has been almost totally ignored in Canadian universities."
3. 1) "Geochemistry-secondary dispersion in variety of media throughout different climate/topography zones of Canada."
 2) "Weathering of rocks-formation of gossans - rates, controls, again across Canada."
 3) "Pleistocene-integration of Pleistocene history and stratigraphy and dispersion trains of mineralization, etc."
 4) "Age dating of rock sequences and ore bodies in volcanic, plutonic, metamorphic terrains."
4. "Less arm-waving, big picture research. Recognition that geology research requires time for good and meaningful work by funding organizations and so remove publish or perish panic requirement. We are being swamped by trivial, repetitious or just plain speculative articles in supposedly learned journals."
5. 1) "Physical and chemical models of ore forming systems - continue the work going on and expand it."
 2) "Studies related to migration and evolution of basinal connate brines."
 3) "Research into improving "metallurgical" recovery of base metal ores."
 4) "Research into the physiochemical effects and ramifications of metamorphism on various sulfide-related equilibrium systems viz: fluid inclusions, solid solution geothermometers, etc."
 5) "Experimental investigations into water/rock reactions aimed at:
 i) whole rock alteration studies and subsequent problems with protolith designation, etc., from samples altered early in their history.
 ii) evolution of ore-forming fluids."
6. "More emphasis on practical means of locating economic and viable ore deposits. Much current research has no economic significance."

Question 18: What should be the balance in Canadian university research amongst field-oriented, laboratory-oriented, and theoretical studies.

No. of Companies	Field	Laboratory	Theoretical
17	50%	25-30%	20-25%
10	60%	20-25%	15-20%
9	30-35%	30-35%	30-35%
2	40%	30%	30%
1	20%	20%	60%
<u>1</u>	80%	10%	10%
40			

Question 19: In your opinion is this balance usually achieved, if not what is overemphasized.

Thirty eight companies replied to this question and the answers are summarized below. 40 companies did not reply.

	No. of replies
Too much laboratory-oriented research	12
Too much laboratory and theoretical oriented research	10
Too much theoretical-oriented research	10
Balance at present about right	4
Too much field-oriented research	2

Question 20: Comments.

A representative sample of comments are listed below to show the range, the contradictions, and thought that went into them.

1. " - too much number gathering
 - too much number crunching
 - too little field time
 - too little problem definition
 - too little geology."

2. " - There appears to be a serious shortage of geoscientists who have any real appreciation of the fundamental aspects of mineral exploration. At the B.Sc. level, I realize time is limited and not all topics can be covered. However, at the higher degree level, some training in these areas, beyond those currently generally available, would be a good idea. I do not mean purely practical field experience such as the use of specific instruments and sampling methods, but rather a fundamental knowledge of Em, IP, etc., the movement of metals under different conditions, effect of different conditions, effect of different overburden on geochemistry, etc., and a knowledge of the genesis of different classes of ore deposits. In a country where mineral export is so important, this gets very minor attention at virtually all universities."
3. "Without wishing to be regressive or particularly small "c" conservative."
"Recent graduates in Geology lack:"
 - (i) "Any ability to identify rocks in the field/in drill core or to have some reasoned approach to naming rocks."
 - (ii) "Any confidence in their ability to map, and construct a geological map or to draw a cross-section of their own geological map."
 - (iii) "Very few Canadian graduate geologists have any feel, or interest in the Pleistocene -especially "hard rock" geologists and yet 90% of their field areas are "unexposed" e.g. Pleistocene."
 - (iv) "Few recent graduates have any real feel for constraints on the paragenesis of rocks; they do not seem to have grasped the fundamentals of element distribution in nature."
 - (v) "Whatever geophysics has been taught at B.Sc. (or even M.Sc. course) level seems to be "independent" of the rocks; there seems to be no "feel" that geophysics, and measuring physical properties of rocks, helps to construct geological maps/cross-sections, etc."
 - (vi) "Basic principles of geochemical dispersion at N.T.P. seems to be wholly lacking; recent graduates seem to have no "feel" as to why a rock should chemically weather, what processes are involved, or at what rates reactions proceed, what products are produced, what is left behind, what is in solution and when, what and how these solutions would precipitate. Recent graduates radiate a feeling that the present earth's surface is geochemically completely static or in complete equilibrium."
 - (vii) "90% of recent graduates cannot construct a histogram or contour a geochemical or geophysical plan."
 - (viii) "90% of recent graduates cannot write, even a simple, descriptive account of what they achieved on a geological/exploration project, let alone analyse, integrate, and synthesize their data."

"Virtually all these criticisms are directed at University teaching staffs not the graduates, who, almost without exception, are delight to learn: how to map; how to interpret their maps; how to write about their maps; how to recognize rocks; Pleistocene features; and to interpret geophysical/geochemical anomalies, etc., etc."

"One sometimes wonders exactly what they do in four years of geology at university."

4. "University of Waterloo's Co-op program seems like one of the best concepts for actually training people to do something useful or economically beneficial."
"More educational programs involving university/industry cooperation are necessary."
"I don't think people can afford and I don't think business or society can afford to have people spend 4 years or more straight at university. This is particularly true when the average B.Sc. or B. Eng. is now becoming obsolete in 7 years. The "only" solution to this problem is to have people "being educated" and "working" simultaneously. i.e. integration of universities with business."
(Oh dear - the academics won't like that!)
5. "Historically, universities in the 1960's and 1970's have tended to stress theoretical studies more than field studies. This is a logical consequence of striving for some originality in research (it is easier to perform original lab work than field research). To a point, this "box of rocks" philosophy has been over-emphasized in some sub-disciplines and sectors leading to competition and duplication of effort. Because of ever-tightening financial belts on research funding, many universities have turned increasingly to industry for research problems and funding. This is a healthy balance and should be encouraged. At no time, however, should the value of "pure research" be equated in temporal dollars and cents. Pure research must be funded on its own, longterm merits with federal governments usually the "patron saints". Applied research and co-operation between universities and industry is a dynamic equilibrium. Hopefully, the free energy of reaction is tending toward increased rather than decreased interaction."
6. a) "There appears to be too much emphasis on training undergrads to become a grad student. Many of the basic skills are lacking upon graduation."
"Perhaps more professors (advisors) should take a more active role in communicating with their students and acting as a liaison to industry, particularly by following up experience their students receive before, during, and after summer employment (which I consider a critical part of any student's training)."

- b) "The treatment of ore deposits and economic geology is superficial at most universities, or in some instances, focused entirely on one aspect or type of ore deposit."
7. "On the whole I believe Canadian universities are producing a lot of very keep people at the M.Sc. level and Ph.D. level, but with some tendency to forget that in some way their knowledge and work has to make a contribution to the national economy as well as pure knowledge."
 8. "Universities are not fulfilling the role that they should play. They are putting most of their eggs in theoretical research, without any regard for the priorities of society."
 9. "While I may be labelled a materialistic person, the obvious fact is that viable mineral deposits in large numbers will have to be located and utilized within the next 50 years if our world economy is to survive. Emphasis should therefore be placed on the location and methods of utilization of such deposits with decreased emphasis on what is in many cases minor ecological impact. Theoretical considerations are important only where they may lead to significant discoveries."
 10. "We note that university graduates with honors degrees have a distinctly better knowledge of petrology, sedimentology etc."
 "Many technical colleges produce well-trained and motivated geological technicians, etc. to fill less demanding positions. This places a responsibility on universities to provide a distinctly higher level of training and knowledge."
 11. "Question 17 was the most important. I would like to have had more time to consider the question, but certainly if CGC can bring any improvement in that area especially the area referred to in 17 (b), this will be of great significance to Canadian geosciences education."
 "In undergraduate level programs, little consideration is evident of the fact that the majority of these people will be placed on the job market with very few skills obtained from the university program. Consideration is not apparent, on the university's part, of this fact."
 "Many undergraduate courses tend to ignore the basic building blocks of knowledge, which are necessary for understanding any subject. The impression one gets is that many professors find the basic knowledge required in many subjects to be too mundane to teach."
 "Shortcomings in the undergraduate training may directly lie in the fact there has been an alarming decrease in professors with significant practical or industrial experience."
 12. " - An M.Sc. should be able to participate in feasibility market studies (Mineral economics).
 " - A B.Sc. should know the principles of reserve estimates, grade control and mining."
 " - University of Waterloo Co-operative Education system, which sees students alternate between campus and related "work term jobs" seems to be a very good experiment in which we participate and which we recommend."
 13. "I believe that some non-practical i.e. academic studies are being emphasized in universities that used to be known for their economic-exploration oriented geological engineers because of a trend by some graduates toward non-field jobs. Perhaps it is therefore not the universities fault but industries fault for not making the exploration geological positions of a more attractive nature to future geological graduates."
 14. "I think the major weaknesses are:
 - 1) "Lack of Fundamental Geology in Bachelor's Program. The esoteric stuff should be at the graduate level."
 - 2) "Lack of Economic Geology - Mineral Economics - Mining Geology courses at Bachelor's level."
 - 3) "Lack of Applied Geophysics courses at all levels - lack of Applied Geophysics research."
 - 4) "Dismal State of Research in Economic Geology at most Universities."
 - 5) "Lack of interdisciplinary approaches to problems of economic geology."
 15. Several employees stated that they were primarily interested in employing bright motivated young geologists and that they would train them for the job.

Mining Companies

72 mining companies included in categories 3 and 4 replied to Money's questionnaire. 6 of them do not employ a geologist, the remaining 66 employ 202 geologists or equivalent. More than 80% of these employees have a bachelors degree or less and normally new employees are hired at this level. Many state a preference for engineering graduates in geology. Their answers to questions 11, 12, 17, 18, and 19 are similar to those from exploration companies with even more emphasis on practical courses. Only 20 of the companies rated the universities and these ratings applied to 12 universities, none being referred to more than 3 times.

The most interesting part of these questionnaires was the comments and reproduced below are samplings of them.

- 1) "From a practical and economic viewpoint one should strive for application of theory to field-oriented projects. Lab-oriented studies are necessary for determining and planning economic feasibility of projects. Emphasis must be placed on application of geology for practical conditions. It is my opinion that some universities are leaning too heavily towards theory and in many instances undertaking irrelevant research, possibly with an aim to prepare undergraduates for postgrad studies. Research and theory are acceptable as long as the end result will aid in ore search, (coal and oil included), and economic development of ore. It seems that some students are studying or researching a finite topic that will never have any application, to ore search and therefore little or no contribution, to the mineral industry."
- 2) "I think overall geoscience programs in Canadian Universities are in a fairly good balance. However slightly more time could be spent training students in the practical aspects of exploration and mining, e.g. mapping, geophysics, diamond drilling, core logging, mining methods, economics. It could be argued that these subjects should be learned at technical schools but university graduates should at least have some exposure."
- 3) "Very little exposure to industry is made during the school year. Guest speakers are usually of the professor or sabbatical type or with G.S.A. or G.A.C. working on pet projects, why can't guest speakers include: (i.e.) the chief geologist of (i.e.) Campbell Red Lake Mines; exploration manager of any natural resource company (i.e.) mining analyst with a financial institution, etc."
4. "University studies do no benefit as much as they should from the practical side and experiences of industry (mining) because of an over-emphasis on theoretical geology and hypothetical models rather than real-life models and practical geology and geophysics."
5. "In our slope stability and mine geology work we frequently uncover mistakes, (often very costly ones) which can be directly attributed to false, or unrealistic, geological concepts. It has been obvious that the observation of geological phenomena and the conceptualization of these observations into useful models has been the "weak link" in the chain of events leading to some economic decision; that is, the transformation of a geological concept into numbers and its eventual computerization is generally well done but unfortunately, since the foundation is weak, the results fall short of expected. The basic problem here is that geologists have not identified and stressed the geological reality of the situation - in most cases, it appears that the geologist couldn't recognize the geological phenomena before him."
- "If this same process is occurring in other geoscience fields, where perfect mathematical, physical or chemical models are being applied to false geological concepts, then the results are akin to that structurally perfect skyscraper built on a foundation of bentonite. This is why we stress, first and foremost, the development of fundamental recognition skills in whatever field the geologist claims to have expertise."
- 6) "The majority of graduates B.Sc. and M.Sc. today can tell you a great deal about theories of origin etc., but could not go underground and differentiate between ore and waste. They also seem to lack the ability to think in three dimensions."
- "A graduate of a technical school has been taught generally in all phases of the mining operation (milling, assaying, surveying, etc.) and has a better overall understanding of what is required in each place."
- 7) "For a mine geologist's job, the universities should put more emphasis on practical training in an operating mine. Each year of university training, the B.Sc. student should acquire 2 months of practical training in an operating mine or in an exploration camp. Subjects like surveying, elementary mining methods, structural geology and ore genesis along with other basics of geology will be quite useful for a practicing mine geologist. Above all, a mine geologist should have a strong 3 dimensional concept."
- 8) "I am a geologist with 11 years experience both underground and open pit. It would seem that the new graduate is very soundly trained but for what. Here, geologists are treated as second class to an engineer of equivalent training and undergraduate studies are very similar. I am involved in Grade Control but in order to do it my company classification was changed to Mining Engineer. Production needs have hit all-time highs while I've been in charge of scheduling ore and waste movements. It is disillusioning to think a "geologist" couldn't achieve the same results."
9. "A reluctance on the part of some recent (minimal experienced) graduates to "get their hands dirty" in mining or related fields such as diamond drilling or rock mechanics."
- These types want to be able to sit in an office and work at everything on paper.
- a) "Industry should be given tax incentives to hire students; this would insure field/lab training."

- b) "Perhaps necessary to expand co-op system to other universities seems to work well at University of Waterloo."

or

"establish a 5th year of "on-the-job" training-funded jointly by industry and government. This would insure that young students who did not acquire summer jobs obtain the necessary training to secure a permanent job."

- c) "Computer Science should be made a prerequisite to graduation (i.e. do away with Arts & Science courses i.e.) Philos-etc."
- d) "Universities should provide more "Short Courses" for past graduates to update their knowledge. These short courses might equally be extended to field trips. People who take such courses should be given a certificate to that effect."
- e) "If possible "mobile" - lectures should be made available for remote communities, i.e. - often individuals cannot attend out of the way courses etc."
- i.e. courses could be of 1 to 2 weeks duration.
- f) "A "report writing" course should also be made mandatory at all universities."
- g) "Economic geology courses should include geophysical techniques etc."
10. "The following is a reflection of the need of the industry I am currently associated with and based on my personal contacts with geoscientists from the aforementioned universities."
- "It appears that the balance of field/laboratory theory in any of the subdisciplines of geochemistry mining and geotechnology has not been sufficient."
- "The geochemists are well trained in laboratory and statistical analysis tools, however deficient in field and occasionally theoretical applications."
- "The mining geologists are rare and frequently their training is insufficient in either engineering or scientific fields."
- "The science of geotechnology and structural geology are rarely offered as research topics to the mining industries."
- "Though a happy balance of all training is not practical for each individual. The quality of a team abilities, rather than individual ability, must be considered as the main compensation force behind the successful application of any geoscience."

ANNEXE 4A
DOMAINES MAJEURS AU NIVEAU DES 2^e ET 3^e CYCLES EN
GÉOLOGIE ET GÉOPHYSIQUE DANS LES DÉPARTEMENTS
D'UNIVERSITÉS CANADIENNES

<u>Name of University and Department</u>	<u>Major Fields and Special Aspects</u>	<u>Degrees</u>
*Acadia (Geology):	Appalachian geology, economic geology, petrology, sedimentology, stratigraphy, and structural geology	M.Sc. and M.A.
*Alberta (Geology):	Mineral deposits, petrology, vertebrate and invertebrate paleontology, palynology, sedimentology, biostratigraphy, physical stratigraphy, structural geology, tectonics, Quaternary research, hydrogeology, coal geology, geochronology, isotope geochemistry, inorganic geochemistry	M.Sc. and Ph.D.
*Alberta (Geophysics):	Seismology, geodynamics, electromagnetic and magneto- telluric studies, geophysical instrumentation, paleomagnetism, mass spectrometry and isotope studies, gravity and magnetic interpretation, numerical modelling, heat flow, and geothermal resources	M.Sc. and Ph.D.
*British Columbia (Geological Sciences):	Cordilleran geology, mineral deposits, coal geology, marine geology, Quaternary, groundwater and engineering geology, mathematical modelling, theoretical geochemistry, experimental petrology, structure, tectonics, geochronology, applied geochemistry, paleontology.	M.Sc., M.A.Sc. and Ph.D.
(Geophysics and Astronomy):	Aeronomy, applied geophysics, communication theory, geo- dynamics, geomagnetism, geo- physical instrumentation, glaciology, inversion theory, isotopic studies and mass spectrometry, seismology, tectonophysics.	M.Sc. and Ph.D.
Brock (Geological Sciences):	Quaternary studies, particular geochronology, stratigraphy, palynology, glacial geology, limnogeology, geomorphology and hydrology. Studies of mobile regions, particular petrology, volcanology, structural geology, tectonics, sedimentology, economic geology and paleontology.	M.Sc.
Calgary (Geology and Geophysics):	Sedimentology, stratigraphy, structure, petrology, geochemistry, economic geology, mineralogy, paleontology, palynology, geophysics, surficial geology.	M.Sc. and Ph.D.

*Except the departments marked with an asterisk all the information in this table was obtained from Geoscience Canada, V. 6, no. 3, p. 167-170 (1979).

<u>Name of University and Department</u>	<u>Major Fields and Special Aspects</u>	<u>Degrees</u>
Carleton (Geology):	Precambrian studies, resource geology, structure and geodynamics. Collaboration with scientists at the Geological Survey of Canada, Earth Physics Branch, and University of Ottawa.	M.Sc. and Ph.D. in geology and geophysics
Dalhousie (Geology):	Marine geology and geophysics, oceanic crust. Appalachian geology; sedimentology, petrology; geochemistry, including REE, oxygen isotopes; geochronology; metallogeny; Quarternary studies. Joint programs with Oceanography Department. Close association with Bedford Institute of Oceanography and International Program of Ocean Drilling.	M.Sc. and Ph.D.
*École Polytechnique (Genie Geologique):	Economic geology, engineering geology, mineralogy, petrology, mathematical geology, and exploration geophysics and geochemistry. Associated with Mineral Exploration Research Institute.	M.Sc.A. and Ph.D.
Guelph (Land Resource Science):	Soil physics, soil chemistry, soil genesis, clay mineralogy, soil-plant relations, weathering geochemistry, applied sedimentology, agrometerology. Associated with Centre for Resources Development and Interdepartmental Program of Hydrology.	M.Sc. and Ph.D.
Lakehead (Geology):	Structural and metamorphic geology, petrology and geochemistry, mineralogy, sedimentology, and stratigraphy. Strategically located for Archean, Proterozoic, and Quaternary Studies.	M.Sc.
Laurentian (Geology):	Regional and economic geology of the Precambrian Shield (eastern Superior, Southern, northern Grenville, and Sudbury Basin), Precambrian and Ordovician-Silurian stratigraphy, sedimentation, paleoecology.	M.Sc.
*Laval (Geologie):	Engineering geology, economic geology, mineralogy, petrology, stratigraphy and structural geology, geochemistry, and exploration geophysics.	M.Sc., M.Sc. and Ph.D.

<u>Name of University and Department</u>	<u>Major Fields and Special Aspects</u>	<u>Degrees</u>
Manitoba (Earth Sciences):	<u>Ore deposits and metallogeny</u> ; volcanology; mineralogy and crystallography; structural and metamorphic petrology, tectonics and geochronology of Precambrian provinces; carbonate sedimentology; Quaternary sedimentology; exploration geophysics; seismology; crustal studies, paleomagnetism, remote sensing. Associated with the Centre for Precambrian Studies.	M.Sc. and Ph.D in geology and geophysics
McGill (Geological Sciences):	Petrology, sedimentary geology, <u>economic geology</u> , structural geology, geophysics, geochemistry crystallography, geochronology, geomorphology, paleontology. Associated with Marine Sciences Institute and Mineral Exploration Research Institute.	M.Sc. Ph.D. and non-thesis M.Sc. program in Mineral Exploration and in Engineering Geology
McMaster (Geology):	Elemental, isotopic geochemistry; <u>precious metal studies</u> ; petrology of alkaline rocks; silicate crystallo- graphy; volcanology. Clastic sed- imentology; palaeocology; Mesozoic biostratigraphy; palaeotemperature studies; structural geology. Pollutants in atmosphere and lakes.	M.Sc. Ph.D. (Geology) Ph.D (Geochemistry)
Memorial (Geology):	Igneous, metamorphic petrology, petrochemistry, structure; Lower Paleozoic biostratigraphy; clastic, carbonate sedimentology.	M.Sc. and Ph.D.
Memorial (Geophysics in Department of Physics):	Rock magnetism, paleomagnetism; crustal/mantle investigations of electromagnetism, gravity, and heat flow; seismology; theoretical studies in global geophysics and planetary physics. Geomagnetic Research Laboratory is a major facility.	M.Sc. and Ph.D. (Geophysics) M.Sc. and Ph.D. (Physics)
*Montreal (Geologie):	Stratigraphy, paleontology, structural geology, sedimentology petrology, geochemistry, and geochronology.	M.Sc. and Ph.D.
*New Brunswick (Geology):	<u>Economic geology</u> , mineralogy, mineralogy, petrology, structure, rock mechanics, geophysics and biostratigraphy.	M.Sc. and Ph.D.
Ottawa (Geology):	Precambrian studies (petrology, structure, <u>ore deposits</u>); Arctic geology (biostratigraphy, sed- imentology, paleontology); Geochemistry (granites, magmatites, rare earth elements); Quaternary geology (sedimentology, permafrost).	M.Sc. and Ph.D.

<u>Name of University and Department</u>	<u>Major Fields and Special Aspects</u>	<u>Degrees</u>
Ottawa (Geology): cont'd-	Collaboration with scientists at the Geological Survey of Canada, Earth-Physics Branch, and Carleton University (cooperative graduate program) and with other departments in the University of Ottawa.	M.Sc. and Ph.D.
*Universite de Québec à Chicoutimi Sciences de la Terre:	Precambrian exploration and mining geology, mineral deposits, sed- imentology, volcanology, petrology, geochemistry, exploration geophysics, rock mechanics, and physical properties of rocks and minerals.	M.Sc. A.
*Universite de Québec à Montréal Sciences de la Terre:	Quaternary research, environmental geology, radiocarbon dating, and petrology.	M.Sc.
Queen's (Geological Sciences):	Exploration geochemistry, exploration geophysics, economic geology, engineering geology, environmental geology, geochemistry, geochronometry, hydrogeology, marine geology, mineralogy, paleontology, igneous and metamorphic petrology, stratigraphy, sedimentology, structural geology, tectonics. Non-research M.Sc. in mineral explor- ation; association with Centre for Resource Studies	M.Sc. and Ph.D.
*Regina (Geological Sciences):	Precambrian geology, petroleum, and coal geology, geothermal energy, economic geology, petrology, structural geology, and geochemistry. Associated with Energy Research Unit.	M.Sc.
Saskatchewan (Geological Sciences):	Palaeontology (particular micro- palaeontology, palynology); petrology, geochemistry, mineral deposits; sedimentology; stratigraphy; structural geology; geophysics (including seismology); engineering geology (including rock mechanics). Associated with interdisciplinary divisions within university and with geological sections of governmental institutions.	M.Sc. and Ph.D. Post-graduate Diploma
Toronto: Geology and other departments listed under major fields	A comprehensive array of programmes covering most aspects of the earth and planetary sciences, many of which are unavailable elsewhere in Canada, are offered by the Department of Geology and in co-operation with Geophysics, Geography, Metallurgy and materials Science, Geotechnical Engineering, Institute for Environmental Studies, and Royal Ontario Museum.	M.Sc., M.A.Sc. and Ph.D.
*Victoria (Geophysics in the Physics Department):	Electromagnetic induction in the earth and ocean, analogue models and theoretical studies, geomagnetism, theory of plasma waves, upper atmosphere physics.	M.Sc. and Ph.D. in physics (geophysics option)

<u>Name of University and Department</u>	<u>Major Fields and Special Aspects</u>	<u>Degrees</u>
Waterloo (Earth Sciences):	Environmental geology with special emphasis on hydrogeology, isotope hydrology, geochemistry, mathematical geology, shallow geophysics and engineering geology; Paleozoic stratigraphy and micropaleontology palynology; Precambrian geology (structural, metasomatic, economic); Quaternary geology; sedimentology (carbonates, clastics). Non-thesis M.Sc. in Environmental Geology; interdisciplinary programs available; excellent geochemical, geophysical, engineering, stable isotope, age-dating, computing and drilling facilities.	M.Sc. in geology and Ph.D. in all aspects of environmental geology and engineering geology.
Western Ontario (Geology):	Quaternary geology, environmental geology (with engineering), geochemistry, biogeochemistry, isotope geochemistry, <u>economic geology</u> , fluid dynamics, global tectonics, x-ray crystallography, petrology, structural geology, mathematical geology. Joint projects with Chemistry, Engineering and Bacteriology.	M.Sc. and Ph.D.
(Geophysics):	Age determinations, laboratory Measurements of physical properties under mantle conditions, paleomagnetism, seismology, terrestrial heat flow.	M.Sc. and Ph.D.
Windsor (Geology):	Sedimentology emphasizing applied stratigraphy and petroleum geology; <u>Economic geology emphasizing industrial mineral deposits</u> ; Engineering geology emphasizing rockfluid interactions; Analytic geochemistry; igneous petrology; terrain geology, tectonophysics.	M.Sc. and M.A. Sc.
*York (Earth and Environmental Science Programme):	Earth dynamics, long baseline interferometry (precision geodesy), rotating fluids (applications to core dynamics), and gravity studies	M.Sc. and Ph.D.

*Except the departments marked with an asterik all the information in this table was obtained from Geoscience Canada, V. 6, no. 3, p. 167-170 (1979).

ANNEXE 5A
SPÉCIALITÉS CHEZ LES GÉOLOGUES ET GÉOPHYSICIENS
DIPLOMÉS D'UNIVERSITÉS CANADIENNES ET CLÉ DU CODE
DU CONSEIL DES SCIENCES

The specialities are those recognized by the Science Council of Canada and modified by the authors.

	Number of Academics (see footnotes)			Number of Academics (see footnotes)	
	Principal speciality	Secondary and tertiary specialities		Principal speciality	Secondary and tertiary specialities
1. Coal geology	3	2	25. Volcanology	5	9
2a. Economic geology - metals	40	17	26. Other fields in geological sciences	1	3
2b. Economic geology - nonmetals	3	2	27. Exploration geophysics	23	9
3. Engineering geology	16	3	28. Geodesy	1	3
4. Environmental geology	3	6	29. Geomagnetism and paleomagnetism	21	11
5. General and regional geology	14	10	30. Geophysical instrumentation	-	8
6. Geomorphology (see also 49a)	7	5	31. Gravity	2	1
7. Historical geology	1	6	32. Heat flow	1	3
8. Hydrogeology	10	6	33. Magneto-telluric studies	4	4
9. Marine geology	6	4	34. Marine geophysics	4	4
10. Mineralogy	22	2	35. Physical properties of rocks and minerals	2	
10a. Crystallography	13	1	36. Remote sensing	7	5
10b. Clay mineralogy	-	4	37. Seismology	8	4
10c. Soil mineralogy	1	2	38. Tectonophysics	1	6
11. Mining geology	-	3	39. Other fields in geophysics	13	7
12. Paleobotany	2	3	40. Biogeochemistry	1	8
13. Paleontology	22	14	41. Exploration geochemistry	13	1
13a. Micropaleontology	13	-	42. Inorganic geochemistry	7	1
13b. Vertebrate paleontology	6	-	43. Isotope geochemistry and geochronology	27	7
14. Palynology	7	2	44. Physical geochemistry	7	8
15. Soil Science (Pedology), general (footnote 3)	13	-	45. Organic geochemistry	1	5
15a. Soil chemistry and biochemistry	12	-	46. Other fields in geochemistry	5	2
15b. Soil physics	7	1	47. Mathematical geology	1	3
15c. Soil biology	6	-	48. Computer applications to earth sciences	2	7
15d. Soil genesis, classification, and land evaluation	12	3	49. Physical geography		8
15e. Soil fertility	9	5	49a. Geomorphology, includes fluvial coastal, glacial, alpine, arctic, karst, and arid land (see also 6)	60	
15f. Soil management	5	1	49b. Hydrology, water resources, limnology, and groundwater	7	7
15g. Soil hydrology	2	2	49c. Climatology, and meteorology	12	12
15h. Agrometeorology and biometeorology	5	2	49d. Natural hazards, slope stability and mass wasting	5	2
16. Petrology (general)	-	10	49e. Energy budget and heat balance	5	7
16a. Igneous petrology	30	9	49f. Biogeography	5	3
16b. Metamorphic petrology	16	4	49g. Terrain evaluation	2	0
16c. Sedimentary petrology	-	2	49h. Permafrost, periglacial, ice, snow, and glaciology	5	1
17. Petroleum geology	6	6	49i. Physical environment	3	4
18. Photogeology	-	7	49j. Pedology (see 15 also)	8	0
19. Quarternary geology and Quarternary research	19	20	50. History of earth sciences	-	3
20. Rock mechanics (see footnote 2)	16	9	51. Oceanography, mainly physical	15	0
21. Sedimentology	37	14	52. Geotechnical engineering (includes 20 and 22)	83	1
22. Soil mechanics (see footnote 2)	46	2	53. Mining research (funded by NSERC)	4	1
23a. Physical stratigraphy	8	11			
23b. Biostratigraphy	9	16			
24. Structural geology, Tectonics and geotectonics	35	19			

Footnotes:

- (1) Listed here are the prime specialities as indicated by the various departments. A majority of the academics listed indicate more than one speciality as shown in the faculty index.
- (2) The cataloguing of soil science departments has not been completed. Information missing from, McGill, and Laval.
- (3) Six geography departments have been missed, 28 are included.

ANNEXE 5B

INDEX DES GÉOLOGUES, GÉOPHYSICIENS ET GÉOGRAPHES PHYSICIENS UNIVERSITAIRES POUR 1979

Following each name are the research specialities of faculty members as indicated by the individual faculty members or if this information was not available, the information was taken from the A.G.I. 1978-79 (17th) edition of directory of geoscience departments. In a few cases where the faculty members are not involved in research the teaching disciplines are listed. Where more than one discipline is indicated the most important one is listed first. The specialities are catalogued according to the list of Solid-Earth Science Disciplines recognized by the Science Council of Canada. The authors have made a few modifications as indicated.

Faculty Index

- Abbot, R.N., Geol., Dalhousie, (16a)
 Achab, A., INRS-Pétrole, Québec - a - St. Foy (17)
 Acton, C.J., Land Resource Sci., Guelph
 Adams, W.P. Geog., Trent, (49h,49c,49b)
 Aldridge, K., Earth Environ. Sci., York, (39)
 Allen, C.M., Geol., Mount Allison, (16a,25)
 Allen, J.M., Geol., Toronto, (10,44)
 Anderson, D.D., Earth Sci., Manitoba, (27,29)
 Anderson, D.T., Earth Sci., Manitoba, (36,2a)
 Anderson, G.M., Geol., Toronto, (44,2a)
 Anderson, M.M., Geol., Memorial, (13,23b)
 Appleyard, E.C., Earth Sci., Waterloo, (16b,24)
 Archibald, O.W., Geog. McMaster, (49f,49k)
 Armbrust, G.A., Geol., Ottawa, (2a)
 Armon, J.A. Geog., McMaster, (49a)
 Armstrong, R.L., Geol., U.B.C. (43,24)
 Arndt, N.A., Geol. Sci., Saskatchewan, (16a,2a)
 Assad, N.A., Geol., Laval, (2a)
 Atkinson-Keen, S., Geol., St. Mary's, (24)
 Aumento, F., Geol., Dalhousie, (10)
 Ayres, L.D., Earth Sci., Manitoba, (25,2a)
 Azzaria, L.M. Geol., Laval, (41,42,4)

 Baadsgaard, H., Geol., Alberta, (41,43)
 Bachinski, D., Geol., U.N.B., (16b)
 Bachinski, S., Geol., U.N.B., (16a)
 Baer, A.J., Geol., Ottawa, (24,5,16)
 Bailey, R.C., Geophys., Toronto, (29,33,48)
 Baracos, A., Geol. Eng., Manitoba, (3,20)
 Barker, J.F., Earth Sci., Waterloo, (43)
 Barnes, C.R., Earth Sci., Waterloo, (13a)
 Barnes, M.A., Geol. Sci., U.B.C. (45)
 Barnes, W.C., Geol. Sci., U.B.C. (21,45)
 Barr, S.M., Geol., Acadia, (16a)
 Barr, W., Geog., Saskatchewan, (49a)
 Bartlett, G.A., Geol. Sci., Queen's, (13,9)
 Bates, T.E., Land Resource Sci., Guelph, (15e)
 Bayliss, P., Geol. Geophys., Calgary, (10a)
 Beales, F.W., Geol., Toronto, (23,2a,21)
 Beaty, C.B., Geog., Lethbridge, (49a,6)
 Beauchamp, E.G., Land Resource Sci., Guelph, (15c,15e)
 Beaumont, C., Oceanogra. Geol., Dalhousie, (27,28)
 Beck, A.E., Geophys., Western Ontario, (32,27)
 Becker, A., Génie Minéral, École Polytechnique, (27)
 Beland, J., Géol., Montréal (24)
 Belisle, J.M., Génie Minéral, École Polytechnique, (2a)
 Bell, K., Geol., Carleton, (43)
 Benoit, P., Sciences de la Terre, Québec a Montréal, (5)
 Berard, J., Génie Minéral, École Polytechnique, (36)
 Berger, A.R., Geol., Memorial, (16a, 24)
 Berry, L., Geol. Sci., Queen's (10)
 Berube, M.A., Géol., Laval, (10,2a)
 Best, R.W., Geol. Sci., U.B.C. (13, 13b)
 Bettany, J.R., Soil Sci., Saskatchewan, (15a)
 Beswick, A.E., Geol., Laurentian, (44,16,25)
 Bird, J.B., McGill (49a)
 Bilodeau, M.L., Min. Metall., McGill (53)
 Black, T.A., Soil Sci., U.B.C. (15h)

 Bomke, A.A., Soil Sci., Manitoba, (15e)
 Bonn, F., Geog., Sherbrooke, (49e)
 Borradaile, G.J., Geol., Lakehead, (24)
 Bouchard, M., Géol., Montréal, (6,19)
 Bourne, J.H., Sciences de la Terre, Montréal a Québec, (16b)
 Bourque, P.A., Geol., Laval (21,23a)
 Bovis, M.V., U.B.C., (49a,49d)
 Bowen, A.J., Oceanog., Dalhousie, (51)
 Boyer, L., Génie Minéral, École Polytechnique, (3)
 Braun, W.K., Geol. Sci., Saskatchewan (23b,13)
 Brisbin, W.C., Earth Sci., Manitoba, (24,5)
 Bristol, C.C., Geol., Brandon, (10,2a)
 Brooke, M.M., Geol. Sci., Saskatchewan, (13a)
 Brookes, I., Geog. York, (49a, 19)
 Brookfield, M.E., Land Resource Sci., Guelph, (23a, 13, 24)
 Brooks, C., Géol., Montréal, (25,43)
 Brown, A.C., Génie Minéral, École Polytechnique, (2a)
 Brown, D.M., Land Resource Sci., Guelph, (15h)
 Brown, M.C., Geog., Alberta, (49a, 49b)
 Brown, R.L., Geol., Carleton, (24)
 Brown, T.H., Geol. U.B.C. (44,20,47)
 Bryan, R., Geog., Toronto, (49a, 49d, 49i)
 Bunting, B.T., Geog., McMaster, (49j)
 Burke, K., Geol., U.N.B. (31)
 Burley, B.J., Geol., McMaster, (10,16)
 Burling, R.W., Oceanog., U.B.C., (51)
 Burwash, R.A., Geol., Alberta, (16b,24,42)
 Busten, R.M., Geol. Sci., U.B.C., (1)

 Caldwell, W.G.E., Geol. Sci., Saskatchewan, (23b,13)
 Calon, T.J., Geol., Memorial, (24)
 Cameron, R.A., Geol., Laurentian, (27)
 Campbell, F.A., Geol. Geophys., Calgary, (2a)
 Campbell, I.A., Geography, Alberta (49a)
 Cannon, Earth Environ. Prog., York, (28)
 Carbonneau, C., Géol., Laval, (2b)
 Carmichael, C.M., Geophys., Western Ontario, (29)
 Carmichael, D.M., Geol. Sci., Queen's, (16b)
 Carroll, R.L., Redpath Museum, McGill, (13b)
 Carson, M.A., Geog., McGill, (49a,49d)
 Carter, A., Soil Sci., U.B.C., (15c)
 Casteel, R.W., Archeology, Simon Fraser, (19)
 Caty, J.L., Sciences de la Terre, Québec à Chicoutimi, (21)
 Caviedes, C.N., Geog., Regina, (49a)
 Cawker, K.B., Geog., Western Ontario, (49f,14)
 Cerny, P., Earth Sci., Manitoba, (10,16a)
 Chagnon, L.Y., Géol., Laval, (3,4)
 Chakravarti, A.K., Geog., Saskatchewan, (49c)
 Chao, G.Y., Geol., Carleton, (10)
 Chapman, C.H., Phys. Geophys., Toronto, (37)
 Charbonneau, J.M., Sci. de la Terre, Québec à Montréal, (24)
 Charlesworth, H.A., Geol., Alberta, (24)
 Chase, R.L., Geol. Sci., U.B.C. (9,24)
 Chatterton, B.D., Geol., Alberta, (13)
 Cherry, J.A., Earth Sci., Waterloo, (8)
 Chesworth, W.A., Land Resource Sci., Guelph, (46)
 Cho, C.M., Soil Sci., Manitoba, (15a)
 Church, M.A., Geol., U.B.C., (49a)

Church, W.R., Geol., Western Ontario (16a)
 Churcher, C.S., Zoology, Toronto, (13b)
 Chou, C.L., Geol., Toronto, (42,26)
 Chown, E.H., Sciences de la Terre, Québec à Chicoutimi, (16b)
 Clark, A.H., Geol. Sci., Queen's (2a)
 Clark, D.B., Geol., Dalhousie, (16a)
 Clark, G.S., Earth Sci., Manitoba, (43)
 Clarke, G.K., Geophys., Astronomy, U.B.C., (39)
 Clarke, W.B., Phys., McMaster, (43)
 Clement, P.M.J., Géog., Sherbrooke, (49a)
 Clifford, P.M., Geol., McMaster, (24)
 Clowes, R.M., Geophys and Astronomy, U.B.C., (37,34)
 Cogley, J.G., Geog., Trent, (49a, 49b)
 Collerson, K.D., Geol., Memorial, (16b,24)
 Coleman, L.C., Geol. Sci., Saskatchewan, (10,16)
 Colwell, J.A., Geol., Acadia, (41,2a)
 Cooke, H.B., Geol., Dalhousie, (19,12,23a)
 Cooke, R.C., Oceanog., Dalhousie, (51)
 Cooper, P., Geol., Laurentian, (13)
 Corlett, M.L., Geol. Sci., Queen's (10,44)
 Cormier, R.F., Geol., St. Francis Xavier, (43)
 Cossa, D.J., INRS-Océanologie, Québec à Ste-Foy, (51)
 Crampton, C.B., Geog., Simon Fraser, (49f,49h)
 Crocket, J.H., Geol., McMaster, (2a,43)
 Crossley, D.J., Min. Metall., McGill, (27,37)
 Cruden, D.M., Geol., Alberta, (3,20)
 Cumming, G.L., Physics, Alberta, (43,29,37)
 Cunningham, F.J., Geog., Simon Fraser, (49a,50)
 Currie, J.B., Geol., Toronto, (24,17)

Dalrymple, R.W., Geol. Aci., Brock, (21,9,19)
 d'Anglejan, B.F., Marine Sci. Centre, McGill, (9)
 Danner, W.R., Geol. Sci., U.B.C., (23b,13,5)
 Darling, R., Génie Minéral, École Polytechnique, (10)
 David, P.P., Géol., Montréal, (19,21,23a)
 Davidson-Arnott, R., Geog., Guelph, (49a)
 Davies, J.F., Geol., Laurentian, (2a,24)
 Davis, M.W.D., Génie Minéral, École Polytechnique, (2a)
 Davis, T.L., Geol. Geophys., Calgary, (27,37,3)
 Day, J.C., Geog., Waterloo, (49b,49d)
 De Albuquerque, Geol., St. Mary's (10)
 Dean, W.G., Geog., Toronto, (49a,19)
 De Boutray, B.U., Sci. de la Terre, Québec à Montréal, (16a,10)
 De Jong, E., Soil Sci., Saskatchewan, (15b)
 Deland, A.N., Geol., Concordia, (16a,10)
 Denner, W.W., Phys., Memorial (39)
 De Romer, H.A., Geol., Concordia, (5,24,18)
 Deutsch, E.R., Phys. (Geophysics), Memorial, (2a)
 De Vries, J., Soil Sci., U.B.C., (15b, 15g)
 Dimroth, E.V., Sci. de la Terre, Québec à Chicoutimi (25)
 Dixon, J.M., Geol. Sci., Queen's, (24)
 Dixon, O.A., Geol., Ottawa, (13,23b)
 Doig, R., Geol. Sci., McGill, (43)
 Donaldson, J.A., Geol., Carleton, (21,5)
 Donnay, G.H., Geol. Sci., McGill, (10a)
 Dosso, H.S., Phys., Victoria, (27,29,39)
 Dostal, J., Geol., St. Mary's, (44,2a)
 Drake, J.J., Geog., McMaster, (49c,49a)
 Dreimanis, A., Geol., Western Ontario, 919)
 Duffus, H.J., Phys., Royal Roads, (29)
 Duberger, R.U., Sci. de la Terre, Québec à Chicoutimi, (27,37)
 Duckworth, K., Geol. Geophys., Calgary (27,33)
 Dunlop, D.J., Geophys., Toronto, (29)
 Durand, M., Sci., de la Terre, Québec à Montréal, (3)

Eakins, P.R., Geol. Sci., McGill, (24,2)
 Edgar, A.D., Geol., Western Ontario, (16a,44)
 Edmund, A.G., Geol., Toronto, (13b)
 Edwards, R.M., Geophys., Toronto, (33,30)

Ek, C.M., Géog., Montreal (49a,19)
 Elbrond, J., Génie Minéral, École Polytechnique, (53)
 Elias, R.J., Earth Sci., Manitoba, (13)
 Ellis, R.M., Geophys. Astronomy, U.B.C. (37)
 Elrich, D.E., Land Resource Sci., Guelph, (15b)
 El Sabh, M., Québec à Rimouski (51)
 Elson, J.A., Geol. Sci., McGill, (19,18)
 Emery, W.J., Oceanog., U.B.C., (51)
 England, J.H., Geog., Alberta, (19,49a)
 Erb, D.K., Geog., Waterloo, (49a,49g,36)
 Ervine, W.B., Geol. Dalhousie, (42)
 Evans, L.J., Land Resource Sci., Guelph, (10d,15b)
 Evans, M.E., Phys., Alberta, (29)
 Everall, M.D., Mines Métall., Laval, (53)

Faessler, W.C., Génie Minéral, École Polytechnique, (27)
 Fahey, B.D., Geog., Guelph, (49h)
 Fahraeus, L.E., Geol., Memorial, (13a, 23b)
 Falconer, R.K., Geol., Dalhousie (34)
 Farquhar, R.M., Phys. Geophys., Toronto, (43)
 Farrar, E., Geol. Sci., Queen's, (43)
 Farvolden, R.N., Earth Sci., Waterloo, (8)
 Fawcett, J.J., Geol., Toronto, (16b,25)
 Ferguson, L., Geol., Mount Allison, (13)
 Ferguson, R.B., Earth Sci., Manitoba, (10a)
 Fitzgibbon, J.E., Geog., Saskatchewan, (49a,49b)
 Fleet, M.E., Geol., Western Ontario, (10a)
 Fletcher, R.J., Geog., Lethbridge, (15)
 Fletcher, W.K., Geol. Sci., U.B.C. (41)
 Flint, J.J., Geol. Sci., Brock, (6,8)
 Ford, D.C., Geog., McMaster, (49a, 49b,46,6,19)
 Foster, H.D., Geog., Victoria, (49a,49d)
 Fox, R.C., Geol., Alberta, (13b)
 Francis, D., Geol. Sci., McGill, (10,16a)
 Fransham, P., Earth Sci., Waterloo, (3,22)
 Freeze, R.A., Geol. Sci., U.B.C., (8,48,47)
 French, H.M., Geol. Geog., Ottawa, (6,49h)
 Frind, E.A., Earth Sci., Waterloo, (47)
 Fritz, P., Earth Sci., Waterloo, (43)
 Fryer, B.J., Geol., Memorial, (43)
 Fyfe, W.S., Geol., Western Ontario, (44)
 Fyson, W.K., Geol., Ottawa, (24)

Gagnon, H., Géog., Ottawa, (49d,18)
 Gale, J.E., Earth Sci., Waterloo, (3,20)
 Gangloff, P., Géog., Montréal, (49a)
 Gardner, J.S., Geog., Waterloo, (49a,49d)
 Garland, G.D., Phys. Geophys., Toronto, (33,32)
 Garneir, B.J., Geog., McGill, (49c)
 Garrett, C.J., Oceanog., Dalhousie, (34)
 Gautier, C.H., INRS-Pétrole, Québec à Ste. Foy, (51)
 Gelinas, L., Génie Minéral, École Polytechnique, (16a)
 Geninas, P.J., Géol., Laval, (8,19)
 Gendzwill, D.J., Geol. Sci., Saskatchewan, (27)
 Generst, C., Sciences Humaines, Québec à Trois Rivières, (6)
 Geurts, M.A., Géog., Ottawa, (49f)
 Ghent, E.D., Geol. Geophys., Calgary, (16b)
 Gibson, I.L., Earth Sci., Waterloo, (16a)
 Gilbert, R., Geog., Queen's, (51)
 Giles, P.S., Geol., Dalhousie, (21)
 Gill, D.E., Génie Minéral, École Polytechnique, (3,20)
 Gillham, R.W., Earth Sci., Waterloo, (15b,8)
 Gillespie, T.J., Land Resource Sci., Guelph, (15h)
 Gilliland, J., Phys., Royal Roads, (29,39)
 Giovanella, C.A., Geol. Sci., U.B.C. (5)
 Gittins, J., Geol., Toronto, (16a, b)
 Godwin, C.L., Geol. Sci., U.B.C., (2a,43)
 Goodchild, M.F., Geog., Western, (49a)
 Goodwin, A.M., Geol., Toronto, (6)
 Gordon, W.A., Geol. Sci., Regina, (13,7)
 Gorman, D.H., Geol., Toronto, (10)
 Gorman, W.A., Geol. Sci., Queen's, (5,19)

- Gorton, M.P., Geol., Toronto, (43)
 Gough, D.I., Phys., Alberta, (29,28,27)
 Goulet, N., Sci. de la Terre, Québec à Montréal, (24)
 Grant, B., Geol. Sci., Brock, (5)
 Grant, R.H., Geol. U.N.B., (32a)
 Gravenor, C.P., Geol., Windsor (19)
 Gray, J., Physics, Alberta, (43)
 Gray, J.T., Géog., Montréal, (49h)
 Greenhouse, J.P., Earth Sci., Waterloo, (27,29)
 Greenwood, B., Geog., Toronto, (49a)
 Greenwood, H.J., Geol. Sci., U.B.C., (44,16)
 Greggs, R.G., Geol.Sci., Queen's, (13,23b,7)
 Gretner, P.E., Geol. Geophys., Calgary, (3,27,35,20,24)
 Grice, H.R., Geol. Sci., McGill, (3,8)
 Grill, E.V., Oceanog., U.B.C., (51)
 Grundy, H.D., Geol., McMaster, (10a)
 Gwyn, Q.H.J., Géog., Sherbrooke, (49a,19)
- Hajnal, L., Geol. Sci., Saskatchewan, (27)
 Hale, W.E., Geol., U.N.B., (2a)
 Hall, D.H., Earth Sci., Manitoba, (29)
 Hall, J.M., Geol., Dalhousie, (29,34)
 Hall, R.D., Geol., St. Francis Xavier, (16b)
 Hall, R.L., Geol. Geophys., Calgary, (13a)
 Halls, H.C., Geol., Toronto, (29)
 Halstead, E.H., Soil Sci., Saskatchewan, (15a,15e)
 Hanley, T.O., Phys., Saskatchewan, (39)
 Haq, A-U., Land Resource Sci., Guelph, (15)
 Harding, N.E., Geog., Toronto, (36)
 Harris, S.A., Geog., Calgary, (49a,19)
 Harrison, R.S., Earth Sci., Manitoba, (21,16c,17)
 Hay, J.E., Geog., U.B.C., (49c)
 Hayatsu, A., Geophys., Western Ontario, (43)
 Haynes, S.J., Geol. Sci., Brock, (2a,11)
 Hebda, R., Biology, Waterloo, (14)
 Hedlin, R.A., Soil Sci., Manitoba, (15e)
 Hemstaedt, H., Geol. Sci., Queen's, (24,16)
 Hendry, H.E., Geol. Sci., Saskatchewan, (21)
 Hennigar, T., Geol., Dalhousie, (9)
 Henry, J.L., Soil Sci., Saskatchewan, (15e)
 Heroux, Y., INRS-Pétrole, Québec à Ste. Foy, (17)
 Hesse, R., Geol. Sci., McGill (5,21)
 Hickin, E.J., Geog., Simon Fraser, (49a)
 Hill, A.R., Geog., York, (49b,8)
 Hill, P.A., Geol., Carleton, (4)
 Hillaire-Marcel, C., Sci. de la Terre, Québec à Montréal, (19)
 Hills, L.V., Geol. Geophys., Calgary, (14,12,19,21)
 Hiscott, R.N., Geol., Memorial, (21)
 Hodder, R.W., Geol., Western Ontario, (2a)
 Hodgins, L.E., Geog., York, (19,49a,49b)
 Hodgson, C.J., Geol. Sci., Queen's, (2a)
 Hodych, J.P., Geol. Phys., Memorial (27,33)
 Hoffman, D.W., Land Resource Sci., Guelph, (15)
 Hoffman, H., Géol., Montreal, (13,23b)
 Hogarth, D.D., Geol., Ottawa, (10)
 Holmes, J.W., Geol., Toronto, (2a,11)
 Hooper, K., Geol., Carleton, (13a, 23b)
 Hope-Simpson, D., Geol., St. Mary's, (5,7,23a,25)
 Hopkins, J.C., Geol. Geophys., Calgary, (15,23b)
 Horita, R.E., Physics, Victoria, (39)
 Howarth, P.J., Geog., McMaster, (36,49a,49b)
 Howatson, C.H., Geog., Victoria, (5,18)
 Hron, F., Physics, Alberta, (37)
 Huagn, C-h, Geol., Windsor, (42)
 Huang, P.M., Soil Sci., Saskatchewan, (15a,10b)
 Hubert, C., Geol., Montreal, (23a,24)
 Hudec, P.J., Geol., Windsor, (3,20,2b)
 Hughes, C.J., Geol., Memorial, (16a)
 Hunting, B.T., Geog., McMaster, (49j)
 Huntley, D.A., Oceanog., Dalhousie, (51)
 Hutcheon, I., Geol. Geophys., Calgary, (42,21)
 Hutchinson, I., Geog., Simon Fraser, (49f)
- Hutchingson, R.W., Geol., Western Ontario, (2a)
 Hynes, A.J., Geol. Sci., McGill (24)
- Ingram, R.G., Marine Sci., McGill, (51)
- Jackson, E.L. Geog., Alberta (49d)
 Jacobs, J., Geog., Windsor, (49c,49a,36)
 James, N.P., Geol., Memorial, (21)
 James, R., Geol., Lakehead, (16b)
 Jansa, L.F. Geol., Dalhousie, (21).
 Jaouich, A., Sci. de la Terre, Québec à Montréal, (8)
 Jenking, J.T. Geol., Concordia, (10,16)
 Jensen, O.G., Min. Metall., McGill, (37)
 Jeremic, J., Min. Eng., Alberta, (53,20)
 Johnson, J., Geol. Sci., Regina, (1,13)
 Johnson, J.P., Geog., Carleton, (49a,49h)
 Johnson, P.G., Geog., Ottawa, (49a,49d)
 Jolly, W.T., Geol. Sci., Brock, (25,16a)
 Jones, B., Geol., Alberta, (13,23,21)
 Jones, F.W., Physics, Alberta, (27,32,39)
 Jones, R.W., Land Resource Sci., Guelph, (15)
 Jopling, A.V., Geog., Toronto, (49a)
- Kanasewich, E.R., Physics, Alberta, (37,38)
 Karrow, P.W., Earth Sci., Waterloo, (19)
 Kay, B.D., Land Resource Sci., Guelph, (15b)
 Kehlenback, M.M., Geol., Lakehead, (24,16b)
 Kemp, D.D., Geog., Lakehead, (49a,19)
 Kennedy, M.J., Geol. Sci., Brock, (24,16)
 Kent, D.M., Geol. Sci., Regina, (21,17)
 Kerrich, R.W., Geol., Western Ontario, (43)
 Kesik, A.B., Geog., Waterloo, (49a,36)
 Ketcheson, J.W., Land Resource Sci., Guelph, (15f,15g)
 Kimberley, M.M., Geol., Toronto, (2a,21)
 King, A.F., Geol., Memorial, (21)
 King, K.M., Land Resource Sci., Guelph, (15h)
 King, L.H., Geol., Dalhousie, (9)
 King, M.S., Geol. Sci., Saskatchewan, (3,20,27)
 King, R.H., Geog., Western, (49j)
 Kisak, E., de Mathématiques, Montreal, (33)
 Kissin, S.A., Geol., Lakehead, (2a,10a)
 Klován, J.E., Geol. Geophys., Calgary, (21,47,48)
 Knowles, R., Marine Sci., McGill, (15)
 Kobluk, D., Geol., Toronto, (13)
 Kontak, D., Geol., St. Francis Xavier, (2b)
 Koster, E.H., Geol. Sci., Saskatchewan, (21)
 Kramer, J.R., Geol., McMaster, (42)
 Kretz, R., Geol., Ottawa, (16b)
 Krogh, T.E., Geol., Royal Ont., Museum, Toronto, (43)
 Krouse, H.R., Physics, Calgary, (43)
 Kubalova-Peck, Geol., Carleton, (13)
 Kucera, R.E., Geol. Sci., U.B.C., (6)
 Kumarapeli, S., Geol., Concordia, (39)
 Kupsch, W.O., Geol. Sci., Saskatchewan, (6,19,50)
- Laidlaw, D.D., Min. Metall., McGill, (20)
 Lajoie, J., Géol., Montréal, (21)
 Lajtai, E.Z., Geol., U.N.B., (3)
 Lambert, R., St. J., Geol., Alberta, (16a,b,24,38,52,53)
 Lancery, J.M., Sci. Humaines, Québec a Trois Rivières, (6)
 Lane, T.H., Land Resourve Sci., Guelph, (15f)
 Langford, F.F., Geol. Sci., Saskatchewan, (2a)
 Langleben, M.P., Physics, McGill, (39)
 Laurent, R., Géol, Laval, (16a,25,43)
 Laval, P.D., Geog., Windsor, (49a)
 Lavkulitch, L., Soil sci., U.B.C., (15d,10c)
 Lawson, D.E., Earth Sci., Waterloo, (21)
 Laycock, A.H., Geog., Alberta, (49b,18)
 Laznicka, P., Earth Sci., Manitoba, (2a)
 Lebel, J., Océanog., Québec à Rimouski, (51)
 LeBlond, P.H., Oceanog., U.B.C. (51)
 Ledoux, R., Géol., Laval, (10)

- Legault, J.A., Earth Sci., Waterloo, (14)
 Leighton, H.G., Meteorology, McGill, (49c)
 Lenz, A.C., Geol., Western Ontario, (13)
 Lerbekmo, J.F., Geol., Alberta, (21,29,17,1,23)
 Lespérance, P.J., Géol., Montréal, (13)
 Levinson, A.A., Geol. Geophys., Calgary, (41,42,40)
 Lewis, J.E., Geog., McGill, (49c,49e)
 Lewry, J.F., Geol., Sci., Regina, (24,5,16)
 Liberty, B.A., Geol. Sci., Brock, (23a,13)
 Loewen-Rudgers, L.A., Soil Sci., Saskatchewan, (15a,15e)
 Logan, A., Geol., U.N.B., St. John, (13)
 Longerich, H., Geol., Memorial, (48)
 Longstaffe, F., Geol., alberta, (43,42)
 Lowe, L.E., Soil Sci., U.B.C., (15a)
 Luckman, H.B., Geog., Windsor, (49a)
 Ludden, J.N., Géol., Montréal, (25,42)
 Luk, S.H., Geog., Brock (49d)
 Ludvigsen, R., Geol., Toronto, (23b,13)
 Lyttle, N.A., Geol., Dalhousie, (5)
- Mackay, J.R., Geog., U.B.C. (49h)
 Mackenzie, B.W., Geol. Sci., Queen's (2a)
 Mackintosh, E.I., Land Resource Sci., Guelph, (15f,10b)
 Maclean, W.H., Geol.Sci., McGill, (2a)
 Macneill, R., Geol., Acadia, (19,8,18)
 Macqueen, R.W., Earth Sci., Waterloo, (23a,21,2a)
 Macrae, N.D., Geol., Western Ontario, (16a)
 Mahanney, W.C., Geog., York, (49a,49j)
 Malpas, J.G., Geol., Memorial, (16a)
 Mamet, B.L., Géol., Montréal, (7,13,23b)
 Mansinha, L., Geophysics, Western Ontario, (37)
 Mark, D., Geog., Western Ontario, (49a,48)
 Martignole, J., des Sci. de la Terre, Québec à Montréal, (24)
 Martin, R.F., Geol. Sci., McGill, (16a)
 Martini, I.P., Land Resource Sci., Guelph, (21,19)
 Mathews, R.J., Biol. Sci., Simon Fraser, (14)
 Mathews, W.H., Geol. Sci., U.B.C., (19,5,6,21)
 Matthews, B.C., Earth Sci., Waterloo, (15)
 May, R.W., Geol., alberta, (19,21,6,47)
 Mayr, F., Sci. de la Terre, Québec à Montréal (19)
 McAllister, A.L., Geol., U.N.B., (2a)
 McCann, S.B., Geog., McMaster, (49a,21)
 McCaughey, J.B., Geog., Queen's, (49e)
 McDougal, D.J., Geol., Concordia, (10)
 McFarlane, W., Physics, Royal Roads, (34)
 McGowan, C., Zoology, Toronto, (13b)
 McGugan, A., Geol. Geophys., Calgary, (13a)
 McKercher, R.B., Soil Sci., Saskatchewan, (15a)
 McLellan, A.G., Geog., Waterloo, (49a)
 McMurray, J.H., Geog., Wilfred Laurier, (49a)
 McNutt, R.H., Geol., McMaster, (43)
 McPherson, H.J., Geog., Alberta, (49a,49d)
 McTaggart, K.C., Geol. Sci., U.B.C., (16b)
 Meagher, E.P., Geol. Sci., U.B.C., (10a)
 Medioli, F., Geol., Dalhousie, (13a)
 Mellinger, M., Génie Minéral, École Polytechnique, (41)
 Menzies, J., Geog., Brock, (49a)
 Mercy, E.L., Geol., Lakehead, (42,16a)
 Middleton, G.V., Geol., McMaster, 921)
 Miller, E.E., Geog., Lethbridge, (49a)
 Miller, M.H., Land Resource Sci., Guelph, (15e)
 Milligan, G.C., Geol., Dalhousie, (24,2a,11)
 Miryneck, E., Geol. Sci., Brock, (19)
 Misener, D., Earth Environ. Sci., York, (2a)
 Mitchell, R.H., Geol., Lakehead, (43,16a)
 Moore, Jr., J.M., Geol., Carleton, (16b)
 Moore, J.C.G., Geol., Mount Allison, (2a)
 Moore, R.G., Geol., Acadia, (23b,13)
 Moore, T.R., Geog., McGill, (49j)
 Morency, M., Sci., de la Terre, Québec à Montréal, (46)
 Morgan, A.V., Earth Sci., Waterloo, (19)
 Morton, R.D., Geol., Alberta, (10,2a)
- Mossman, D.J., Geol. Sci., Saskatchewan, (2a)
 Mothersill, J.M., Geol., Lakehead, (21)
 Mountjoy, E.W., Geol. Sci., McGill, (23a,5,24)
 Muecke, G.K., Geol., Dalhousie, (43)
 Muehlenbachs, K., Geol., Alberta, (46)
 Mukherji, K.K., Geol., Concordia, (21)
 Muller, F., Geog., McGill, (49h)
 Munroe, D.S., Geog., Toronto, (49c, 49e)
 Murray, J.W., Geol. Sci., U.B.C., (9,17,23a)
 Murtha, P.A., Soil Sci. Forestry, U.B.C. (36)
 Murthy, G.S., Phys (Geophys.), Memorial, (29)
- Nagy, A., Sci. de la Terre, Québec à Chicoutimi, (10)
 Naldrett, A.J., Geol., Toronto, (2a,16a)
 Nance, R.D., Geol., St. Francis Xavier, (24)
 Nelson, J.G., Geog., Waterloo, (49i)
 Nelson, S.J., Geol. Geophys., Calgary, (23b,13)
 Nesbitt, H.W., Geol., Western Ontario, (21)
 Nichol, I., Geol. Sci., que en's, (41,2a)
 Nicholls, J.W., Geol. Geophys., Calgary, (16a,25)
 Nickling, W., Geog., Guelph, (49d)
 Nkemdirin, L.C., Geog., Calgary, (49e)
 Noble, J.P., Geol., U.N.B., (23b,13)
 Norris, G., Geol., Toronto, (14,23b)
 North, F.K., Geol., Carleton, (17,24)
 North, R.B., Geol. Sci.,Saskatchewan, (13a)
 Nyland, E., Physics, Alberta, (38,37)
- Oke, T.R., Geog., U.B.C., (49c)
 Oldenburg, D.W., Geophys. Astronomy, U.B.C., (33,28,39)
 Oldershaw, A.E., Geol. Geophys., Calgary, (21,24,16c)
 Oliver, T.A., Geol. Geophys., Calgary, (21)
 Ongley, E.D., Geog., Queen's, (49a,49b)
 Osborn, G.D., Geol. Geophys., Calgary (6,4, 19)
- Packer, R.W., Geog. Western Ontario, (49a)
 Pageau, Y., Sci., de la Terre, Québec à Montréal, (13b)
 Pajari, Jr., G.E., Geol., U.N.B., (16a)
 Palmer, H.C., Geophys., Western Ontario, (29)
 Papezik, V.S., Geol., Memorial, (10,5,2b)
 Parry, J.T., Geog., McGill, (49g,18)
 Parslow, G.R., Geol. Sci., Regina, (41,16a,2a)
 Patterson, R.J., Geol. Sci., Queen's, (8,46,4)
 Paul, E.A., Soil Sci., Saskatchewan, (15)
 Peach, P., Geol. Sci., Brock, (16a,19)
 Pearce, G.W., Geol., Toronto, (29,24)
 Pearce, T.H., Geol. Sci., Queen's, (16a)
 Pearson, D.A.B., Geol. Laurentian, (23b, 13)
 Perrault, Guy., Génie Minéral, École Polytechnique, (10)
 Peters, H.R., Geol., Memorial (2a)
 Peucker, T.K., Geog., simon Fraser, (49g,48)
 Phillips, B.A.M., Geog., Lakehead, (49a)
 Phipps, M., Geog., Ottawa, (49i)
 Pickerill, R.D., Geol., New Brunswick, (23b,13)
 Pitblado, J.R., Geog., Laurentian, (49j,49b)
 Piper, D.J., Geol., Dalhousie, (21,9)
 Platt, R.G., Geol., Lakehead, (16a)
 Pond, G.S., Oceanog., U.B.C., (51)
 Pouliot, G., Génie Minéral, École Polytechnique, (10)
 Pounder, E.R., Marine Sci., McGill, (51)
 Price, A., Geog, Toronto, (49b,49c)
 Price, R.A., Geol. Sci., Queen's, (24)
 Prichonnet, G., Sci.de la Terre, Québec à Montréal, (21)
 Pride, C.R., Geol., Ottawa, (16a)
 Protz, R.L., Land Resource Sci., Guelph, (15d,10b)
- Racz, G.J., Soil Sci., Manitoba, (15a,15e)
 Rafek, M., Geol. Sci., Saskatchewan, (13a)
 Rains, R.B., Geog., alberta, (49a)
 Ranalli, G., Geol., Carleton, (26,24)
 Rankin, D., Physics, Alberta, (29,33)
 Rasid, H., Geog., Lakehead, (49i,49a)

- Rau, J.L., Geol. Sci., U.B.C., (4,8)
 Reinson, G., Geol., Dalhousie, (4)
 Reardon, E.J., Earth Sci., Waterloo, (10c,46)
 Reid, I., Geol., Dalhousie, (34,37)
 Rennie, D.A., Soil Sci., Saskatchewan, (15a,15d)
 Reynolds, P.H., Geol., Phys. Dalhousie, (43,35)
 Richards, N.R., Land Resource Sci., Guelph, (15d)
 Ridley, A.O., Soil Sci., Manitoba, (15f)
 Risk, M.G., Geol., McMaster, (13)
 Riva, J., Géol., Laval, (13,7,50)
 Roberts, M.C., Geog., Simon Fraser, (49a,49b)
 Roberts, R.G., Earth Sci., Waterloo, (2a)
 Robin, P-Y, R., Geol., Toronto, (35,38)
 Rochester, M.G., Phys. (Geophys.), Memorial, (39)
 Roeder, P.L., Geol. Sci., Queen's, (44,16,25)
 Rogerson, R.J., Geol. Geog., Memorial, (49a,6)
 Ross, D.I., Geol., Dalhousie, (9)
 Ross, J.V., Geol. Sci., U.B.C., (24,35,5)
 Rostoker, G., Physics, Alberta, (39)
 Rouse, G.E., Geol. Sci., U.B.C., (14,12)
 Rouse, W.R., Geog., McMaster, (49e,49b)
 Rousell, D.H., Geol., Laurentian, (24)
 Rowles, C.A., Soil Sci., U.B.C., (15d)
 Roy, D.W., Sci. de la Terre, Québec a Chicoutimi, (24)
 Rucklidge, J.C., Geol., Toronto, (10,42)
 Russell, D.J., Earth Sci., Waterloo, (3,10b,22)
 Russell, R.D., Geophys. Astronomy, U.B.C., (43,30)
 Rust, B.R., Geol., Ottawa, (21,19)
 Rutherford, G.K., Geog., Queen's, (49j)
 Rutter, N.W., Geol., Alberta, (19,4,45)
- Sabins, G., Geog., Wilfred Laurier, (49b)
 Sagar, R.B., Geog., Simon Fraser, (49c)
 Sanderson, N.E., Geog., Windsor, (49c)
 Sarjeant, W.A.S., Geol. Sci., Saskatchewan, (12,14,23b,50)
 Sassano, G.P., Geol., Concordia, (2a)
 Saundersen, H.C., Geog., Wilfred Laurier, (49a)
 Scarfe, C.M., Geol., Alberta, (25)
 Schenck, P.E., Geol., Dalhousie, (23a)
 Schloessin, H.H., Geophys., Western Ontario, (35,39)
 Schwarcz, H.P., Geol., McMaster, (43,19)
 Schwartz, F.W., Geol., Alberta, (8)
 Schwarz, E.J., Génie Minéral, École Polytechnique, (29)
 Schwerdtner, W.M., Geol., Toronto, (24,38)
 Schurer, P., Physics, Royal Roads, (34)
 Scott, S.D., Geol., Toronto, (2a,44)
 Sequin, M.K., Geol., Laval, (27,29,30)
 Sewell, W.R., Geog., U.B.C., (49b)
 Shaw, D.M., Geol., McMaster, (46)
 Shaw, J., Geog., Alberta, (49a,19,21)
 Shaw, W.S., Geol., St. Francis Xavier, (17)
 Shaykewich, C.F., Soil Sci., Manitoba, (15b, 15h)
 Shear, R.W., Land Resource Sci., Guelph, (15e)
 Shegelski, Geol., Lakehead, (21,23)
 Sheppard, S.C., Land Resource Sci., Guelph, (15)
 Siddiqui, O.A., Geol., St. Mary's, (13a,7)
 Simony, P.S., Geol. Geophys., Calgary, (24,5)
 Simpson, F., Geol., Windsor, (21,3,4)
 Sims, W.A., Geol., Mount Allison, (41)
 Sinclair, A.J., Geol. Sci., U.B.C., (2a,47)
 Singh, B., Géog., Montréal, (49c)
 Sitar, N., Geol. Sci., U.B.C., (3)
 Skevington, D., Geol., Memorial, (13,23b)
 Skippen, C.B., Geol., Carleton, (44)
 Sklash, M.G., Geol., Windsor, (8,43,3)
 Slawson, W.F., Geophys. and Astronomy, U.B.C., (43,39)
 Slaymaker, O., Geog., U.B.C., (49a)
 Smith, D.G., Geog., Calgary, (49a,21)
 Smith, D.G.W., Geol., Alberta, (10,16,48,25)
 Smith, D.L. Geol. Sci., Queen's, (21,23)
 Smith, F.G., Geol., Toronto, (44,47)
 Smith, I.E.M., Geol., Toronto, (39)
- Smith, J.A., Land Resource Sci., Guelph, (15c)
 Smith, L., Geol. Sci., Queen's, (21)
 Smith, M.W., Geog., Carleton, (49c,49h)
 Smith, T.E., Geol., Windsor, (16a,42)
 Smylie, D., Earth Environ., York, (31,30,39)
 Sonnenfeld, P., Geol., Windsor, (17,9,21)
 Soon, Y.K., Land Resource Sci., Guelph, (15)
 Soper, R.J., Soil Sci., Manitoira, (15a,15e)
 Spang, J.H., Geol. Geophys., Calgary, (24,20)
 Spooner, E.T.C., Geol., Toronto, (2a)
 Springer, R.K., Geol., Brandon, (16b)
 Starkey, J.W., Geol., Western Ontario (24)
 St. Arnaud, R.J., Soil Sci., Saskatchewan, (15d,10c)
 Stauffer, M.R., Geol. Sci., Saskatchewan, (24)
 Stearn, C.W., Geol. Sci., McGill, (13,23b)
 Steeves, M.W., Geol. Sci., Saskatchewan, (13a)
 Steiner, J., Geol., Alberta, (24,23a)
 Stelch, C.R., Geol., Alberta, (13,7,23b)
 Stesky, R.M., Geol., Toronto, (24,38,35)
 Stevens, G.R., Geol., Acadia, (24,25)
 Stevens, R.K., Geol., Memorial, (5,23a)
 Stewart, J.W.B., Soil Sci., Saskatchewan, (15a)
 Stewart, I.C., Phys. (Geophy.), Memorial, (37)
 St-Julien, P., Géol., Laval, 924)
 St. Onge, D.A., Geog., Ottawa, (49a)
 Stockey, R.A., Botany, Alberta, (12)
 Strangway, D.W., Geol., Toronto, (27,29,33,39)
 Stringer, P., Geol., U.N.B., (24)
 Strong, D.F., Geol., Memorial, (2a,43)
 Stupavsky, M., Geol., Windsor, (48,30,29)
 Suckling, P., Geog., Brandon, (49c)
 Sullivan, H.M., Physics, Victoria (39)
 Symons, D.T., Geol., Windsor, (29,27,2a)
 Syvitski, J., Geol. Geophys, Calgary, (2a,48)
- Tanguay, M.G., Génie Minéral, École Polytechnique, (3,36)
 Tapper, G.O., Geog., Laurentian, (36)
 Taylor, C.H., Geog., Trent, (49b)
 Telford, W.M., Min. metall., McGill, (27)
 Teller, J.T., Earth Sci., Manitoba, (19)
 Terasmae, J., Geol. Sci., Brock, (14,19)
 Thode, H.A., Chemistry, McMaster, (43)
 Thomas, R.L., Land Resource Sci., Guelph, (15a)
 Thurtell, G.W., Land Resource Sci., Guelph, (15b,15h)
 Tinkler, K.J., Geog., Brock, (49a)
 Tiphane, M., Géol., Montréal, (5,26)
 Torrance, J.K., Geog., Carleton, (49j)
 Tovell, W.M., Geol., Toronto, (5)
 Trembath, L.T., geol., U.N.B., (10)
 Tremblay, J.J., Génie Minéral, École Polytechnique, (8)
 Tremblay, M., Génie Minéral, École Polytechnique, (2a)
 Trenbaile, A-S., Geog., Windsor, (49a)
 Trzcienski, W.E., Génie Minéral, École Polytechnique, (10)
 Tuller, S.E., Geog., Victoria, (49c,49e)
 Tupper, W.M., Geol., Carleton, (2b)
 Turek, A., Geol., Windsor, (42,41,43)
 Turmock, A.C., Earth Sci., Manitoba, (10,16b)
- Uffen, R.J., Geol.Sci., Queen's, (29)
 Ulrych, T.J., Geophys. Astronomy, U.B.C., (39)
- Valiquette, J., Génie Minéral, École Polytechnique, (10)
 Van De Poll, H.W., Geol., U.N.B., (21)
 Van Den Brock, B., Land Resource sci., Guelph, (15)
 Van der Eyk, J.J. Geog., Toronto, (36)
 Van Dine, D., Geol., Sci., Queen's, (3)
 Van Loon, J.C., Geol., Toronto, (41,46)
 Veizer, J., Geol., Ottawa, (42)
 Vigrass, L.W., Geol. Sci., Regina, (21,17)
 von Bitter, J.C., Geol., Toronto, (13a)
 Vreeken, W.J., Geog., Queen's, (49j,49a)

- Walker, R.G., Geol., McMaster, (21)
Wangersky, P.J., Oceanog., Dalhousie, (51)
Wardlaw, N.C., Geol., Geophys., Calgary (17,21)
Warren, H.V., Geol. Sci., U.B.C., (40)
Watanabe, T., Geophys. Astronomy, U.B.C., (39,29)
Watkinson, D.H., Geol., Carleton, (2a)
Watters, B.R., Geol. Sci., (16a,42)
Weaver, D.T., Physics, Victoria, (27)
Webber, L.R., Land Resource Sci., Guelph, (15)
Webber, R.G., Geol. Sci., McGill, (41)
Webster, G.R.B., Soil Sci., Manitoba, (15)
Welsted, J., Geog., Brandon, (49a)
West, G.F., Phys. Geophys., Toronto, (27,38)
Westgate, J.A., Geol., Toronto, (19)
Whitehead, R.E., Geol., Laurentian, (41,2a)
Wilkinson, T.P., Geog., Carleton, (49a)
Williams, G.D., Geol., Alberta, (17,1,23a,47)
Williams, H., Geol., Memorial, (5,24)
Williams-Jones, A.E., Geol. Sci., McGill, (2a)
Williams, P.J., Geog., Carleton, (49a,49j)
Williamson, D.H., Geol., Laurentian, (10)
Willis, A.L., Land Resource Sci., Guelph, (15)
Wilson, D.W.R., Elementary Education, Alberta, (13,26)
Wilson, H.D., Earth Sci., Manitoba, (2a)
Wilson, M.V.H., Zoology, Alberta, (13b)
Winder, C.G., Geol., Western Ontario, (23a,13,50)
Woo, M.K., Geog., McMaster, (49b)
Woods, D., Geol., Sci., Queen's, (27)
Woussen, G., Sci. de la Terre, Québec Chicoutimi, (16a)
Wright, J.A., Phys. (geophys.), Memorial, (29)
Yole, R.W., Geol. Carleton, (21,23b)
York, D., Phys. Geophys., Toronto, (43)
Young, G.S., Geol., Lethbridge, (49a)
Young, G.M., Geol., Western Ontario (21)
Zentilli, M., Geol., Dalhousie, (2a)
Zeiber, G.H., Geog., Lethbridge, (49a)
Zodrow, E.L., Geol., St. Francis Xavier, (1)
Zwarich, M.A., Soil Sci., Manitoba, (15d)

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