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Geological Survey of Canada

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CURRENT ACTIVITIES FORUM 1988
PROGRAM WITH ABSTRACTS

19-20 January 1988

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CURRENT ACTIVITIES FORUM

18-20 JANUARY, 1988

1988 Forum Chairman

M.J. Berry, Director, Geophysics Division

Place:	Halls A and E, Ottawa Congress Centre, 55 Colonel By Drive, Ottawa
Non-Technical Event:	An informal get-together with cash bar on Tuesday afternoon (19 January) from 1620h to 1900h
Popular Lecture:	At 1930h on the evening of Monday, 18 January, P.W. Basham will present a talk entitled "Earthquakes in Canada". The poster sessions will be open from 1930h to 2100h.
Program:	Over 70 poster sessions and 25 formal presentations.

PROGRAM

Tuesday, 19 January 1988

0900 Welcome and opening remarks
R.A. Price

0920 Federal-Provincial Mineral Development Agreements
W.H. Poole

0940 Federal Panel on Energy Research and Development activities
R.P. Riddihough

1000 Official opening of poster sessions

1010 **Coffee break / Pause-café**

1040 Achievements of the Frontier Geoscience Program: the Western Arctic and Arctic Islands task
W.W. Nassichuk

1100 Queen Charlotte Islands Frontier Geoscience Program: conception and implementation
D.J. Tempelman-Kluit

1120 Achievements of the Frontier Geoscience Program: the East Coast task
M.J. Keen

1200 Deep seismic profiling across the Great Lakes in the Lithoprobe program
A.G. Green

1220 Lithoprobe East: deep structure of the Grand Banks region
C.E. Keen

1240 **Lunch**

1400 Queen Charlotte Islands Frontier Geoscience Program: results
R.I. Thompson

1420 Geology of the southeast margin of the Beaufort-Mackenzie Basin
J. Dietrich, J. Dixon, L. Lane

1440 Structural investigations in the Thompson Nickel Belt, Manitoba
W. Bleeker

1500 Regional geochemical reconnaissance drainage surveys and related studies
P.B.W. Friske, E.H. Hornbrook

1520 Using organic geochemistry to find oil in the Williston Basin organique
K.G. Osadetz, L.R. Snowdon, P.W. Brooks

1540 Modelling overpressures: the Venture field off Nova Scotia
M. Best, E. Mudford

1600 Aeromagnetic surveys off the East Coast
B. Loncarevic

1620-1900 Informal get-together in poster hall; cash bar

Wednesday, 20 January 1988

0900 Geophysical and geological explorations of the Arctic Ocean Basin
J.R. Weber

0920 Geophysical characteristics of the Canadian polar margin
D.A. Forsyth, J. Broome, A.F. Embry, I. Asudeh,, J. Halpenny

0940 Crustal structure of the northeast Canadian polar margin
I. Asudeh, D.A. Forsyth, A.F. Embry, R. Stephenson, H.R. Jackson, J. Broome, J. Halpenny, L.W. Sobczak

1000 Quaternary studies and Arctic paleoclimates: anticipating global change
P. Mudie

1020 The last glaciation: changing flow patterns and paleogeography
A.S. Dyke, L.A. Dredge, V.K. Prest, L.H. Thorleifson, J.-S Vincent

1040 **Coffee break**

1100 The current potential for major earthquakes in southwest British Columbia
G.C. Rogers, H. Dragert

1120 The Tetagouche Group, New Brunswick: remnants of the formation and destruction of a Cambrian-Early Ordovician passive margin and Middle Ordovician back-arc marginal basin
C. van Staal

1140 The 1.9 Ga Cape Smith Thrust-Fold Belt: structural and petrological constraints for mineral exploration in an imbricate stack of continental rift to ophiolitic thrust sheets
M.R. St-Onge, S.B. Lucas, D.J. Scott, N.J. Bégin

1200 A comparison of structural style of three gold districts, Superior Province, Central Canada
K.H. Poulsen, F. Robert

1220 Structural evolution and plutonism in the western Contwoyto Lake map area, N.W.T.: implications for gold exploration
J.E. King, C. Relf, W. Davis

1240 Gold and silver metallogeny in the Yukon Territory
J.A. Morin

POSTER SESSIONS

Tuesday
1000-1900

Wednesday
1000-1300

FEDERAL-PROVINCIAL MINERAL DEVELOPMENT AGREEMENTS

W.H. Poole[1]

Federal-provincial mineral development agreements (MDAs) have become significant contributors of new information to mineral exploration, to mining and mineral processing and to identification of mineral economic opportunities.

The MDAs represent an instrument of regional economic development of the federal and provincial governments. A common objective is to "strengthen and diversify the mineral economy of the province". MDAs are subsidiary agreements to an umbrella Economic Regional Development Agreement (ERDA) in the Territories. MDA work is intended to supplement regular work of the federal and provincial agencies.

A typical MDA contains four programs: geoscience, mining and mineral processing technology, mineral economic studies, and public information, evaluation and administration.

Geoscience programs make up from 55% to 75% of the total MDA funds in most MDAs, and total $134 million. Most geoscience programs contain 30 to 50 projects within the fields of regional geology, mineral deposits, overburden mapping and till geochemistry, geochemistry of lake and stream sediments and waters, and airborne and ground geophysical surveys and tests. The programs focus on metallic minerals and industrial minerals. Oil and gas and offshore projects are not included.

[1] Programs, Planning and Services Branch

FEDERAL PANEL ON ENERGY RESEARCH AND DEVELOPMENT ACTIVITIES

R.P. Riddihough[1]

The Office of Energy Research and Development (OERD) is the secretariat of the Interdepartmental Panel on Energy Research and Development (PERD). OERD coordinates the distribution of PERD resources ($88.8M in 1987-88) which augment the existing budgets of twelve participating departments or agencies in order to accelerate their response to federal energy policy objectives. The Geological Survey of Canada was allocated approximately $4.1M of these resources to implement and manage over 40 geoscience-related projects. Review committees with industry, university, provincial and federal government participants provide advice to help maintain a focus and direction for the projects. Research results from coal, petroleum geoscience, permafrost, gas hydrate and offshore geotechnical projects contribute to technological and computer modeling development, to improved methods of resource analyses, to discovering potential natural hazards of relevance to the development of resources, and to augmenting the energy related geoscientific knowledge base necessary to make sound decisions for the Canadian onshore and offshore areas.

[1] Programs, Planning and Services Branch

ACHIEVEMENTS OF THE FRONTIER GEOSCIENCE PROGRAM: THE WESTERN ARCTIC AND ARCTIC ISLANDS TASK

W.W. Nassichuk[1]

The Frontier Geoscience Program is designed to accelerate the study of sedimentary basins in Canada's frontier areas in anticipation of future exploration for oil and gas. Principle objectives of the program are to determine the deep structural controls on the evolution of oil- and gas-bearing sedimentary basins, to describe the tectonic and sedimentary evolution of the basins and to elucidate the processes governing the generation, accumulation and preservation of hydrocarbon resources. In Arctic Canada, Frontier Geoscience Program activities are centred in the Queen Elizabeth Islands in the High Arctic where abundant oil and gas resources have been discovered in 17 fields, and in the Beaufort Sea-Mackenzie Delta area in the Western Arctic where oil and gas are known from 42 fields. In the Arctic Islands Frontier Geoscience Program studies are underway in the Arctic Interior Platform-Franklinian Geosyncline, the Sverdrup Basin and the Polar Continental Shelf. Other significant activities are concentrated on structural, stratigraphic, biostratigraphic and geochemical interpretation of Cretaceous and Tertiary strata of the Beaufort-Mackenzie Basin and Proterozoic to Tertiary strata in the northern Cordillera and Interior Plains.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

QUEEN CHARLOTTE ISLANDS FRONTIER GEOSCIENCE PROGRAM: CONCEPTION AND IMPLEMENTATION

D.J. Tempelman-Kluit[1]

A multidisciplinary scientific program to assess the hydrocarbon potential of the Queen Charlotte Basin was initiated April 1st, 1987 as part of the Frontier Geoscience Program. It involves a range of disciplines including geological mapping, stratigraphic and structural analysis, organic geochemistry, paleontology and biostratigraphy, heat flow analysis, seabed hazard analysis, earthquake monitoring, potential field analysis, and acquisition of reflection and refraction seismic data.

Forty-two scientists are involved. They represent the several GSC divisions, University of British Columbia, University of Ottawa and private consulting companies.

Industry response to the program is enthusiastic. They are monitoring our progress closely and have been very cooperative. Company geologists and geophysicists perceive us as a "scientific springboard" to a better understanding of the geological framework of the Queen Charlotte Basin.

[1] Cordilleran and Pacific Geoscience Division, Vancouver

ACHIEVEMENTS OF THE FRONTIER GEOSCIENCE PROGRAM: THE EAST COAST TASK

M.J. Keen[1]

The study area covers the continental margin of eastern Canada, from Georges Bank to northern Baffin Bay. Investigations carried out under the program are directed towards the lithosphere framework, the sedimentary basins, and constraints to development. These include: multichannel seismic reflection studies and complementary refraction studies to depths of many tens of kilometres; aeromagnetic surveys offshore, and associated programs of analysis; the biostratigraphy and sedimentology of the sedimentary basins, using information from the offshore wells; exploration at sea of poorly delineated sedimentary basins; and exploration at sea of the engineering properties of the seafloor.

Many advances have been made as a result of the program. We have the beginnings of a first-class set of multichannel seismic data to "depths" of 20 seconds. The aeromagnetic data allow very precise dating of the record of opening of the North Atlantic and its contiguous ocean basins, and these events can now be tied to the record of the sedimentary basins of the continental margin.

[1] Atlantic Geoscience Centre, Dartmouth

DEEP SEISMIC PROFILING ACROSS THE GREAT LAKES IN THE LITHOSPHERE PROGRAM

A.G. Green[1]

Data for approximately 1350 km were collected along eight profiles in the Great Lakes. The survey was designed to resolve the deep structure of the Keweenawan Rift in Lake Superior, the Grenville Front and Huronian continental margin in Lake Huron and the Penokean Orogen and Niagara Fault in Lake Michigan.

Data from Lake Superior reveal a remarkably thick sequence of sedimentary and volcanic rocks associated with the 1.1 Ga Mid-Continent Rift System. Beneath the central part of the lake, approximately 10 km of sediments overlie a 15 to 20 km thick sequence of volcanics and inter-flow sediments. West of the lake lies the south-dipping Isle Royale fault and in the centre lies the north-dipping Keweenaw fault.

The Grenville Front at the western end of Georgian Bay is imaged as the westernmost reflection of a spectacular 70-km-wide band of southeast-dipping reflections that clearly truncates the terrane to the west. A laterally extensive zone of flat reflections in that terrane separates a complex and highly reflective lower crust from a less reflective upper crust.

[1] Lithosphere and Canadian Shield Division

LITHOPROBE EAST: DEEP STRUCTURE OF THE GRAND BANKS REGION

C.E. Keen[1]

About 4000 km of marine deep seismic reflection data have been collected across the Appalachians and the offshore sedimentary basins and continental margins of Eastern Canada. This includes 2300 km of data in the Grand Banks region characterized by the presence of rifted continental margins. Landward dipping reflectors near the foot of the continental slope may mark the ocean-continent boundary and signify the presence of magmatic material which has underplated the rifted and thinned lower continental crust adjacent to the boundary. Deep seismic results from conjugate margins of the Grand Banks and west European margin were used to reconstruct the deep structure of the rift system which existed between Europe and North America before seafloor spreading began. The results show a 60 km wide zone of crust which has been stretched by a factor of 3 to 4, bounded on both sides by thick continental crust. The rift zone was symmetric, although it must have ruptured along the Canadian side because most of the stretched zone is now on the European plate. Reflection geometry near this rupture zone provides important evidence that ductile necking of the lower crust occurred during extension.

[1] Atlantic Geoscience Centre, Dartmouth

QUEEN CHARLOTTE ISLANDS FRONTIER GEOSCIENCE PROGRAM: RESULTS

R.I. Thompson[1]

Please refer to abstract of talk presented by D.J. Tempelman-Kluit.

[1] Cordilleran and Pacific Geoscience Division, Vancouver

GEOLOGY OF THE SOUTHEAST MARGIN OF THE BEAUFORT-MACKENZIE BASIN

J.R. Dietrich[1], J. Dixon[1], L.S. Lane[1], K. Coflin[2], F. Cook[2]

As part of the Frontier Geoscience Program activities in the Beaufort Sea-Mackenzie Delta area, 200 km of on-land deep reflection seismic data were collected in 1986 across the southeast margin of the Beaufort-Mackenzie Basin from Inuvik to the Arctic Ocean. The interpretation of this data has provided significant new structural information. The geological observations include the recognition of pre-Mesozoic thrust faults in the Campbell Uplift, basement detached normal listric faults across the basin-bounding Eskimo Lakes fault zone and intra-basin fill detached normal listric faults disrupting Tertiary strata. The base of the Cretaceous-Tertiary basin fill was imaged at depths of 11-12 km beneath the Richards Island-Beaufort Sea coastline.

Studies of the deep crustal structure of the more basinward Beaufort Sea region are currently in progress through the analyses of 460 km of 20 second marine reflection seismic data acquired in 1987. The reflection seismic interpretations are being integrated with the analysis of seismic refraction and potential field data.

[1] Institute of Sedimentary and Petroleum Geology, Calgary
[2] University of Calgary

STRUCTURAL INVESTIGATIONS IN THE THOMPSON NICKEL BELT, MANITOBA

W. Bleeker[1]

Structural investigations were initiated in the Thompson Nickel Belt (TNB), following the development of a new open pit at the Thompson Mine. These unique outcrops in the otherwise poorly exposed Early Proterozoic mobile belt representing the Churchill-Superior boundary zone, revealed a structural history of much higher complexity than previously recognized. The Thompson Mine macrostructure, a doubly plunging antiform, is a relatively late F_3 structure, which possibly formed in response to the vertical block movements as recorded in an abundance of mylonite zones. In contrast with earlier suggestions that the TNB represents a sinistral transcurrent shear zone, the present investigations reveal dominantly dip-slip movements. These large vertical movements are probably responsible for the steep metamorphic gradients perpendicular to the trend of these dip-slip shear zones. Transcurrent offsets, both dextral and sinistral, are found in late pseudotachylite-generating fault zones.

[1] Department of Geology, University of New Brunswick

REGIONAL GEOCHEMICAL RECONNAISSANCE DRAINAGE SURVEYS AND RELATED STUDIES

P.W.B. Friske[1], E.H.W. Hornbrook[1]

These surveys have covered approximately 1.8 million km^2 of the mainland mass of Canada by 155 000 sample sites.

Most of this coverage has been from routine, multi-element, relatively low density (1 sample/13 km^2), helicopter supported sediment and water surveys. The methodology has recently changed to incorporate increased sample density over volcanic-sedimentary belts, additions of new elements to the core element suite, improvements in data presentation, reanalysis and release of data from archived samples, and high density in-fill surveys in areas of economic interest.

Regional geochemical surveys are supported by investigative orientation and follow-up studies on specific geochemical problems. These include studies of the applicability of lake sediment surveys for gold and platinum group element exploration in northwestern Ontario and multi-media stream sediment evaluations in New Brunswick. New methods of presenting multi-element geochemical maps and the integration of geochemical data with related geoscience data are being investigated via the recently acquired image analysis facility.

[1] Mineral Resources Division

USING ORGANIC GEOCHEMISTRY TO FIND OIL IN THE WILLISTON BASIN

K.G. Osadetz[1], L.R. Snowdon[1], P.W. Brooks[1]

Information gained from the study of the organic geochemistry of oils and their source rocks is being employed to evaluate the hydrocarbon potential of Paleozoic plays in the Williston Basin.

Organic geochemistry makes three important contributions to the identification of the most prospective areas for exploration. The study of the composition of families of oils, their stratigraphic distribution, maturity and the location of their sources provides a primary constraint upon migration pathways. Within the Canadian portion of the basin, most oils are sourced by laterally equivalent strata lying within the same stratigraphic group as the reservoirs. A few oils show evidence for substantial vertical and lateral migration through the stratigraphic section, suggesting that plays along the migration pathway are also prospective. Identification of the distribution of extraordinary petroleum source rocks, their thermal maturity, and their relationship to potential reservoirs allows the rating and exploitation of exploration fairways. Studies of the mechanism and thresholds of hydrocarbon generation for distinct organic matter types allows the modelling and appraisal of prospects prior to their drilling.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

MODELLING OVERPRESSURES: THE VENTURE FIELD OFF NOVA SCOTIA

M. Best[1], B. Mudford[1]

The Venture gas field is a deep overpressured gas reservoir on the Scotian Shelf of Eastern Canada. The overpressuring occurs at depths below 4.5 km and appears to be due to recent and continuing gas generation. The overpressured zone is composed of undercompacted sandstones interbedded with low porosity, low permeability, normally compacted shales. Pore pressures show a stepwise increase with depth and the pressure jumps correlate with the low permeability ($<10^{-20}$m^2) shale beds. Petrophysical and lithological data for the sandstones and shales in the overpressure zone are used to constrain a one dimensional, single phase model of pore pressure development. Simple kinetic reaction theory is used to model the conversion of kerogen to hydrocarbons. The geochemical data (for example vitrinite reflectance and Rock Eval.) provide a first approximation to a total organic content profile. Results using the model and the above data were able to yield estimates of the quantity and level of source rock required to generate the pressures observed within the Venture field.

[1] Atlantic Geoscience Centre, Dartmouth

AEROMAGNETIC SURVEYS OFF THE EAST COAST

B.D. Loncarevic[1]

A compilation of the GSC's new offshore aeromagnetic surveys, together with earlier surveys over the Provinces of Nova Scotia and Newfoundland, represents a substantial coverage of the northern terminus of the Appalachian orogenic belt.

A number of "suspect terranes" of unknown origin have coalesced to form the Appalachians as a result of the opening and subsequent closure of the Iapetus Ocean during an earlier phase of ocean floor spreading and continental drift. Some of these terranes can be traced using aeromagnetic (and other geophysical) evidence. The new data are thus contributing to the delineation of different zones and the reconstruction of their development in time and space.

Newfoundland and the area to the northeast demonstrate a reasonably clear picture of converging continental margins separated by remnants of the old ocean floor. Cape Breton geology is much more complicated and it is not possible to make a clear connection between different suspect terranes across the Laurentian Channel. In addition to the known Meguma suspect terrane which occurs only in Nova Scotia and the surrounding offshore, it is postulated that at least one other suspect terrane is uniquely present in Cape Breton.

[1] Atlantic Geoscience Centre, Dartmouth

GEOPHYSICAL AND GEOLOGICAL EXPLORATIONS OF THE ARCTIC OCEAN BASIN

J.R. Weber[1]

The first truly scientific attempt to penetrate the Arctic Ocean was an expedition into the marginal ice zone north of Spitsbergen in 1773. Led by the Hon. Captain Constantine John Phipps it was perhaps the first truly multi-disciplinary, multi-national field research expedition in the modern sense. Among the many studies carried out were the determination of the gravity difference between Spitsbergen and Greenwich, the first measurements of the West Spitsbergen and East Greenland currents, and the first temperature and salinity measurements and depth soundings of Arctic Ocean waters. Subsequent geophysical and geological investigations that have been carried out during the *Fram's* transpolar voyage, 1893-1896, from Soviet and U.S. ships and drifting stations, during the Canadian North Pole expeditions and during the more recent AIDJEX and Fram operations, from the ice breaker *Ymer*, during LOREX and CESAR, and activities on *Hobson's Choice* are briefly reviewed. Aeromagnetic surveys over the Arctic Ocean Basin and gravity and seismic surveys over the polar continental shelf are also briefly examined.

[1] Geophysics Division

GEOPHYSICAL CHARACTERISTICS OF THE CANADIAN POLAR MARGIN

D.A. Forsyth[1], J. Broome[1], A.F. Embry[2], I. Asudeh[1], J. Halpenny[3]

The Canadian "passive" polar margin is characterized by many features that appear similar to those found along the Atlantic margins off North America and Norway. Interesting variations are found however, in the inverse relationship between the elliptical free air gravity highs and magnetic lows, and between features indicated by potential field anomalies and seismicity along the continent-ocean transition zone. Particular features are: the existence of a zone of negative magnetic anomalies north of Ellesmere Island to the Beaufort Sea; the bisection of the Beaufort Sea by a central linear magnetic low; the variation of margin rifting along strike, as suggested by observed changes in margin strike, changes in the character and relationship between potential field anomalies and the pattern of extensional features across the northern Sverdrup Basin; elliptical gravity highs along the outer shelf which may be explained as major sedimentary depocentres along the margin; and, the need to consider regional geometry of the Canadian polar margin as delineated by the gravity and magnetic anomalies and the differences in the nature of the crust between the eastern and western Beaufort Sea in plate reconstruction schemes.

[1] Lithosphere and Canadian Shield Division
[2] Institute of Sedimentary and Petroleum Geology, Calgary
[3] Geophysics Division

CRUSTAL STRUCTURE OF THE NORTHEAST CANADIAN POLAR MARGIN

I. Asudeh[1], D.A. Forsyth[1], A.F. Embry[2], R. Stephenson[2], A.R. Jackson[3], J. Broome[1], J. Halpenny[4], L.W. Sobczak[1]

The 1985 Ice Island refraction survey covered a northern transition zone along the Canadian polar margin near Nansen Sound. Characteristics of this zone are reflected in the onshore geology and are verified by results reported here.

A seaward thickening wedge of probable Neogene to Recent sediments was observed almost everywhere beneath the survey area. The sedimentary thickness increases from near zero onshore to about 5 km beneath the offshore line.

Beneath the onshore line, upper crustal materials are probably deformed and metamorphosed Franklinian strata containing upper Paleozoic carbonates and clastics with some Cretaceous volcanics.

Beneath the transitional onshore-offshore line, the Neogene sediments form a basin floored by a faulted block of probable deformed Proterozoic to Lower Paleozoic rocks on the landward side. Fault blocks of probable Cretaceous to Lower Tertiary rocks floor the basin on the seaward side.

On the offshore line, beneath 5 km of Neogene to Cretaceous sediments lie as much as 10 km of probable sedimentary material overlying basement. The ages of lower crustal material are uncertain.

1 Lithosphere and Canadian Shield Division
2 Institute of Sedimentary and Petroleum Geology, Calgary
3 Atlantic Geoscience Centre, Dartmouth
4 Geophysics Division

QUATERNARY STUDIES AND ARCTIC PALEOCLIMATES: ANTICIPATING GLOBAL CHANGE

P.J. Mudie[1]

Climatic change is affected by the complex feedbacks between ocean, atmosphere, cryosphere and land. The sediment record in the oceans, sampled in long cores, provides proxy information on past climates and past oceanographic conditions. This information is of particular importance in the Arctic Ocean, where minor changes in temperature, insolation or freshwater discharge may have a profound effect on Arctic climate. The range of conditions and types of feedback mechanisms that might be obtained in the next hundred years can be illustrated from changes that have taken place in the Late Cenozoic.

1 Atlantic Geoscience Centre, Dartmouth

THE LAST GLACIATION: CHANGING FLOW PATTERNS AND PALEOGEOGRAPHY

A.S. Dyke[1], L.A. Dredge[1], V.K. Prest[1], L.H. Thorleifson[1], J-S. Vincent[1]

The Wisconsin Glaciation spanned the interval 120 000 to 5000 BP. Major oscillations of ice volume and extent are indicated by oxygen isotopic records and terrestrial stratigraphy, but extent and timing of oscillations and ice sheet configurations before 30 000 BP remain obscure. Hence much remains unknown about glaciological conditions through the first 75% of the last glaciation, particularly ice extent throughout the Sangamonian (120-80 ka), at the Early Wisconsinan maximum (ca 75 ka), and during Middle Wisconsinan (65-23 ka). Researchers tend to interpret drift dispersal patterns in terms of Late Wisconsinan ice sheet configurations or in terms of flow patterns preserved in the landscape, which date from deglaciation. But most debris entrainment occurs in the marginal zone of an ice sheet so the history of large scale marginal oscillation prior to Late Wisconsinan time may be more important. Recent summaries of the stratigraphic record of the last glaciation illustrate the range of possible glaciological conditions.

1 Terrain Sciences Division

THE CURRENT POTENTIAL FOR MAJOR EARTHQUAKES IN SOUTHWEST BRITISH COLUMBIA

H. Dragert[1], G.C. Rogers[1]

Contemporary tectonic activity on Canada's west coast is characterized principally by the convergence of the North American and Juan de Fuca plates at the Cascadia Subduction Zone noted for the extreme youth (and subsequent greater

buoyancy) of the lithosphere being subducted, and the lack of historical thrust earthquakes along this zone of convergence. Of the six similar zones around the Pacific subducting young lithosphere, five have had major (m>8) thrust events on the subduction interface in historical times. No compelling arguments exist to preclude the analogous occurrence of megathrust events in the Pacific Northwest region. Recent geological evidence (wetland deposit sequences, raised beaches, turbidite layers) from local coastal areas evince the past occurrence of major earthquakes within this region having return periods of hundreds of years. Vertical and horizontal crustal deformation determined from geodetic measurements and mean-sea-level trends over the past few decades is consistent with a model of accumulating elastic strain over a locked subduction zone.

[1] Cordilleran and Pacific Geoscience Division, Vancouver

THE TETAGOUCHE GROUP, NEW BRUNSWICK: REMNANTS OF THE FORMATION AND DESTRUCTION OF A CAMBRIAN-EARLY ORDOVICIAN PASSIVE MARGIN AND MIDDLE ORDOVICIAN BACK-ARC MARGINAL BASIN

C.R. van Staal[1]

The central part of the New Brunswick Appalachians is underlain by Cambro-Ordovician volcanic and sedimentary rocks of Tetagouche Group and correlatives. Cambrian to Arenigian marine quartzose sediments with local Tremadocian and Arenigian black shales occur in the Miramichi zone and Cookson Inlier in southern New Brunswick.

Rocks below and above the disconformity known as the "Penobscot disturbance" record an identical structural history and pebbles in a conglomerate overlying quartzite and the black shale do not contain a predepositional cleavage. This disconformity is explained by thermal bulging related to earliest rifting associated with eruption of extensive silicic volcanics. Basalts have compositions typical of ocean floor and oceanic island. The MORB and WPB basalts erupted locally on sialic crust. These relationships suggest that the Tetagouche volcanics formed in a back-arc basin that evolved into a marginal sea floored by oceanic crust. The allochthonous basalts and oceanic sediments are interpreted as part of a southeast verging accretionary wedge that formed during closure of the marginal sea in late Ordovician and/or early Silurian time.

[1] Lithosphere and Canadian Shield Division

THE 1.9 GA CAPE SMITH THRUST-FOLD BELT: STRUCTURAL AND PETROLOGICAL CONSTRAINTS FOR MINERAL EXPLORATION IN AN IMBRICATE STACK OF CONTINENTAL RIFT TO OPHIOLITIC THRUST SHEETS

M.R. St-Onge[1], S.B. Lucas[2], D.J. Scott[3], N.J. Bégin[3]

The occurrence of mineralization in the 1.9 Ga Cape Smith Thrust-Fold Belt is controlled by both tectono-stratigraphy and structural geometry. Continental rift units, transitional-crust and true oceanic crust are contained in thrust sheets bound by south-verging thrust-faults (D_1) and preserved as a result of two post-thrusting episodes (D_2, D_3) of thick-skinned crustal folding. Volcanic and sedimentary deposits in progressively more internal (northern) thrust sheets record the evolution of a rift system to transitional-crust and finally to true oceanic crust. Gabbro-peridotite sills and dykes with PGE-Ni-Cu mineralization are contained within specific thrust sheets of rift margin and transitional-crust units. Towards the hinterland (northern) margin of the belt, ophiolite imbricates contain either (1) sheeted dykes overlain by basalts intruded by mafic dykes and sills, or (2) mafic and ultramafic cumulates host to asbestos deposits and chromite occurrences. D_1 out-of-sequence thrusting, associated with interleaving of basement and cover units, resulted in re-imbrication of the thrust stack and farther southward transportation.

[1] Lithosphere and Canadian Shield Division
[2] Department of Geological Sciences, Brown University, Providence, Rhode Island
[3] Department of Geological Sciences, Queen's University, Kingston, Ontario

A COMPARISON OF STRUCTURAL STYLE OF THREE GOLD DISTRICTS, SUPERIOR PROVINCE, CENTRAL CANADA

K.H. Poulsen[1], F. Robert[1]

The Val d'Or-Malartic (VM), Rice Lake-Beresford Lake (RB) and Mine Center (MC) districts each contain gold deposits and occurrences with similar lithological setting, structural associations and scales of hydrothermal alteration.

The structural style of all three districts is best explained by transpressive tectonic regimes with different proportions of compressive and dextral transcurrent components; MC is the most transcurrent, VM the least. VM deposits are typically associated with high angle reverse shear zones and sub-horizontal extensional veins, whereas MC deposits occur in strike-slip shears with vertical extensional veins and RB deposits have characteristics of both types. These variations suggest that VM, RB and MC represent successively deeper crustal levels in which structural style influences fluid dynamics. Vertical hydraulic extensional fractures and shoots in transcurrent regimes would promote upward fluid mobility, whereas episodic seismic failure in steep veins and opening of sub-horizontal extensional fractures in compressive regimes would impede fluid escape and favor gold deposition.

[1] Mineral Resources Division

STRUCTURAL EVOLUTION AND PLUTONISM IN THE WESTERN CONTWOYTO LAKE MAP AREA, N.W.T.: IMPLICATIONS FOR GOLD EXPLORATION

J.E. King[1], C. Relf[2], W.J. Davis[3]

Archean turbiditic metasediments in the western Contwoyto Lake area, have experienced four phases of Archean folding and cleavage formation. The multiple-folding events have produced complex fold interference patterns that have been analyzed using bedding-cleavage and cleavage-cleavage relations together with the trace of marker beds. Six phases of plutonism in the area have been distinguished on the basis of modal composition and interpreted chronology of emplacement. The first four intrusive phases predate and the sixth phase postdates the most intense folding (D_3) and thermal-peak conditions. The fifth phase, biotite tonalite, was intruded late during D_3 and thermal-peak conditions. Results of this study which may be of special interest for gold exploration include 1) expansion of area underlain by iron-formation-bearing metaturbidites, 2) the use of the proposed structural model for prediction and/or interpretation of structural patterns, most notably for the tracing of gold-bearing iron formation horizons.

[1] Lithosphere and Canadian Shield Division
[2] Department of Geological Sciences, Queen's University
[3] Department of Earth Sciences, Memorial University

GOLD AND SILVER METALLOGENY IN THE YUKON TERRITORY

J.A. Morin[1]

Precious metal distribution in Yukon is related to the lithotectonic character of the host terrane and mode of hydrothermal deposition. Middle Proterozoic gold is found chiefly in volcanic massive sulphides of a passive continental margin terrane that lasted until the Triassic. Silver occurs in Cambro-Ordovician sulphide deposits in an extensional basin, and in Devono-Mississippian barite sulphide deposits in clastic continental margin rocks. Mesozoic island arc-continent collision and resulting metamorphism formed gold lodes that probably contributed to the Klondike placer gold deposits. Post-accretionary magmatism, e.g. Cretaceous cauldron-subsidence volcanism and widespread granitoid plutonism, resulted in porphyry gold, vein deposit gold, silver-base metal veins, silver and gold in contact skarns, and chimney-deposit-gold. Late Cretaceous arc volcanism and hypabyssal magmatism in a transtensional environment produced gold and silver in cauldron-subsidence complexes. Tertiary arc volcanics and hypabyssal intrusions caused epithermal volcanic-hosted mineralization and magmato-hydrothermal mineralization, resulting in further gold and silver. Transtensional volcanism, along the Tintina Fault about 50 Ma, caused disseminated gold.

[1] Indian and Northern Affairs, Exploration and Geological Services Division

CURRENT ACTIVITIES FORUM

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ABSTRACTS

CRUSTAL STRESSES IN NORTH AMERICA

J.E. Adams[1], J.S. Bell[2]

Crustal stress determinations for Canada and adjacent areas have been compiled into a computer database, currently containing 1175 entries (GSC Open File Report 1622). The data come from well breakouts, hydro-fracturing, earthquake focal mechanisms, direct stress measurements, and geological evidence. They strongly suggest that the whole of the North American plate east of the Cordillera is being compressed along the northeast-southwest azimuth – a uniform mid-plate stress field.

In and west of the Cordillera, the stress field is more complex. In the Pacific Northwest, two separate stress fields exist (NE-SW and N-S trending) and are related to subduction of the Juan de Fuca plate. To north and south, the stress field along the Pacific margin is dominated by the relative motions of the Pacific and North American plates. In the United States the mid-plate and Pacific Margin stress provinces are separated by the extensional Basin and Range province. Although data are sparse, current evidence suggests that this extensional province dies out to the north and does not extend into Canada.

[1] Geophysics Division
[2] Institute of Sedimentary and Petroleum Geology, Calgary

EARTHQUAKES IN NORTH AMERICA

J.E. Adams[1], G.C. Rogers[2], P.W. Basham[1], R. Horner

Within the southern part of the continental region, seismicity is clustered in four zones. In three of these zones – western Quebec, Charlevoix, and the lower St. Lawrence – most of the earthquakes are occurring at depths of 5 to 25 km within the Grenville basement. The fourth zone is located in the northern Appalachians.

Along the eastern margin of the continent, the seismicity includes the 1929 M7.2 Grand Banks and 1933 M7.3 Baffin Bay earthquakes. In the Labrador Sea, earthquakes are associated with the extinct spreading ridge and its associated transform faults.

In Arctic Canada, continental earthquakes occur on Baffin Island, along an arcuate band between the Boothia and the Ungava peninsulas, and in the Sverdrup Basin. Along the Arctic Ocean margin, earthquakes appear to be concentrated where thick sediments have loaded the rifted transitional and oceanic crust.

In Western Canada the most intense region of seismicity is the northern end of the Juan de Fuca Ridge System west of Vancouver Island. Most of the earthquake activity occurs on, or near, major seafloor transform fault regions. Minor seismicity occurs inland across all of the Cordillera. The Prairie regions are mainly aseismic with the exception of a pocket of minor activity in southern Saskatchewan.

[1] Geophysics Division
[2] Cordilleran and Pacific Geoscience Division, Vancouver

AEROMAGNETIC TOTAL FIELD, GRADIOMETER, VLF SURVEYS – NEWFOUNDLAND

Aeromagnetic contract Survey Group[1]

Contract aeromagnetic total field/gradiometer/VLF surveys were flown in 1984/85 and 1986/87. In both cases flight line separation was 300 m at 150 m above ground. VLF EM data have also been recorded using stations at Cutler Maine and Annapolis Maryland. The vertical gradient and total field data are presented as 1:20 000 contour maps and as 1:50 000 colour interval maps. The VLF quadrature data are plotted as stacked profiles on the back of the vertical gradient colour maps so that they may be viewed concurrently with the gradiometer data using a light table. The zero contour of the vertical gradient has been shown to closely outline contacts between rock masses with contrasting magnetization such as volcanics and sedimentary units, whereas VLF data have proven to be useful for the delineation of near surface zones of contrasting conductivity. The 1984/85 survey was in the central mobile belt of Newfoundland whereas the 1986/87 survey was in the northern portion. These two surveys bracket the earlier GSC Queenair gradiometer survey in the area.

Contribution to Canada-Newfoundland Mineral Development Agreement 1984-1989.

[1] Geophysics Division

AEROMAGNETIC TOTAL FIELD, GRADIOMETER, VLF SURVEYS – NOVA SCOTIA

Aeromagnetic Contract Survey Group[1]

Contract aeromagnetic total field/gradiometer/ VLF surveys were flown during 1985/86 and 1986/87. In both cases flight line separation was 300 m at 150 m above ground. VLF EM data have also been recorded. The vertical gradient and total field data are presented as 1:25 000 contour maps and as 1:50 000 colour interval maps. The VLF quadrature data are plotted as stacked profiles on the back of the vertical gradient colour maps so that they may be viewed concurrently with the gradiometer data using a light table. The zero contour of the vertical gradient has been shown to outline very closely contacts between rock masses with contrasting magnetization such as volcanic and sedimentary units, whereas the VLF data have proven to be useful for the delineation of near surface conductors and zones of contrasting conductivity. The 1985/86 survey was in the Musquodoboit area which has been an area of extensive gold exploration in recent years. The 1986/87 survey was in the Cobequid highlands area of northern Nova Scotia – also an area of current exploration interest.

Contribution to Canada-Nova Scotia Mineral Development Agreement 1984-1989.

[1] Geophysics Division

AEROMAGNETIC TOTAL FIELD, GRADIOMETER, VLF SURVEYS – NEW BRUNSWICK

Aeromagnetic Contract Survey Group[1]

Contract aeromagnetic total field/gradiometer/ VLF surveys were flown during 1985/86 and 1987/88. In both cases flight line separation was 300 m at 150 m above ground. VLF EM data have also been recorded using stations at Cutler Maine and Annapolis Maryland. The vertical gradient and total field data are presented as 1:20 000 contour maps and as 1:50 000 colour interval maps. The VLF quadrature data are plotted as stacked profiles on the back of the vertical gradient colour maps so that they may be viewed concurrently with the gradiometer data using a light table. The zero contour of the vertical gradient has been shown to outline very closely contacts between rock masses with contrasting magnetization such as volcanics and sedimentary units, whereas VLF data have proven to be useful for the delineation of near surface conductors and zones of contrasting conductivity. These two surveys essentially complete the gradiometer-VLF mapping of the northern part of the Miramichi volcanic-sedimentary belt.

Contribution to Canada-New Brunswick Mineral Development Agreement 1984-1989.

[1] Geophysics Division

APPLICATIONS OF AIRBORNE GAMMA RAY SPECTROMETRY TO GEOLOGICAL MAPPING AND MINERAL DEPOSIT STUDIES

Airborne Geophysics Section[1]

The acquisition of detailed, high sensitivity airborne gamma ray spectrometric data covering large areas of the Canadian Shield and Appalachian region of Canada over the last several years by the Geological Survey of Canada has expanded the role of gamma ray spectrometry beyond a primary uranium exploration tool to include regional and detailed geological mapping applications and mineral deposit studies. These expanded roles have been enhanced by the implementation of a modified ternary radioelement mapping technique which has been designed to optimize the display of radioelement contrasts in the data.

Several examples are provided which illustrate some of these expanded roles including terrane identification or characterization and radioelement discrimination of various phases of a composite suite of plutonic rocks. Also illustrated is the ability of airborne gamma ray spectrometry to distinguish magmatic versus late magmatic or post-crystallization alteration through the use of radioelement variations as lithogeochemical indicators.

[1] Mineral Resources Division

CRUSTAL STRUCTURE OF THE NORTHEAST CANADIAN POLAR MARGIN

I. Asudeh[1], D.A. Forsyth[1], A.F. Embry[2], R. Stephensen[2], A.R. Jackson[3], J. Broome[1], J. Halpenny[4], L.W. Sobczak[1]

The 1985 Ice Island refraction survey covered a northern transition zone along the Canadian polar margin near Nansen Sound. Characteristics of this zone are reflected in the onshore geology and are verified by results reported here.

A seaward thickening wedge of probable Neogene to Recent sediments was observed almost everywhere beneath the survey area. The sedimentary thickness increases from near zero onshore to about 5 km beneath the offshore line.

Beneath the onshore line, upper crustal materials are probably deformed and metamorphosed Franklinian strata containing upper Paleozoic carbonates and clastics with some Cretaceous volcanics.

Beneath the transitional onshore-offshore line, the Neogene sediments form a basin floored by a faulted block of probable deformed Proterozoic to Lower Paleozoic rocks on the landward side. Fault blocks of probable Cretaceous to Lower Tertiary rocks floor the basin on the seaward side.

On the offshore line, beneath 5 km of Neogene to Cretaceous sediments lie as much as 10 km of probable sedimentary material overlying basement. The ages of lower crustal material are uncertain.

1 Lithosphere and Canadian Shield Division
2 Institute of Sedimentary and Petroleum Geology, Calgary
3 Atlantic Geoscience Centre, Dartmouth
4 Geophysics Division

GEOLOGICAL MAPPING OF NORTHERN CAPE BRETON ISLAND, NOVA SCOTIA

S.M. Barr[1], R.P. Raeside[1], R.A. Jamieson[2]

Results of recent geological mapping of igneous and metamorphic rocks in the highland areas of northern Cape Breton Island have been compiled, including all, or parts of, ten 1:50,000 map sheets. Approximately forty metasedimentary and metavolcanic units and sixty intrusive units have been distinguished. The mapping combined with on-going petrological and geochronological studies has led to the recognition of four contrasting tectonostratigraphic zones: 1) the Northwestern Highlands, characterized by quartzofeldspathic gneisses, anorthosite, and syenite, and interpreted to represent Grenville basement; 2) the Aspy zone, characterized by gneissic and metavolcanic and metasedimentary units intruded by compositionally varied, mainly Devonian granitoid plutons; 3) the Ingonish zone, characterized by Late Precambrian metamorphic units and dioritic to tonalitic plutons; 4) the Bras d'Or zone, characterized by low-pressure gneissic rocks, a carbonate-clastic sequence, and Late Precambrian dioritic, granodioritic and granitic plutons.

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UPPER PALEOZOIC HYDROCARBON POTENTIAL AT THE SOUTHERN MARGIN OF THE SVERDRUP BASIN, CANADIAN ARCTIC

B. Beauchamp[1]

Unusually high carbon isotope ratios in the carbonate rocks demonstrate that preferential removal and preservation of organic matter took place in the central parts of the Sverdrup Basin, suggesting that the basinal black shales of the Hare Fiord and Van Hauen formations may be potential source rocks. It is conceivable that these hydrocarbons migrated into nearby dolomitized *Palaeoaplysina*-, phylloid algal-, sponge-, and bryozoan-constructed reefs or farther inland into highly porous coastal plain fluvial sandstones. Emplacement of the larger reefs was controlled by synsedimentary block faulting. Dolomitization, too, appears to be related to the proximity of synsedimentary growth faults, and this association points towards a hydrothermal origin for the dolomitizing fluids.

The local first-order sea level curve indicates a major sea level rise from the Carboniferous-Permian boundary until the early Late Permian. The sea level rise, accompanied by marine transgression at the shoreline and stratigraphic coastal onlap, could have led to deposition of impermeable sediments that sealed potential reservoirs.

1 Institute of Sedimentary and Petroleum Geology, Calgary

DEMONSTRATION OF A MICROCOMPUTER-BASED SPATIAL DATA INTEGRATION SYSTEM WITH EXAMPLES FROM NOVA SCOTIA, NEW BRUNSWICK AND SASKATCHEWAN

G.F. Bonham-Carter[1], A.N. Rencz[1], H. George[1], D.F. Wright, G.P. Watson, C.E. Dunn[1], A.L. Sangster[1]

For a single project, a large number of individual map layers can be studied simultaneously, permitting multiple overlays of various kinds, display of simple or complex map combinations, and statistical analyses. Digital input to the system can be from a variety of sources: 1) point/line/polygon maps can be directly digitized from documents fixed to a large digitizing table; 2) point/line/polygon data can be digitized at other facilities and input in vector or raster form; 3) geophysical flight-line data can be gridded and transferred to the system either on magnetic tape or via a communication line; 4) geochemical data can be input as points or as catchment basin images; and 5) satellite and airborne remote-sensing imagery can be input from magnetic tapes. The hardware consists of two supermicrocomputers with co-processors, equipped with graphics boards, colour monitors, large internal hard disks, and optical disk drives with removable diskettes. Two commercial software packages are employed. The system is capable not only of rectifying and merging diverse map types, but also is designed to carry out modelling operations – either statistical or subjective models based on geological reasoning.

[1] Mineral Resources Division

TIDAL AND COSEISMIC WELL-LEVEL OBSERVATIONS AT THE CHARLEVOIX GEOPHYSICAL OBSERVATORY, QUEBEC

D.R. Bower[1]

The observatory is located within the Charlevoix Seismic Zone which is the most active in eastern Canada. Water level in two 68 m-deep boreholes was recorded continuously throughout the period 1979 to early-1986 as part of a multiparameter investigation of the dilatation theory of earthquakes.

A change in well tide during the period may be related to an increasing concentration of tidal strain at nearby northeast striking faults or to a change in local elastic properties due to the nonlinear response of intact rock to increasing stress. Correlated changes in tidal amplitude and phase are further evidence for a possible connection with the ambient stress field.

The coincident response of well level to four local earthquakes is larger than expected. Triggered, aseismic slip of faults located much closer to the wells than the hypocentres, seems to be the most likely explanation.

Relatively large residual (after known effects are removed) water level changes probably rule out the detection of dilatancy effects associated with the small earthquakes ($M \leq 5$) experienced during the investigation.

[1] Geophysics Division

APPLICATION OF GROUNDWATER GEOCHEMISTRY IN MINERAL EXPLORATION

D.R. Boyle[1]

Groundwater geochemistry, when properly integrated with hydrological, lithological and structural data offers a good three dimensional approach to exploration for blind mineral deposits. Sampling methodologies can essentially be divided into lithospheric and overburden techniques. Downhole geochemical techniques would involve aquifer isolation and sampling methods together with multi-element, speciation, isotope and facies analyses; these are complimented by downhole geophysical methods capable of mapping the location, frequency and porosity-permeability characteristics of flow zones. Incorporation of these parameters in suitable fluid mass transport models may supply drill vectors to undiscovered ore deposits. Overburden techniques require the implementation of combined overburden drilling-piezometric groundwater surveys in order to adequately assess the subsurface and blind resource potential of glacial drift and lacustrine covered regions.

Groundwaters, which may be gravity, compaction or heat driven, play a major role in the formation of a wide variety of deposit types. The recognition of regions having 'fertile' source rocks contiguous to receptive depositional environments should be a priority for those exploring for groundwater infiltration-type mineral deposits.

[1] Mineral Resources Division

BOREHOLE SENSORS FOR EXPLORATION APPLICATIONS

Q. Bristow[1]

An inductive conductivity/magnetic susceptibility sensor and a high sensitivity temperature sensor have been developed at the Geological Survey of Canada for use in "slim-hole" borehole logging applications. These will be demonstrated using an IBM-PC based data acquisition system. The technology involved is available to interested Canadian companies from the Crown agency Canadian Patents and Developments Ltd.

[1] Mineral Resources Division

SEISMIC SURVEYS: CUMBERLAND BASIN AND OFFSHORE CAPE BRETON ISLAND, NOVA SCOTIA

D.S. Bromley[1], J.H. Calder[2]

Since 1985, the Geological Survey of Canada has been conducting high resolution seismic surveys under the Canada-Nova Scotia Mineral Development Agreement. In these studies, over 230 line-km of data have been collected in both on and offshore areas of Nova Scotia. The main objective of this project was to attempt to delineate regional structure of Carboniferous strata in the Cumberland Basin and offshore areas of western Cape Breton Island, Nova Scotia. Also of interest, was the detailed mapping of coal-bearing structure found within the Upper Carboniferous groups near Springhill, Nova Scotia.

The results of this study have been successful in delineating several reflecting horizons from within Carboniferous strata. While the main objective has been to concentrate on coal-bearing reflectors in the upper 1500 m, some of the data show strong reflecting events that can be traced to depths of over 4000 m subsurface.

[1] Terrain Sciences Division
[2] Nova Scotia Department of Mines and Energy

INTEGRATED GEOPHYSICAL IMAGERY: APPLICATIONS TO GEOLOGICAL INTERPRETATION IN THE WAGER BAY AND BAKER LAKE AREAS, DISTRICT OF KEEWATIN

J. Broome[1], A.N. LeCheminant[1]

Imagery produced from geophysical data helps the geologist to identify and characterize map units, to trace structures and to interpolate between isolated bedrock exposures. In this study, aeromagnetic, gravity and gamma-ray spectrometry data from the Baker Lake and Wager Bay areas are displayed as individual and composite images and correlated with existing geological knowledge.

Potential field data provide information about lithological units and structures, both at the surface and at depth. Gamma-ray spectrometry data are a measurement of radioelement concentrations in near surface materials. The potential field and radioelement signatures of different plutons in the 1.82 Ga calc-alkaline magmatic belt north of Wager Bay correlate well with detailed bedrock maps of individual plutons. Characteristic geophysical signatures from areas of detailed mapping can be extrapolated to adjacent regions mapped only at reconnaissance level. In the region north of Baker Lake, images derived from potential field data are useful for tracing shear zones and they enhance structural detail in complexly folded supracrustal rocks known to be anomalous in Au and base metals.

[1] Lithosphere and Canadian Shield Division

GEOMAGNETIC FORECASTING IN CANADA

R.L. Coles[1], J. Hruska[1], H.-L. Lam[1]

Forecasting of geomagnetic activity is in increasing demand by a variety of user groups, including the exploration industry, telecommunications agencies, electric power utilities, the military, pipeline corrosion prevention system operators, geodetic surveyors, and scientific researchers. The Geological Survey of Canada provides several types of geomagnetic forecast. A medium-term forecast (up to 27 days in advance) is issued every 3 weeks. Short-term forecasts for up to 3 days in advance are made available on a telephone answering system and also by means of a computer dial-up facility. Alert messages are issued when severe magnetic storms are expected.

[1] Geophysics Division

SCOPE OF THE QUEEN CHARLOTTE ISLANDS FRONTIER GEOSCIENCE PROGRAM

Cordilleran and Pacific Geoscience Division

"A multidisciplinary scientific program to assess the hydrocarbon potential of the Queen Charlotte Basin was initiated April 1st, 1987 as part of the Frontier Geoscience Program. It involves a range of disciplines including geological mapping, stratigraphic and structural analysis, organic geochemistry, paleontology and biostratigraphy, heat flow analysis, seabed hazard analysis, earthquake monitoring, potential field analysis, and acquisition of reflection and refraction seismic data.

Forty-two scientists are involved. They represent the several GSC divisions, University of British Columbia, University of Ottawa and private consulting companies.

Industry response to the program is enthusiastic. They are monitoring our progress closely and have been very cooperative. Company geologists and geophysicists perceive us as a "scientific springboard" to a better understanding of the geological framework of the Queen Charlotte Basin."[1]

[1] From the talk presented by D.J. Tempelman-Kluit

QUATERNARY GEOLOGY AND DRIFT GEOCHEMISTRY IN THE DRYDEN AREA, NORTHWESTERN ONTARIO

W.R. Cowan[1], G.V. Minning[2], D.R. Sharpe[3]

Most of the study area occurs within the Wabigoon Subprovince and consists predominantly of metavolcanic rocks intruded by granitoid rocks, some of batholithic proportions. The bedrock surface of the area is usually strongly glacially eroded; striations and stoss and lee features indicate a dominant ice flow direction toward 210°, within a range of 185° to 235°. All Quaternary deposits are attributed to the last (Late Wisconsinan) glaciation and are primarily deglacial in origin, deglaciation having occurred between 11 000 and 9500 years ago. Till deposits are very thin and discontinuous and are compositionally dominated by local lithologies. Major end moraines consist primarily of sand with lesser components of gravel, boulders, and flow till. It is suggested that these moraines contain considerable subaqueous outwash deposited within Glacial Lake Agassiz and that they may be "re-equilibration moraines". Glaciolacustrine clay sediments are usually draped directly on the bedrock surface with intervening till being thin or absent. Results of till geochemical analyses indicate a few occurrences of above background gold and uranium-thorium values. Some of the gold values are related to known gold occurrences while others require further investigations.

Contribution to Canada-Ontario Mineral Development Agreement, 1985-1990.

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[3] Terrain Sciences Division

TECTONIC STUDIES IN THE SOUTHWEST GRENVILLE PROVINCE, ONTARIO

A. Davidson[1], K.M. Bethune[2], N.G. Culshaw[3], D.W. Halliday[4], P.H. McGrath[1]

Two mapping projects were initiated in 1987, one along the northeast shore of Georgian Bay and the other encompassing the Grenville Front and adjacent tectonic zone along the north shore. Other work completed in the region includes seismic reflection, gravity, and aeromagnetic surveys, as well as a related project to study diabase dykes which is currently underway.

Preliminary findings are: 1), the ca. 1.74 Ga granitic and felsic granitic rocks and the ca. 1.24 Ga diabase dykes northwest of the Grenville Front can be traced across the front and recognized in the Grenville Front Tectonic Zone in a deformed and metamorphosed state; 2), by analogy with the geology along the north shore, southeast-dipping reflectors in Georgian Bay are probably due to mylonite and ductile shear zones; 3), Britt domain is the locus of distinctive, polycyclic gneiss associations that may represent terranes assembled before mid-Proterozoic (ca. 1.45 Ga) granite plutonism, itself preceding and unrelated to the compressive Grenvillian Orogeny.

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[4] Geophysics Division

SEAFLOOR MAPPING OFF WESTERN CANADA

E.E. Davis[1], R.G. Currie[1], B.S. Sawyer[1]

A variety of geophysical mapping tools including SEABEAM, SeaMARC II, SeaMARC I, and GLORIA have been used in western Canadian offshore regions since 1983 to provide better information about this geologically active area. Joint surveys between GSC, NOAA (with SEABEAM), and the Hawaii Institute of Geophysics (with SeaMARC II) have been designed to provide detailed yet continuous coverage of areas of greatest potential interest, including much of the axial zone of the northern Juan de Fuca Ridge system, and the tectonically active lower continental slope. The resultant high resolution swath bathymetry and acoustic imagery have been compiled using two common scales, 1:50 000 and 1:250 000, and formats, and published as series of maps. The bathymetry and acoustic image mosaics characterize the recent volcanism and faulting at the offshore spreading centres, recent off-axis seamount volcanism, sediment distributary channels, and the deformation and faulting of sediments along the Queen Charlotte and Vancouver Island transform and subduction plate boundaries.

[1] Cordilleran and Pacific Geoscience Division, Sidney, B.C.

QUATERNARY STRATIGRAPHY AND TILL PROVENANCES IN THE TIMMINS AREA, ONTARIO: AIDS TO MINERAL EXPLORATION BY DRIFT PROSPECTING

R.N.W. DiLabio[1], R.F. Miller[2], R.J. Mott[1], W.B. Coker[3]

From top to bottom, the Quaternary sequence in the Timmins area consists of: glaciolacustrine clays of the Barlow-Ojibway succession, containing the Cochrane till; the Matheson till; the fossiliferous nonglacial Owl Creek beds; and at least two older tills and associated stratified sediments. The Owl Creek beds discontinuously underlie an area of at least 2000 km^2 and form a distinctive stratigraphic marker. This unit may represent a complete Sangamon or Middle Wisconsinan nonglacial cycle. Ice-flow directions and provenances for tills under the Owl Creek beds are being investigated because these tills have the largest contact areas with the local bedrock and therefore are prime sampling media for drift prospecting in the areas of thicker drift.

Contribution to Canada-Ontario Mineral Development Agreement 1985-1990.

[1] Terrain Sciences Division
[2] New Brunswick Museum, Saint John, New Brunswick
[3] Mineral Resources Division

DECADE OF NORTH AMERICAN GEOLOGY (DNAG) MAGNETIC ANOMALY MAP OF NORTH AMERICA

S.D. Dods[1], D.J. Teskey[1], P.J. Hood[1]

The final version of this map was compiled by the Geological Survey of Canada's Aeromagnetic Data Processing Section, from the following forms of data: original shiptrack data, flight-line data, gridded data, and compiled regional maps.

This map has been compiled using a nucleus of data from the conterminous United States, Canada, and Alaska. Each of the three data sets forming the nucleus was prepared individually using the new Definitive Geomagnetic Reference Field (DGRF), and the original join between them was remarkably free of major discrepancies. Some adjustments to this nucleus were however necessary. The extensive shiptrack data were also corrected using the DGRF.

Control lines flown by the Geological Survey of Canada for the purpose of providing data for this map were used to resolve leveling problems.

All data were transformed to map coordinates using the North American Transverse Mercator Projection with a central meridian of long. 100° west and a scale factor of 0.926, and were gridded at 2 km intervals using the minimum curvature method.

Colour separates produced from the final gridded data were forwarded to the U.S. Geological Survey for final cartographic preparation and printing.

[1] Geophysics Division

GEOPHYSICAL CHARACTERISTICS OF THE CANADIAN POLAR MARGIN

D.A. Forsyth[1], J. Broome[1], A.F. Embry[2], I. Asudeh[1], J. Halpenny[3]

The Canadian "passive" polar margin is characterized by many features that appear similar to those found along the Atlantic margins off North America and Norway. Interesting variations are found however, in the inverse relationship between the elliptical free air gravity highs and magnetic lows, and between features indicated by potential field anomalies and seismicity along the continent-ocean transition zone. Particular features are: the existence of a zone of negative magnetic anomalies north of Ellesmere Island to the Beaufort Sea; the bisection of the Beaufort Sea by a central linear magnetic low; the variation of margin rifting along strike, as suggested by observed changes in margin strike, changes in the character and relationship between potential field anomalies and the pattern of extensional features across the northern Sverdrup Basin; elliptical gravity highs along the outer shelf which may be explained as major sedimentary depocentres along the margin; and, the need to consider regional geometry of the Canadian polar margin as delineated by the gravity and magnetic anomalies and the differences in the nature of the crust between the eastern and western Beaufort Sea in plate reconstruction schemes.

[1] Lithosphere and Canadian Shield Division
[2] Institute of Sedimentary and Petroleum Geology, Calgary
[3] Geophysics Division

GRAPHICAL DATA ANALYSIS WITH IDEAS: INTERACTION COMPUTER GRAPHICS FOR THE EXPLORATION GEOCHEMIST

R.G. Garrett[1]

A colour interactive graphics system (IDEAS) has been designed and implemented to assist exploration geochemists in interpreting their data and preparing camera ready line drawings. IDEAS consists of three main components for: database management, plotting and simple statistics, and multivariate statistics. The majority of modules required in the first two parts are operational, whereas the multivariate statistical modules are still under development. Geochemists may build databases from their field and analytical data, and selectively retrieve data items and individual, or groups of, samples as they require. Data subsets may be prepared by entering logical criteria or by enclosing points within polygons on the graphics displays. The graphics displays may be modified in real-time to prepare diagrams suitable for publication. IDEAS is written in Fortran 77 and runs under VMS on a DEC VAX 8700 employing Tektronix graphics terminal equipment and Plot10GKS graphics software.

[1] Mineral Resources Division

GRAVITY MAPS: CANADIAN GEOPHYSICAL ATLAS

A.K. Goodacre[1], R.A.F. Grieve[1], J. Halpenny[1], L.A. Warren[1]

As a contribution to the Canadian Geophysical Atlas, a set of five coloured gravity maps of Canada (Observed, Free air, Bouguer, Isostatic and Horizontal gradient) are being produced at a scale of 1:10 000 000. These maps differ from previous gravity maps of Canada in that they do not employ contours but instead assign the appropriate colour to individual pixels (small rectangular elements of area) in order to better display the information contained within the potential field data. The maps are designed to show the progression from gravity values observed during field surveys to gravity anomalies arising from various increasingly more complex methods of reduction. Each map shows a different facet of Canada's gravity field and is designed to be of assistance in studies of the crust and upper mantle. For example, the horizontal gradient map helps to extend our knowledge of major structural boundaries, such as the Circum-Superior belt, beneath areas where these features are buried or poorly exposed. These maps are forerunners of other maps which will display geophysical and geodynamic data over Canada and be incorporated into the Geophysical Atlas.

[1] Geophysics Division

DEEP SEISMIC PROFILING ACROSS THE GREAT LAKES IN THE LITHOSPHERE PROGRAM

A.G. Green[1]

Data for approximately 1350 km were collected along eight profiles in the Great Lakes. The survey was designed to resolve the deep structure of the Keweenawan Rift in Lake Superior, the Grenville Front and Huronian continental margin in Lake Huron and the Penokean Orogen and Niagara Fault in Lake Michigan.

Data from Lake Superior reveal a remarkably thick sequence of sedimentary and volcanic rocks associated with the 1.1 Ga Mid-Continent Rift System. Beneath the central part of the lake, approximately 10 km of sediments overlie a 15 to 20 km thick sequence of volcanics and inter-flow sediments. West of the lake lies the south-dipping Isle Royale fault and in the centre lies the north-dipping Keweenaw fault.

The Grenville Front at the western end of Georgian Bay is imaged as the westernmost reflection of a spectacular 70-km-wide band of southeast-dipping reflections that clearly truncates the terrane to the west. A laterally extensive zone of flat reflections in that terrane separates a complex and highly reflective lower crust from a less reflective upper crust.

[1] Lithosphere and Canadian Shield Division

GREAT SLAVE LAKE SHEAR ZONE MEETS THELON TECTONIC ZONE, DISTRICT OF MACKENZIE, N.W.T.

Simon Hanmer[1]

The early Proterozoic Great Slave Lake shear zone and the Thelon Tectonic Zone are co-extensive elements of the same tectonic structure; the Great Slave - Thelon shear zone. The 060° trending elements (Laloche segment) are transcurrent. The 030°-010° trending elements (Schist-Daisy segment and Thelon Tectonic Zone) are dextral transcurrent on their west side and dip-slip on their east side. The broad Daisy Lakes belt of high grade dip-slip mylonites brings granulites up into the map-plane and postdates the Schist Lakes belt, a broad belt of high grade dextral strike-slip finely homoclastic protomylonites. The trend of all high grade mylonites wraps around the southeast corner of Slave Craton, but is crosscut by an 060° trending narrow belt of greenschist facies strike lineated dextral transcurrent mylonites. The early Proterozoic Great Slave Supergroup unconformably overlies the Great Slave - Thelon shear zone. These observations are compatible with recent modeling of the tectonics of southeastern Slave Craton in terms of early Proterozoic oblique convergence, collision and indentation.

[1] Lithosphere and Canadian Shield Division

STRUCTURAL AND KINEMATIC ANALYSIS OF THE WAGER BAY SHEAR ZONE, N.W.T., USING GEOLOGICAL AND AEROMAGNETIC DATA

J.R. Henderson[1], J. Broome[1]

Curvature of older aeromagnetic lineaments into parallelism with E-W striking anomalies, caused by subvertical mylonites, indicates dextral shear along the Wager Bay Shear Zone (WBSZ), an early Proterozoic mylonite zone recognizable on the Magnetic Anomaly Map of Canada.

In Wager Bay, at the eastern limit of magnetic mapping bordering NW Hudson Bay, structural mapping combined with analysis of digitally-enhanced aeromagnetic total field and calculated vertical magnetic gradient data reveal that the dextral transcurrent WBSZ widens by stepping right through several extensional duplexes.

[1] Lithosphere and Canadian Shield Division

THE GEOLOGY OF THE CANADIAN BEAUFORT SEA COASTAL ZONE AND ADJACENT CONTINENTAL SHELF

P.R. Hill[1], S.M. Blasco[1]

The Atlantic Geoscience Centre's (AGC) activities in the Beaufort Sea are contained within two projects: Beaufort Sea Coastal Zone Geotechnics and Surficial Geology, funded by the Northern Oil and Gas Action Plan (NOGAP) and Geomorphology, Beaufort Sea Continental Shelf, funded by the Panel on Energy Research and Development (PERD). The projects are designed to provide the regional geological and geotechnical information base that will be required as offshore oil discoveries move into a production phase. The coastal project is focused on establishing rates of coastline change, understanding the processes of coastline change and the properties of materials, both onshore and offshore in the coastal zone. Results of studies in the

North Head region (a potential pipeline landfall site) are shown, including onshore terrain conditions, coastal retreat rates, offshore sediment facies distribution and a discussion of wave and current resuspension processes. The offshore project comprises studies of seabed stability, sediment properties, sediment dynamics, permafrost, ice scour and in situ testing methods. Surficial and deep stratigraphic sections are illustrated as well as an interpretative section of permafrost distribution on the continental shelf.

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GEOPHYSICAL METHODS FOR THE DELINEATION OF SUBSEABOTTOM PERMAFROST

J.A. Hunter[1], S.E. Pullan[1], R.M. Gagné[1], R.A. Burns[1], R.L. Good[1]

The Terrain Geophysics section has recently applied several geophysical techniques to the detection and characterization of subseabottom permafrost in the southern Beaufort Sea. This work forms part of multidisciplinary studies of both a geological and geotechnical nature supported by Energy R&D and Northern Oil and Gas Action Plan funding. The geophysical techniques include combined marine seismic reflection and deep-towed refraction surveying as well as electrical, seismic, temperature and other logging of geotechnical drillholes conducted during winter-time on-ice operations. The studies have been directed towards developing techniques to delineate permafrost in the immediate sub-bottom as an aid in geotechnical assessment for pipeline routes and bottom-founded structures.

[1] Terrain Sciences Division

STREAM SEDIMENT, GROUNDWATER, AND LITHO-GEOCHEMISTRY, SOUTH NAHANNI RESOURCE ASSESSMENT, DISTRICT OF MACKENZIE

C.W.Jefferson[1], W.A. Spirito[2], S.M. Hamilton[3], F.A. Michel[3]

Standard stream silts and heavy mineral separates, rock samples, and thermal and cold springs were sampled in 1985, 1986 and 1987 as part of a non-renewable mineral resource assessment of proposed extensions to Nahanni National Park Reserve. Gold anomalies were detected in heavy mineral concentrates, but not silts, in the Nahanni Karst - Tlogotsho Plateau area. The gold may have been derived from local tetrahedrite-bearing veins, although a continental glacial source is also possible. Tungsten and gold correlate strongly with each other, and are erratically associated with lead-zinc-silver veins but not with zinc in regional background samples. Heavy mineral sampling is essential in geochemical reconnaissance of the northern Cordillera.

Preliminary chemistry of tufa-precipitating, iron-precipitating, granite-hosted, and high-discharge cold springs appears to vary according to lithological and fault settings. Zn dominated heavy mineral (not silt) anomalies, and springwater anomalies in Zn, Cd, Ni, Co, Cu and U, are spatially associated in the Meilleur River area. Springwater geochemistry is a useful complement to regional stream-sediment geochemistry.

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MAGNETOTELLURIC STUDIES ACROSS SELECTED KEY TARGETS IN CANADA

A.G. Jones[1], R.D. Kurtz[1], J.C. Gupta[1]

The Ottawa magnetotelluric group has been involved in various electromagnetic, geothermal and seismicity-related studies and has been working on the processing and display of magnetotelluric (MT) data.

In 1984, an MT survey conducted across Vancouver Island identified a conductive zone coincident with a prominent seismic reflector and associated with the Juan de Fuca plate currently subducting beneath the island. Also in British Columbia, 27 MT measurements were made in the southeastern Cordillera in 1987 and show exciting correlations with LITHOPROBE reflection data. In a related study of the subducting Juan de Fuca plate, in 1985 GSC participated in EMSLAB which involved deployment of MT systems and magnetometers in a transect over the ocean and continent to study a tectonic plate from its beginning to its subduction.

The MT method has proven to be a valuable tool for interpretation of structure from sedimentary basins. A number of MT surveys have also been conducted in the shield regions of Canada. An ongoing project involves the study of the Kapuskasing Structural Zone which is interpreted to be an oblique cross-section of the upper two thirds of the earth's crust.

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SULPHIDE FORMATION IN MIDDLE VALLEY, NORTHERN JUAN DE FUCA RIDGE

Juan de Fuca Hydrothermal Minerals Working Group[1]

Three styles of sulphide formation observed at Middle Valley are: 1) hydrothermally inactive mounds (400 m x 50 m) of massive sulphides and sulphidic sediment with an apron of sulphide debris, and capped by pelagic sediment; 2) a zone between two of the mounds of almost continuous sulphide beneath the sediment, and patchy sulphide outcrop; 3) a high heat-flow area (2 km north) with numerous black smokers situated in local patches of sulphide. The surrounding sediments are dessicated, baked, silicified, and locally indurated and veined.

Sulphide formation initiates with intense hydrothermal venting and chimney growth; subsequent mound growth is promoted by retardation of the fluids beneath the hydrothermally indurated cap and sulphide overgrowth of the highly indurated sediments.

[1] Mineral Resources Division

GOLD AND ARSENIC IN TILL, WHEATCROFT LAKE DISPERSAL TRAIN, MANITOBA

C.A. Kaszycki[1], W. Suttner[2], R.N.W. DiLabio[1]

In 1984, a zone of high As values in till was outlined south of Wheatcroft Lake. This anomaly was based on 9 samples taken over an area of approximately 600 km^2. In 1986, 114 additional till samples were collected to define the anomaly more clearly, as well as to delineate possible source areas and lithologies.

Well defined As and Au distribution patterns have been established. Arsenic-enrichment in till (>20 ppm) occurs within a well-defined northeast-southwest trending zone extending approximately 60 km southwest of Wheatcroft Lake. Distribution patterns, in part, reflect glacial dispersal along known ice flow directions. Trace element concentrations as high as 227 ppm As and 69 ppb Au have been recorded. No single source area or lithology has been identified and the anomaly may have multiple sources. It is possible however, that Au mineralization is associated with the margins of post-Sickle intrusions, and with sulphide mineralization in the Burntwood River Metamorphic Suite.

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PETROPHYSICS: PERMEABILITY, DIFFUSIVITY AND POROSITY OF CRYSTALLINE ROCKS

T.J. Katsube[1]

Although the porosity of crystalline rocks (plutonic rocks) is often in the order of 0.2-0.4%, which is about 10-100 times smaller than that of sedimentary rocks, the velocity at which fluids or ions can migrate through the unfractured phase is not necessarily as low as may be expected. This is due to the particular pore structure characteristics of crystalline rocks. Although the flux may be small, fluids and ions can travel hundreds to thousands of metres in a million year time period, or one to tens of metres in a hundred year period, depending on the type of transport mechanism and hydrogeological conditions that are involved. A considerable amount of information on porosity, permeability and diffusivity and their relation to geophysical parameters has been collected under scientific projects carried out under the auspices of the Canadian Nuclear Fuel Waste Management Program. Data on these physical properties will be displayed and their relation to fluid and ion migration and to geophysical parameters will be discussed.

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STRUCTURAL EVOLUTION AND PLUTONISM IN THE WESTERN CONTWOYTO LAKE MAP AREA, N.W.T.: IMPLICATIONS FOR GOLD EXPLORATION

J.E. King[1], C. Relf[2], W.J. Davis[3]

Archean turbiditic metasediments in the western Contwoyto Lake area, have experienced four phases of Archean folding and cleavage formation. The multiple-folding events have produced complex fold interference patterns that have been analyzed using bedding-cleavage and cleavage-cleavage relations together with the trace of marker beds. Six phases of plutonism in the area have been distinguished on the basis of modal composition and interpreted chronology of emplacement. The first four intrusive phases predate and the sixth phase postdates the most intense folding (D_3) and thermal-peak conditions. The fifth phase, biotite tonalite, was intruded late during D_3 and thermal-peak conditions. Results of this study which may be of special interest for gold exploration include 1) expansion of area underlain by iron-formation-bearing metaturbidites, 2) the use of the proposed structural model for prediction and/or interpretation of structural patterns, most notably for the tracing of gold-bearing iron formation horizons.

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REGIONAL AND DETAILED PATTERNS OF GLACIAL DISPERSAL, LABRADOR

R.A. Klassen[1], F.J. Thompson[1]

Quaternary studies in Labrador, based on striae and the distribution of indicator erratics, have revealed a complex history of ice flow that reflects major shifts in the location of dispersal centres of the Laurentide Ice Sheet. The changes in ice flow are directly recorded by marked variation in the configuration and orientation of dispersal trains. A series of dispersal trains have been mapped that serve to illustrate the relation between glacial history and drift composition, and to provide a basis for developing effective strategies of mineral exploration by drift prospecting.

In eastern Labrador, near the ice sheet margins, local-scale (tens of kilometres) dispersal trains defined by the distribution of 'indicator' erratics are relatively simple whereas in western Labrador, near the location of former ice divides, the trains are far more complex.

Detailed-scale (hundreds of metres to a few kilometres) trains can be defined by geochemical analysis of the clay or silt-and-clay size fraction of till.

Quaternary stratigraphic sections found in Schefferville and Wabush are of great potential significance as they represent an opportunity to correlate glacial events recorded in surficial sediments with a vertical stratigraphic sequence and to establish a chronologic control for regional glacial history.

[1] Terrain Sciences Division

PRELIMINARY RESULTS OF ROTASONIC OVERBURDEN DRILLING, BACKHOE TRENCHING AND GEOCHEMICAL TILL SAMPLING, MIRAMICHI ZONE, NEW BRUNSWICK

M. Lamothe[1]

In this project, field and laboratory research focuses on the lithology and geochemistry of till, in the vicinity of the mineralized Miramichi Zone. So far, a total of 4000 samples of surficial till have been collected, and 200 new striated sites are being compiled. Deep overburden drilling in the St. John River valley and in the Bathurst area yielded about 1220 m of core and 300 trenches have been dug over the highlands. Stratigraphical investigations reveal the presence of at least two till sheets, and possibly three, in a few localities.

Samples are split into two grain-size fractions for geochemical analysis (clay and clay-plus-silt). Detailed investigations are in progress in the vicinity of three metallogenic environments: the Elmtree gold district, the massive sulphides of the Heath Steele Mine area, and the Devonian Sn-W-Mo granites of central New Brunswick. Previously unmapped drift geochemical anomalies have been delineated for several elements (e.g. Au and Sn), in till overlying geologically favorable terrane.

Contribution to Canada-New Brunswick Mineral Development Agreement, 1984-1989.

[1] Terrain Sciences Division

FRONTIER GEOSCIENCE PROGRAM ATTACKS BEAUFORT CONTINENTAL MARGIN

L.S. Lane[1], J.R. Dietrich[1], J. Dixon[1], F.A. Cook[2], K.C. Coflin[2]

A multidisciplinary program of geological and geophysical investigation is elucidating the geological evolution of the important petroleum-bearing Beaufort-Mackenzie Basin. Deep crustal reflection profiles totalling 181 km were collected in 1986 across the Mackenzie Delta. The base of the crust is imaged near 40 km depth in the south, but the regional gravity field indicates depth to mantle is near 30 km at the north end of the profile. Beneath the Campbell Uplift, thrust faults predate Cretaceous deposition and may be as old as the Proterozoic. Major listric normal faults that were active during continental rifting in Late Jurassic to Early Cretaceous time flatten into a décollement zone in the lower crust. At the north end of the profile, the Early Cretaceous to Tertiary petroleum-bearing succession is 12 km thick and rests on either thinned continental or transitional crust.

In 1987, major seismic reflection and refraction programs defined the nature and thickness of the crust across the continental shelf, and a geological mapping program established ground controls on the stratigraphy and deformation history in the region.

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GEOLOGY AND STRUCTURE OF THE ELMTREE OPHIOLITE AND ITS RELATIONSHIPS TO THE TETAGOUCHE GROUP IN NORTHERN NEW BRUNSWICK

J. Langton[1], C. van Staal[2]

The Elmtree Inlier in northern New Brunswick is made up of the Ordovician Fournier and Elmtree groups. The Fournier Group is generally considered to represent an ophiolite assemblage.

The Elmtree Inlier and the Ordovician Tetagouche Group of the Bathurst Camp in the nearby Miramichi Zone were always thought to represent two separate terranes that were juxtaposed during the Taconian orogeny. However, our work shows that lithological correlatives of the Elmtree and Fournier groups occur in the Tetagouche Group, and both areas record an identical deformation history. It is therefore postulated that the Elmtree Inlier and Bathurst Camp, which are now separated by a 6 km-wide strip of Silurian sediments, represent one continuous terrane that records the opening and closure of a marginal basin similar to the Japan Sea.

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[2] Lithosphere and Canadian Shield Division

MAGMATIC AND HYDROTHERMAL PROCESSES OF PRECIOUS METAL ENRICHMENT IN NEWFOUNDLAND OPHIOLITES

J.W. Lydon[1], T. Al, D.G. Richardson[1], R.D. Lancaster[1]

Sulphides and platinum group elements are anomalously enriched in the border zones of late stage gabbroic plutons that intrude the tectonized peridotite of the Bay of Islands Ophiolite Complex. The sulphidic zones are characterized by the development of multi-textural and compositional variants of plagioclase-pyroxene lithologies covering the spectrum from granoblastic anorthosite to pegmatitic pyroxenite. The process is tentatively regarded as the sub-liquidus and/or subsolidus remelting and redistribution of crystalline magmatic phases by interaction with introduced volatile fluids.

Hydrothermal gold enrichments in the Baie Verte Peninsula are spatially associated with carbonatized thrust and fault zones. The mineralized structures are most obvious where they cut serpentinized ultramafic lithologies of the tectonically dismembered ophiolites. The style of mineralization is consistent with a model of sudden decompression of H_2O-CO_2 fault-zone fluids by hydrofracturing of the hanging wall, leading to the separation of a gold-bearing H_2O-rich fluid from which quartz and gold precipitated in the hydrofractures.

[1] Mineral Resources Division

GEOLOGICAL STUDIES OF INTERISLAND CHANNELS OF THE CANADIAN ARCTIC ARCHIPELAGO

B. MacLean[1], G. Vilks[1], G. Sonnichsen[1]

The investigations of seabed geology of interisland channels of the Canadian Arctic Archipelago have dealt primarily with the Quaternary sediments: their distribution, composition, thickness, geotechnical properties, depositional environments, modifying processes, and regional geological setting. These studies have also provided reconnaissance information on the near surface bedrock.

The seismic data suggest that glacial drift is the most widespread and thickest surficial sediment unit. Apparent morainal accumulations and multiple drift sequences have been observed locally on acoustic profiles in these areas.

The glacial drift locally is overlain by up to a few metres of acoustically stratified and acoustically transparent glaciomarine and postglacial sediments. The sediments in many areas are mantled by a thin veneer of watery, silty, clayey, sandy and gravelly sediment.

Sidescan imagery indicates that the seafloor sediments, primarily the glacial drift, have been modified by ice scour in many areas. No absolute ages are available yet for the unconsolidated seabed sediments.

Bedrock consists of variably dipping sedimentary rocks which are presumed to mainly represent extensions of bedrock sequences from the adjacent islands.

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THE EVOLUTION OF BASIN DEPTH CONCEPTS IN THE SCOTIAN BASIN

B.C. MacLean[1], J.A. Wade[1]

Early studies, based mainly on seismic refraction and potential field methods, predicted a maximum depth to basement to be no greater than 6 km. These interpretations assumed that refractor velocities of 5-6 km/s represented crystalline basement.

Recent reflection seismic and drilling results have established that limestones within the Upper Jurassic were the source of the shallow 5-6 km/s velocities. Steady improvements in reflection seismic technology have increased the depth of resolution to the point where occasional reflections in the basinal areas from a depth of 15 km can be seen. These are interpreted to be from within the Lower Jurassic section.

A basement reflector cannot be expected in the deepest portions of the basins, even on today's seismic, due to the similarity of the velocities of basement and the deeper sediments.

The basement map is made from released industry seismic and well data. In the shallow areas, where the basement reflector can be seen, the mapping was straightforward. In the depocentres, however, composite stratigraphy derived from seismic interpretation of the sedimentary sequences was used to determine maximum depths. Comparison with earlier refraction indicates that a 7-8 km/s refractor assigned to a "major crustal layer" is, in fact, the Mesozoic-Paleozoic boundary.

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THE LITHOSPHERE FRAMEWORK: GRAND BANKS AND GULF OF ST. LAWRENCE

F. Marillier[1], W.A. Kay[1], C.E. Keen[1]

About 4000 km of deep seismic reflection data have been collected in offshore eastern Canada as part of the Frontier Geoscience Program and in connection with LITHOPROBE. The majority of these data were collected across the sedimentary basins and continental margins of the Grand Banks region with the objective of obtaining the structure of the crust and uppermost mantle below these features. This will help provide a better understanding of the processes of formation and evolution of these extensional features. We show here seismic lines which cross the Jeanne d'Arc Basin, a potentially important source of petroleum.

A second target of this project has been the deep structure of the Appalachian Orogen and the associated late Paleozoic successor basins. Data have been collected across the entire orogen northeast of Newfoundland and in the Gulf of St. Lawrence. Deep structure is especially clear on the seismic data from the gulf, and examples are shown crossing most of the major crustal blocks underlying the orogen in this region.

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BRECCIAS, HYDROTHERMAL ALTERATION AND STRAIN IN THE HOLLINGER-MCINTYRE-CONIAURUM COMPLEX AT TIMMINS, ONTARIO

R. Mason[1], J. Davies[1], N. Melnik[1], C. Rennie[1]

High level breccia dykes are associated with porphyry intrusion in the Hollinger-McIntyre-Coniaurum complex at Timmins. The dykes were emplaced after the porphyries but prior to the extensive fracture controlled hydrothermal alteration which preceded gold mineralization. High strain zones correspond to zones of intense sericitic alteration. High strain zones associated with the margins of the Pearl Lake porphyry and the main ore zones in the complex, are sites of inhomogeneous bulk shortening and are not shear zones. Inhomogeneous bulk shortening clearly postdates hydrothermal alteration and associated mineralized structures throughout the complex.

The style of porphyry intrusion associated breccias, hydrothermal alteration and mineralization is typical of a near surface (<3-5 km) porphyry-type hydrothermal system. The subsequent deformation and metamorphism under greenschist facies conditions are typical of features generated in mid-crustal regions (10-15 km depth).

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GOLD AND PLATINUM-GROUP ELEMENT DISTRIBUTION IN SURFICIAL MATERIALS IN THE EASTERN TOWNSHIPS OF QUEBEC

Y.T. Maurice[1]

Since 1984, the Geological Survey of Canada has been engaged in mapping the distribution of some 30 elements in the Eastern Townships, including gold and platinum group elements (PGE), by analyzing heavy mineral concentrates collected from stream alluvium at a sample density of one per 12.5 km^2. The data indicate clearly that erosion by the southeastward-flowing Laurentide ice sheet is the dominant dispersal mechanism for the heavy minerals. Gold, which has been known to occur in the region's streams for over a century, displays a large number of anomalies. These are believed to be related to glacial erosion and dispersal of a gold-enriched preglacial regolith and paleoplacers developed on or near auriferous bedrock and polymetallic sulphide deposits. The PGEs, on the other hand, are enriched along chromite dispersal trains that derive from glacial erosion of an alpine ophiolite complex. The data show that the PGEs are not evenly distributed within the complex which could signify that some parts are more favourable than others for hosting PGE mineralization. Other PGE anomalies could indicate the presence of unconventional types of PGE mineralization in the Eastern Townships.

[1] Mineral Resources Division

THE STRATIGRAPHY OF THE JEANNE D'ARC BASIN

K.D. McAlpine[1], T. Edwards[1]

The major oil discoveries on the eastern continental shelf of Canada have been made in the Jeanne d'Arc Basin, a Mesozoic failed rift basin containing in excess of 22 km of sedimentary fill. The basin fill and adjacent platform areas suffered intense erosion during the Mesozoic and were subsequently covered beneath a seaward thickening wedge of Upper Cretaceous and Tertiary sediments.

A new lithostratigraphic nomenclature with widespread application for the basins of the Grand Banks of Newfoundland, and specifically the Jeanne d'Arc basin, is proposed. A standard lithostratigraphic nomenclature is not in use despite almost a decade of intense exploration activity in the region following the 1979 discovery of the Hibernia oilfield. This has led to a plethora of lithostratigraphies in use by various government agencies, industry groups and academia, a situation which has caused numerous problems in communication. The lithostratigraphic framework proposed here consists of previously published units as well as units newly introduced.

The interpretation of reflection seismic data in conjunction with well data, including biostratigraphic information, has enabled the identification of several genetically related sequences. These sequences can be related to plate tectonic events associated with the separation of the Grand Banks from Europe and can be compared directly with equivalent sequences elsewhere.

[1] Atlantic Geoscience Centre, Dartmouth

DECADE OF NORTH AMERICAN GEOLOGY (DNAG) GRAVITY MAP OF NORTH AMERICA

R.K. McConnell[1]

The map represents some 1 869 000 gravity anomaly values derived from surface, airborne and satellite measurements. Anomalies have been computed from direct gravimeter measurements, from contour maps digitized to provide synthetic point gravity values and from satellite derived Free Air values.

Computation of the gravity anomalies is based on the International Gravity Standardization Net 1971 and the Geodetic Reference System 1967. Bouguer anomalies are calculated with the standard crustal density of 2670 kg/m^3. Most of the data in the western Cordillera of Canada and the United States have been terrain corrected. Elsewhere, the data are generally not terrain corrected. The estimated rms error for land, surface marine and airborne data ranges from +1 to +5 mGal. Satellite data have an estimated rms error of +8 mGal.

For plotting purposes data were interpolated to a uniform grid using Briggs' minimum curvature method. Satellite data, which were provided on a 15' by 15' geographic grid, were first gridded at 16 km to remove the short wavelength components at higher latitudes and then combined with the surface data. The resultant data set was then interpolated to a 6 km grid.

[1] Geophysics Division

GEOLOGICAL MAPPING AND ENGINEERING GEOLOGY ON THE GRAND BANKS OF NEWFOUNDLAND

K. Moran[1], G. Fader[1], R. Parrott[1]

The Atlantic Geoscience Centre has initiated a borehole program in order to collect and analyse samples for verification of seismic reflection interpretations and to determine sediment physical properties.

This poster displays and discusses examples of the seismic reflection and borehole data collected from two sites on the Grand Banks; one near the Hibernia region of Grand Bank and the second in Halibut Channel. These examples show two different depositional settings and stress histories on the Grand Banks. The Hibernia site is interpreted as a Tertiary progradational depositional setting which has since experienced significant stress history changes due to erosion and subaerial exposure. The Halibut Channel site is interpreted as a glacially dominated environment with a simple stress history since deposition. In addition, the poster shows and describes examples of the limited sample recovery using conventional oceanographic piston coring techniques in comparison to sample recovery using borehole technology. Verification of interpretation of high resolution seismic reflection data would not be possible without the use of boreholes in most areas of the continental shelves off eastern Canada.

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U-Pb CHRONOSTRATIGRAPHY OF THE ABITIBI GREENSTONE BELT

J.K. Mortensen[1]

The Abitibi Belt offers an unparalleled opportunity to study the growth of Archean cratons. Models for the stratigraphic and tectonic evolution of the Abitibi have been greatly hampered by a lack of regional marker horizons and absolute age constraints. Over 30 new U-Pb zircon ages have been obtained for volcanic and plutonic rocks from the central and eastern Abitibi Belt. Together with previously published ages these data form the basis for an on-going chronostratigraphic analysis of the belt.

Volcanism and coeval mafic and felsic plutonism in the Abitibi ranges in age from 2747 to 2698 Ma. Syn- and post-Kenoran felsic plutonism commenced immediately after cessation of volcanism, and persisted for at least 25 Ma. No older crystalline basement has as yet been positively identified in the region. The age data therefore document a major period of craton formation and stabilization spanning about 75 Ma.

[1] Lithosphere and Canadian Shield Division

GEOLOGY AND METALLOGENY OF SOUTH STURGEON LAKE GREENSTONE BELT, NORTHWESTERN ONTARIO

R.L. Morton[1], J. Walker[1], G. Hudak[1]

Archean volcanic rocks which host the Mattabi and F-Zone massive sulphide deposits in the Sturgeon Lake area are composed of more than 1800 m of massive to bedded pyroclastic flow deposits

which contain abundant pumice. The pyroclastic flows overlie a coarse heterolithic breccia which varies from 50 to 1000 m in thickness and can be traced along strike for 15 km. This breccia is believed to represent a mesobreccia which formed during the initial collapse of the Sturgeon Lake caldera. Both the breccia and the ash flow tuff units have undergone extensive hydrothermal alteration. Alteration varies from large semi-conformable zones of Fe-metasomatism (iron carbonate, chloritoid, Fe-chlorite) to linear and lens-like zones composed of andalusite, pyrophyllite and quartz. Aluminosilicate minerals outline synvolcanic faults and potential zones of sulphide mineralization.

[1] University of Minnesota - Duluth

BOREHOLE GEOPHYSICAL RESPONSES OF MASSIVE SULPHIDE DEPOSITS IN THE CORDILLERA

C.J. Mwenifumbo[1], P.G. Killeen[1]

To improve the effectiveness of geophysical exploration for mineral deposits, better information on the physical characteristics of the deposits and their host rock is required. Realistic measurements of these physical properties can best be made in situ via borehole logging as opposed to measurements made on core samples in laboratories.

A collaborative effort between the GSC and several mining companies operating in British Columbia began in 1986 to provide the needed information on physical characteristics of exploration targets. Using the GSC's R&D logging system, borehole geophysical measurements have been conducted in several volcanogenic massive sulphide deposits of the Cordillera.

Measurements included IP, resistivity, self potential, magnetic susceptibility, conductivity, natural gamma (K, U and Th), spectral gamma-gamma (including density), temperature and temperature gradient.

The borehole geophysical measurements were able to identify changes not detected in the drill core on examination, assist in hole-to-hole correlation, and delineate mineralized zones. The potential for quantitative borehole assaying was also demonstrated.

[1] Mineral Resources Division

MAFIC-ULTRAMAFIC ROCKS IN THE NEW BRUNSWICK APPALACHIANS: SPECIAL REFERENCE TO THE PLATINUM-GROUP ELEMENT CONCENTRATIONS

A.D. Paktunc[1]

The mafic-ultramafic intrusions occurring in the New Brunswick Appalachians have been investigated for their platinum-group element (PGE) potential. Among the intrusions studied, the St. Stephen, Mechanicsville, Portage Brook and Goodwin Lake intrusions have been considered as possible PGE environments associated with magmatic nickel-copper sulphides whereas some ultramafic bodies associated with major fault systems in northern New Brunswick (i.e. Rocky Brook - Millstream break) form possible hydrothermal environments. The St. Stephen, Goodwin Lake and Portage Brook intrusions occurring in the sulphidic metasedimentary rocks of Ordovician age appear to be depleted in PGEs. Total PGE concentrations do not exceed 220 ppb. The Mechanicsville intrusion occurring in a different setting, in the Precambrian volcano-sedimentary rocks has somewhat elevated PGE concentrations. To date, concentrations up to 394 ppb Pt and 1877 ppb Pd have been measured in some peridotitic rocks with 2-3% interstitial sulfides. No significant PGE concentrations were obtained from the intrusions regarded as the possible hydrothermal environments.

[1] Mineral Resources Division

CHARACTERIZATION OF PLATINUM GROUP MINERALS USING AUTOMATED IMAGE ANALYSIS TECHNIQUES

A.D. Paktunc[1], D.A. Walker[1]

Integrated image and X-ray microanalysis is becoming an important quantitative tool in mineralogy. Image analysis is based upon detection and counting of points of features in a digitized image whose brightness lies within a pre-defined range. X-ray microanalysis is the subsequent characterization of features based upon a chemical classification scheme.

PGMs are mostly small in size (usually less than several microns) and occur in many species; examination of such small grains is better accomplished with a scanning electron microscope

(SEM) which surpasses the capabilities of an optical microscope in magnification and spatial resolution. An automated image analysis technique has been developed to overcome the difficulties associated with the study and characterization of PGMs under the optical microscope. The method involves 1) detection of grey level signals produced by backscattered electrons in the SEM, 2) collection of X-rays from the detected feature, 3) processing of the X-ray data to match a chemical class previously defined, and 4) measurement of the image. This procedure is repeated automatically by a motorized stage until all the fields in a sample are scanned.

[1] Mineral Resources Division

METALLOGENY OF THE RAINY RIVER DISTRICT, NORTHWESTERN ONTARIO

K.H. Poulsen[1], D.W. Davis, L. Diamond, R. Brommecker, I. Derome

The Rainy River District encompasses Archean rocks belonging to the Quetico metasedimentary-gneissic subprovince and the Wabigoon metavolcanic-plutonic subprovince in western Superior Province. Major faults separate these rocks into large domains which each have unique lithological and metallogenic components. Much of the northeastern part of the district is underlain by 2950-3000 Ma volcanic and plutonic rocks and is characterized by a wide variety of iron formations in the Atikokan area. A wedge-shaped domain in the Mine Centre-Fort Frances area contains a 2730 Ma mafic-felsic volcanic edifice with stratabound Cu-Zn-Pb, and Cu-Ti with synvolcanic layered mafic intrusions. Gold-quartz veins in carbonate-rich shear zones are widely distributed and equally abundant in the greenschist facies portions of both the older and younger volcanic-plutonic rocks. Quartz-molybdenite veins near Fort Frances and Ni-Cu occurrences in the Quetico Subprovince are associated with late tectonic (<2690 Ma) magmatic activity.

Contribution to Canada-Ontario Mineral Development Agreement 1984-1989.

[1] Mineral Resources Division

MEGATHRUST EARTHQUAKE ON CANADA'S PACIFIC COAST

G.C. Rogers[1], H. Dragert[1]

"Contemporary tectonic activity on Canada's west coast is characterized principally by the convergence of the North American and Juan de Fuca plates at the Cascadia Subduction Zone noted for the extreme youth (and subsequent greater buoyancy) of the lithosphere being subducted, and the lack of historical thrust earthquakes along this zone of convergence. Of the six similar zones around the Pacific subducting young lithosphere, five have had major (m>8) thrust events on the subduction interface in historical times. No compelling arguments exist to preclude the analogous occurrence of megathrust events in the Pacific Northwest region. Recent geological evidence (wetland deposit sequences, raised beaches, turbidite layers) from local coastal areas evince the past occurrence of major earthquakes within this region having return periods of hundreds of years. Vertical and horizontal crustal deformation determined from geodetic measurements and mean-sea-level trends over the past few decades is consistent with a model of accumulating elastic strain over a locked subduction zone."[2]

[1] Cordilleran and Pacific Geoscience Division
[2] From the talk presented by H. Dragert and G.C. Rogers

THE 1.9 GA CAPE SMITH THRUST-FOLD BELT: STRUCTURAL AND PETROLOGICAL CONSTRAINTS FOR MINERAL EXPLORATION IN AN IMBRICATE STACK OF CONTINENTAL RIFT TO OPHIOLITIC THRUST SHEETS

M.R. St-Onge[1], S.B. Lucas[2], D.J. Scott[3], N.J. Bégin[3]

The occurrence of mineralization in the 1.9 Ga Cape Smith Thrust-Fold Belt is controlled by both tectono-stratigraphy and structural geometry. Continental rift units, transitional-crust and true oceanic crust are contained in thrust sheets bound by south-verging thrust-faults (D_1) and preserved as a result of two post-thrusting episodes (D_2, D_3) of thick-skinned crustal folding. Volcanic and sedimentary deposits in progressively more internal (northern) thrust sheets record the evolution of a rift system to transitional-crust and finally to true oceanic crust. Gabbro-peridotite sills and dykes with PGE-Ni-Cu mineralization are contained within specific thrust

sheets of rift margin and transitional-crust units. Towards the hinterland (northern) margin of the belt, ophiolite imbricates contain either (1) sheeted dykes overlain by basalts intruded by mafic dykes and sills, or (2) mafic and ultramafic cumulates host to asbestos deposits and chromite occurrences. D_1 out-of-sequence thrusting, associated with interleaving of basement and cover units, resulted in re-imbrication of the thrust stack and farther southward transportation.

[1] Lithosphere and Canadian Shield Division
[2] Department of Geological Sciences, Brown University, Providence, Rhode Island
[3] Department of Geological Sciences, Queen's University, Kingston, Ontario

SULPHATE CONTENT OF EASTERN ONTARIO LAKES: ACID RAIN OR...?

D.F. Sangster[1], D.R. Richardson[1], J.J. Carrière[1]

The sources of acid rain pollutants in eastern Ontario lakes are by-products of smelting of sulphide-bearing ores and burning of sulphur-bearing coals.

A small pilot study was initiated to study sulphur isotopes in lake water sulphate (SO_4) in an attempt to trace how the proportion of sulphate pollutants in these lakes might vary from one part of the study area to the other.

An unexpected result of the pilot study to date has been the recognition of a correlation between total lake water sulphate content and the lithologies of underlying bedrock. Lakes receiving the major portion of their surface drainage from metasedimentary rocks of the Grenville Supergroup have notably higher sulphate content than those lying on other rock types, which suggests that a significant proportion of sulphate is not derived from acid rain but is contributed by the weathering of accessory sulphides in underlying metasedimentary rocks.

The evaluation of this bedrock correlation problem is presently underway and consists of collecting, separating, and isotopically analyzing accessory sulphides (usually pyrite) in outcrops of Grenville Supergroup metasedimentary rocks.

[1] Mineral Resources Division

CANADIAN ICE ISLAND: DRIFT PATH 1983-1987

M. Schmidt[1], J. Kouba[1], J. Popelar[1]

The Canadian Ice Island calved from the Ward Hunt Ice Shelf in 1982. The following year an ARGOS buoy was placed on the island to track its movement. NAVSAT satellite receivers have been deployed during the operational seasons 1985 to 1987; thus a continuous data set is available from August 1983 to the present. Data processing has shown that a complex drift pattern is emerging. The net motion is characterized by short bursts of rapid movement with maximum velocities of the order of 1200 m per hour. The oscillating drift path shows an overall systematic trend to the southwest. The amount and direction of rotation has also varied significantly from a net rotation of 46° in 1986 to a low of 5° in 1987.

[1] Geophysics Division

THE METHUEN ILMENITE DEPOSIT, SOUTHEASTERN ONTARIO

J.S. Scoates[1], J.M. Duke[1], D. Phipps[2], J.W.F. Ketchum, F. Ford

The Middle Proterozoic, pre-tectonic Twin Lakes "diorite" conformably intrudes arkose, quartzite and felsic volcanics in the Central Metasedimentary Belt of Grenville Province. The intrusion is made up predominantly of gabbronorite with a thin marginal zone of biotite quartz diorite/monzodiorite. These mafic rocks are intruded in turn by felsic plugs and dykes ranging in composition from tonalite through quartz syenite. An ilmenite deposit with measured resources of about 12 million tonnes grading 21% TiO_2 occurs within the gabbronorite and is characterized by cumulus textures with one or more of ilmenite, plagioclase and hypersthene as cumulus minerals. Igneous layering is present in the oxide rich zone but is poorly defined and locally disrupted.

[1] Mineral Resources Division
[2] Inco Limited

PLATINUM-GROUP ELEMENT MINERALIZATION IN THE UPPER CENTRAL LAYERED ZONE OF THE FOX RIVER SILL, NORTHEASTERN MANITOBA

R.F.J. Scoates[1], P.L. Schwann[2]

Three main intervals of anomalous platinum-group element (PGE) concentrations and a number of minor anomalous PGE concentrations occur within the lower 600 m of the Upper Central Layered Zone (UCLZ) stratigraphy. These concentrations occur predominantly in sulphide-bearing, clinopyroxene-rich rocks. Minor differences in the petrological and textural character of the host pyroxenites and in the geochemical character of PGE and sulphide mineralization exist among the three intervals. There is a general relationship between abundance of cumulus clinopyroxene, the presence of disseminated sulphides and anomalous PGE concentrations.

A number of samples display anomalously high Se/S ratios, although most samples are of mantle character, indicating the sulphur is of mantle derivation.

Chondrite normalized profiles range, at the upper end, from those similar to J-M Reef (Stillwater Complex) and Merensky Reef (Bushveld Complex) to profiles resembling Sudbury and komatiites at the lower end. Generally, the chondrite normalized profiles are steeply positive due to low concentrations of Os, Ir and Ru and relatively high concentrations of Pt and Pd.

[1] Mineral Resources Division
[2] Carleton University, Ottawa

QUATERNARY STRATIGRAPHY OF THE HUDSON BAY LOWLAND: KEY TO DECIPHERING STRATIGRAPHY OF MINERALIZED BELTS IN NORTHEASTERN ONTARIO

W.W. Shilts[1], S.L. Smith[1], L.H. Thorleifson[1], P.H. Wyatt[1]

Thick, stratigraphically and sedimentologically complex glacial overburden covers much of the mineralized terrane of the Timmins-Noranda region. Mineral exploration techniques employing mainly reverse circulation techniques, have been used in the past but do not permit development of detailed stratigraphic or sedimentological models because this method returns only a sand/gravel slurry.

Commencing in 1983, excellently exposed stratigraphic sequences of the Hudson Bay Lowland were examined using modern sedimentological and dating techniques in order to assemble a viable model with which the boreholes through the unexposed sequences of shield terrane could be compared. At least six glacial events have been identified in the lowlands, with interglacial conditions existing there not only 125 000 years ago but also about 75 000 years ago. At least one of these interglacial events has been observed in the Timmins area along with associated tills deposited by ice masses flowing in various directions. Preliminary results of these investigations have been used to refine interpretations of the geological history of the central part of the Laurentide ice sheet.

[1] Terrain Sciences Division

CANADA'S DIVERSE COAL RESOURCE INVENTORY – ENERGY FOR THE 21ST CENTURY AND BEYOND

G.G. Smith[1], F. Goodarzi[1], J.D. Hughes[1], M. Labonté[1]

Coal deposits in Canada are widely distributed and vary significantly in geological complexity, rank, composition and properties. Coal currently represents nearly 15% of the nation's primary energy economy – about the same as the combined hydro and nuclear contribution. The expanded use of Canadian coals, both nationally and internationally, can only be fully considered in the light of available coal resource possibilities. In this context the Geological Survey of Canada conducts a program of coal geoscience studies and is establishing a national inventory of coal resources to provide the basis for considering future developmental opportunities and for addressing related national policy issues within the Federal government's jurisdiction. The scope of this program extends well beyond fundamental geological studies of the nation's coalfields. Geoscience studies of critical environmental significance to future coal utilization are integrated with other geological studies to provide a basis for considering future coal development options.

The development of new and environmentally safe uses of coal, combined with the depletion of other conventional fossil fuel resources, will

encourage the expanded use of coal into the 21st century.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

FAMILIES OF OILS IN SOUTHEASTERN SASKATCHEWAN

L.R. Snowdon[1], P.W. Brooks[1], K.G. Osadetz[1]

Each of the four distinctive families of oils in southeastern Saskatchewan is compositionally distinct and is attributed to a specific petroleum source rock which was previously believed to have been in the Upper Devonian and Lower Mississippian Bakken Formation. Now, the source of most of the oils is believed to be a starved carbonate facies in the Lodgepole Formation of the Carboniferous Madison Group.

The majority of oil pools are sourced from within the stratigraphic group where the oil is entrapped. There is some evidence for cross-formational migration and mixing of oils from more than one source in a single pool; however, this represents only a small number of pools and a very small proportion of the reserves. Local sourcing of oil pools is important especially for Ordovician and Middle Devonian oil pools whose sources are thin and commonly under mature. Discovery of these relationships amongst oils and their sources provides an important constraint on the hydrocarbon potential of prospective structural and stratigraphic plays in the Williston Basin. The recognition that the Bakken Formation is not the source of the majority of oils suggests that a serious revision of the petroleum resource endowment of the Williston Basin be considered.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

STRUCTURAL STUDIES IN THE RANKIN INLET-CHESTERFIELD INLET REGION, DISTRICT OF KEEWATIN, N.WT.

S. Tella[1]

The Rankin Inlet region is underlain by an (?)Archean greenstone-metasedimentary sequence comprising two major cycles of volcanism with intervening turbidite deposition. The sequence forms an east-dipping F_1 homocline that is folded into a southeast plunging F_2 upright syncline. The metamorphic grade is within the greenschist to lower amphibolite facies. Two structural discordances within the upper volcanic cycle are interpreted as thrusts with opposing vergence that juxtapose rocks of different structural geometry.

The (?)Archean lithologies in the Chesterfield Inlet region are dominated by polydeformed granulite, orthogneiss, migmatite, pelitic gneiss, amphibolite and banded quartz-magnetite iron formation, and weakly deformed granitoid plutons. The Hanbury Island Shear Zone exposed north of the Chesterfield Inlet is a NE trending, synformal structure formed under amphibolite to granulite facies that overlies a lower grade granitoid gneiss terrane. The zone is believed to be an integral part of a number of ductile high-strain zones associated with the uplift of granulite-anorthosite complexes exposed between Baker Lake and Daly Bay, and is tentatively interpreted as a deformed remnant of a late Archean or early Proterozoic (NE or SW directed) ductile thrust.

[1] Lithosphere and Canadian Shield Division

MAGNETIC ANOMALY MAP OF CANADA: COMPILATION, ENHANCEMENT AND INTERPRETATION

D.J. Teskey[1], S.D. Dods[1], P.J. Hood[1]

The fifth edition of the Magnetic Anomaly Map of Canada is the first all digital version of the map. The major land portion is compiled from data collected under the ongoing regional aeromagnetic program of the Geological Survey of Canada. More than 10 million kilometres of data have now been flown, most in co-operative programs with the provinces. In recent years this program has included large offshore areas on the east coast and in the Beaufort Sea.

The extensive gridded data set has enabled a number of enhancement and interpretation techniques such as Shaded-Relief – to emphasize fine detail, vertical derivatives – to delineate contacts between zones of contrasting magnetization, and continuation to provide an estimate of depth extent. One technique which has proven to be particularly effective for enhancing trends over long distances is Curvature Analysis, in which the minimum and maximum curvature and the strike angle at each

point are calculated. The map can then be plotted with colours assigned according to the strike direction. Additional parameter extraction techniques have been applied to estimate features such as dips and depths of contacts between zones of differing magnetization.

[1] Geophysics Division

STRATIGRAPHY AND VISIBLE GOLD CONTENT OF SURFICIAL SEDIMENTS IN THE BEARDMORE-GERALDTON AREA, ONTARIO

L.H. Thorleifson[1], F.J. Kristjansson[2]

A joint Geological Survey of Canada – Ontario Geological Survey program of glacial geological research has been initiated in the Beardmore-Geraldton area as part of the Canada-Ontario Mineral Development Agreement. The increased use of till sampling in the search for potential ore bodies obscured by glacial overburden has produced a requirement for a better understanding of the nature of glacial sediments, especially till, in the vicinity of potential gold mineralization. An extensive sheet of till is well exposed throughout the Beardmore-Geraldton area, but the extent to which the composition of this till reflects local mineralization varies greatly, particularly in response to till thickness. Visible gold in till has been encountered frequently in areas of thin till in the Beardmore area, but similar occurrences are lacking at the surface of thicker deposits near Geraldton. Drilling in this area of thick till has yielded evidence for greater local derivation at the base of thick till. A separate, more locally derived lower till unit was encountered at several sites.

A contribution to the Canada-Ontario Mineral Development Program, 1985-1990.

[1] Terrain Sciences Division
[2] Ontario Geological Survey, Engineering and Terrain Geology Section

THE ROLE OF POTENTIAL FIELD METHODS IN GEOSCIENCE

M.D. Thomas[1], D.D. Abbinett[1], J. Broome[1], M.J. Drury[1], L.J. Kornik[1], P.H. McGrath[1], E.J. Schwarz[1], L.W. Sobczak[1]

Gravity and magnetic data fulfill two principal roles in geoscience: they are excellent mapping tools and they provide models of the third dimension of the lithosphere. Heat flow data provide additional information on the composition and age of the crust. Gravity and magnetic data can be displayed in a variety of formats designed to enhance features of geological interest. Thus, in addition to conventional Bouguer gravity and total field magnetic anomaly maps, an interpreter may employ shaded relief anomaly maps, horizontal and vertical gradient maps and composite gravity-magnetic maps, among others. The utility of such images is demonstrated with several examples: investigation of Precambrian geology beneath Phanerozoic sediments in the Prairies – heat flow also contributes in this area; mapping of fold axes in the Appalachians; and crustal studies in the Arctic. An innovative method of analyzing gravity anomalies over a faulted slab is presented to illustrate the role of quantitative interpretation of potential field data.

[1] Lithosphere and Canadian Shield Division

DEGLACIATION HISTORY OF THE ABITIBI-TIMISKAMING AREA AND THE CONFIGURATION OF THE LATE WISCONSINAN ICE SHEET

J.J. Veillette[1]

Several hundred cross-striated sites, lithological indicators of glacial transport, landform distribution, and radiocarbon ages form the basis to estimate the configuration of Late Wisconsin ice shortly before and during deglaciation in the area. Prior to deglaciation the dominant ice flow in the area was toward the SW, across the space occupied by the Harricana-Lake McConnell interlobate moraine, thus confirming the flow lines shown by several glaciological models of the Late Wisconsinan ice

sheet. It is proposed that the same ice mass was subjected (1) to a general change in flow direction from the SW to the SE and (2) to a complete scission which led ultimately to the deposition of the Harricana-Lake McConnell Moraine. The absence of differential weathering on SSW (180°-220) and SSE (130°-170°) striated planes and glacial transport to the SW at several locations support this interpretation. This major change in ice flow direction is attributed to drawdown in the ice mass initiated by faster basal flow rates over the deformable substrate of the Great Lakes area.

[1] Terrain Sciences Division

GEOCHEMISTRY OF SILURIAN AND DEVONIAN VOLCANIC ROCKS, CHALEURS BAY BELT, NEW BRUNSWICK

G.P. Watson[1]

The Chaleurs Bay Belt is underlain by Silurian and Devonian volcanic and sedimentary rocks which trend northeast along the west margin of the Miramichi Tectonic Zone in New Brunswick. Since 1985, these rocks have been sampled along a series of traverses across the width of the belt. Over 600 samples have been collected and analyzed. Preliminary results from analysis of volcanic rocks and interpretations relating to tectonic setting are presented in this display.

The volcanic rocks exhibit a compositional range from basalt to rhyolite with few intermediate rocks noted. The mafic rocks of the Lower Devonian Dalhousie Group are commonly basaltic andesite characteristic of a calc-alkaline suite. Silurian mafic volcanic rocks tend to have slightly greater abundances of TiO_2 compared to the Devonian and may have a more alkaline affinity.

[1] Mineral Resources Division

FIELD, GEOCHEMICAL, AND ISOTOPIC STUDIES OF GRANITOID ROCKS, NEW BRUNSWICK

J.B. Whalen[1], M.L. Bevier[1]

Detailed geochemical and isotopic studies of Paleozoic granitic rocks in New Brunswick, combined with field work and petrographic analyses, provide data important to petrologic, tectonic, and metallogenic models for the New Brunswick Appalachians. Most New Brunswick granites are I- and A-types, although some S-type granites are present in Miramichi terrane. New U-Pb zircon ages from Miramichi terrane confirm the existence of both Middle to Late Ordovician and Siluro-Devonian plutonic episodes therein. Initial Pb isotopic ratios for Miramichi granites indicate the presence of an old upper crustal component in the granite source area. This component has similar Pb isotopic ratios to Precambrian Avalonian basement from southern New Brunswick, thus raising the possibility that Avalonian basement is more extensive in the substrate than previously supposed.

[1] Lithosphere and Canadian Shield Division