Current Activities Forum

January 22-23
1991

Program with Abstracts

Energy, Mines and Resources Canada
Hon. Jake Epp, Minister

Énergie, Mines et Ressources Canada
L'hon. Jake Epp, Ministre

Canada

THE ENERGY OF OUR RESOURCES

THE POWER OF OUR IDEAS

Geological Survey of Canada

CURRENT ACTIVITIES FORUM

22-23 January, 1991

Place:

Halls A, E
Ottawa Congress Centre
55 Colonel By Drive, Ottawa

Non-Technical Event:

An informal get-together with cash bar on

Tuesday, 22 January, from

1630h to 1930h in Hall A

Popular Lecture:

At 1930 on the evening of Monday, 21 January

Mr. Allan Morgan will present a talk entitled

"The Changing Planet Earth: Global Change research by the Geological Survey of Canada"

in Hall E

Scientific displays:

Over 100 displays will be on view

after the lecture in Hall A

PROGRAM

TUESDAY, 22 January 1991

09h00 Introduction
E.A. Babcock

09h20 FORUM overview
R.P. Riddihough

09h40 Evolution of two magmatic arcs, Ungava Peninsula, Quebec: Archean and Early Proterozoic magmatism and subsequent (ca. 1.8 Ga) collisional juxtaposition
M. St-Onge, S. Lucas

10h00 Regional geology and tectonics of the Archean Minto block, northern Quebec
J.A. Percival, K. Card, R. Stern, N. Bégin

10h20 Tectono-magmatic evolution of Contwoyto Lake area, central Slave Province, N.W.T.
J. King, W.J. Davis, C. Relf

10h40 Extending our knowledge of the Canadian Shield - U-Pb and Nd isotopic studies of the Precambrian basement beneath the Western Canada Sedimentary Bassin
M. Villeneuve, R. Thériault, G. Ross, R. Parrish

11h00 Snowbird tectonic zone, northern Saskatchewan - a geological window on a 2000 km long geophysical anomaly
S. Hanmer

11h20 Thickness and chemistry of ocean crust correlated with initial crustal water depth
M.J. Keen

13h40 The scientific program of the Quebec Geoscience Centre
A. Achab

14h00 Gold mineralization in the Canadian Appalachians: observations on geological settings and structural controls
B. Dubé, A. Tremblay, M. Malo, F. Mengel, G. Lynch, K. Lauzière, R. Godue

14h20 Relationships between metallogeny and diagenesis in paleozoic carbonate rocks
N. Tassé, M. Savard, D. Lavoie, S. Paradis, Y. Héroux, A. Chagnon

14h40 Regional and metallogenic studies in the Grenville Province at the Québec Geoscience Centre
T. Birkett, L. Corriveau, T. Feininger, L. Nadeau

15h00 New seismic and electromagnetic investigations at the Buchans mine, Newfoundland
C. Spencer, D.E. Boerner, A.G. Jones, L. Reed, J. A. Wright

15h20 Early Proterozoic hot spring deposition of bedded cherts: the Hawk Hill Member (Hurwitz Group), N.W.T.
L.B. Aspler

15h40 Drift prospecting studies in support of mineral exploration: an example from the Beardmore-Geraldton area, Ontario
H. Thorleifson, F.J. Kristjansson

WEDNESDAY, 23 January 1991

09h00 The scientific program of the Institute of Sedimentary and Petroleum Geology
G. Smith

09h20 The conodont as a tool in Cordilleran geoscience
M.J. Orchard

09h40 Multidisciplinary studies along the Southern Cordilleran LITHOPROBE transect
R. Parrish, C. Spencer, A.G. Jones, M. Thomas and the LITHOPROBE Southern Cordillera Working Groups

10h00 Understanding Canada,s east coast hydrocarbon resource in the 1990s
M. Williamson

10h20 Calcium and magnesium-rich brines: a possible antidote to carbon dioxide pollution
H.E. Dunsmore

10h40 The move towards environmental geochemistry
C.E. Dunn

11h00 Onshore-offshore transect of the Beaufort Shelf: preliminary geological, geophysical, and geotechnical results
S.R. Dallimore, D. Gillespie,S.M. Blasco, J.A. Hunter, P.J. Kurfurst, F.M. Nixon, A.E. Taylor, J.-S. Vincent

11h20 Landslide hazards in Canada
S.G. Evans

TALKS

EVOLUTION OF TWO MAGMATIC ARCS, UNGAVA PENINSULA, QUÉBEC: ARCHEAN AND EARLY PROTEROZOIC MAGMATISM AND SUBSEQUENT (CA. 1.8 GA) COLLISIONAL JUXTAPOSITON

M.R. St-Onge[1] and S.B. Lucas[1]

Three tectonic domains occur within the internal zone of the Ungava orogen: (1) (par)-autochthonous Superior Province basement (ca. 2.80 Ga); (2) Cape Smith Belt allochthons (2.00-1.92 Ga); and (3) the allochthonous Narsajuaq terrane (1.86-1.83 Ga). The Superior Province comprises tonalite and monzogranite plutons emplaced in metasedimentary rocks and mafic to ultramafic intrusions. The Narsajuaq terrane is characterized by layered tonalite-quartz diorite and metasedimentary rocks intruded by tonalite and monzogranite plutons. The plutonic suites in domains (1) and (3) show a temporal calcic to potassic evolution and may represent the plutonic foundations of magmatic arcs. Collision of the Narsajuaq terrane and Superior Province ca. 1.8 Ga resulted in accretion of the terrane to the Cape Smith Thrust Belt. Pre-accretion structures and granulite-facies assemblages are recognized in domains (1) and (3), whereas syn- and post-accretion deformation and amphibolite-facies histories are common to all three domains.

1 Continental Geoscience Division

GEOLOGICAL TRANSECT OF THE MINTO SUB-PROVINCE, SUPERIOR PROVINCE, ACROSS THE UNGAVA PENINSULA, QUEBEC

J.A. Percival[1], K.D. Card[1], R.A. Stern[1], N.J. Bégin[2]

The Minto Subprovince is a 450 km wide, dominantly plutonic region with north-northwest structural trends. A 400 km long transect from Hudson to Ungava Bay crosses four distinct lithotectonic domains, from west to east: 1) Tikkerutuk terrane, containing granodiorite and granite with hornblende-biotite assemblages; 2) Lake Minto terrane, with metasedimentary and metavolcanic remnants cut by orthopyroxene-bearing granodiorite and granite; 3) Goudalie terrane of predominant tonalite, with supracrustal relics and deformed mafic dykes; and 4) Utaslik terrane consisting of granodiorite and granite with both hornblende-biotite and pyroxene-bearing assemblages. Terranes 2) and 3) have independent lithotectonic histories prior to emplacement of the regional calc-alkaline granodiorite suite 2.72 Ga ago and have limited mineral potential within supracrustal remnants.

1 Continental Geoscience Division
2 University of Calgary, Calgary

TECTONO-MAGMATIC EVOLUTION OF THE CENTRAL SLAVE PROVINCE, N.W.T.

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

The central Slave Province contains two superposed tectonomagmatic assemblages. The earlier assemblage comprises ca. 2670-2650 Ma calc-alkaline volcanic and plutonic rocks, as well as extensive, rhythmically layered metaturbidites. This assemblage predates multiple folding, crustal imbrication, and cleavage formation (D_1, D_2). The later assemblage includes ca. 2610 Ma calc-alkaline, diorite to monzogranite plutons that were emplaced synchronously with D_2, and 2585-2580 Ma peraluminous granites the emplacement of which spanned late cross-folding (D_3). The early assemblage is interpreted to represent remnants of an island arc(s) accreted during D_1 and D_2. The later assemblage is interpreted as a product of late- to post-accretion continental margin magmatism and associated crustal melting. Nd/Sm isotopic data and the surface distribution of 2.9 Ga basement rocks suggest that the margin was east-facing (present co-ordinates).

1 Continental Geoscience Division
2 Memorial University, St. John's
3 Queen's University, Kingston

EXTENDING OUR KNOWLEDGE OF THE CANADIAN SHIELD: U-PB AND ND ISOTOPIC STUDIES OF THE PRECAMBRIAN BASEMENT BENEATH THE WESTERN CANADA SEDIMENTARY BASIN

M. Villeneuve[1], R. Thériault[1], G. Ross[2], and R. Parrish[1]

The regional tectonic framework for the western Canadian Shield has been extended from limits of exposure in eastern Alberta, to the foothills of the Canadian Cordillera, by combining isotopic and lithological analysis of basement-intersecting drill core with potential field interpretation. Southern Alberta consists of Archean domains welded together by a probable early Proterozoic collisional orogeny. Amalgamation of 2.3 to 1.8 Ga domains of central Alberta is dominated by activity along the Snowbird Tectonic Zone. Northern Alberta consists of a nucleus of a 2.4 to 2.0 Ga rocks around which 1.95 to 1.85 Ga magmatic arcs formed.

Sm-Nd analysis shows that the magmatic rocks of the Alberta subsurface were derived from reworked evolved Archean material. Exceptions are found in one of the two samples from the Fort Simpson magnetic high (1.84 Ga age, 2.15 Ga T_{DM}) and in some samples from Hottah Terrane (age 1.9 Ga, 2.3-2.4 Ga T_{DM}), both from northwestern Alberta. Both of these domains also contain rocks with an Archean signature and are north of the Great Slave Lake shear zone.

1 Continental Geoscience Division
2 Institute of Sedimentary and Petroleum Geology, Calgary

SNOWBIRD TECTONIC ZONE, NORTHERN SASKATCHEWAN: A GEOLOGICAL WINDOW ONTO A 3000 KM LONG GEOPHYSICAL ANOMALY

S. Hanmer[1] and Shaocheng Ji[1]

Snowbird tectonic zone is marked by a 3000km long linear gravity and aeromagnetic anomaly extending from the Canadian Rockies, possibly as far as northern Québec. In northernmost Saskatchewan it is geologically expressed as a triangle of penetratively developed high grade mylonites — Tantato domain. A newly in-

itiated program of structural mapping has already shown that supposed supracrustal rocks of the Tantato Domain comprise a footwall of steeply dipping granulite and upper amphibolite facies mylonites overlain by an hanging wall of granulite mylonites, all derived from layered mafic, tonalitic and granitic plutonic rocks and migmatitic protoliths. The footwall comprises two kinematic sectors, defined on the basis of syn and post-thermal peak structures: dextral in the west and sinistral in the east. The hanging wall was initially emplaced as a thrust sheet. Subsequently, positive feedback was established between post-granulite facies extensional(?) movements and associated syntectonic granite emplacement at the hanging wall - footwall interface. The kinematically complex Tantato domain may lie at the northeastern end of a 300 by 100 km crustal scale "boudin" structure subjected to bulk pure shear.

[1] Continental Geoscience Division

THICKNESS AND CHEMISTRY OF OCEAN CRUST CORRELATED WITH INITIAL WATER DEPTH

M.J. Keen[1]

The thickness, chemistry, and topography of the crestal regions of mid-ocean ridges depend in part on the initial temperature beneath the ridge crest, and so they should be correlated. Klein and Langmuir showed that chemistry corrected for initial fractionation correlates with the axial water depth of eruption of modern basalts. Keen, Klein, and Melson demonstrated that this is true for ocean ridges in general: they restored old sites to their initial crestal depths, sliding them up the Parsons and Sclater subsidence curve, as it were. Keen, Courtney, McClain, and Purdy have shown that ocean crustal thickness also correlates crudely with initial restored crestal depth, using seismic refraction results from sites restored in the same way to their initial crestal depths. The data are more scattered than the chemistry data, and Klein and Langmuir's theoretical calculations of crustal thickness may be upper bounds to crustal thickness: not all melt gets out, perhaps. The author describes these results and offers comments on their implications for modern ocean crust and perhaps ophiolites.

[1] Atlantic Geoscience Centre, Dartmouth

THE SCIENTIFIC PROGRAM OF THE QUEBEC GEOSCIENCE CENTRE

A. Achab[1]

The Quebec Geoscience Centre (QGC) is not only the newest GSC division, but also its most unusual. It was created in 1988 under a novel partnership arrangement worked out with the Institut National de la Recherche Scientifique, a branch of the Université du Québec.

Most activities of the QGC take place in Eastern Canada, and provide a valuable contribution to three areas identified under the GSC's new program structure.

The Geoscience Surveys Program deals with both bedrock and surficial geology. While Quaternary geology surveys cover extensive areas of Quebec, bedrock studies are limited to the Appalachian and Grenville regions.

Work under the Minerals Program covers these same areas and is focused on the metallogeny of base and precious metals, and on problems associated with drift prospecting.

Finally, an indirect contribution to the Environmental Geoscience Program component is made through the QGC's work in paleo-ecology, and its ongoing study of geomorphological processes in those areas.

[1] Quebec Geoscience Centre, Ste-Foy

GOLD MINERALIZATION IN THE CANADIAN APPALACHIANS: OBSERVATIONS ON THEIR TECTONIC AND STRUCTURAL CONTROLS

B. Dubé[1], A. Tremblay[2], M. Malo [2], F. Mengel[2], G. Lynch[1], K. Lauzière[1], and R. Godue[1]

Significant gold-only mineralizations spatially related to major fault zones have been discovered in the Canadian Appalachians during the last decade, especially in western Newfoundland. These gold-only deposits can be morphologically divided into two main types: i) disseminated stratabound sulphide gold; and ii) mesothermal vein type. The latter is more common and most of the veins are related to subsidiary structures associated with major fault zones. In Newfoundland, these faults represent major break or suture zones such as the Baie Verte-Brompton Line and the reverse-dextral Cape Ray fault. In northern New Brunswick and in the Gaspé Peninsula (project funded by MERQ, contribution 90-5110-21) the mineralized structures are associated with dextral fault systems such as the Grand Pabos fault zone. On Cape Breton Island, they are reverse-oblique second order structures with unclear relationships to a major fault system.

The contrasting types of deposits, and the differences in the deformation regime (ductile versus brittle-ductile) and in the age of the hosting structures (Taconian versus Acadian), indicate multiple gold mineralizing events. Multistage faulting results in additional structural complexities in several mineralized zones.

[1] Quebec Geoscience Centre, Ste-Foy
[2] INRS Géoressources, Quebec

RELATIONSHIPS BETWEEN METALLOGENY AND DIAGENESIS IN PALEOZOIC CARBONATE ROCKS

N. Tassé[1], M. Savard[1], D. Lavoie[1], S. Paradis[1], Y. Héroux[1], and A. Chagnon[1]

Ore deposits in sedimentary rocks are often the result of diagenetic processes taking place during the normal evolution of sedimentary basins. Accordingly, the Gays River Formation, the Upton Group and the Beekmantown Group, in the Paleozoic of the Appalachians and the St. Lawrence Lowlands, are currently being studied in order to decipher the relationships between the diagenesis of the rock units and their metallogeny. Ongoing research suggests that this approach can have significant implication for mineral exploration. Stable isotope compositions of authigenic minerals, organic matter petrography and clay mineralogy can establish not only diagenetic events of importance for ore genesis, but can also help outline anomalous zones corresponding to ore fluid conduits. The association of mineralization with such anomalies has been demonstrated, thus emphasizing the practical application of this approach.

[1] Québec Geoscience Center, Ste-Foy

REGIONAL AND METALLOGENIC STUDIES IN THE GRENVILLE PROVINCE AT THE QUÉBEC GEOSCIENCE CENTRE

T.C. Birkett[1], L. Corriveau[1], T. Feininger[1], and L. Nadeau[1]

Grenville Province research at the Quebec Geoscience Centre is based on regional mapping projects with associated petrological, tectonic and metallogenic studies.

Preliminary results establish that (i) the parautochthonous belt east of Val d'Or contains a large band of mafic rocks which may represent the extension of the Abitibi greenstone belt; (ii) in the Mont-Laurier region, several lithotectonic entities can be identified and their geological history reconstructed from the plutonic associations of the monocyclic belt; (iii) in the Quebec City region, the Grenville rocks include orthogneisses and paragneisses that are cut by three meta-igneous sequences —anorthositic, granitic and late gabbroic; (iv) in the Mauricie region, a ductile shear zone dipping eastward forms a major tectonic discontinuity marking the eastern side of the monocyclic allochthonous belt.

These regional mapping projects provide supplementary geological and geographical information in the interest of a broader understanding of Grenville Province geology.

1 Quebec Geoscience Centre, Ste-Foy

NEW SEISMIC AND ELECTROMAGNETIC INVESTIGATIONS AT THE BUCHANS MINE, NEWFOUNDLAND

C.P. Spencer[1], D.E. Boerner[1], A.G. Jones[1], L.E. Reed[2], and J.A. Wright[3]

As part of the LITHOPROBE project in the Buchans mine region of central Newfoundland, regional reconnaissance and high resolution seismic reflection work were carried out in conjunction with electromagnetic (EM) studies near the mine site.

The combination of seismic and electromagnetic methods produces interpretational advantages and insights into the strengths and weaknesses of both.

During the experiment the seismic data were collected with some of the most advanced acquisition tools ever used in a mining environment, while novel CSAMT techniques were employed for the EM data acquisition.

The seismic results are of very high quality and have clearly imaged several major reflectors, at least one of which is associated with mineralization. The dip and depth of a reflector at 1200 m correlate with a strong resistivity contrast detected by the EM survey. Therefore, this reflector must correspond to a lithological contact with the units juxtaposed by faulting.

1 Continental Geoscience Division
2 BP Resources Canada, Mining Division, Toronto
3 Memorial University, St. John's

EARLY PROTEROZOIC HOT SPRING DEPOSITION OF BEDDED CHERTS: THE HAWK HILL MEMBER (HURWITZ GROUP), DISTRICT OF KEEWATIN, N.W.T.

L.B. Aspler[1]

Contrary to previous interpretations, bedded cherts that lie conformably between Whiterock Member quartz arenites and Ameto Formation mudrocks are not siliceous paleosols, but sinter deposits, a lithofacies lacking well-documented ancient examples. Basement fracturing (of uncertain origin) provided fluid conduits for efficient convective heat transfer to the surface, and silica-enriched hot springs. Amorphous silica (subsequently neomorphosed to microquartz) accumulated on sporadically distributed, topographically elevated sinter fans, reaching thicknesses of 23 m. Asymmetrical iron-rich to silica-rich microbands represent sequential precipitation from iron- and silica-laden hydrothermal pulses. Breccias formed by dehydration-induced soft sediment deformation, surface reworking, and hydrothermal eruption. Fluidized ascending waters reworked partially cemented Whiterock Member quartz sands to deposit single grains within chert, and cleared bottlenecks created by subsurface veining to yield local megaquartz-adularia clasts within breccias. Although apparently barren of precious metals, the unit marks sites of hydrothermal processes that may have concentrated precious metals in subjacent units. Slightly elevated gold values are in Whiterock Member crackle breccias (subsurface feeders?, 11-460 ppb) and in ferruginous lowermost Ameto Formation mudrocks (8-25 ppb).

1 Mineral Resources Division

DRIFT PROSPECTING STUDIES IN SUPPORT OF MINERAL EXPLORATION: AN EXAMPLE FROM THE BEARDMORE-GERALDTON AREA, ONTARIO

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

A Canada-Ontario Mineral Development Agreement glacial geological research program was initiated by GSC and OGS in the Beardmore-Geraldton area in 1986. The study was meant to establish guidelines for drift sampling as a mineral exploration method. Elsewhere, analysis of drift geochemistry and mineralogy has led to the discovery of mineralized bedrock which acted as the source of glacially dispersed debris.

Near Beardmore, samples from the uppermost metre of thin, discontinuous till yield fine grained visible gold and geochemical patterns that indicate nearby mineralization. Soil sampling, therefore, is likely to be an effective exploration tool in this area where till is exposed at surface. In the Wildgoose Lake-Geraldton area, however, thick till contains abundant Paleozoic carbonate and Proterozoic metasedimentary rocks derived from the Hudson Bay Lowland, at least 150 km to the northeast. This exotic material dilutes and/or buries locally derived debris so drilling is required in much of this area for more locally derived till to be obtained. This local till is more likely to reflect nearby mineralization than is the exotic till.

1 Terrain Sciences Division
2 Ontario Geological Survey, Toronto

THE SCIENTIFIC PROGRAM OF THE INSTITUTE OF SEDIMENTARY AND PETROLEUM GEOLOGY (ISPG)

G.G. Smith[1]

ISPG conducts extensive geoscience research in the sedimentary basins of western and northern Canada. These basins underlie about one-third of Canada's landmass and contain the vast majority of the nation's oil, gas and coal resources.

The Institute's scientific activities contribute mainly to GSC's Energy and Geoscience Surveys programs. Important contributions are also made to Global Change and Environmental Geochemistry research conducted within the Sector's Environmental Geoscience Program. ISPG's research is planned, directed and coordinated within an operational framework that includes the following six scientific subdivisions: 1) Western Canada Regional Studies, 2) Northern Canada Regional Studies, 3) Petroleum, 4) Coal, 5) Geochemistry, and 6) Paleontology. In addition, a Petroleum Resource Appraisal Secretariat provides authoritative advice to government and industry on matters pertaining to the nation's petroleum resources.

Research is supported by an infrastructure of central services that includes extensive electronic data processing capabilities, editing services, publications production facilities, major collections of drillcore, rock and fossil samples, and the most comprehensive geoscience library in western Canada. The Core and Sample Repository, Library, and a Publications Distribution facility serve industry, the scientific community and the public.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

THE CONODONT AS A TOOL IN CORDILLERAN GEOSCIENCE

M.J. Orchard[1]

A conodont is a remarkably versatile phosphatic microfossil with highly variable age-diagnostic morphology, temperature-dependent colour (CAI), a crystallinity that changes with diagenetic/metamorphic effects, and trace element/isotopic chemistry through which paleo-oceanographic conditions and absolute age may be determined. The extinct animal that bore the tooth-like elements was environmentally and paleogeographically differentiated, thus facilitating use of conodonts in the depositional basin and tectono-stratigraphic terrane analysis.

During the last decade, several thousand conodont collections have been extracted from Cordilleran strata through acid digestion. Thus far, the major application of the conodont tool has been in the relative dating of often metamorphosed calcareous and siliceous rocks. Through the use of new (particularly Triassic) conodont zonations, and the adaptation of existing ones, a temporal framework for Paleozoic-Triassic strata has been constructed and is routinely used to elucidate Cordilleran geology.

Examples of significant progress in our understanding of the stratigraphy, structure, and tectonic evolution of each of the major Cordilleran terranes, and of the epicratonal autochthon are summarized.

[1] Cordilleran Division, Vancouver

MULTIDISCIPLINARY STUDIES ALONG THE SOUTHERN CORDILLERAN LITHOPROBE TRANSECT

R.R. Parrish[1], C. Spencer[1], A.G. Jones[1], M. Thomas[1] and the LITHOPROBE Southern Cordillera Working Groups

The Southern Cordillera Transect of LITHOPROBE is near completion following more than five years of multidisciplinary scientific activity. Seismic reflection data show that the Moho is remarkably planar across most of the Cordillera, despite the large structural relief resulting from Mesozoic compression and Eocene extension. Major features that have been identified by geophysical and geological methods include the Eocene Slocan Lake normal fault, Late Cretaceous to Paleocene thrust zones in Valhalla and Monashee complexes, a Cretaceous west-vergent thrust zone in the eastern Coast Plutonic Complex, a high amplitude (magmatic?) reflector in the upper crust near Holocene volcanic centres, and a near-continuous linkage of reflectors beneath the mainland Cordillera with those beneath Vancouver Island. The data constitute a nearly complete record of crustal structure from the active downgoing slab to the stable craton of Alberta, providing new insights into the tectonic evolution of the Cordillera.

[1] Continental Geoscience Division

UNDERSTANDING CANADA'S EAST COAST HYDROCARBON RESOURCE IN THE 1990S

M.A. Williamson[1]

A multidisciplinary research effort underway at Atlantic Geoscience Centre attempts to develop a quantitative understanding of the hydrocarbon charge history of Canada's east coast basins. The utility of such research will lie in the capacity of the models to predict the probable distribution, volume, and composition of discovered and remaining hydrocarbons within both well-explored and under-explored basins. Such models, ranging in scale from the molecular to the sedimentary basin, will be developed for each of four major subelements within the project: source rock, primary migration, secondary migration, and entrapment. Initially developed for high data volume areas of the Jeanne d'Arc and Sable basins, the predictive models and general process will be exportable to other less well-known basins. The models will be subsequently melded into comprehensive, numerically constrained hydrocarbon charge analyses of east coast basins. Geared chiefly to contribute to the Energy Programs strategic plan, there will be measurable impact on other elements of the GSC's core activities. The scope, current progress and five year plan of this initiative will be discussed together with implications for future resource appraisal/management.

[1] Atlantic Geoscience Centre, Dartmouth

CALCIUM- AND MAGNESIUM-RICH BRINES: A POSSIBLE ANTIDOTE TO CARBON DIOXIDE POLLUTION AND GLOBAL WARMING

H.E. Dunsmore[1]

Life flourishes on earth because surface temperatures are maintained within tolerable limits. Nature achieves this end by varying the concentration of greenhouse gases. Humankind has begun to interfere with this vital biogeochemical thermostat, primarily by releasing to the atmosphere vast amounts of fossil carbon — carbon that had been safely locked away in the lithosphere. To avoid

upsetting earth's atmothermal balance, we should either stop burning fossil fuels or start refossilizing an equivalent amount of carbon. Any geological source of carbon should be matched by a geological sink.

Nature cycles carbon back into the lithosphere either as carbonate minerals or as remnants of organic matter. Four times out of five, carbon is fossilized in the oxidized form, as calcite or dolomite. Using calcium and magnesium from subsurface, evaporite-associated brines in Ontario, Saskatchewan and Alberta, it should be possible to follow nature's example and fix the carbon dioxide produced at large point-sources as geochemically stable carbonate minerals. The principal products of such a process, precipitated calcium carbonate and hydrochloric acid, are themselves marketable industrial commodities.

[1] Mineral Resources Division

THE MOVE TOWARDS ENVIRONMENTAL GEOCHEMISTRY

C.E. Dunn[1]

In Europe and the Soviet Union the legacy of chemical pollution from poorly controlled mining and industrial development is considered so severe that many geoscientists are now focusing their efforts on the geochemistry of the environment. Fortunately, the Canadian environment is still relatively clean, and so it is timely to establish data bases of the natural distribution of chemical elements, and the processes that modify these distributions, to permit future evaluation of environmental change. GSC programs are establishing geochemical data bases, with new emphasis on "toxic" elements in sediments, waters, and coals.

Rocks form the bottom end of the food chain. The composition of rocks and their comminuted derivatives (glacial deposits, soils, sediments) governs the chemistry of groundwaters and crops, and ultimately, therefore, the quality of human health. Geochemists and health specialists are seeking links between natural metal enrichment and diseases. Other GSC activities include production of natural radioactivity maps, "forensic" investigations of hydrocarbon traces, research on acid mine drainage and acid rain, and the use of natural brines to capture CO_2 emissions.

[1] Mineral Resources Division

ONSHORE-OFFSHORE TRANSECT OF THE CANADIAN BEAUFORT SHELF: PRELIMINARY GEOLOGICAL, GEOPHYSICAL, AND GEOTECHNICAL RESULTS

S.R. Dallimore[1], D. Gillespie[1], S.M. Blasco[1], J.A. Hunter[1], A.S. Judge[1], P.J. Kurfurst[1], F.M. Nixon[1], B.R. Pelletier[1], A.E. Taylor[1], and J-S. Vincent[1]

Efficient exploitation of hydrocarbon resources from the Beaufort Shelf will require detailed knowledge of the geological and geotechnical conditions of seabed materials. In the spring of 1990, scientists and technicians from the Terrain Sciences Division and the Atlantic Geoscience Centre participated in a drilling and geophysics study along a 30 km transect from northern Richards Island to the edge of the landfast sea ice. The goals of this work were to establish the stratigraphy and ground ice content of seabed sediments and to quantify their geothermal and geotechnical properties.

Preliminary results suggest that Pleistocene sediments dominate the upper 100 m with only a thin (m thick) cover of Holocene transgressive sediments. The Pleistocene stratigraphy includes an 8 to 20 m thick marine clay which separates upper and lower sand sequences. Ice-bonded sediments with low pore water salinities and massive ice were encountered below 14 m depth in the farthest offshore borehole sited in the vicinity of an anomalous permafrost occurrence. Sediments in other offshore boreholes, in shallower water, were not ice-bonded suggesting permafrost is degrading in these areas.

[1] Terrain Sciences Division

LANDSLIDE HAZARD IN CANADA

S.G. Evans[1]

As a result of a recent collation of data on known historical landslides in Canada over the period 1840 to 1984, it has become apparent that some of the largest rapid landslide events have occurred in Quaternary materials viz. glaciomarine/glaciolacustrine sediments or volcanic rocks. Of 16 known major landslides with volumes in excess of 5×10^6 m^3 , 12 are located in the Cordillera and its margins, and 4 in the St. Lawrence Lowlands. With respect to materials, 7 occurred in Quaternary sediments and 5 in Quaternary volcanics. Of the 7 in Quaternary sediments 5 occurred in Champlain Sea Clays. The largest historical landslide in Canada is the remarkable and comparatively unknown St. Alban landslide (estimated volume 185×10^6 m^3) in Quebec which occurred in Champlain Sea clays in 1894. In 9 major landslide disasters since 1840, 5 landslides in surficial deposits caused as many as 153 deaths while those involving rock slopes caused 209 fatalities. Landslides in Canada cause many millions of dollars of damage to the economic infrastructure each year.

[1] Terrain Sciences Division

POSTERS

GEOSCIENCE SURVEYS

GIS ANALYSIS OF GEOPHYSICAL DATA FOR THE ABITIBI BELT, ONTARIO AND QUÉBEC

D. Baril[1] and J. Broome[1]

Geographical Information Systems (GIS) facilitate the integration, display, and analysis of point, vector, and gridded geoscience data. In this study, the SPANS GIS was used to evaluate the correlations between potential field data and lithology. Selected geophysical, geological, and mineralogical data were input to the GIS as well as the gridded gravity and magnetic data. The OGS/MERQ regional geological map (1:500 000) was digitized for use as the geological reference.

In addition to image processing and overlay capabilities commonly used for qualitative analysis of potential field data, GIS allow statistical analysis and modelling of relationships among the various data sets. This capability is used to test the correlations between mapped lithologies and various characteristics of the magnetic and gravity data and their derivatives such as vertical gradients. Characteristics studied include field intensity, textural direction and intensity, and spatial frequency distribution. Initial results indicate that texture is a more useful indicator of surface lithology than intensity.

1 Continental Geoscience Division

NEW SEISMIC AND ELECTROMAGNETIC INVESTIGATIONS AT THE BUCHANS MINE, NEWFOUNDLAND

D.E. Boerner[1], C.P. Spencer[1], A.G. Jones[1], L.E. Reed[2], and J.A. Wright[3]

In a project funded by LITHOPROBE, the GSC, and BP Resources, high resolution seismic reflection profiling was carried out in conjunction with CSAMT studies at the Buchans mine in central Newfoundland. The seismic survey was conducted with two Vibroseis sources and a sweep with frequencies of 40 to 120 Hz.

A split spread of 240 channels was used, geophone separations were 10 m, and shot points were separated by 20 m. The CSAMT survey was conducted with two nearly orthogonal grounded bipole sources and all five components of the electromagnetic field were measured over the frequency band 0.5 to 4096 Hz. In all, 16 km of high resolution seismic and electromagnetic data were collected.

The excellent geological control from detailed mapping, drilling, mining, and geochemical work provide strong constraints on the near-surface geology. Thus data acquired in this region provide a test case for determining the advantages and limitations of the electromagnetic and seismic methods for mapping complicated structure in mining environments.

Processed images from both surveys will be presented with an emphasis on a comparison of the two data sets.

1 Continental Geoscience Division
2 BP Resources Canada, Mining Division, Toronto
3 Memorial University, St. John's

AN INTERACTIVE 3D GRAVITY MODELLING PROGRAM FOR IBM-COMPATIBLE MICROCOMPUTERS

J. Broome[1]

Three-dimensional modelling of gravity anomalies can be used to investigate the geometry and density contrast of possible causative bodies. Compared to profile modelling (2 and 2.5 dimensional modelling), three-dimensional modelling allows the effects of more geometrically complex bodies to be studied.

G3D utilizes a graphical user interface to allow creation of polygonal bodies with constant depth and thickness. Complex shapes can be approximated with multiple bodies. The resulting gravity anomaly can then be calculated at irregularly-spaced gravity stations or on a regular program-generated grid using Plouff's algorithm. Images of the observed, calculated or residual anomaly can then be generated by interpolating the data points onto a regular grid and quantized, displaying the results.

The program is written in FORTRAN utilizing Halo graphics to run on any IBM-compatible computer equipped with a monochrome and VGA-compatible display. Cursor position can be controlled from the keyboard or using a mouse or graphics tablet.

1 Continental Geoscience Division

NATMAP: CANADA'S NATIONAL GEOSCIENCE MAPPING PROGRAM

M.E. Cherry[1]

Canada faces a growing demand from many facets of modern society for geoscientific maps. The mineral industry demands accurate, comprehensive maps that reflect recent advances in the earth sciences, in order to counter the escalating costs of exploration and development. As well, the demand for geoscientific maps is growing rapidly in such non-traditional fields as urban, rural and wilderness land use planning; environmental assessment and protection; and groundwater resource identification and use. Rates of map production have not kept pace with this growing demand.

The Geological Survey of Canada has initiated the national Geoscience Mapping Program (NATMAP) to address this demand. NATMAP will enhance the level of geoscience mapping in Canada by coordinasting the efforts of provincial and federal government mapping agencies, academia and industry. The program will facilitate multidisciplinary regional surface mapping programs, and support thematic mapping in three dimensions where economic and scientific interests warrant. It will promote the development of national map standards, and the use of computer technologies for all components of map production.

1 Continental Geoscience Division

PLUTONIC ASSEMBLAGES IN THE CENTRAL METASEDIMENTARY BELT OF THE SOUTHWESTERN GRENVILLE PROVINCE

L. Corriveau[1]

Based on the distribution of potassic alkaline plutons, the Central Metasedimentary Belt (CMB) of Quebec has been divided into two lithotectonic terranes extending southward into Ontario. Interterrane contrasts among pre-amalgamation plutonic suites and similarities among later ones would thus be expected. Sediment-hosted zinc mineralizations in the Adirondack and Mont-Laurier areas occur in different terranes and would not belong to the same basin. In order to alleviate the shortage of modern mapping, an impediment to mineral exploration and tectonic investigations (e.g. Lithoprobe), regional mapping has been initiated in the CMB. Mapping of the 31-J-2 sheet at 1:50 000 in collaboration with J. Martignole and mining companies (Rio Algom, SOQUEM) indicates that supracrustal rocks are similar and plutonic rocks different across the eastern boundary of the CMB. Five plutonic associations are potentially lithotectonic assemblages within and across the CMB: porphyritic monzonite and metagabbro, charnockite and anorthosite, noritic gabbro and syenite, potassic alkaline plutons, and granite. A major, possibly interterrane, shear zone has been recognized, but its regional extent is presently unknown.

[1] Quebec Geoscience Centre, Ste-Foy

DEVELOPMENT OF THERMAL INSTABILITIES BENEATH THE CANADIAN CRATON: IMPLICATIONS FOR BASIN FORMATION

R.C. Courtney[1]

The development of a stable thermal lithosphere beneath continental cratons must be limited by the growth of convective instabilities. The formation and downwelling of cold thermal plumes at the lithospheric base induces a downward deformation of the surface of the craton that varies with time. The rate of subsidence and the size and width of the deflection depend critically on the rate of heat transmitted through the thermal lithosphere and the temperature dependence of mantle rheology. The temporal development of the thermal lithosphere underlying the Canadian craton is modelled with a finite difference convection code which incorporates a thermally activated viscosity. Digital animation sequences of the formation of convective instabilities are presented. The predictions of this model are contrasted with the subsidence and stratigraphic evolution of the Hudson Bay basin, to explore whether convective downwelling is a principal force driving the development of these structures.

[1] Atlantic Geoscience Centre, Dartmouth

ASPECTS OF THE QUATERNARY GEOLOGY OF THE NORTHEASTERN UNGAVA PENINSULA, NORTHERN QUEBEC

R.-A. Daigneault[1]

In the northeastern section of the Ungava Peninsula, a systematic survey of glacial erosion microforms indicates that the dominant ice flow was radially northward from an area centered on Nantais Lake. Detailed surveys of cross-sections, till fabric orientation and surface boulder distribution seem to suggest the presence of a single till sheet on the peninsula associated with this phase of radial flow. However, indications of movement prior to this main flow have been observed in the northern part of the peninsula: striations on Cape Nouvelle-France and striations, grooves and a carbonate till on Charles Island could be associated with ice flow in Hudson Strait.

[1] Quebec Geoscience Centre, Ste-Foy

HYDROTHERMAL CIRCULATION AND DISCHARGE IN THE ESCANABA TROUGH AND MIDDLE VALLEY SEDIMENTED RIFTS: INFERENCES FROM HEAT FLOW AND OTHER GEOPHYSICAL DATA, AND PLANS FOR OCEAN DRILLING

E.E. Davis[1], R.G. Currie[1], K. Becker[2], and H. Villinger[3]

Geophysical studies carried out in the sedimented rift valleys of the northern Juan de Fuca Ridge (Middle Valley) and southern Gorda Ridge (Escanaba Trough) have permitted the structural, sedimentary, and thermal regimes of these rare but important geological features to be defined well. At both locations the rift valleys are hydrologically "sealed" by thick distal turbidite sediments. Discharge of hydrothermal fluids and associated near-surface mineralization occur only where local permeable pathways have been created above syn- and postsedimentary volcanic intrusions and by buried volcanic edifices that are only thinly sedimented. Many questions about the source regions of the hydrothermal fluids, the flow pathways, and the subsurface mineral precipitation mechanisms remain unanswered, however. These will be studied during an extensive ODP component scheduled to begin in 1991.

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[3] Alfred Wegener Institut, Bremerhaven

SURFICIAL GEOLOGY AND QUATERNARY STUDIES OF PRINCE OF WALES ISLAND, ARCTIC CANADA

A.S. Dyke[1]

This poster illustrates the major components of an Arctic Quaternary mapping program conducted through three field seasons with 25 000 km of ground traversing. A Wisconsinan till sheet covers most of the island and is divided into three crosscutting morphostratigraphic units that reveal different phases of ice flow resulting from sudden shifts in flow direction accompanied by changes in basal thermal regime. Each flow phase accounts for aspects of till lithic composition which allow assessment of dispersal distances, hence of flow durations. Postglacial sea level history, reconstructed from a wealth of driftwood and whale remains, reveals a major tectonic complication of rebound resulting from reactivation of Boothia Arch. Despite this, emergence curves are of normal form. The wood and whales also reveal changing patterns of oceanic circulation and sea ice severity during the Holocene including establishment of the modern circulation regime 8500 years ago.

[1] Terrain Sciences Division

A CROSS-SECTION OF THE SOUTHWESTERN GRENVILLE PROVINCE FROM REFLECTION DATA RECORDED IN LAKES ONTARIO, ERIE AND HURON

D.A. Forsyth[1], B. Milkereit[1], W.J. Hinze[2] and R.F. Mereu[3]

Over 1300 km of newly licensed reflection data in the Great Lakes provide first images of basement structures along a cross-section of the southwestern Grenville Province. Seismic images from lines in Lake Ontario portray a cross-section of the Central Metasedimentary Belt (CMB) dominated by a remarkable series of easterly dipping, apparently folded thrust sheets. Lake Erie data provide a structural section from the CMB across most of the Central Gneiss Belt (CGB). In contrast to Lake Ontario, about 20% of the Lake Erie data are characterized by southwesterly dipping reflections from beneath the Phanerozoic sediments. Lake Huron data image structural features near the Grenville Front. The interpretation of basement structures beneath southern Lake Huron is complicated by (a) unknown tectonic effects near the junction of the Grenville Front and the mid-continent rift, (b) a major circular structure beneath Lake Huron (CAN-AM structure), and (c) unknown tectonic developments within the western CGB.

1 Continental Geoscience Division
2 Purdue University, Indiana
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DEVELOPMENT OF A DIGITAL DATA BASE FOR CANADA'S NATIONAL GEOCHEMICAL RECONNAISSANCE GEOCHEMICAL DATA: PROGRESS, APPLICATIONS, AND OUTLOOK

P.W.B. Friske[1], S.W. Adcock[1], and M.W. McCurdy[1]

The goal of Canada's National Geochemical Reconnaissance (NGR) program is to establish and maintain a nationally consistent geochemical drainage data base. Toward this end, systematic surveys have been conducted since 1973. To date (1991), more than 200 surveys have been completed to NGR standards, representing 180 000 sites, covering about 2.1 million square kilometres throughout Canada. At present, digital data for each survey are available on floppy disks.

To simplify access to the broad range of geochemical information, the Exploration Geochemistry Subdivision of the Mineral Resources Division, using ORACLE RDBMS software, is creating a data base containing all the NGR data. Benefits of the data base include consistent, improved and simplified storage of data, plus the ability to rapidly retrieve data as needed for special projects or outside requests. The data are stored in a fully relational format, thus allowing retrieval by ordinary SQL statements. To make the data even more accessible, a menu-driven retrieval system has been designed to handle the most common types of requests. By mid-1991 the data base will be able to supply digital geochemical information for large regions of Canada.

1 Mineral Resources Division

QUEBEC-LABRADOR GEOCHEMICAL TRANSECT, JAMES BAY TO THE LABRADOR SEA, 53-55$N

R.G. Garrett[1], M. Beaumier[2], and P.H. Davenport[3]

Regional geochemical data sets arising from centre-lake bottom sediment surveys undertaken by the James Bay Corporation, Québec Ministère de l'Énergie et des Ressources, and the Geological Survey of Canada under the Canada-Newfoundland-Labrador Mineral Development Agreement have been compiled. The surveys, undertaken between 1977 and 1989, used different methods of chemical analysis and are not directly comparable. Research work undertaken by the authors has shown that the use of a normalized rank transform permits the preparation of coherent regional geochemical maps. The procedures for compilation are described, and the methodology developed is demonstrated by maps of the Ni and U distribution across the 1300 km x 200 km transect.

The broad geochemical patterns based on the median values for 25 km x 25 km cells reveal the major, and many of the minor, geological features related to the crustal and metallogenic development of the region. The geological and geochemical correlation of the features exhibited by these maps is discussed.

This work was undertaken in part as a contribution to the International Geological Correlation Programme's Project 259, "International Geochemical Mapping" as a demonstration that divergent regional geochemical data sets can be compiled.

1 Mineral Resources Division
2 Ministère de l'Énergie et des Ressources du Québec, Quebec
3 Newfoundland and Labrador Department of Mines and Energy, St. John's

PLATE REORGANIZATION: A CAUSE OF RAPID LATE NEOGENE SUBSIDENCE AND SEDIMENTATION AROUND THE NORTH ATLANTIC

F.M. Gradstein[1], S. Cloetingh[2], H., Kooi[2], A.C. Grant[1], and M.A. Kaminski[3]

Subsidence analysis of wells in the central North Sea and Labrador-Grand Banks and off the West Greenland, Scotian shelf, and United States Atlantic margins shows distinct correlation patterns. A significant departure from the overall decrease in subsidence for the Pliocene occurs in many wells, when the rate is found to have increased one or more orders of magnitude from Oligocene/Miocene rates. More basinward sites experienced up to four times larger subsidence rates in the late Neogene than in the Oligocene/Miocene, with a peak in the Pliocene. Wells at the basin edge experienced much less subsidence or showed uplift. Major reorganizations of spreading direction and rate occurred during the Pliocene along the entire Atlantic spreading system, possibly in conjunction with more global changes in plate motions. We propose that the associated changes in intraplate stress caused the excess margin subsidence. Relative uplift along basin edges is consistent with this mechanism of relative movement and may explain apparent eustatic changes in sea level.

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2 Institute of Earth Sciences, Free University, Amsterdam
3 Dalhousie University, Halifax

BEDROCK GEOLOGY STUDIES, GULF OF ST. LAWRENCE

A.C. Grant[1] and B.V. Sanford

Cruises in the Gulf of St. Lawrence by the Atlantic Geoscience Centre since 1971 have recovered approximately 13 000 km of high resolution reflection seismic profiles. These data are being analyzed in conjunction with some 40 000 km of industrial multichannel seismic records to produce a revised map of bedrock geology for the Gulf of St. Lawrence, and structure and isopach maps of subsurface geology. These maps will be part of the "Basin Atlas"in preparation for this region.

A significant result indicated by the preliminary synthesis of these data sets is that Carboniferous strata of the Magdalen Basin extend somewhat farther northward than previously recognized. In the northwestern part of the gulf this may superimpose structured and reservoir-rich Carboniferous sequences on potential source rocks of the Anticosti Basin, and present additional targets for hydrocarbon exploration.

1 Atlantic Geoscience Centre, Dartmouth

COMPARISON OF REFLECTION PATTERNS IN THE SWISS ALPS, NORTHERN APPALACHIANS, AND SOUTHEASTERN CANADIAN CORDILLERA

A.G. Green[1], L. Levato[2], P. Valasek[3], L. Dubois[2], R. Olivier[2], S. Sellami[2], J-J. Wagner[2], B. Milkereit[1], and C. Spencer[1]

Seismic reflection sections recorded across the Swiss Alps are similar in many respects to those recorded across the thrust/fold belts of the northern Appalachians and the southeastern Canadian Cordillera. In all three mountain ranges, the deep seismic reflection data have imaged thin thrust sheets stacked on top of ancient continental margins, large wedges that have influenced styles of deformation, and deep-penetrating backthrusts or backfolds. Transport of thrust sheets in the Appalachians and Canadian Cordillera occurred mostly along major crustal décollements. No extensive décollement surfaces have been reported previously for the European Alps, but on new coherency-filtered explosion data there is evidence that such structures do occur beneath the orogen. At greater depth, the Alps are distinguished by strong Moho reflections and a major crustal root. Although depth to Moho is poorly resolved beneath the Canadian examples, models based on low-resolution seismic refraction data include a zone of thickened crust beneath the Rocky Mountain Trench, and there is now support for this interpretation on coherency-filtered seismic sections.

1 Continental Geoscience Division
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PC-BASED APPLICATIONS DEVELOPED TO PRODUCE NATIONAL GEOCHEMICAL RECONNAISSANCE OPEN FILES

H. Gross[1], P.W.B. Friske[1], and M.W. McCurdy[1]

The last few years have seen, in conjunction with significant price decreases, considerable growth in the use and capabilities of personal computers (PCs). Personal computers are now used by the Exploration Geochemistry Subdivision of the Mineral Resources Division at all stages in the production of geochemical Open File reports, from data input and verification, to publication on paper and disc, and mapping. Geochemical data are now available in a form that allows clients to import data into PCs using commercial software.

Substantial savings have been made by eliminating rental charges on a mainframe computer and purchasing PCs and accessory hardware. At the same time, other than for mapping applications, the flexible PC-based system developed in-house has proven to be superior to the previous mainframe-based system of Open File publication. Plans for the future include growth in networking, map production and the publication of software tools that allow clients to print their own maps based on the variables of importance in a particular application.

1 Mineral Resources Division

DYNAMIC GRAVITY - FROM SEA TO AIR

J.F. Halpenny[1], R.V. Cooper[1], R.J. Beach[1], and T.R. Flint[1]

The Geophysics Division has been operating a dynamic gravity meter since the early seventies, and has covered much of the east and west coast offshore areas. The original analog gravity computer was replaced by a digital one and finally by a lap-top personal computer. Omega navigation and dead reckoning have been replaced by loran and now GPS. All of these factors have led to an increase in survey accuracy. In the last year, two separate tests have shown that the meter can operate in an aircraft, and remarkable increases in survey speed and flexibility are anticipated.

1 Geophysics Division

SNOWBIRD TECTONIC ZONE, NORTHERN SASKATCHEWAN: A GEOLOGICAL WINDOW ONTO A 3000 KM LONG GEOPHYSICAL ANOMALY

S. Hanmer[1] and Shaocheng Ji[1]

Snowbird tectonic zone is marked by a 3000km long linear gravity and aeromagnetic anomaly extending from the Canadian Rockies, possibly as far as northern Québec. In northernmost Saskatchewan it is geologically expressed as a triangle of penetratively developed high grade mylonites — Tantato domain. A newly initiated program of structural mapping has already shown that supposed supracrustal rocks of the Tantato Domain comprise a footwall of steeply dipping granulite and upper amphibolite facies mylonites overlain by an hanging wall of granulite mylonites, all derived from layered mafic, tonalitic and granitic plutonic rocks and migmatitic protoliths. The footwall comprises two kinematic sectors, defined on the basis of syn and post-thermal peak structures: dextral in the west and sinistral in the east. The hanging wall was initially emplaced as a thrust sheet. Subsequently, positive feedback was established between post-granulite facies extensional(?) movements and associated syntectonic granite emplacement at the hanging wall - footwall interface. The kinematically complex Tantato domain may lie at the northeastern end of a 300 by 100 km crustal scale "boudin" structure subjected to bulk pure shear.

1 Continental Geoscience Division

LINCOLN SEA AEROMAGNETIC SURVEY: PROGRESS IN FLYING, COMPILATION, AND INTERPRETATION

D. Hardwick[1], D. Marcotte[1], D.J. Teskey[2], D.A. Forsyth[3], R.F. MacNab[4], B. Nelson[5] and M. Macpherson[5]

An aeromagnetic survey of the Lincoln Sea was initiated in 1989, jointly funded by the Institute for Aerospace Research (IAR), the Defence Research Establishment Pacific (DREP), and the Geological Survey of Canada (GSC). The survey was flown with the triple magnetometer and multinavigational system IAR Convair 580. Approximately 45 percent of the 20 000 km survey was flown in 1989 and a further 40 percent in 1990. The remainder will be completed in 1991. Despite problems encountered with navigation and flight path recovery with the 1989 data, due to limited Global Positioning System (GPS) coverage and problems encountered with the GPS receiver, the availability of the Global Navigation System (GNS) and inertial data has resulted in a data set that is of great value in understanding the complex geology of the area. GPS was greatly improved for the 1990 survey. Preliminary levelling of the existing data has been carried out by the participants.

General features in the data have been identified with shelfward extensions of the regional geological structures of the Northern Ellesmere magmatic belt, the Hazen Fold Belt, and the transition from the Ellesmere Island shelf to the Lomonosov Ridge. The relatively smooth magnetic field over the eastern Lincoln Sea appears anomalous in view of the major tectonic features hypothesized for Nares Strait.

1 Institute of Aerospace Research
2 Geophysics Division
3 Continental Geoscience Division
4 Atlantic Geoscience Centre, Dartmouth
5 Defence Research Establishment Pacific

AIRBORNE GAMMA RAY SPECTROMETER SURVEY OF THE SNOW LAKE AREA, MANITOBA, 1990

R.J. Hétu[1]

Airborne gamma ray spectrometric data were acquired over a study area in the Flin Flon-Snow Lake area of Manitoba, as part of the GSC Exploration Science and Technology Program (EXTECH), an integrated multidisciplinary study directed toward improving exploration for base metals.

The survey provides a geophysical data set covering a portion of this greenstone belt that contains several base metal deposits. These data will be used in conjunction with other geophysical, geochemical, and geological data to develop new interpretation techniques and demonstrate new approaches to base metal exploration.

The results of this gamma ray survey are being released as GSC Open File 2300.

1 Mineral Resources Division

GEOLOGY OF NORTHERN WOPMAY OROGEN AND COPPERMINE HOMOCLINE, NORTHWESTERN CANADIAN SHIELD, N.W.T.

R.S. Hildebrand[1]

The Coronation Supergroup, eastern Wopmay orogen (1.9 Ga), unconformably overlies the rifted western margin of the Archean Slave craton and constitutes a shelf-rise and overlying foredeep succession that was tectonically shortened, transported eastward along a basal décollement, and intruded by 1.90 to 1.88 Ga mafic to siliceous magmas during accretion of a 2.4 to 1.9 Ga arc-bearing microcontinent. Eastward subduction following collision led to continental arc magmatism (1.88 to 1.86 Ga), oblique folding of arc rocks, intrusion of granitic plutons (1.86 to 1.84 Ga), and east-west compression resulting in widespread conjugate transcurrent faults.

Unconformably overlying Archean and Proterozoic rocks of Wopmay orogen are Coppermine homocline (1.7 to 0.8 Ga) Hornby Bay (1.66 Ga), Dismal Lakes (both siliciclastic to carbonate successions), Coppermine River (1.27 Ga flood basalts, fluvial sediments, and basaltic lava flows), and Rae (sandstones, shales, and carbonates, intruded by the 0.75 Ga gabbroic Coronation Sills). Eastward- to southward-vergent thrust faults in the Coppermine River Group may be related to a subsurface Proterozoic thin-skinned thrust-fold belt located to the west.

1 Continental Geoscience Division

PRELIMINARY GEOLOGICAL MAP OF THE CANADIAN SHIELD (1:5 000 000) SCALE

P.F. Hoffman[1], K.D. Card[1], and A. Davidson[1]

Abstract not submitted

1 Continental Geoscience Division

MAGNETOTELLURIC STUDIES ALONG THE LITHOPROBE SOUTHERN CORDILLERAN TRANSECT

A.G. Jones[1], R.D. Kurtz[1], D.E. Boerner[1], J.A. Craven[1], G.W. McNeice[1], J.M. DeLaurier[2], and D.I. Gough[3]

Preliminary results of 80 magnetotelluric (MT) sites collected during the summer and fall of 1990 as part of the LITHOPROBE Southern Cordillera Transect will be presented. These data augment a large data base of electromagnetic responses in the Southern Canadian Cordillera. The 1990 MT survey extends areally from the Coast Plutonic Complex eastward to the Cordilleran Foreland Thrust Belt and investigates to depths corresponding to the upper mantle. The three-dimensional MT coverage of this region will make possible a more rigorous interpretation of the electromagnetic response than previously obtainable with two-dimensional surveys.

The cover sequences in this region are detached from the basement hindering the use of surface faults and folds to constrain the basement dynamics. The MT data suggest the electrical nature of the basement is, in part, structurally controlled. The deep information derived from this survey should therefore impose additional constraints on the behaviour and state of the basement and mantle across British Columbia.

1 Continental Geoscience Division
2 Pacific Geoscience Center, Sydney
3 University of Alberta, Edmonton

HIGH RESOLUTION SEAFLOOR SURVEYS: BASELINE DATA FOR ENVIRONMENTAL ASSESSMENT

H. Josenhans[1] and P. Moir[1]

The Atlantic Geoscience Centre has undertaken a study of the marine geology adjacent to the Great Whale River and Little Whale River outflows in order to assess the potential environmental impact of the proposed Great Whale River hydroelectric power project. A combination of subsurface seismic reflection profiles (Huntec Sea Otter boomer and 3.5 kHz), sidescan sonograms, and short (m) gravity cores allow us to define the dynamics, regional distribution, and volume of the various Quaternary sedimentary sequences offshore. The data also allow us to map the glacial and postglacial sediment distribution and determine the style of glaciation and direction of glacial flow.

Sediment dispersion from the rivers into the marine environment is strongly influenced by local bottom currents which are directed by the complex seafloor topography (mesas and steep valleys) of the region. Local slumping along steep gradients and sediment remobilization due to the scouring by bottom currents add to the complexity of sediment dispersal from the river mouths.

1 Atlantic Geoscience Centre, Dartmouth

A NEW METHOD FOR THE COMPUTATION OF EQUIVALENT DENSITY

P. Keating[1]

Equivalent density mapping is a mathematical technique to transform a Bouguer gravity anomaly map into an equivalent density map, which can be more easily related to geology than the original Bouguer map. It is analogous to susceptibility maps used in magnetic interpretation. These types of transformations are usually calculated by means of linear filtering. A new technique based on the Walsh Transform has been developed. The main advantages are that it results in sharp transitions between different density units and that the size of the density blocks can be selected by the user. Two examples from the Canadian Shield are presented. One, from the Noranda-Val d'Or area, shows that the cause of the gravity anomalies is from within the first five kilometres of the crust. This is consistent with the results obtained from LITHOPROBE. The other is from a gravity high located 75 km southeast of the Grenville Front, east of the Manicouagan reservoir, Quebec.

1 Geophysics Division

AEROMAGNETIC TOTAL FIELD, GRADIOMETER AND VLF-EM SURVEY, SNOW LAKE, MANITOBA

F. Kiss[1], J. Tod[1], P.E. Stone[1], B. Ellis[1], D.J. Teskey[1], and E.E. Ready[1]

In Manitoba, a vertical gradient survey was flown over the highly prosperous gold and base metal producing areas surrounding Snow Lake. The mapped aeromagnetic data provided useful structural detail to assist in the geological mapping of the metavolcanic-sedimentary rocks of the Flin Flon greenstone belt and adjacent metamorphic rocks of the Kisseynew Gneiss Complex to the north. Differences in the magnetic susceptibility of lithological units provided sufficient contrast to allow the airborne instrumentation to locate contacts and trace some formations for considerable distances.

1 Geophysics Division

KIMBERLITES OF SOMERSET ISLAND, DISTRICT OF FRANKLIN, N.W.T.

B. Kjarsgaard[1] and T.D. Peterson[2]

The kimberlite field of Somerset Island is the best exposed and probably the largest in Canada. Seven Cretaceous (ca. 88 Ma) kimberlite diatreme/dyke complexes which intruded early Paleozoic limestones on Somerset Island were sampled in July 1990. The Batty Bay complex, which contains 20 to 30 separate intrusions (at least 2 are diamond bearing), has been mapped and sample locations, xenolith types, and localities, etc. are being digitally compiled into maps and linked data bases. Results of 1990 field work indicate that crustal and mantle xenoliths (12 cm) are more abundant there than previously thought. Types of mantle xenoliths include sheared and nondeformed dunites and garnet and spinel lherzolites. Crustal xenoliths are of limestone and Precambrian, amphibolite grade crystalline basement. Results from geothermobarometry, geochemistry, radiogenic isotope measurements, and U-Pb age dating will be incorporated into the data base and used to deduce conditions in the lower crust and deep upper mantle at 88 Ma. A related study of the Prince Albert field, which is of similar age, will provide contemporary data for samples of the Canadian lithosphere spearated by thousands of kilometres.

1 Mineral Resources Division
2 Continental Geoscience Division

SUB-PALEOROIC GEOLOGY OF THE CORMORANT LAKE MAP AREA, MANITOBA

L.J. Kornik[1], J.B. Dugal[1], and B.B. Blair[2]

The Cormorant Lake Project, funded under the Canada-Manitoba Mineral Development Agreement, was designed to map sub-Paleozoic geology adjacent to the Flin Flon greenstone belt. The objective is to assist mineral exploration of shallow Precambrian basement. Aeromagnetic gradiometer and total field maps have been used along with geological maps of the Flin Flon belt and drill-hole data to extrapolate the Precambrian geology southward. A new geological map of the Cormorant Lake area extends the Snow Lake-File Lake volcanic-sedimentary rocks in the east to the southern limits of the map. A large granitic body in the lower central area of the map indents the western boundary of the Snow Lake-File Lake group of rocks eastward. A zone of mainly syntectonic intrusives and related gneisses separates the Snow Lake-File Lake assemblage from the Flin Flon volcanic-sedimentary rocks. This mobile zone also separates the latter and the central granite, and truncates the eastern end of the large Sturgeon Weir structural boundary fault. The fan of Flin Flon volcanic-sedimentary rocks and the many contained block-bounding faults splay from and wedge into the linear zone along the western edge of this mobile syntectonic area.

1 Continental Geoscience Division
2 Geoscience Information Division

LIMS: A LONG PERIOD INTELLIGENT MAGNETOTELLURIC SYSTEM

R.D. Kurtz[1], D.E. Boerner[1], A.G. Jones[1], R. Charbonneau[1], K. Harding[1], J.A. Parmelee[1], and D.F. Trigg[1]

A low-power, microprocessor-controlled long period magnetotelluric system has been developed for unattended recording of data in the period range from 15 Hz to 2 days.

It is designed to be small (40 cm x 28 cm x 25 cm) and portable (5 kg including the internal battery pack for memory backup). Recording time is limited only by the memory (5 Mbyte) and the power source.

The magnetic sensor is a three-component ring core fluxgate (sensitivity of 0.016 nT /RHz mounted with a levelling assembly in a waterproof cylinder.

The system incorporates selectable digital low-pass filtering and decimation which permit a wide variety of recording bands and sampling rates.

Data are transferred from the LIMS system via an RS232 port, usually to IBM-compatible personal computers.

Preliminary hardware and software plans for the second generation of LIMS include a 32 Mflop DSP (Digital Signal Processor) chip. The DSP-based system will undertake real time data analysis, time series data quality evaluation, and recording in an number of frequency bands to reduce the data storage requirements for extended deployments.

1 Continental Geoscience Division

NARSAJUAQ TERRANE, UNGAVA PENINSULA, QUEBEC: TECTONIC HISTORY OF AN EARLY PROTEROZOIC MAGMATIC ARC IN THE UNGAVA OROGEN

S.B. Lucas[1], M.R. St-Onge[1], J.M. Dunphy[2], and R.R. Parrish[1]

Narsajuaq terrane is an assemblage of metasedimentary and metaplutonic rocks which was accreted to the Superior Province. Metaplutonic rocks include an older layered unit of tonalite (1863 Ma) and quartz diorite which is intruded by sheets of granodiorite (1861 Ma), quartz diorite (1844 Ma), monzogranite (1836-1834 Ma), and tonalite (1830 Ma). Metasedimentary rocks include semipelite, quartzite, pelite, ironstone, marble, and calc-silicate rock. Detrital zircons from a quartzite sample indicate erosion of both Archean and 1863-1830 Ma rocks followed by deformation and metamorphism ca. 1830 Ma. The terrane records an early episode of synmagmatic, granulite grade metamorphism (1825 Ma) and dextral transcurrent deformation prior to accretion as a wedge at the base of the Cape Smith Thrust Belt. In total, Narsajuaq terrane appears to record 1863-1830 Ma arc magmatism, coeval underplating of subducted sedimentary rocks derived in part from the arc itself, and post-1825 Ma collision with the Superior Province.

1 Continental Geoscience Division
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DIP AND DEPTH EXTENT OF AN INCLINED PLANAR GEOLOGICAL BOUNDARY DERIVED FROM HORIZONTAL DERIVATIVES OF AN UPWARD-CONTINUED GRAVITY PROFILE

P.H. McGrath[1]

Computer and graphical methods were developed to derive the dip, vertical extent, and location of a truncated horizontal-plate model from its gravity profile. The methods are based on lateral offsets of the zero-crossover point of second horizontal derivatives of a gravity profile which has been upward-continued over a fixed interval to several elevations above ground level. Upward-continuation and horizontal derivation are achieved by Fourier techniques. Application requires that the distance to the upper surface of the model be known. Numerical tests indicate useful results are obtained when both the length of the gravity profile, and the finite-strike length of the model are at least three times the maximum depth extent of the model. Random noise with standard deviations up to 0.3 mGal are tolerated given an anomaly amplitude of 70 mGal. An interpretation example from the Trans-Hudson orogen of central Manitoba indicates that the Kisseynew metasedimentary gneisses extend over a vertical distance of 15 to 18 km, and are separated from the Baldock Batholith to the north by a near-vertical boundary.

1 Continental Geoscience Division

THE SAINT-MAURICE TECTONIC ZONE: A MAJOR STRUCTURE OF THE CENTRAL GRENVILLE OROGEN, QUEBEC

L. Nadeau[1] and D. Corrigan[2]

The Saint-Maurice tectonic zone is a regional-scale easterly dipping mid- to deep crustal ductile shear zone that separates the allochthonous monocyclic belt (AMB) on the west from the Laurentides park plutonic complex, part of the allochthonous polycyclic belt (APB), to the east.

A section across this structure shows that its eastern margin is a steeply dipping zone of subhorizontal sinistral shearing. Farther to the west, the shear zone dips gently to the east and projects structurally above the AMB. Kinematic constraints suggest that the shear zone is the product of northwest-directed compression. However, the large-scale tectonic flow pattern is complex and reflects changing boundary conditions.

Published regional interpretations of the southwestern part of the Grenville orogen show the AMB to be overthrusted onto the APB. Although overthrusting is well established in western Quebec and Ontario, our observations at the Saint-Maurice tectonic zone show that the history of the eastern border of the AMB does not fit such a simplified model.

1 Quebec Geoscience Centre, Ste-Foy
2 Ottawa-Carleton Geoscience Centre, Ottawa

A PRELIMINARY MAGNETIC ANOMALY MAP OF THE ARCTIC PRODUCED FROM DIGITAL DATA

G. Oakey[1], K.G. Shih[1], R.F. Macnab[1], J. Verhoef[1], and S.P. Srivastava[1]

Within the last two years a project has been underway to compile magnetic data from the Arctic and North Atlantic regions to produce a comprehensive data base to be used for advanced analyses and the production of high quality maps. Data have been received from many international agencies in both original profiles and digital grids. These data have been combined using various conversion and adjustment techniques to produce a data base in excess of 20 million original observations supplemented by grid sets covering a similar sized area.

This poster features a 1:6 million scale map of all data north of 60$N and to date is the most comprehensive magnetic anomaly map of the Arctic region. The data sets still require further adjustment and levelling, and there remains important gaps where data are not yet available. However, the map serves a useful purpose by focusing attention on the blank areas that need to be filled, whether by contributions of existing data or by future surveys.

1 Atlantic Geoscience Centre, Dartmouth

THE CONODONT AS A TOOL IN CORDILLERAN GEOSCIENCE

M.J. Orchard[1]

A conodont is a remarkably versatile phosphatic microfossil with highly variable age-diagnostic morphology, temperature-dependent colour (CAI), a crystallinity that changes with diagenetic/metamorphic effects, and trace element/isotopic chemistry through which paleo-oceanographic conditions and absolute age may be determined. The extinct animal that bore the tooth-like elements was environmentally and paleogeographically differentiated, thus facilitating use of conodonts in the depositional basin and tectono-stratigraphic terrane analysis.

During the last decade, several thousand conodont collections have been extracted from Cordilleran strata through acid digestion. Thus far, the major application of the conodont tool has been in the relative dating of often metamorphosed calcareous and siliceous rocks. Through the use of new (particularly Triassic) conodont zonations, and the adaptation of existing ones, a temporal framework for Paleozoic-Triassic strata has been constructed and is routinely used to elucidate Cordilleran geology.

Examples of significant progress in our understanding of the stratigraphy, structure, and tectonic evolution of each of the major Cordilleran terranes, and of the epicratonal autochthon are summarized.

1 Cordilleran Division, Vancouver

MAPPING OF QUATERNARY SEDIMENTS NEAR KAPUSKASING, ONTARIO, WITH A HELICOPTER ELECTROMAGNETIC SYSTEM

G.J. Palacky[1], J.S. Holladay[2], and P.W. Walker[2]

Results of test surveys in northeastern Ontario demonstrate that multifrequency helicopter electromagnetic (EM) surveys can be effectively used in mapping of Quaternary sediments. Airborne geophysical surveys are inherently cost-effective over large areas. Statistical analysis of electrical properties of clay, till, and sand layers has shown that all three sediment types have distinct conductivities. Therefore, lithology can be determined from conductivity maps or pseudosections. Correlation of airborne and ground EM data with the results of Rotasonic drilling has indicated that determinations of conductivity of overburden are reliable in most situations. Estimates of overburden thickness, which is another parameter of interest, critically depend on the quality of raw data and the type of interpretation technique used. Two methods have been used to process helicopter EM data: a) inversion based on singular value decomposition; and b) centroid depth approach developed by P. Sengpiel of Bundesanstalt für Geowissenschaften und Rohstoffe. While the second method appears more robust, both are sensitive to levelling errors. The poster depicts field examples obtained in different geological situations along the Kapuskasing transect.

1 Mineral Resources Division
2 Aerodat Ltd., Toronto

MULTIDISCIPLINARY STUDIES ALONG THE SOUTHERN CORDILLERAN LITHOPROBE TRANSECT

R.R. Parrish[1], C. Spencer[1], A.G. Jones[1], M. Thomas[1] and the LITHOPROBE Southern Cordillera Working Groups

The Southern Cordillera Transect of LITHOPROBE is near completion following more than five years of multidisciplinary scientific activity. Seismic reflection data show that the Moho is remarkably planar across most of the Cordillera, despite the large structural relief resulting from Mesozoic compression and Eocene extension. Major features that have been identified by geophysical and geological methods include the Eocene Slocan Lake normal fault, Late Cretaceous to Paleocene thrust zones in Valhalla and Monashee complexes, a Cretaceous west-vergent thrust zone in the eastern Coast Plutonic Complex, a high amplitude (magmatic?) reflector in the upper crust near Holocene volcanic centres, and a near-continuous linkage of reflectors beneath the mainland Cordillera with those beneath Vancouver Island. The data constitute a nearly complete record of crustal structure from the active downgoing slab to the stable craton of Alberta, providing new insights into the tectonic evolution of the Cordillera.

1 Continental Geoscience Division

A GEOLOGICAL TRANSECT OF THE MINTO SUBPROVINCE, SUPERIOR PROVINCE, ACROSS THE UNGAVA PENINSULA, QUEBEC

J.A. Percival[1], K.D. Card[1], R.A. Stern[1], N.J. Bégin[2], and J.K. Mortensen[1]

The Minto Subprovince is a 450 km wide, dominantly plutonic region with north-northwest structural trends. A 400 km long transect from Hudson to Ungava Bay crosses four distinct lithotectonic domains, from west to east: 1) Tikkerutuk terrane, containing granodiorite and granite with hornblende-biotite assemblages; 2) Lake Minto terrane, with metasedimentary and metavolcanic remnants cut by orthopyroxene-bearing granodiorite and granite; 3) Goudalie terrane of predominant tonalite, with supracrustal relics and deformed mafic dykes; and 4) Utaslik terrane consisting of granodiorite and granite with both hornblende-biotite and pyroxene-bearing assemblages. Terranes 2) and 3) have independent lithotec-

tonic histories prior to emplacement of the regional calc-alkaline granodiorite suite 2.72 Ga ago and have limited mineral potential within supracrustal remnants.

1 Continental Geoscience Division
2 University of Calgary, Calgary

AUTOMATED DEPTH ESTIMATION FROM GRIDDED POTENTIAL FIELD DATA

M. Pilkington[1], W.R. Roest[1], and J. Verhoef[2]

Two recently developed 3-D methods for the automated estimation of source positions and depths are 3-D Euler and Analytic Signal approaches. These methods can be applied to gravity as well as magnetic data, and in the case of magnetic data do not require reduction to the pole. Both methods use the derivatives of field data in x, y, and z directions. In the absence of measured gradients, frequency domain techniques can be used to obtain them. Special care should, however, be given to the creation of the grid, as gridding artifacts may lead to severe errors in the depth estimates.

The two methods produce estimates of source geometry and depth, which can be easily displayed, and define structural trends, with the added dimension of depth.

An example is given from the North American gridded magnetic data set, across a recently discovered feature in Lake Huron that was identified as a possible impact crater.

1 Geophysics Division
2 Atlantic Geoscience Centre, Dartmouth

CHALLENGES OF SEAFLOOR MAPPING IN FRONTIER REGIONS

D.J.W. Piper[1], B. MacLean[1], H. Josenhans[1], and P. Mudie[1]

Marine frontier areas include deep-water areas adjacent to Canada and continental shelves of arctic and subarctic regions. There is a demand for seafloor geological maps in frontier regions for a variety of purposes, but principally at present as baseline information for environmental assessment. Demands in such areas are commonly unexpected: information for wildcat oil wells, deep-water telecommunications routes, sovereignty issues, and potential National Parks have in the past arisen in areas where mapping had been inadequate or non existent.

Commonly, the geological processes and sediment distribution in such frontier areas is quite different from those in the better known southern coastal zone and shelves. Experience from these better known areas cannot be extrapolated to frontier areas. In deep water and ice-covered waters there are, in addition, severe technological constraints on mapping and geological interpretation. As a result, a long lead time is needed to develop both technological competence and scientific concepts. At a time when resources are limited, cost-effective work requires close collaboration with colleagues overseas working in similar environments.

1 Atlantic Geoscience Centre, Dartmouth

GEOSCIENCE APPLICATIONS OF DIGITAL ELEVATION MODELLING TO REGIONAL STRUCTURAL ANALYSIS

A.N. Rencz[1] and G.P. Watson[1]

The Geomathematics Section has developed procedures to convert vector files of topographic data into digital elevation models (DEMs). The first step is to strip contour and shoreline information from master files obtained from Surveys, Mapping and Remote Sensing Sector of EMR. Using commercially available software (PANACEA), a set of Delaunay triangles are generated linking all adjacent elevation points. Derivatives are calculated between elevations in each triangle and an interpolation is used to grid the data to a user-specified cell size. The final product is a raster image with elevation values for each pixel (cell) which can be integrated with other data such as digital geological maps or remotely sensed imagery.

Examples of the integration of DEMs with geological and remotely sensed data are presented for areas in northern British Columbia and the Cape Breton Highlands. The DEMs are used to add perspective to LANDSAT TM, airborne radar, and geological maps to enhance the identification and interpretation of regional structure.

1 Mineral Resources Division

STRUCTURAL ASPECTS OF NORTH AMERICA IN THE CONTEXT OF THE WORLD BOUGUER ANOMALY MAP

W.R. Roest[1], J.D. Rupert[1], R.A.F. Grieve[1], and A.K. Goodacre[1]

A colour Bouguer anomaly map of the world's oceans has been compiled using SEASAT derived, marine free air gravity data and ETOPO5 ocean bathymetry. The offshore Bouguer anomalies were calculated for each 5 foot by 5 foot grid cell assuming densities of 1.03 g/cm^3 for salt water and 2.99 g/cm^3 for oceanic crust. The Bouguer reduction emphasizes lateral density variations, due to variations in rock composition and/or thermal effects.

In the oceanic areas, fast and slow spreading mid-ocean ridges are clearly seen, as well as steps in the Bouguer field that reflect differences in density and thickness (age) across fracture zones.

The map shows interesting continuations of features across both the active and the passive margins of the North American continent. One example is the alignment of Mendicino Fracture Zone with the Snake River low. Another is the Grenville Front, disrupting the Labrador passive margin, and continuing into the Cartwright Fracture Zone.

1 Geophysics Division

COMPUTERIZED FIELD MAPPING APPLICATIONS: NORTHEASTERN CANADA

M. Schau[1] and B. Brodaric[1]

Transformation of field data into digital form during the field season provides the field geologist with great flexibility in planning traverses while in the field, and capability for rapid production of preliminary maps. There is no saving of time while entering data, but subsequent handling of the field data is facilitated by its digital form. OGS FIELDLOG, a DOS-based software package specifically

designed to store, process, and display map-related data, was evaluated by the GSC last summer and was judged to be an acceptable tool. Both a hardware-hungry, fully-featured version and a low-end, minimal implementation will be exhibited. Both of these can generate and manipulate digital data sets in field settings. As usual, power and flexibility is traded for convenience and ease of use. Preliminary computer-drafted maps of several northeastern Arctic areas, at different scales, and generated for differing purposes — including a compilation of past data, a representation of this summer's field project, and working field documents — are displayed.

It would appear that the geological interpretative phase rather than the production phase will be the rate-determining step in publishing maps, once digital methods such as this are widely implemented.

1 Continental Geoscience Division

EVOLUTION OF THE ARCTIC AND NORTH ATLANTIC OCEANS

S.P. Srivastava[1], W.R. Roest[2], and S. Lévesque[3]

A plate kinematic solution for the North Atlantic and Arctic is derived using magnetic anomaly and fracture zone data from the North Atlantic Ocean, Labrador Sea, Norwegian-Greenland seas, and Eurasian Basin. The evolutions of the North Atlantic and Arctic oceans are complex: the plate boundaries of several large and small plates have shifted with time.

To expedite the depiction of the evolution of the ocean basins and correlate sedimentary basins and their tectonic features, the Atlantic Geoscience Centre has developed a system whereby the entire contents of the plates are rotated in the reconstructions, here based on gridded bathymetry and topography data.

The opening of the North Atlantic was the result of propagation of spreading from between Africa and North America (mid-Jurassic) to the Newfoundland Basin between Iberia and Grand Banks (Early Cretaceous), to the Labrador Sea (Late Cretaceous), and to the Norwegian-Greenland seas and Eurasian Basin (Paleocene). The formation of King's Trough, Newfoundland and New England seamounts, and Canary Islands is detailed. The opening of the Canada Basin is based on the anticlockwise rotation of Arctic Alaska and Kamchatka block.

1 Atlantic Geoscience Centre, Dartmouth
2 Geophysics Division
3 Blue Vajra Computing, Halifax

ISOTOPE AND TRACE ELEMENT GEOCHEMISTRY OF ARCHEAN ROCKS FROM THE MINTO SUBPROVINCE, QUEBEC

R.A. Stern[1]

Neodymium and strontium isotopes and rare earth elements (La-Yb) have been determined by isotope dilution upon whole rocks from the Archean Minto Subprovince. This region contains mostly undeformed hornblende- and orthopyroxene-bearing granitoids and minor supracrustals. A petrogenetic study of the granitoids was undertaken in order to constrain geodynamic models for the formation of this Archean crust. Magmatism occurred at 2.7 (0.2) Ga, and possibly at 3.1 Ga for some tonalites.

Tonalitic rocks are steeply light REE-enriched, and have $_{Nd}$ values at 2.7 Ga of -1.8 to -9.3. They were probably derived from basaltic crust at 3.1 to 3.5 Ga. Abundant 2.7 Ga hornblende-biotite granodiorite-granite have steeply light REE-enriched patterns with minor Eu anomalies, and $_{Nd}$ (2.7 Ga) of 0 to +0.5. These rocks contain a large component of mantle Nd, and possibly a small crustal component. Orthopyroxene granodiorite and granite have low heavy REEs (Yb_n 1), positive Eu anomalies, $_{Nd}$ (2.7 Ga) of +3 to +13, and $I_{Sr} = 0.7021$. These rocks may be derived by melting of mafic crust under eclogite-grade conditions. Late leucogranite has large negative Eu anomalies and $_{Nd}$ (2.7 Ga) = -1 to -2, and probably contains a large component of recycled crust.

1 Continental Geoscience Division

GEOCHRONOLOGICAL CONSTRAINTS ON THE TECTONIC HISTORY OF THE ARCHEAN AND LOWER PROTEROZOIC ROCKS IN THE TAVANI, RANKIN INLET, AND CHESTERFIELD INLET REGIONS, CHURCHILL STRUCTURAL PROVINCE, N.W.T.

S. Tella[1], J.C. Roddick[1], A.F. Park[2], and S. Ralser[2]

Archean and early Proterozoic supracrustal and granitoid rocks are exposed west of Hudson Bay in three regions - Tavani, Rankin Inlet, and Chesterfield Inlet. In the Tavani region, Archean deformation developed northeast-trending folds and associated ductile high-strain zones. Volcanism, deformation, and granite emplacement took place between 2.68 and 2.65 Ga (U-Pb zircon). In the Rankin Inlet region felsic volcanism occurred at 2.63 Ga, with subsequent Archean deformation and metamorphism producing F_1 isoclinal and southeast-plunging F_2 folds. Both regions are in tectonic contact with an intervening ca. 2.72 Ga amphibolite-granulite terrane. In the Chesterfield Inlet region, a 2.73 to 2.63 Ga amphibolite-granulite gneiss terrane comprises three crustal segments separated by ductile, high-strain zones. Tectonic juxtaposition of deep- over mid-crustal rocks occurred prior to emplacement of 1.85 Ga fluorite granites. Thus northeasterly transport of mid- and deep-crustal rocks north of Rankin Inlet resulted in crustal extension and synchronous reactivation of Archean shear zones in the hinterland, postdating early Proterozoic deposition and deformation. Structural, thermobarometric, and geochronological data are used to construct a schematic crustal section.

1 Continental Geoscience Division
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MAGNETIC MODELLING OF THE MID-CONTINENT RIFT SYSTEM — CENTRAL LAKE SUPERIOR

D.J. Teskey[1]

Two and one-half dimensional modelling of the central portion of Lake Superior has been carried out using the high resolution aeromagnetic data collected by the GSC's Queenair aircraft in 1987 for the Great Lakes International Multidisciplinary Program on Crustal Evolution (GLIMPCE). Individual 2.5 dimensional models for profiles spaced approximately 10 km apart can be combined using trigonal surfaces to produce 3 dimensional models. These models indicate up to 40 km of volcanic flows, with the lower

members having reversed magnetization, similar to the lower Osler group. These models tend to agree with the interpretation of the seismic profiles shot in 1986 as part of the GLIMPCE program.

[1] Geophysics Division

AEROMAGNETIC TOTAL FIELD, GRADIOMETER, AND VLF-EM SURVEYS, SAINT JOHN, NEW BRUNSWICK

D.J. Teskey[1], E.E. Ready[1], and P.E. Stone[1]

A 13 500 km gradiometer survey of the Saint John, New Brunswick area was flown in 1987 as a contribution to the Canada-New Brunswick Mineral Development Agreement. The objective of the survey was to assist detailed geological mapping by defining contacts between units of differing magnetization. Detailed mapping of part of the area has been carried out by K.L. Currie of the Continental Geoscience Division. Magnetic units in the area include the Precambrian Kingston formation, a bimodal sheeted dyke complex, the associated calc-alkaline-arc related Coldbrook group, and the Golden Grove dioritic to granodioritic I-type pluton suite. Contacts of these units are well defined on the gradiometer maps. In the Phanerozoic, anomalies seem to be related to Silurian mafic volcanics and to structure within the Mount Douglas Pluton.

[1] Geophysics Division

SM-ND ISOTOPIC STUDIES IN SELECTED REGIONS OF THE WESTERN CANADIAN SHIELD

R.J. Thériault[1] and F.Ö. Dudás[1]

Some of the Sm-Nd isotopic data produced at the Geological Survey of Canada from 1987 to 1990 are reviewed. The regions considered include terranes underlying the western interior platform, the southern Slave Province, and the western Rae and Hearne provinces.

The early Proterozoic basement underlying the interior platform displays 2.5 to 2.8 Ga T_{DM} ages north of the Snowbird line. Terranes proximal to and south of the Snowbird line have T_{DM}s exceeding 3 Ga.

In the southern Slave Province, felsic volcanic rocks, amphibolite dykes, and granitic plutons have juvenile Sm-Nd signatures, suggesting formation of new crust in the late Archean.

The western Rae and Hearne provinces both show 2.5 to 2.9 Ga T_{DM}s and are indistinguishable in terms of Nd isotopic signatures. The early Proterozoic Taltson magmatic zone also displays late Archean T_{DM}s.

The prevalence of late Archean T_{DM}s corroborates existing models of episodic crustal growth. Early Proterozoic orogenic belts feature Nd signatures similar to those of late Archean rocks and thus essentially consist of recycled late Archean crust.

[1] Continental Geoscience Division

DETAILED GRAVITY TRAVERSES ACROSS THE EARLY PROTEROZOIC UNGAVA OROGEN, NORTHERN QUEBEC

M.D. Thomas[1], B. Grover[1], S.B. Lucas[1], M.R. St-Onge[1], and D.W. Halliday[1]

Approximately 320 km of detailed gravity profiling has been completed within the eastern Ungava orogen in support of ongoing geological studies. Older, regional gravity surveys (stations 10 to 20 km apart) defined a large positive anomaly over the Cape Smith Belt (CSB). Ensuing gravity modelling provided insights into its deep geometry. Detailed profiling (stations 1 to 3.5 km apart) was designed with the objectives of refining earlier gravity models of the CSB and of modelling the contact between the Sugluk and Narsajuag terranes and various internal contacts. The new gravity profiles, like the older data, show the strongest anomalies to be associated with the CSB. This is expected, considering that the CSB comprises mainly mafic igneous rocks, which are more dense than flanking granitoid rocks. New models of the CSB are developed in the light of down-plunge constrained, structural cross-sections. The new data indicate that the gravity field over the Sugluk and Narsajuag terranes varies smoothly, presumably because component granitoids differ little in density. The gravity approach is less successful in these areas. Crustal cross-sections across the orogen are presented and their tectonic significance discussed.

[1] Continental Geoscience Division

GRAVITY, GROUND MAGNETIC, AND ROCK MAGNETISM INVESTIGATIONS IN THE APPALACHIAN DUNNAGE AND GANDER TERRANES, NORTHERN NEW BRUNSWICK

M.D. Thomas[1], E.I. Tanczyk[1], D.W. Halliday[2], M. Cioppa[1], and D.V. O'Dowd[1]

Gravity and ground magnetic investigations have been initiated near the Dunnage-Gander terrane boundary. Traverses cross Ordovician rocks of the Elmtree inlier, the Nine Mile synform, the Tetagouche antiform, and a fold-thrust package on the south side of the Rocky Brook-Millstream (RBM) fault. Magnetic models consistently indicate the presence of steeply dipping units extending to minimum depths of 1.5 to 2.5 km. Positive magnetic anomalies over the Elmtree ophiolite complex indicate that it is about 1.5 km thick, but a weak positive gravity anomaly implies that it is only a few hundred metres thick. Natural remanent magnetization (NRM) was measured on oriented samples with the aim of better constraining the magnetic interpretation. This may help resolve the discrepancy between gravity and magnetic models. NRM directions are generally steep, and point downward. Magnetic fabric demagnetization has isolated a removable overprint in the fold-thrust package south of the RBM fault. At another site, much farther from the fault, no overprint was detected. Fabric analysis suggests that the last deformation in the area was dextral displacement along the fault.

[1] Continental Geoscience Division
[2] Geophysics Division

AEROMAGNETIC TOTAL FIELD, GRADIOMETER AND VLF-EM SURVEY, AND YARMOUTH, NOVA SCOTIA

J. Tod[1], P. Stone[1], B. Ellis[1], F. Kiss[1], D. Teskey[1], and E. Ready[1]

Results of the final aeromagnetic project under the Canada-Nova Scotia Mineral Development Agreement (1984-89) were published in 1990. Approximately 30 000 line-km of digital aeromagnetic data were collected over southeast Nova Scotia where relatively little field mapping has been done. New structural information is apparent, particularly in the gradiometer data. The magnetic signature associated with the Halifax Formation (Meguma Group) traces out extensive faulting and folding. In contrast, granitoid intrusions into the Goldenville Formation are identifiable by their absence of magnetic response.

1 Geophysics Division

APPLICATION OF HIGH RESOLUTION SEISMIC REFLECTION TO CCDP SITE SELECTION, ILE AUX COUDRES, ST. LAWRENCE ESTUARY

B.J. Todd[1], S. Occhietti[2], and R.A. Burns[1]

A recent Canadian Continental Drilling Program (CCDP) drillhole proposal has focused attention on the shore of the Île aux Coudres Channel in the middle St. Lawrence River estuary. A drillhole at the Ile aux Coudres site would provide detailed information on the Illinoian/Sangamonian transition (130 ka). The continental climatic change at that time is poorly documented.

Depth to bedrock and the seismo-stratigraphy at the potential drill site were mapped by shooting "optimum offset" seismic reflection survey lines. Data analysis shows 160 m of stratified, basin-fill sediment in a broad, U-shaped valley. The sediment is interpreted to be glacial-marine in origin. Exposed material suggests that the sediment was deposited during late Illinoian and early Sangamonian time. The sediment has similar seismic reflection characteristics as deposits mapped elsewhere in the Middle Estuary using marine seismic methods. These deposits are Late Wisconsinan-early Holocene Goldthwait Sea marine clays and silts. The Île aux Coudres U-shaped valley represents a trap of older sediments. The results could be used in planning CCDP drillhole locations in the Middle Estuary of the St. Lawrence.

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U-PB GEOCHRONOLOGY OF ZIRCON, MONAZITE, AND TITANITE FROM THE PRECAMBRIAN BASEMENT BENEATH THE WESTERN CANADA SEDIMENTARY BASIN

M. Villeneuve[1], G. Ross[2], and R. Parrish[1]

The Precambrian basement that underlies the Western Canada sedimentary basin has been divided into 20 domains based upon interpretation of potential fields data. U-Pb zircon geochronology from over 50 samples of drill core that penetrated crystalline rock provides age control on the domains and acts as a test of the assignment of domain boundaries. U-Pb ages of monazite and titanite help delineate postcrystallization, regional thermal events.

Southern Alberta is Archean, although an early Proterozoic titanite age in the Vulcan Low, when combined with the geophysical signature of the region, suggests metamorphism during a Proterozoic collisional orogeny. Central Alberta is dominated by the formation of 2.3 to 1.8 Ga domains around the Snowbird Tectonic Zone. Northern Alberta contains a large, complex, 2.4 to 2.0 Ga domain which is flanked by 1.95 to 1.85 Ga magmatic arc domains. Ca. 1.9 Ga monazite and titanite ages on 2.0 to 2.4 Ga rocks shows the regional effect of the magmatism at the domain margins.

1 Continental Geoscience Division
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MINERALS

Fe, Cu ± Co, Pb-Zn, U, AND Ba DEPOSITS ASSOCIATED WITH CLEARLY DEFINED AND CRYPTIC SALT DOMES

R.T. Bell[1] and D.P. Cox[2]

Examples of mineral deposits associated with clearly defined and cryptic salt domes are tabulated below:

LOCALITY	EVIDENCE FOR DIAPIRISM	AGE OF EVAPORITES	AGE(S) OF DIAPIRISM
NORTH AFRICA		**Triassic**	**E. Cretaceous to Cenozoic**
Ouenza Fe-Cu	Clear		
Bou Grine Pb-Zn	Clear		
Nebeur Fe-Mn-Pb-Zn	Clear		
SPAIN		**Triassic**	**E. Cretaceous to Cenozoic**
Reocin Pb-Zn	Clear		
Atube Pb-Zn	Clear		
Bilbao-Santander Fe	Reasonable		
IRAN		**Cambrian**	**Cenozoic**
Bandar Abbas Fe	Clear		
Baqeroq Cu	Reasonable		
Nakhlak Pb-Zn	Reasonable		
GULF COAST, U.S.		**Jurassic**	**Cenozoic**
Hockley Dome Pb-Zn	Very Clear		
BOLIVIA		**Cretaceous (?)**	**Cenozoic**
Chacarilla Cu-Ag	Reasonable		
Corocoro Cu-Ag	Speculative		
SHABA, ZAIRE		**Proterozoic**	**L. Proterozoic to Cambrian**
Lolwezie Cu-Co	Speculative		
Kipushi Cu-Pb-Zn-Cd	Reasonable		
Shinkolobwe U-Pt-Pd-Au±Ni	Reasonable		
YUKON, CANADA		**Proterozoic**	**M. Proterozoic (?)**
Igor Cu-U±Fe±Au	Speculative		
Nor U-REE-Fe-Ba	Speculative		
Pagisteel Fe±Cu±U	Speculative		
Iota Pb-Zn-Cu-Ag-Au	Reasonable		
S. AUSTRALIA		**Proterozoic**	**L. Proterozoic to Cambrian**
Beltana Zn	Clear		
Oraparina Ba	Clear		
Mt Plantagenet Fe	Reasonable		
Blinman, Patawarta Cu±Co	Clear		
YUNNAN, CHINA		**Proterozoic**	**M. Proterozoic (?)**
Dongchuan Cu	Speculative		
Laoxue Fe	Speculative		

Conceptual Model: dislocation of evaporite-associated mineral deposits together with convective flow of metalliferous brines accompanying diapir intrusion, solution, and collapse formed deposits associated with megabreccias and sedex deposits flanking emergent diapirs.

1 Mineral Resources Division
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A LOWER PROTEROZOIC CARBONATITE AT LAC LEMOYNE, NORTHERN QUEBEC: GEOLOGY AND MINERAL POTENTIAL

T.C. Birkett[1] and T. Clark[2]

A carbonatite and its associated mafic-ultramafic tuffs and sedimentary rocks near Lac Lemoyne in the northern Labrador Trough were deformed with the rocks of the Kaniapiskau Supergroup during the Hudsonian Orogeny. The carbonatite displays a massive, intrusive facies, and a scoriaceous, blocky extrusive facies. Mafic and ultramafic tuffs associated with the carbonatite are generally sodic, although some potassic rocks are present.

Chondrite-normalized rare earth spectra of these rocks form three groups. Europium anomalies are not present. Mafic volcanic rocks have moderately sloped patterns and variable rare earth concentrations; most carbonatite samples have steeper slopes and moderate concentrations; mineralized carbonatite samples have extreme slopes, the highest light rare earth concentrations and the lowest heavy rare earth concentrations. Mineralization is present as bastnaesite for the rare earths and as columbite and pyrochlore for niobium. Earlier exploration work reported niobium concentrations of up to 7% in hand samples. The highest concentration recorded by the present study is 1.8%. Total rare earth concentrations reach 1.97% in hand samples.

1 Quebec Geoscience Centre, Ste-Foy
2 Ministère de l'Énergie et des Ressources du Québec, Charlesbourg

A GEOLOGICAL RECONNAISSANCE IN THE GRENVILLE PROVINCE TO THE EAST OF VAL D'OR, QUEBEC: A POSSIBLE EXTENSION OF THE ABITIBI BELT IN THE GRENVILLE PARAUTOCHTHONOUS BELT

T.C. Birkett[1], N. Marchildon[2], S. Paradis[1], and R. Godue[1]

Within a previously unmapped segment of the Grenville Province, a band of gneisses some 15 to 20 km wide having a dominant mafic component and a minor but persistent ultramafic component can be followed eastward from the Grenville Front for a distance of about 80 km. These gneisses are separated from the rocks of the Superior Province by a zone of mylonite which marks the Grenville Front. These gneisses, at high metamorphic grade, are in continuity with the Archean low to medium grade supracrustal rocks of the Abitibi greenstone belt.

It is hypothesized that these mafic and ultramafic gneisses within the Grenville parautochthonous belt are the highly metamorphosed extension of the Abitibi greenstone belt. If further study supports this position, a substantial area can be considered interesting for mineral exploration.

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NEW DEVELOPMENTS AND APPLICATIONS OF BOREHOLE GEOPHYSICS FOR MINERAL EXPLORATION

Borehole Geophysics Section[1]

Borehole geophysical measurements are widely accepted and used in oil and gas exploration. However, these measurements are currently beginning to gain a wider acceptance in mineral exploration programs.

The Borehole Geophysics Section of the Geological Survey of Canada has examined the application of a number of borehole geophysical methods to mineral exploration in various mining areas across Canada. Geophysical measurements have included induced polarization (IP), resistivity, self potential, magnetic susceptibility, conductivity, natural gamma (K, U, and Th), spectral gamma-gamma (density, heavy element assay), temperature, and temperature gradient. These have been used for delineating mineralized zones, mapping alteration zones associated with mineralization, hole-to-hole lithological correlation, assaying, detecting groundwater flow within the holes, and determining in-situ physical properties for use in the interpretation of ground and airborne geophysical data.

New developments in the area of borehole directional surveying, and three-component magnetometer and VLF measurements, have also undergone preliminary investigations.

Geophysical logs from various mining areas in Canada illustrate some of these new developments, and their applications.

1 Mineral Resources Division

CHAMPAGNE: AN AURIFEROUS SEDEX DEPOSIT IN THE BLACK ARGILLITES OF THE QUEBEC APPALACHIANS.

J. Bossé[2], S. Paradis[1], M. Gauthier[2], L. Dupuis[3], and J.F. Burzynski[3]

The Champagne polymetallic massive sulphide deposit occurs within black argillites of the Magog Group of the Saint-Victor Synclinorium. These sediments were deposited in a fore-arc euxinic basin of Middle Ordovician age.

The Champagne deposit consists of several conformable lenses that consist of massive, banded, and brecciated fine grained pyrite, pyrrhotite, sphalerite, chalcopyrite, and galena. A chemical and mineralogical zonation is observed from the base to the top of the sulphide lenses: pyrrhotite-chalcopyrite to sphalerite-pyrite with a progressive enrichment in Au, Ag, and As.

The Champagne deposit has most of the characteristics of typical sediment-hosted submarine exhalative deposits.

1 Quebec Geoscience Centre, Ste-Foy
2 Université du Québec à Montréal, Montreal
3 Golden Hope Mines Ltd - Ste Geneviève Resources

GOLD IN EXTENSIONAL TERRAIN: KIRKLAND LAKE, ONTARIO; BASIN AND RANGE, NEVADA; TABAR-LIHIR-FENI ISLANDS, PAPUA NEW GUINEA

E.M. Cameron[1], A.E. Lalonde[2], G. Levesque[2], B. McInnes[2], M. Mihalasky[2], S.M. Rowins[3].

These diverse areas contain some of the largest gold deposits in the world; all are associated with various styles of lithospheric extension. At Kirkland Lake, extension is proposed to have occurred as a product of "end effect" at the termination of a major strike-slip fault. Extension is most obviously represented by pull-apart basins in which Timiskaming sediments were deposited. Upwelling and partial melting of mantle that accompanied extension caused alkaline magmatism that was, in part, intruded into extensional fractures in the Timiskaming. Gold was introduced during a subsequent stage of transpression. The Tabar-Lihir-Feni islands are alkaline island arc volcanoes produced by partial melting of a mantle wedge along strike-slip extensional zones related to oblique convergence of the Pacific and Australian plates. The major Ladolam deposit on Lihir lies within an alkaline volcano. At both Kirkland Lake and Tabar-Lihir-Feni the mantle source was carbonated and volatile-rich. In Nevada, gold in the Carlin and related deposits has been widely thought to have been derived during passage of heated meteoric waters through the rocks of the upper crust. However, there is evidence for deep-seated fluids that migrated upward during extension of the broad mid-continental region.

1 Mineral Resources Division.
2 University of Ottawa, Ottawa
3 University of Western Australia

BOREHOLE VLF LOGGING: A NEW APPROACH TO THE SEARCH FOR CONDUCTORS

A. Cinq-Mars[1], C.J. Mwenifumbo[1], and P.G. Killeen[1]

Surface Very Low Frequency Electromagnetic (VLF-EM) surveys have been used for many years to locate electrical conductors. However, borehole VLF logging has not been used routinely, partly because the utility of such a technique for mining exploration has not been adequately demonstrated.

Borehole VLF measurements were made at a graphite deposit with the Scintrex DHVLF system. This system measures the E-field along the borehole as well as three magnetic components of the VLF signal. Preliminary results of these measurements are presented.

1 Mineral Resource Division

THE CAPE RAY GOLD DEPOSIT, NEWFOUNDLAND: STRUCTURAL CONTROL AND TECTONIC SETTING

B. Dubé[1], K. Lauzière[1], and A. Tremblay[1]

Field investigation of the Cape Ray fault in the area of the Cape Ray gold deposit and in a coastal section near Cape Ray village, suggest that the post-Late Devonian movement of the fault is compatible with a transpressive dextral regime. Two increments of ductile strain have been recorded, the first characterized by reverse-oblique shearing and the second by strike slip movement. These were followed by late brittle faulting associated with barren silicification.

Geometric analysis of the structures hosting the mesothermal gold veins at the Windowglass Hill and Big Pond showings suggests that mineralization is syn- to late-ductile shearing and genetically and spatially related to Acadian movement within the Cape Ray fault zone. The mineralization is compatible with the main ductile, post-Late Devonian deformation event. Both showings are located in brittle units and in subsidiary structures oblique to the main shear direction.

1 Québec Geoscience Centre, Ste-Foy

THE MULTI-ELEMENT GEOCHEMICAL ANOMALY NEAR L'ESPRIT-SAINT, QUEBEC; FOLLOW-UP GEOLOGICAL AND BIOGEOCHEMICAL INVESTIGATIONS

C.E. Dunn[1], Y.T. Maurice[1], W.A. Spirito[1], and R.D. Cardinal[1]

Analyses of heavy mineral concentrates from stream sediments collected as part of a regional survey in 1987, revealed a zone 25 km long with anomalous levels of W, intersected by a second zone enriched in Pb, Sb, Hg, Sn, Zn, Cu, Ba, and As. The area is underlain mostly by folded and weakly metamorphosed Paleozoic shales and carbonates.

The discovery this summer of several scheelite-bearing siliceous outcrops established the source of the W. A biogeochemical survey involving collection of vegetation at 89 sites within an area of 120 km^2 disclosed higher than usual levels of several elements. Of note are Au concentrations (up to 1220 ppb) in the ash of birch bark from the southern half of the area. Marginal to the Au zone the vegetation analyses reveal a halo of Sb, outside of which there are high concentrations of Cs. Tungsten is not readily absorbed by trees, hence W concentrations, although weakly anomalous, are low. The data suggest mineralization at depth related to hydrothermal activity.

1 Mineral Resources Division

PLATINUM GROUP ELEMENTS IN THE PROTEROZOIC NIPISSING INTRUSIONS, NORTHERN ONTARIO

O.R. Eckstrand[1], D.M. Conrod[1], and D.C. Grégoire[1]

Platinum Group Elements (PGE) at background levels in 13 intrusions of Nipissing diabase (2219 to 2209 Ma) from the Sudbury-Cobalt-Gowganda region display highly systematic distributions related to silicate fractionation of the magmas. Analyses were performed by ICP-MS, using stable isotope dilution for Pt(0.1), Pd(0.1), Ru(0.05), and Ir(0.05), and external calibration for Rh(0.05) and Au (0.2). Limits of detection (ppb, 3 sigma) are given in parentheses.

The highest Pt and Pd values (about 20 and 30 ppb, respectively) in the unmineralized sill-like intrusions are associated with the highest Mg/(Mg+Fe) values (0.70-0.75) in gabbronorite cumulates of the lower zone. Pt and Pd values are lower in the more evolved, siliceous differentiates of the upper zone. Chondrite-normalized PGE profiles of all Nipissing differentiates display steeply positive, magmatic sulphide-like slopes. However the cumulates have higher chondrite-normalized values, and the more siliceous differentiates

show a distinct depletion of Pd. The extreme positive slope and high Pd values of the Rathbun Lake sulphides may represent the "missing" Pd that was partitioned into a late-separating sulphide phase.

[1] Mineral Resources Division

MIDDLE VALLEY, A MAJOR CENTRE OF HYDROTHERMAL ACTIVITY IN A SEDIMENTED RIDGE CREST, NORTHERN JUAN DE FUCA RIDGE

J.M. Franklin[1], W.D. Goodfellow[1], D.E. Ames[1], J.W. Lydon[1], I.R. Jonasson[1], and E.E. Davis[1]

Middle Valley, a "failed rift" on the eastern flank of the Endeavour segment, is filled with hemipelagic mud and turbidite, about 350 m thick in the hydrothermally active area. Venting and sulphide formation are confined to two areas.

Sulphides occur in a 400 m long zone, extending immediately south of a prominent mound (50 m high, 400 m diameter). An isolated high-temperature vent is at the southernmost tip of this area. Massive sulphides occur both as a mound and as layers in the subseafloor.

About 3 km northwest, high-temperature venting occurs irregularly through an area 900 m long and 250 m wide. At least 12 separate high-temperature vent sites (265 10$C) occur, each on top of a mound (25 m diameter, 7 m high). Active chimneys contain anhydrite and pyrite; inactive chimneys contain pyrite, pyrrhotite, barite, and sphalerite. The seafloor is highly indurated, with high-temperature smectite, chlorite, silica cement and veins, and disseminated sulphide. Pore fluids reveal a "plume" of Ba- and Ca-enriched, Mg- and SO_4-depleted water. Carbonate nodules are abundant.

High-temperature fluids, generated in the basaltic basement, interact with the sediments. Metals are precipitated in the subseafloor through conductive cooling, in part by locally advecting seawater. The mounds are probably growing by inflation.

[1] Mineral Resources Division

MAGNETITE DEPOSITS IN SOUTHERN GREAT BEAR MAGMATIC ZONE, NORTHWEST TERRITORIES

S.S. Gandhi[1]

Two types of magnetite deposits occur in southern Great Bear magmatic zone: i) breccia-fillings and veins in the felsic volcanoplutonic complex; and ii) stratiform magnetite-hematite concentrations in metasiltstones of the older Snare Group. Examples of the first type are the Sue-Dianne and Mar deposits near Mazenod Lake, and of the second type are the Hump Lake North and nearby Ron deposits.

The breccia-fillings and veins contain notable amounts of Cu, U, and Au. They belong to a varied group that includes large tabular magnetite-apatite-actinolite deposits of the Kiruna district in Sweden, and the hematite-magnetite breccias, containing Cu, U, and rare earths, of the giant Olympic Dam deposit in South Australia. These are all genetically related to continental felsic magmatic activity. Hence the Great Bear magmatic zone has a potential for large polymetallic deposits.

The stratiform deposits are in quartzofeldspathic siltstones, which may be volcaniclastic in part. The siltstones were tightly folded and metamorphosed to amphibolite facies, during late Aphebian events. These were followed by the Great Bear magmatic activity ca. 1850 Ma ago.

[1] Mineral Resources Division

CHEMISTRY OF COMPLEX FE-OXIDE GOSSANS FROM THE TAG HYDROTHERMAL FIELD (26$N), MID-ATLANTIC RIDGE

M.D. Hannington[1], P.M. Herzig[2], D.C. Grégoire[1], and P.G. Bélanger[1]

Massive sulphide deposits at 26$N on the Mid-Atlantic Ridge have undergone extensive seafloor oxidation, and Fe-oxide gossans now cover large areas of the sulphide mounds. The gossans display a long history of submarine weathering (up to 40 000 years) which is recognized in a complex suite of Fe-oxide assemblages. These include (1) Fe-oxides with abundant secondary sulphides, (2) Fe-oxide-atacamite assemblages, (3) Fe-oxide-jarosite assemblages, (4) barren Fe-oxide crusts, (5) resedimented Fe-oxide debris, and (6) manganiferous Fe-oxide umbers. The Fe-oxide mineralogy consists of amorphous oxyhydroxides and goethite, with minor lepidocrocite, akaganeite, and hematite. The chemistry of the gossans reflects the bulk composition of the parent sulphide assemblage, the intensity of weathering, and late-stage diagenetic effects. Selective trace metal leaching, local supergene or residual enrichments, scavenging of trace elements from seawater, and modification by low-temperature hydrothermal fluids are important factors. The study of modern submarine gossans leads to quantitative models of chemical changes which attend seafloor weathering of massive sulphides and provides evidence for the likelihood of sulphide preservation in the geological record.

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METALLIFEROUS SULPHIDE-OXIDE SEDIMENTS FROM THE TAG HYDROTHERMAL FIELD (26$N), MID-ATLANTIC RIDGE: PRE-DIAGENETIC EXAMPLES OF VMS ASSOCIATED RED CHERTS

M.D. Hannington[1], P.M. Herzig[2], G. Thompson[3], and P.A. Rona[4]

The TAG deposit consists of a steep-walled massive sulphide mound (200-250 m diameter) with a central black smoker complex and an apron of sulphide-oxide talus and metalliferous sediment. Sampling of the metalliferous sediments was carried out in January 1990 using the submersible ALVIN. A total of 25 push-cores were collected near the base of the sulphide mound and on debris slopes leading to the top of the deposit. The sulphide-oxide sediments are produced by extensive mass-wasting of chimneys on the surface of the mound and subsequent transport of this material in debris flows. Coarse debris grades laterally away from the base of the mound into Fe-oxide muds and grey carbonate ooze. Diffuse venting of hydrothermal fluids through the sediment has caused local silicification of the Fe-oxides and the formation of red chert. These sediments are modern analogs of the ferruginous sediments commonly as-

sociated with VMS deposits in ancient ophiolites (e.g. Cyprus, Oman, Newfoundland) and provide evidence for their prediagenetic history.

1 Mineral Resources Division
2 Aachen University of Technology, Aachen
3 Woods Hole Oceanographic Institution, Woods Hole
4 National Oceanic and Atmospheric Administration, Miami

LOW-LEVEL ABUNDANCES OF GOLD AND SULPHUR IN BASALTIC GLASS FROM THE GALAPAGOS SPREADING CENTER AND JUAN DE FUCA RIDGE

M.D. Hannington[1], I.R. Jonasson[1], J.F. Allen[2], and G.E.M. Hall[1]

Lavas that host sulphide deposits on the modern seafloor commonly contain abundant immiscible sulphides. The sulphide droplets are a likely source for gold which is leached by high-temperature hydrothermal fluids. The concentrations of gold and sulphur have been determined in 85 samples of fresh basalt glass from the Galapagos Rift, Axial Seamount, and Explorer Ridge. Bulk gold contents were determined by HF-aqua regia digestion followed by extraction of gold onto MIBK and analysis by graphite furnace (0.05 ppb detection limit). Sulphur was determined by pyrohydrolysis/ion chromatography (2 ppm detection limit). The gold contents of the glass range from 0.3 to 2 ppb Au, with an average of 0.6 ppb Au. Sulphur concentrations range from 600 to 2000 ppm S, with an average of 1450 ppm S. If all of the sulphur and gold is contained within immiscible sulphides, the calculated gold contents of the sulphide droplets range from 50 to 450 ppb Au, with an average of 150 ppb Au. The abundance of immiscible sulphides, and therefore the availability of leachable gold, may be related to the petrogenetic history of the host volcanics. Evolved lavas (enriched MORB and andesite) on some mature ridges suggest locally extensive fractional crystallization which could lead to the enrichment of immiscible sulphides in a portion of the erupted lavas.

1 Mineral Resources Division
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STRATIGRAPHY, STRUCTURE, AND GOLD MINERALIZATION IN THE ARCHEAN WHITEHILLS-TEHEK BELT, DISTRICT OF KEEWATIN, N.W.T.

J.R. Henderson[1], M.N. Henderson[1], L. Pryer[2], and R. Cresswell[2]

Supracrustal rocks in the area are intruded by 2.6 Ga batholiths which are not penetratively deformed; we believe therefore that all of the folding and cleavage development in the region is Archean, although the area is within the Churchill Structural Province.

Banded iron formation (mixed chert-magnetite, -silicate, and -carbonate facies) hosts gold mineralization associated with pyrrhotite and pyrite alteration zones. Mafic-ultramafic metavolcanic rocks overlie the banded iron formation. Spinifex textured komatiite locally appears to form the base of this unit. Where komatiite is transformed into ductile talc schist, and is in contact with brittle banded iron formation, gold-pyrite- and gold-pyrrhotite-bearing quartz veins fill fractures in the iron formation.

Generally two secondary fabric elements occur: S_1 pressure solution cleavage and S_2 crenulation cleavage. In the north of the region S_1 dips south more gently than bedding, and a north-directed D_1 thrusting is inferred. Recumbent folds and subhorizontal S_2 crenulation cleavage characterize D_2, and several macroscale north-vergent D_2 folds were documented. Gold values are greatest in fractured iron formation in the short, steeply-dipping limb of an F_2 fold pair.

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2 University of Toronto, Toronto

STYLES OF GOLD MINERALIZATION IN THE ARCHEAN HOOD RIVER BELT, DISTRICT OF MACKENZIE, N.W.T.

M.N. Henderson[1], J.R. Henderson[1], and T.O. Wright[1] and C.W. Jefferson[1]

A homoclinal succession generally east-facing and characterized by turbidites, iron formation, conglomerate, and metavolcanics, mostly of intermediate to mafic composition, the Hood River belt has two distinctive types of gold mineralization.

In the north of the mapping area, the Turner Lake prospect is proximal to a volcanic centre; gold was observed in quartz veins cutting altered intermediate to mafic volcanic or subvolcanic rocks. The host rocks are heavily sericitized and the protolith unclear but the less altered surrounding rocks include metadiorite and epiclastic rocks.

In the area of Pistol Lake, 15 km to the south, gold is associated with the silicate facies of the upper iron formation.

While the gold observed at Turner Lake is no doubt secondary, it might well be remobilized synvolcanic in origin. In the Pistol Lake prospect, available information suggests the gold is not vein related and may be syngenetic or early epigenetic.

1 Mineral Resource Division

ORGANIC MATTER AND CLAYS: A GUIDE TO MINERALIZATION

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Two MVT deposits provide favorable settings to investigate organic matter-orebody relationships.

At Polaris, best ore grades are in the alginite zone. Fossil fragments are ubiquitous and exhibit R_o into the oil window, as confirmed by the thermal alteration index. Lower values of R_o and TAI, together with increasing fluorescence of algae, are related to the Pb/Zn horizon both at the mine and distant from the mine. Further investigations will test the hypothesis that the alteration of the wall rocks might have been caused by the ore-forming solutions.

At Pine Point, solid bitumen accounts for more than 95% of the kerogen (biased sampling?). The remaining organic matter is mainly composed of alginite-bituminite and unidentified fossil fragments. No significant R_o trend is noted at the ore-field. Except for

chemical alteration of solid bitumen, no thermal anomalies have been identified. Detailed studies on zooclasts must be completed in order to compare the mining districts.

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2 University of Toronto, Toronto
3 Polaris Mine (Cominco)
4 Mineral Resources Division
5 Institute of Sedimentary and Petroleum Geology, Calgary

THE WORLDWIDE GAMMA-RAY LOGGING INTER-CALIBRATION PROJECT: EXTENDING GSC'S STANDARDS TO EUROPE

P.G. Killeen[1], B.E. Elliott[1], and L.D. Schock[1]

Calibration of gamma-ray logging equipment is usually carried out in model boreholes constructed with controlled mixtures of uranium ore and concrete. The International Atomic Energy Agency has established a project to intercalibrate model boreholes used as calibration standards around the world. The intercalibration is being conducted by the Geological Survey of Canada (GSC) using a spectral gamma-ray logging system. Inconsistencies in the calibration of gamma-ray probes in model boreholes in Ottawa, Canada, Grand Junction, U.S.A., and Adelaide, Australia were resolved on the basis of measurements made by the GSC in the early 1980s. In 1989 the GSC conducted calibration measurements in model boreholes in Canada, Sweden, Denmark, Czechoslovakia, Hungary, and Greece. In this way, the GSC model boreholes established at Bells Corners (Ottawa area) in 1978 have become a world standard. In the future the intercalibration measurements are expected to be carried to other countries including China, India, Japan, and Argentina. An overview of the Worldwide Intercalibration Project is given, illustrating the equipment, the measurements involved, and some of the calibration facilities visited.

1 Mineral Resources Division

APPLICATIONS OF BOREHOLE GEOPHYSICS TO GREENSTONE BELTS: NORMETAL AREA, QUEBEC

P.G. Killeen[1], E.C. Jowett[2], D.W. Moore[3]

Geological logging of drill core in a greenstone belt mineral exploration project is relatively difficult due to the great visual similarity of the different rock types. Geophysical logging tools measure physical properties that are invisible to the geologist, and may be used in: (1) correlation of volcanic stratigraphy between holes; (2) recognition of potassic alteration; (3) distinction between sills and flows, etc.

Geophysical parameters logged in two holes in the Normetal area include induced polarization, electrical resistivity, self potential, magnetic susceptibility, natural gamma-ray spectrometry, spectral gamma-gamma, temperature and temperature gradient measurements.

Dykes, which are visibly similar to the basic volcanic flows, are easily distinguished using the geophysical logs by high magnetic susceptibility (presence of magnetite) and low gamma-ray response (potassium-poor, low natural radioactivity). Even carbonatization of the magnetite in the dykes is seen because magnetic susceptibility decreases at the edges.

Potassic alteration is identified by a high natural gamma-ray signature, which is not picked up by density, magnetic susceptibility, and geological logs.

1 Mineral Resources Division
2 University of Waterloo, Waterloo
3 Cominco

GEOCHEMISTRY OF PORE WATERS AND SEDIMENTS AROUND ACTIVE HYDROTHERMAL VENTS, MIDDLE VALLEY, EASTERN PACIFIC OCEAN

J.W. Lydon[1], W.D. Goodfellow[1], and J.M. Franklin[1]

Hydrothermal vents in the AAV area of Middle Valley lie on two parallel linear trends which form the opposite sides of a 300 m wide rhombochasm, in which the upper part of the stratigraphic sequence is thickened by at least 10 percent. Pore waters within the rhombochasm have strong vertical compositional gradients which define the margins of a convex upward subsurface hydrothermal plume. The most notable gradients are the downward increases of Ba from 0.4 to 4 mM over two metres and Ca from 13 to 49 mM over three metres, and the downward decreases of Mg from 50 to 34 mM over two metres and SO_4 from 30 to 9 mM over three metres. The main chemical changes to the sediment are the intergranular precipitation of barite and calcite at the plume margins, and the formation of pyrite, particularly in the uppermost two metres of sediment. Within 30 m of the active vents, sediment pore waters have compositions similar to seawater, suggesting the presence of shallow convection cells around active hydrothermal conduits.

1 Mineral Resources Division

DEVELOPMENT OF A GIS-BASED EXPERT SYSTEM FOR EVALUATION OF VMS DEPOSITS IN SNOW LAKE AREA, MANITOBA

R.K.T. Reddy[1], G.F. Bonham-Carter[1], A.G. Galley[1], and D.F. Wright[1]

A GIS-based expert system has been developed using a forward chaining inference net for evaluating volcanogenic massive sulphide resources in the Snow Lake area of Manitoba. The inference net is based on existing Superior-type massive sulphide deposit (SMSD) PROSPECTOR model, but has been significantly modified for regional map implementation.

The computer demonstration of the expert system is on a PC-based system with SPANS GIS software. The input maps are propagated through the inference net in an evidence-hypothesis framework and the probabilities are updated by Bayesian rules and fuzzy logic. The intermediate hypotheses and the final hypothesis are mapped with the GIS system and form the basis of implementation of the expert system.

1 Mineral Resources Division

PALEOWEATHERING AT 3.0 TO 1.7 GA UNCONFORMITIES REFLECTING CHANGE FROM A NONOXIDIZING TO AN OXIDIZING ATMOSPHERE BETWEEN 2.45 AND 2.22 GA

S.M. Roscoe[1] and N. Prasad[1]

Chemical changes through paleoweathering profiles in Precambrian rocks beneath ca. 2.95 Ga, 2.7 Ga, 2.45 Ga, 2.45 to 2.22 Ga, 1.85 Ga, and 1.7 Ga unconformities are compared. Two ca 2.95 Ga Eyapamikama Lake, northwestern Ontario profiles and a selection of ca 2.45 Ga sub-Huronian profiles are derived from analyses of drillcore sections sampled by us. Additional profiles are derived from published data. Chemical variations are illustrated graphically as ratios of elements to aluminum compared to this ratio in the least altered rocks.

The data support published evidence for changes in weathering due to a transition from a nonoxidizing to an oxidizing atmosphere, shortly after 2.45 Ga. In the older paleosols, iron is depleted upward; in younger ones it is enriched. Other features, possibly more common in older than in younger paleosols, include intensive carbonate alteration above unaltered rocks, an intermediate zone of Fe and Mg enrichment, and a cap depleted in Na, Ca, Mg, Fe, and Mn and enriched in K.

1 Mineral Resources Division

USE OF BOREHOLE GEOPHYSICS IN THE CARLETON UNIVERSITY GROUNDWATER HEAT PUMP PROJECT

H.C. Wilson[1], C.J. Mwenifumbo[2], F.A. Michel[1], P.G. Killeen[2], and B.E. Elliott[2]

Five, 30 cm diameter, 120 m deep production wells have been drilled at Carleton University, Ottawa, to supply groundwater for a low-grade geothermal energy system that controls temperatures inside campus buildings year-round. The wells occur in Lower Paleozoic carbonates, sandstones, and shales which are fractured by major faulting and minor cross faults. Groundwater flow is controlled by these fractures, which act either as flow conduits or as barriers where calcite- and pyrite-infilled.

Multiparameter borehole geophysical logging was carried out to aid in the hydrogeological interpretation. The logging parameters include resistivity, self potential, induced polarization (IP), natural gamma ray, density (gamma-gamma), magnetic susceptibility, and temperature. The geophysical logs are more useful than chip samples in identifying formations and in pinpointing formation contacts. The density logs permitted identification of major fractures, while high resolution temperature profiles were particularly useful in locating groundwater flow within certain fractures. IP logs were useful in identifying fractures infilled with pyrite. Together, the geophysical logs have enhanced our understanding of the hydrogeological regime for better utilization of energy resources.

1 Carleton University, Ottawa
2 Mineral Resources Division

ENVIRONMENTAL GEOSCIENCE

DEVELOPING TECHNIQUES FOR GLOBAL CHANGE MONITORING OF HIGH ARCTIC ICE CAPS

B.T. Alt[1], C. Labine[1], R.M. Koerner[1], and D.A. Fisher[1]

The unique challenge of obtaining year round instrumental records of climatic parameters from High Arctic ice caps is being met by a joint Terrain Sciences/industry program begun on Agassiz Ice Cap in May 1988. Data from two full years of record illustrate the types of problems encountered. Sensor design and deployment techniques are being developed to meet the demands of environmental conditions specific to the ice cap. Accurate meteorological data is essential to understanding the link between changes in global circulation, climate, and ice cap mass balance (i.e. growth or decay), and its contribution to changing sea level.

1 Terrain Sciences Division

APPLICATIONS OF GIS IN GLOBAL CHANGE STUDIES

J.R. Bélanger[1], J. Aylsworth[1], S. Courtney[1], and A. Prégent[1]

A Paleogeographic Atlas of Canada is being prepared and a study of the Mackenzie Valley Corridor is presently under way using Geographical Information Systems (GIS) for data analysis and cartographic display.

The Paleogeographic Atlas shows the evolution of ice margins and paleocoastlines from 9000 to 18 000 years ago. The ARC/INFO system used for this atlas is also set up to display by query, sample sites, ages, and types of data.

ATLAS GIS and ARC/INFO are also used to store and manipulate information on the surficial geology, geomorphology, and permafrost conditions in the Mackenzie Valley Corridor. Existing surficial geology maps are being recompiled, digitized, and entered into the GIS. The surficial geology is combined with digital terrain models and borehole information to produce derived maps which will indicate the relationship between geomorphology, terrain sensitivity, and other parameters related to environmental geology.

1 Terrain Sciences Division

NATURAL VARIABILITY OF ENVIRONMENTALLY SENSITIVE ELEMENTS IN LAKE AND STREAM SEDIMENT SAMPLES

G.F. Bonham-Carter[1], G.E.M. Hall[1], R.G. Garrett[1], D.F. Wright[1], W. Spirito[1], and D. Cerisano[1]

Archived lake and stream sediment samples from the National Geochemical Reconnaissance program have been re-analyzed for a new suite of elements. ICP emission and mass spectrometry and graphite furnace atomic absorption spectrometry have been employed to determine Se, Te, Bi, Cr, Be, Tl, Ga, In, and Al following an HF-$HClO_2$-HNO_3-HCl decomposition. The main objective is to assess the natural variation in concentration of these elements in different geological settings across Canada. Six sites were chosen on the basis of contrasting bedrock and Quaternary geology, mineralization, vegetation, and climatic setting. The variability of single elements and their associations are compared

within and between sites, and a geographical information system is used to characterize the various maps at each site. The poster is accompanied by a computer demonstration on SPANS.

[1] Mineral Resources Division

POSSIBLE EVIDENCE FOR HOLOCENE EARTHQUAKES IN SAANICH INLET, B.C.

J.J. Clague[1] and P.T. Bobrowsky[2]

Three piston cores collected from Saanich Inlet, a fiord on southern Vancouver Island, contain a record of episodic, Holocene, sediment gravity flows that may have been triggered by large earthquakes. Much of the sediment in Saanich Inlet is rhythmically laminated mud (varves). Varved sequences, however, are interbedded with massive mud beds from a few centimetres to several tens of centimetres thick. These beds lack sedimentary structures such as crossbeds, laminae, and disrupted layers, although many are capped by a prominent, thick, light-coloured lamina. The massive beds are coarser than enclosing varved sediments, but show no vertical variations in particle size. These and other observations indicate that the massive beds were emplaced by sediment gravity flows. Varve counts and radiocarbon ages suggest that these flows have occurred on average once every 100 years over the last 1500 years. Although sediment gravity flows can be caused by a variety of processes, those in Saanich Inlet most likely have been triggered by earthquakes. If so, it may be possible through this study to obtain a rather precise chronology of prehistoric Holocene earthquakes in coastal southwestern British Columbia.

[1] Terrain Sciences, Vancouver
[2] B.C. Geological Survey Branch, Victoria

DEBRIS FLOWS ON THE WESTERN CANADIAN CONTINENTAL MARGIN

R.G. Currie[1], B.D. Bornhold[1], and E.E. Davis[1]

Regional acoustic surveys of the British Columbia margin provide a synoptic view of sedimentary processes and indicate that debris flows and slides are locally common. Along the pure transform part of the Queen Charlotte margin, debris flows are absent. Farther south, where there is a small component of compression, five debris flows have been identified. Near the Pacific-Explorer-America triple junction, mature canyon and channel systems dominate, which is consistent with the extensional tectonic setting. Debris flows are most common along the convergent margin off Vancouver Island, preferentially associated with the steep limb of compressional anticlines. The distribution of debris flows considered along the entire margin is correlated with convergence rate and inversely correlated with earthquake distribution. These relationships suggest that the tectonically uplifted sediment supply, declivity, and the occurrence of high pore fluid pressures are the primary controlling factors in debris flow generation.

[1] Pacific Geoscience Centre, Sidney

THE DISCOVERY OF THE FIRST EARTHQUAKE FAULT BREAK IN EASTERN NORTH AMERICA

J.A. Drysdale[1], R.J. Wetmiller[1], J. Adams[1], M. Lamontagne[1], and M.G. Cajka[1]

For the first time an earthquake in eastern North America is confirmed to have produced surface faulting. The rupture was found as a result of locating aftershocks during a field survey (July 1990) of the magnitude (M_S) 6.3 earthquake of 25 December 1989 in the Ungava Peninsula of northern Quebec. The fault is centred at 60.12$N, 73.60$W and extends 8.5 km along an average trend of 038$ (concave to the northwest). The fault dips steeply to the southeast and the sense of faulting is reverse, with the southeast side upthrown. The maximum throw is 1.8 m and tapers to less than 0.3 m at each end. Surface effects associated with the fault region include: deformed lake shorelines, discontinuous fault scarps, a left-lateral strike-slip fault, torn muskeg above some traces, sand volcanoes, freshly cracked boulders, and a partly drained lake. Two lakes were discoloured by suspended silt. The observed surface break is inconsistent with the P-nodal solution.

[1] Geophysics Division

THREE YEARS OF ENVIRONMENTAL MONITORING AT GSC'S GLOBAL CHANGE OBSERVATORY, HOT WEATHER CREEK, ELLESMERE ISLAND

S.A. Edlund[1], M-K Woo[2], K.L. Young[2], B.T. Alt[1], and A.N. Headley[3]

The general circulation models (GCM) predict that with a doubling of CO_2 the High Arctic will warm to levels of 6 to 8$C annually, making it one of the regions most severely affected by global warming. Three years of monitoring climate and environmental responses at Hot Weather Creek, Ellesmere Island, show that this area is extremely sensitive to climatic change, even on a seasonal basis. The variability in winter snow depth and cover, rapidity of snowmelt, warmth and duration of temperatures above freezing, and amount of precipitation all affect geomorphic processes, soil hydrology and vegetation. One of the most dramatic processes occurs when active layer detachments are triggered by the deepening of the active layer sufficiently to reach buried ice bodies.

Similar materials and processes occur throughout the Sverdrup Basin, an area that contains reserves of hydrocarbons. An understanding of climate change impacts on such materials are essential before any further regional development takes place.

[1] Terrain Sciences Division
[2] McMaster University, Hamilton
[3] Atmospheric Environment Service

MONITORING IMPACT OF CLIMATE CHANGE ON THE ACTIVE LAYER, MACKENZIE VALLEY, N.W.T.

P.A. Egginton[1] and F.M. Nixon[1]

Observations in the Mackenzie Valley indicate that climate has changed. These include aggradational ice in permafrost, multitiered ice wedges, and ground thermal regime profiles. One response integrating climatic change in the context of a terrain situation in areas underlain by permafrost is maximum annual depth of thaw. It is an important factor influencing land use by plants and animals, including man. Terrain Sciences Division has initiated a system of

thaw depth tubes which will record maximum annual depth of thaw. The system has been installed between the Arctic Coast and Inuvik and will be extended southward to Fort Simpson. Numerous sites along a transect crossing climate and vegetation zones should provide baseline data on this climate-related feature. Monitored over time, the system may distinguish a signal of global climate change from noise. During installation of the tubes, observation and sampling of ground ice is carried out. Aggradational ice in permafrost suggests thinning of the active layer. Isotope analysis of ground ice may indicate time of recent aggradation.

[1] Terrain Sciences Division

MARINE GEOLOGY AND ENVIRONMENTAL ASSESSMENT: AN EXAMPLE FROM HALIFAX HARBOUR

G.B.J. Fader[1], R.O. Miller[1], and D.E. Buckley[1]

Halifax Harbour receives 40 million gallons of raw sewage per day from 50 outfalls from the surrounding communities. In 1989, the Province of Nova Scotia commissioned the Halifax Harbour Task Force to review a proposed regional sewage treatment system in the outer part of the harbour, focusing on the marine environment.

The Atlantic Geoscience Centre assessed the marine environmental quality of the harbour, and conducted additional research on the marine geology and geochemistry as part of the task force. From a study of the distribution of sediments and dynamic features such as bedforms and geochemical anomalies, sediment transport pathways were inferred, suggesting shoreward migration of silt and clay particles and the containment of trace metals and organic contaminants within the inner harbour.

Containment of wastes being preferable to dispersion, a new location for the consolidated sewage outfall in the inner harbour was recommended, where a competent seafloor foundation exists for the outfall diffuser and where sediments are not presently accumulating. Geological and geochemical studies of the harbour were instrumental in choosing the most appropriate marine outfall location.

[1] Atlantic Geoscience Centre, Dartmouth

MEASUREMENT OF THE SHEAR-WAVE VELOCITY STRUCTURE OF THE FRASER DELTA: WEST COAST GEOHAZARDS STUDY

J.A.M. Hunter[1], K.G. Neave[1], B.J. Todd[1], and J.L. Luternauer[1]

It has been well established that the intensity of ground shaking during an earthquake is directly related to the thickness and strength of unconsolidated sediments. Studies by the USGS in California have shown that a relation exists between average shear-wave velocities of unconsolidated materials and earthquake ground motion, and between velocities and liquefaction potential of cohesionless soils. Predictive maps of ground motion parameters have been constructed for this area.

The Fraser River delta consists of thick unconsolidated sediments and is in an earthquake hazard zone. A regional scale map of generalized shear-wave velocity groups may provide a first approximation of the areal variability of shaking response that might be expected, and could be used for community planning and emergency preparedness.

Shear-wave velocities of delta sediments have been measured at over 60 sites using three different techniques — surface refraction, borehole seismic, and seismic cone penetrometer — which have been compared and evaluated for reliability and cost effectiveness. Results indicate shear-wave velocities that are as low as, or lower, than those observed for similar sediments in California.

[1] Terrain Sciences Division

NATIONAL PALEOECOLOGICAL DATA BASE IN SUPPORT OF GLOBAL CHANGE STUDIES

H. Jetté[1]

The Geological Survey of Canada is currently developing a national paleoecological data base which will eventually contain: (1) the paleoecological information accumulated in the laboratories of the Geological Survey of Canada since 1960: identification of fossil wood, pollen analyses, diatom analyses, and analyses of macrofossils including plants, arthropods, and bryophytes; and (2) the paleoecological information from published sites and any paleoenvironmental data available.

This data base will be useful for paleoecological research and reconstructions of Holocene and Pleistocene paleoenvironments. In Global Change research, it is possible to visualize the paleoecological information available for a given area. A map of the region under study is drawn, and to this are added the sites for which paleoecological information is available. The process is entirely computerized. In the Mackenzie Delta region, we have evaluated the quality of the available paleoecological coverage. We can thus identify those regions not adequately covered and orient field work in accordance with the information already available.

[1] Terrain Sciences Division

DISTRIBUTION OF GAS HYDRATES IN CANADA AND IMPLICATIONS FOR GLOBAL CHANGE

A.S. Judge[1]

Gas hydrates are globally widespread beneath the permafrost regions and beneath the sea in ocean sediments to sub-bottom depths of 2000 m. Recent studies of well logs from exploratory wells and of reflection seismic records have identified gas hydrates as present in the Canadian arctic areas including the onshore Mackenzie Delta and the Beaufort continental shelf, and in offshore sediments on both the east and west coasts.

Globally gas, especially methane, hydrates probably contain up to 4×10^6 Gt of organic carbon although numbers are still speculative until more surveys have been completed. This as a reservoir exceeds many others of the global carbon cycle, e.g. the atmosphere (3.6 Gt) and terrestrial biota (830 Gt).

Because gas hydrates contain so much methane, are found in the shallow geosphere, and became unstable with modest changes to temperature and pressure, they may contribute to and modify the chemistry of the earth's atmosphere. During cold glacial epochs hydrates form in the subsurface providing a sink for methane whereas during interglacials hydrates dissociate supplying an additional source of methane to the atmosphere.

[1] Terrain Sciences Division

GLACIAL SEDIMENTS GEOCHEMISTRY OF THE GEORGIAN BAY-MUSKOKA REGION: APPLICATIONS TO ENVIRONMENTAL PROBLEMS

I.M. Kettles[1]

Systematic sampling of till and related sediments was carried out over the Georgian Bay-Muskoka region, one of the most important recreational areas in Ontario. The area is deemed potentially sensitive to the effects of acid rain as it is underlain by carbonate-poor Precambrian bedrock of the Central Gneiss Belt and is covered by only a thin (usually m), discontinuous blanket of drift. Two groups of compositional characteristics of glacial sediments, thought to bear directly on terrain sensitivity to acid loading, were determined — trace element contents (potential sources of environmental contamination) and carbonate contents and texture (the buffering components). Results indicate that drift composition can generally be related to composition of the underlying or nearby bedrock. For example, in drift, Cu and Ni concentrations are high northeast of Parry Sound overlying gneisses, some of which have mafic volcanic origin, and Cd and Mn concentrations are consistently high north of Huntsville overlying bedrock of the Novar subdomain. Also, as would be expected for tills derived from gneissic bedrock, contents of carbonate and clay-sized detritus are low (% $CaCO_3$ equivalent and approximately 4%, respectively).

1 Terrain Sciences Division

THE USE OF GEOMORPHIC AND ECOLOGICAL PROCESSES AS INDICATORS OF HOLOCENE CLIMATIC CHANGES.

Y. Michaud[1] and C. Bégin[1]

Several geomorphic and ecological processes are controlled by climate. When climatic conditions favoring the activity of these processes are known and that their past activity can be recognized as well as dated, these processes can be used as paleoclimatic indicators. As part of the Global Change Program, an attempt to reconstruct Holocene environmental changes in the Mackenzie Valley is undertaken by using processes that are particularly sensitive to climatic changes. Processes such as eolian activity, evolution of permafrost features (palsas, patterned ground), mass wasting (skin flows, rotational slumps and gelifluction), tree-line fluctuations and variation of growth form of trees have been selected for this study.

The chronology of events is established mostly by tree-ring analysis of both fossil wood and living trees and in some cases, by ^{14}C dating of buried organic debris.

1 Quebec Geoscience Centre, Ste-Foy

MODERNIZATION OF THE CANADIAN NATIONAL SEISMOGRAPH NETWORK

R.G. North[1], K. Beverley[1], J.A. Lyons[1], and M.D. Andrew[1]

The National Seismograph Network will be completely modernized over the period 1991 to 1994. Digital data from approximately 80 sites throughout Canada will be continuously telemetered in real time from the individual sites via either dedicated satellite links, dedicated telephone lines, or UHF radio links, to data acquisition and processing systems located in both Ottawa and the Pacific Geoscience Centre (PGC). Data from sites linked by radio or telephone will be acquired only in either PGC or Ottawa; data from satellite-linked sites will be simultaneously acquired in both centres to provide essential backup of basic earthquake detection and location capability in the case of failure of either centre due to a variety of causes, including major earthquakes. The real-time telemetry of the data will permit the rapid determination of accurate locations and magnitudes for events in Canada and worldwide.

1 Geophysics Division

CANADIAN VLBI/GPS REFERENCE NETWORK: APPLICATIONS TO CRUSTAL DEFORMATION STUDIES

J. Popelar[1], J. Kouba[1], W. Petrachenko[1], A. Lambert[1], H. Dragert[2]

The Geodynamics Service of the GSC and the Canada Centre for Surveying of SMRS are establishing a Canadian Crustal Motion Network (CCMN) of monitoring sites across Canada using high precision space positioning and gravity techniques. The CCMN has four basic components: (1) a very long baseline interferometry (VLBI) reference frame; (2) an absolute gravity network; (3) a GPS Active Control System (ACS); and (4) denser regional and local GPS/gravity networks. The VLBI framework (five of 12 fiducial sites operational) connects the CCMN to the terrestrial co-ordinate system and verifies the accuracy of GPS determinations of crustal motion. The absolute gravity network (14 of 24 sites operational) provides data for gravity surveys and facilitates studies of vertical crustal motion. Three of 30 GPS Active Control Points are operational and instrumentation for four additional stations is being assembled; the ACS facilitates high precision differential positioning for regional and local surveys and monitors GPS performance. Regional and local networks (ultimately 1000 to 2000 stations) have been established on the west coast and along the St. Lawrence seismic zone.

1 Geophysics Division
2 Pacific Geoscience Centre, Sydney

ENVIRONMENTAL GEOCHEMISTRY AND LIQUID FOSSILS

L.R. Snowdon[1], M.G. Fowler[1], P.W. Brooks[1], and L.E. Harding[1]

Steranes are a class of organic compounds derived from ancient organisms that are found in sedimentary rocks and crude oils. These compounds are therefore fossils (remnants of ancient organisms), which occur in the liquid state in the subsurface. Steranes are unknown in living organisms and thus they are a useful chemical marker for differentiating between geological and biological organic matter in modern sediments. Because these compounds contain a large number of optically active centres and they occur with a variable carbon number range specific to the various organisms that biosynthesize them, detailed analyses of their stereochemical structure and relative distribution is a useful tool for fingerprint correlation of samples from which they were recovered.

GC-MS analysis of subtidal sediment recovered from the west side of Vancouver Island after the Nestucca barge spill of about 875 000 litres of bunker C oil indicate that most of samples contain petroleum-like hydrocarbons.

1 Institute of Sedimentary and Petroleum Geology, Calgary

HOLOCENE PALEOENVIRONMENTAL RECONSTRUCTION FROM DEEP GROUND TEMPERATURES, CANADIAN ARCTIC ARCHIPELAGO

A.E. Taylor[1] and J. Ogilvie[2]

Precise ground temperatures to depths ranging from 400 to 1100 m have been measured over the past two decades at 40 suspended petroleum exploration wells in the Canadian Arctic Archipelago. Such data may provide a window not only on past climate but also on past environmental conditions.

Many, but not all, of these profiles exhibit curvature that may be analyzed in terms of past changes in ground surface temperature. At most sites, it appears that surface temperatures have increased by 1 to 5$K, but several indicate cooling and some show little change either way; the time of onset of these changes varies from within the last century to several centuries ago. A comparison with the paleoclimate record derived from oxygen isotope ratios in the nearby Agassiz Ice Cap drillhole emphasizes that ground temperatures reflect changes not only in air temperatures but also in environmental conditions such as snow cover.

1 Terrain Sciences Division
2 University of Waterloo, Waterloo

LATE QUATERNARY PALEOCEANOGRAPHY ALONG THE EASTERN CANADIAN CONTINENTAL SHELF: KEY TO FUTURE ENVIRONMENTAL CHANGE

G. Vilks[1] and C. Rodrigues[2]

Late Quaternary water masses are deduced from foraminiferal zones in cores from Western Lancaster Sound, Eastern Hudson Strait, Labrador Shelf, and Gulf of St. Lawrence.

Deglaciation of the inner shelf was time transgressive from south to north, and ^{14}C dates suggest that the glacial marine phase in Western Lancaster Sound was shorter than along the shelf to the south, suggesting a relatively short meltwater phase.

In Lancaster Sound, Hudson Strait, and Gulf of St. Lawrence (but not on Labrador Shelf) the glacial marine phase was followed by an interval of more saline bottom waters than at the present. The presence of these offshore waters in the three major glacial meltwater outlets is due to an offshore counterflow in response to a period of increased runoff (meltwater).

The postglacial oceanographic setting has not changed drastically in Lancaster Sound and on Labrador Shelf. During the same time watermass characteristics have fluctuated in Hudson Strait and Gulf of St. Lawrence. The more complicated paleoceanography signifies fluctuations in freshwater drainage.

The historical data suggest that increased volumes of the southward flowing water containing a large Arctic component will cause cooling of the maritime climate of eastern Canada. Increased runoff through Hudson Strait and Gulf of St. Lawrence will cause climate warming.

1 Atlantic Geoscience Centre, Dartmouth
2 University of Windsor, Windsor

TOWARD AN UNDERSTANDING OF LATE NEOGENE HIGH-LATITUDE PALEOCLIMATE

J.A. White[1]

Concern about anthropogenic global warming has challenged our knowledge of past global climates. Geological evidence concerning circulation patterns, stability, and rates of change is needed to constrain Global Circulation Models. This evidence is most appropriate from the Neogene and Quaternary periods, when the distribution of continents and oceans was similar to present. Marine and continental geology has demonstrated that global climates have been much warmer during much of the Cenozoic, with a cooling trend during the last 55 million years. Fossils from Arctic Islands and Arctic mainland sites corroborate the trend and document the flora and fauna associated with a formerly warm Arctic. The demand for higher resolution in high latitude paleoclimatology requires recovery and analysis of long, relatively continuous sections with paleomagnetic and radiometric data to help define absolute ages.

The Geological Survey of Canada and the United States Geological Survey are collaborating to obtain and analyze long sedimentary records. Marine sediment cores from the Beaufort Sea, obtained in 1989 by the United States Coast Guard Cutter Polar Star, are under analysis. In 1990, Miocene organic sediment, tephra, and basalt from the Porcupine River, Alaska, were obtained to correlate faunal and floral data with independent chronometry. A medium-term objective is a long, cored borehole in a continental sedimentary basin.

1 Institute of Sedimentary and Petroleum Geology, Calgary

INFORMATION

DIGITAL CARTOGRAPHY — NO MORE PEELCOATS

R. Allard[1], M. Sigouin[1], R. Burns[1], and D. Ellwood[1]

The Cartography Section and the Data Systems Section of the Geoscience Information Division of the GSC are applying digital technologies to automate map production. Author's map originals can now be scanned, edited, colour coded and processed into colour separations on computer systems. The use of digital systems greatly reduces the amount of work required to colour separate maps and provides improved methods of editing manuscripts. The display includes examples of proof plots, colour separate screens, and final prints.

1 Geoscience Information Division

GEOSCIENCE INFORMATION FOR VISITORS TO GROS MORNE NATIONAL PARK

A.R. Berger, I.A. Brookes[1], D.R. Grant[2], S.G. Hay[3], and R.K. Stevens[4]

A holistic view of the biophysical environment of Gros Morne National park is presented by a map illustrating relationships between vegetation, landforms, elevation, surface materials and bedrock, and their development through time. The map is a cooperative project of the Geological Survey of Canada and the Canadian

Parks Service, with contributions by specialists from York University, Memorial University and the Montréal Botanical Garden, and is scheduled for release in mid-1991.

The front of the map, designed for the educated layperson, features four multi-colour thematic panels: 1) *shaded relief of land and seafloor* (with park facilities, trails and historical notes), 2) *vegetation*, 3) *bedrock geology*, 4) *surface materials and geomorphic features* at 1:50 000 scale. The back of the map has descriptive text and 25 diagrams and landscape sketches. The text traces the geological evolution, outlines the landscape development, reconstructs the sequence of glaciations, sea-level fluctuations and climatic change, and explains the relationship of vegetation to soil, elevation and climate. The diagrams depict views which illustrate the key features.

1 York University, Toronto
2 Terrain Sciences Division
3 Université du Québec à Montréal, Montreal
4 Memorial University, St. John's

THE GEOPHYSICAL DATA CENTRE: PRODUCTS, SERVICES, AND FUTURE PLANS

S.D. Dods[1], K.W. Anderson[1], I. Butt[1], J.F. Janveau[1], L.D.H. Lawley[1], W.F. Miles[1]

The Geophysical Data Centre, Geophysics Division, Geological Survey of Canada, plays an important role in meeting the needs of scientists and the mining and exploration industries in Canada. Its mandate is to maintain the integrity and security of Canada's aeromagnetic and gravity data bases, to provide effective and efficient public access to the data, and to compile standard and customized map products.

Enhanced data bases and software on UNIX-based computer systems are currently under development which will give users direct access to the data via a local area network.

As a public service, the Data Centre presently offers digital data on nine track magnetic tapes and diskettes, for use on mainframe to personal computers, and provides customized map products. Is CD-ROM the mass data distribution media of the future?

A live demonstration is provided to illustrate the value and ease of using digital geophysical data on personal computers.

1 Geophysics Division

NOT JUST BOOKS: THE SERVICES OF THE GSC LIBRARY

E. Frebold[1]

The Geological Survey of Canada Library is the gateway to the span of geoscience information. Access to this information is provided through the world-class library collection, experienced staff, and a variety of services. The Library is used by GSC personnel, other government agencies, universities, industry, media, and the public. The collection is an invaluable resource consisting of 400 000 volumes, 4000 current periodicals, 200 000 maps, 300 000 photographs, open files, and a variety of microforms and video cassettes. The services provided include a comprehensive reference service, an online library catalogue, online data base searching, Selective Dissemination of Information, data bases on CD-ROM, Russian translations, Scientific and Technical Information referrals, and Interlibrary loans through which publications from around the world can be obtained. The Library staff handles over 16 000 inquiries a year from all clients, and lends over 45 000 items, of which 13 000 go to outside borrowers. One of the primary goals of the GSC is the dissemination of geoscience information, and in this process the Library plays an instrumental role.

1 Geoscience Information Division

A CANADIAN INDEX OF STRATIGRAPHIC UNITS

A. Fricker[1], R.C. Boehner[2], S.P. Colman-Sadd[3], L.R. Fyffe[4], R.J. Wardle[3], and G.L. Williams[1]

An index of names of geological units has been created for the Atlantic region (four provinces and the offshore). The information is maintained with the co-operation of geologists throughout the region. The first printed bulletin is in preparation for late summer 1991. The content is available in Open File on floppy computer discs.

Although originating from Volume 6 of the Lexicon of Canadian Stratigraphy (Canadian Society of Petroleum Geologists, 1985), the index is intended to remain current. The content is focused on items appropriate for search and organization, as is appropriate for a computer data base.

The index could be expanded to give national coverage. Either the annual bulletins or the data base will be a reference for local geological studies, will co-ordinate formal definition of the stratigraphy, and should replace present card index systems. A bibliography for all the rock units of Canada will also be useful in its own right.

1 Atlantic Geoscience Centre, Dartmouth
2 Nova Scotia Department of Mines and Energy, Halifax
3 Newfoundland Department of Mines and Energy, St. John's
4 New Brunswick Department of Natural Resources and Energy, Fredericton

THE FUTURE IS NOW: ACCESSING CANADA'S GEOSCIENCE LITERATURE USING GEOSCAN

A. Kopf-Johnson[1], B. Blair[1], J. Caron[1], and D.S. Reade[1]

GEOSCAN is the national bibliography for the earth sciences in Canada, providing bibliographic and subject access to over 130 000 documents. Co-ordinated by the Geological Survey of Canada, GEOSCAN is co-operatively produced through the activities of federal and provincial geological surveys, a university library, and one professional society. In this respect, the GEOSCAN network is an excellent example of federal-provincial cooperation.

Working in the mini- and micro-computer environment, it is possible through data bases, such as GEOSCAN, to track the history of geological work in a geographic area or find out what properties have been explored by a particular mining company. This information can be helpful not only in summarizing the geology of an area, but also in the development of future exploration programs and avoiding the duplication of basic research.

1 Geoscience Information Division

GEOLOGICAL MAP PRODUCTION WITH A GEOGRAPHIC INFORMATION SYSTEM

G. Labelle[1], V. Dohar[1], M. Méthot[1], P. Huppé[1], and J. Glynn[1]

The Cartography Section and the Data Systems Section of the Geoscience Information Division of the GSC are developing procedures and evaluating techniques for producing 1:250 000 and 1:1 000 000 scale geological maps using the geographic information system, Arc/Info. Techniques have been developed to incorporate digital topographic data available from the Surveys, Mapping and Remote Sensing Sector of EMR, to produce key maps, scale bars, legends, and other marginalia, and to output the resulting geological maps on large format electrostatic plotters. The results to date have been encouraging. The display will include copies of maps produced on electrostatic plotters using this technology.

[1] Geoscience Information Division

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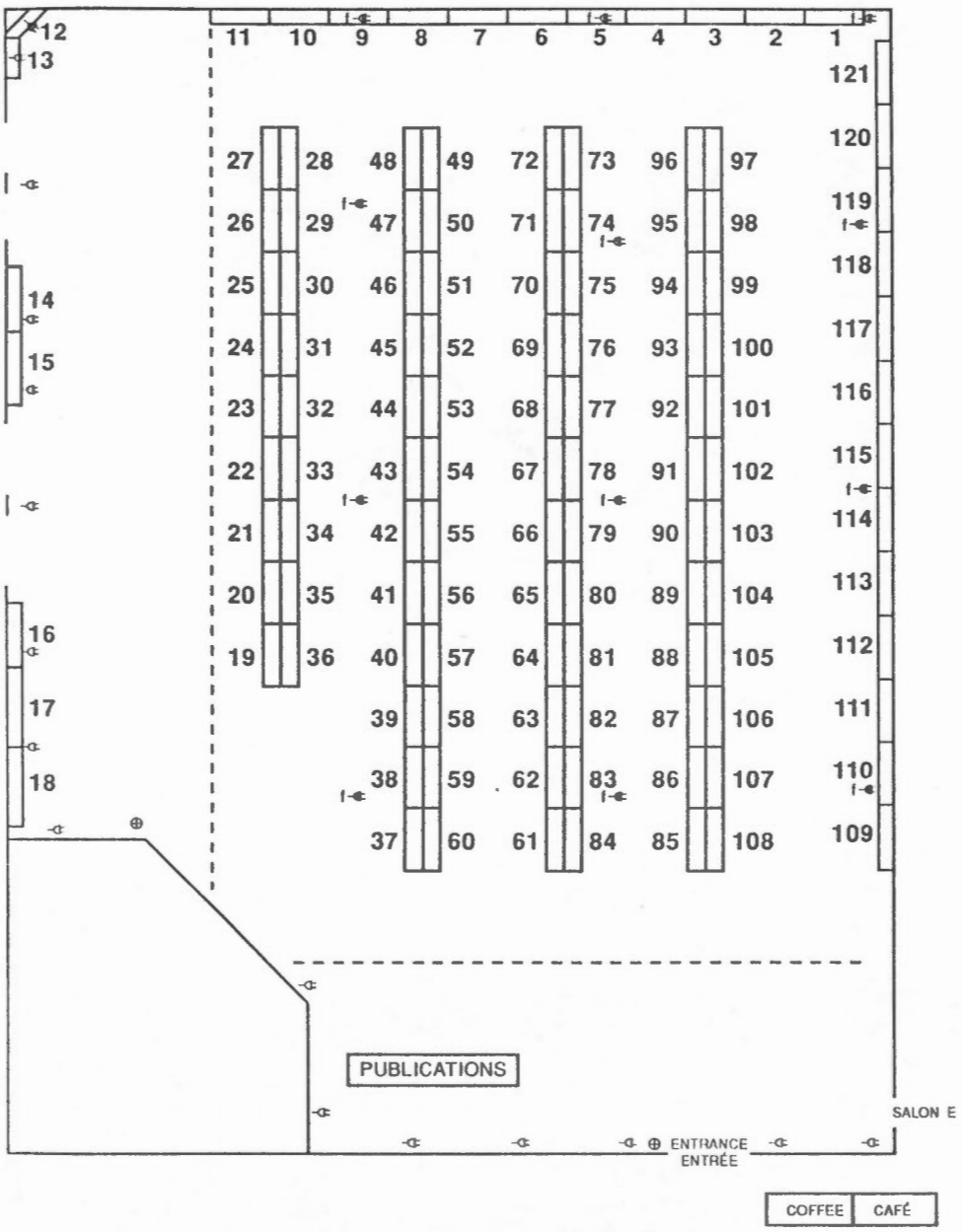

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