FORUM 1990

CURRENT ACTIVITIES FORUM

JANUARY 15-17, 1990

PROGRAM WITH ABSTRACTS

GEOLOGICAL SURVEY OF CANADA

OTTAWA CONGRESS CENTRE

OTTAWA ▲ ONTARIO

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

THE ENERGY OF OUR RESOURCES

Canada

THE POWER OF OUR IDEAS

Geological Survey of Canada

CURRENT ACTIVITIES FORUM

16-17 January 1990

Place:

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

Non-Technical Event:

An informal get-together with cash bar on

Tuesday, 16 January, from

1630h to 1930h in hall A

Popular Lecture:

At 1930 on the evening of Monday, 15 January,

Dr. R.P. Riddihough will present a talk entitled

"Geoscience in Canada's Arctic"

in hall E

Scientific displays:

Some 90 displays will be on view

after the lecture in hall A

PROGRAM

TUESDAY, 16 January 1990

08h45 Introduction
E.A. Babcock

09h00 The origin of the Arctic Ocean
A.F. Embry

09h20 Ideas vs. constraints about Arctic seafloor evolution
J. Sweeney

09h40 Geological comparisons across Canada Basin; Canada-USSR Arctic Scientific Exchange Program
M.P. Cecile, L.S. Lane, J.C. Harrison

10h00 Geological, geophysical and organic geochemical studies in the Beaufort Sea
J. Dixon, J.R. Dietrich, L.S. Lane, D.H. McNeil, L.R. Snowdon

10h20 The Arctic Marine Environment – a Canadian challenge for the 90's
D.I. Ross

10h45 Official opening of poster sessions

13h30 Arctic bioclimatic indicators, a key to understanding northern paleoenvironments
S.A. Edlund

13h50 Arctic marine sediments – records of environmental changes
P.J. Mudie

14h10 Tertiary fossil forests of the Arctic archipelago
N.J. McMillan, R.L. Christie

14h30 Global change studies on Ellesmere Island, N.W.T.
D.G. Harry

14h50 Postglacial tectonic and sea level history of the Central Canadian Arctic
A.S. Dyke

15h10 Permaforst aggradation and degradation on Arctic coasts in North America
J.A. Hunter

WEDNESDAY 17 January 1990

09h00 Northern research by the Continental Geoscience Division: continued relevancy after 120 years
J.E. King

09h20 Results and progress of geophysical surveys in the Arctic with emphasis on the Alpha Ridge
J.R. Weber

09h40 Seismograph facilities in northern Canada: the Yellowknife array and earthquake monitoring
R.G. North

10h00 Geological and geotechnical studies of the nearshore zone, southern Beaufort Sea
S.R. Dallimore, P.J. Kurfurst, J.A. Hunter

10h20 Engineering geology constraints associated with offshore oil and gas development in the Canadian Arctic
S.M. Blasco

10h40 Minerals-related research in Yukon and Northwest Territories by the Geological Survey of Canada in 1989
C.W. Jefferson

TALKS

THE ORIGIN OF THE ARCTIC OCEAN

A.F. Embry[1]

The Arctic Ocean is divided into two main basins, Eurasia and Amerasia, each of which had a distinct tectonic history. The origin of the Eurasia Basin is reasonably well understood. It opened during the Tertiary as a continuation of the North Atlantic. The evolution of the Amerasia Basin is poorly known mainly because a coherent pattern of magnetic anomalies has not been recognized and it has not been possible to take cores from the ocean crust.

Geophysical and geological data from Arctic Canada and northern Alaska support a tectonic model of the anticlockwise rotation of Alaska away from the Arctic Islands during the Late Cretaceous. Upper Devonian structural and depositional trends, Carboniferous-Jurassic basin axes and Lower Triassic facies belts established in the two widely separated area become aligned on this reconstruction.

In contrast to this, data from northeastern Siberia appear to be in conflict with the rotational hypothesis.

1 Institute of Sedimentary and Petroleum Geology, Calgary

IDEAS VERSUS CONSTRAINTS ABOUT ARCTIC SEAFLOOR EVOLUTION

J. Sweeney[1]

The Arctic seafloor developed in two main stages. First, the Amerasia Basin formed between about 130 and 80 million years ago when crustal blocks containing northern Alaska and parts of northeastern Siberia separated from polar Canada and rotated to their present positions.

The great submarine mountain range between Canada and Siberia, the Alpha-Mendeleev ridge complex, formed during or shortly after this event. It is composed of oceanic rocks near Canada and may contain continental rocks elsewhere.

Later, starting about 60 million years ago, the Eurasia Basin formed when the Mid-Atlantic rift pierced northward, separated the Lomonosov Ridge from the Eurasian continent and deformed the crust within and around the Amerasia Basin. The Eurasia Basin continues to expand along this rift system today.

The modern Beaufort Shelf is undergoing compressional deformation directed northeastward. The activity appears related to convergence of the Pacific plate against North America along the Aleutian trench.

1 Pacific Geoscience Centre, Sidney

GEOLOGICAL COMPARISONS ACROSS CANADA BASIN: CANADA-USSR ARCTIC SCIENTIFIC EXCHANGE PROGRAM

M.P. Cecile[1], L.S. Lane[1], J.C. Harrison[1]

In 1984 Canada and the USSR entered into an Arctic Science Exchange agreement, Theme 1 of which is the comparison of the geological evolution of Arctic regions and hydrocarbon resources. Project 3.2 (Theme 1) is the comparison of key geological provinces around the Amerasian Basin. One of Project 3.2's objectives is to acquire a better understanding of the constraints that can be applied to hypotheses concerning formation of the Canada Basin, and to assess the economic implications of the results. To date scientists have participated in two joint field programs in Canada and two in the USSR. The most significant results have been: recognition of major geological relationships which deny involvement of Chukotka and Alaska, independent of Eurasia, in a mid-Cretaceous opening of Canada Basin, recognition that important North American source rock shales are in greenschist facies in adjacent parts of the USSR, and a tremendous improvement in communications.

1 Institute of Sedimentary and Petroleum Geology, Calgary

GEOLOGICAL, GEOPHYSICAL AND ORGANIC GEOCHEMICAL STUDIES IN THE BEAUFORT SEA

J. Dixon[1], J.R. Dietrich[1], L.S. Lane[1], D.H. McNeil[1], L.R. Snowdon[1]

Integration of potential field data, reflection and refraction seismic, lithostratigraphic and biostratigraphic data, and organic geochemistry has led to a better understanding of the geology and evolution of the Beaufort-Mackenzie Basin. These data sets also have been used to estimate the basin's hydrocarbon potential. The Beaufort Sea is underlain by up to 16 km of Mesozoic and Cenozoic strata. Upper Cretaceous to Holocene sediments form a thick, oceanward prograding continental terrace wedge which overlies extensionally faulted older strata on the southeastern basin margin. Along the southwestern margin, Early Tertiary compressional structures mask older features.

Hydrocarbons from three different source rocks have been recovered from a variety of Paleozoic to Tertiary units although the bulk of the recovered hydrocarbons occur in Eocene and Oligocene delta-front sandstones. Gas is the most abundant hydrocarbon, especially in the southern part of the basin. A significant amount of oil and gas awaits to be discovered.

1 Institute of Sedimentary and Petroleum Geology, Calgary

THE ARCTIC MARINE ENVIRONMENT - A CANADIAN CHALLENGE FOR THE 90s

D.I. Ross[1]

Canada is one of five nations bordering the Arctic Ocean and has an Arctic coastline, in length, second only to the USSR. Protected by the polar ice, the Arctic Ocean provides a unique laboratory for studying past climatic change, for testing new sophisticated technology and for understanding the evolution of the world's oceans. Canada's northwest margin, the Beaufort Sea, contains substantial hydrocarbon resources, the safe and cost-effective exploitation of which will challenge the skills of our scientists and engineers. Permafrost and ice-bonded sediments of the northern coasts make these regions particularly susceptible to natural and man-made damage. The Arctic Island channels, offer important transportation corridors and unique problems to the sovereignty of our North. The sediments of the Arctic Ocean and adjacent continental shelves hold clues to past global warming cycles and recent man-made stress on our global environment. A knowledge of the underlying crustal rocks is essential to understanding the evolution of the North and the mineral and energy resources that might be hidden in the overlying sediments.

As both a maritime and a polar nation, Canada must take a strong and integrated approach to research in the Arctic offshore.

[1] Atlantic Geoscience Centre, Dartmouth

ARCTIC BIOCLIMATIC INDICATORS, A KEY TO UNDERSTANDING NORTHERN PALEOENVIRONMENTS

S.A. Edlund[1]

Recent work on modern terrestrial vegetation distribution patterns in Arctic Canada has led to the linking of regional differences in major species, their growth forms and dominance with summer temperature distribution patterns. This relationship allows many types of woody species, both evergreen and deciduous shrubs, as well as a number of sedges and some herbaceous species to serve as modern Arctic bioclimatic indicators. Fortunately many of the species that are the best modern bioclimatic indicators, are also those best preserved in the fossil record. Knowledge of northern summer temperature tolerances and limits of individual species enables more detailed reconstructions of northern plant communities in the past and more refined interpretations of past summer climates. It also suggests possible responses to change in the future, under a variety of climate change scenarios.

[1] Terrain Sciences Division

ARCTIC MARINE SEDIMENTS - RECORDS OF ENVIRONMENTAL CHANGES

P.J. Mudie[1]

The Arctic Ocean and its ice cover are major regulators of Canada's climate, ocean circulation and marine productivity. The Arctic is also very sensitive to changes in the global environment because sea ice magnifies small changes in temperature, and because polar regions are sinks for air pollutants. Marine geology studies are being carried out to determine the nature and rate of these environmental changes by study of modern ice and seabed environments, and by interpretation of geological records imprinted in the seafloor sediments. Sea ice camps, an ice island and polar icebreaker have been used to study both western and eastern Arctic Ocean basins.

The geological records suggest that a temperature increase of 1-4°C would result in summer open water throughout the Arctic, with major changes in ocean circulation and productivity of waters off Eastern Canada, and more widespread transport of pollutants from eastern to western Arctic basins. More studies of longer sediment cores and needed to confirm these interpretations, but it is now clear that the Arctic Ocean has been the pacemaker of climate change during the past 1 million years, and that the key to understanding global change lies in the Arctic.

[1] Atlantic Geoscience Centre, Dartmouth

TERTIARY FOSSIL FORESTS OF THE ARCTIC ARCHIPELAGO

N.J. McMillan[1], R.L. Christie[1]

The term "fossil forest" refers to groups or clusters of more or less upright stumps of trees consisting of dried out original wood or petrified wood. Four lower Tertiary sites on Ellesmere Island contain fossil forests. They are at Vesle and Strathcona Fiords, Judge Daly Promontory, and Hot Weather Creek area, 20 km east of Eureka. A fifth site is situated 10 km northeast of Geodetic Hills on Axel Heiberg Island. The fossil flora are dominated by Redwood. Trunks range from 30 cm to 2.5 m situated 4 m to 5 m apart. Underbrush was dense with ferns. Leaf litter is well preserved on a soil which may have been a podzol where drainage was good. Elsewhere the soil is glei where free land drainage was impeded. Two sites, Hot Weather Creek and Geodetic Hills, contain well in excess of 20 forest stratigraphic levels.

Studies reveal the environment was moist and warm temperate in the Arctic during the 40-65 Ma span. Amber and resin are widespread; fossil forest fires are well preserved.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

GLOBAL CHANGE STUDIES ON ELLESMERE ISLAND, N.W.T.

D.G. Harry[1]

A multidisciplinary program involving GSC and university scientists is now in place to study both present and past global change on central Ellesmere Island. This area was selected as a focus for global change activities for several reasons. First, global circulation models predict that High Arctic regions will experience the earliest and strongest climate change signal. Second, the area encompasses a wide range of geomorphic and biotic environments, ranging from barren ice cap to tundra lowland with a warmer climate and richer vegetation than normal for that latitude. Some areas are underlain by ice-rich and thaw sensitive permafrost. Third, a high-resolution paleoclimatic record is available from analysis of ice cores drilled through the Agassiz Ice Cap. Studies of contemporary climate-vegetation-surface process relationships are complemented by paleoenvironmental studies of lake sediments and ice cores. These provide a baseline against which the nature and significance of contemporary global change may be measured.

[1] Terrain Sciences Division

POSTGLACIAL TECTONIC AND SEA LEVEL HISTORY OF THE CENTRAL CANADIAN ARCTIC

A.S. Dyke[1]

During deglaciation the Boothia Arch was reactivated, producing 60-120 m of relief on the 9.3 ka shoreline. This deformation could have been a symmetrical ridge or a ridge faulted on the west side. The ridge was flanked to the west by an isobase plateau where the 9.3 ka shoreline has little gradient. The 8 ka and younger shorelines are not affected by the Boothia Arch, but the Prince of Wales Island isobase plateau persisted as the dominant regional isobase feature throughout postglacial time. Since 8 ka Prince of Wales Island has emerged without delevelling, a glacioisostatically abnormal pattern. We propose a Holocene block tectonics hypothesis: that postglacial rebound of the archipelago involved movement of a mosaic of blocks, some tilting, others not tilting. Some lineaments on eastern Prince of Wales Island may indicate continued minor tectonism.

[1] Terrain Sciences Division

PERMAFROST AGGRADATION AND DEGRADTION ON ARCTIC COASTS ON NORTH AMERICA

J.A. Hunter[1]

Permafrost conditions on the Arctic coasts of North America are related to the Pleistocene history of the area and the relative changes in sea level. In general, the western Arctic is presently experiencing rising sea levels with submergence, coastal recession and permafrost degradation; whereas the eastern Arctic Archipelago are experiencing isostatic uplift and permafrost aggradation at emergent shorelines. The effect of these changes

on ground temperatures, and on the occurrence of ice-bonding, depends on such factors as sea water temperatures and salinities as well as local thermal effects.

[1] Terrain Sciences Division

NORTHERN RESEARCH BY THE CONTINENTAL GEOSCIENCE DIVISION: CONTINUED RELEVANCY AFTER 120 YEARS

J.E. King[1]

The Geological Survey of Canada has been responsible for geoscientific research in Canada's North since Canada's annexation of Rupert's Land in 1870. When the predecessor of the present Continental Geoscience Division became a separate division in 1955, it assumed responsibility for the northern Canadian Shield. Since then the Division's geologists have produced numerous maps and reports that have expanded and updated the geoscience database of the North. In particular, regional geological mapping projects have advanced the understanding of Precambrian tectonics and thus also its metallogenic implications. Geochronological and geophysical studies have proven to be essential companions to the geological mapping. The continuously evolving information base is extensively used in mineral exploration and in public and private sector research and policy development. In response to this demand the Division provides up-to-date geoscientific information on Canada's North through integrated regional and detailed mapping, geochronology, petrology and geophysics.

[1] Continental Geoscience Division

RESULTS AND PROGRESS OF GEOPHYSICAL SURVEYS IN THE ARCTIC, WITH EMPHASIS ON THE ALPHA RIDGE AND EVOLUTION OF THE CANADA BASIN

J.R. Weber[1]

National gravity survey programs currently cover most of the Arctic Islands and continental shelf area and about 28% of the Arctic Ocean Basin within the Canadian sector. Aeromagnetic coverage of the High Arctic is complex, has been carried out by various Canadian and U.S. agencies, and involves highly variable flight line spacings and altitudes. Potential field data along with other geological and geophysical data have been used extensively in crustal studies. Geophysical and geological similarities between Iceland-Faeroe and Alpha ridges suggest that the latter was formed by sea floor spreading. It is proposed that in early Cretaceous a continental Chukchi Borderland and Mendeleev Ridge rotated away some 35° from the Arctic Islands, and that Alpha Ridge was formed by channeling of plume material from a nearby hot spot into the spreading centre. This opening of part of Canada Basin was antedated in late Jurassic by Alaska's anticlockwise rotation away from the western Arctic Islands, leaving behind the east-facing scarp of Northwind Ridge as shear margin.

[1] Geophysics Division

SEISMOGRAPH FACILITIES IN NORTHERN CANADA: THE YELLOWKNIFE ARRAY AND EARTHQUAKE MONITORING

R.G. North[1]

The Canadian Seismograph Network, consisting of 97 seismograph stations throughout Canada, provides the basic information for the detection and location of earthquakes throughout Canada as well as for research aimed towards a better understanding of their causes and potential effects. Fifteen of these stations were installed in the Yukon and the N.W.T. in the 60s. An ambitious program of modernisation, which will upgrade many sites from analogue photographic recording to broadband digital recording transmitted to Ottawa in real time by satellite telemetry, is now underway.

A medium aperature short-period seismograph array, consisting of 18 seismometers distributed over an area of 150 square km, was installed just to the west of Yellowknife in 1963. This is one of ten similar facilities in the world and the only array in North America. It has recently been completely modernised in order to better perform its primary task of detecting, locating and identifying underground nuclear explosions worldwide.

[1] Geophysics Division

GEOLOGICAL AND GEOTECHNICAL STUDIES OF THE NEARSHORE ZONE, SOUTHERN BEAUFORT SEA

S.R. Dallimore[1], P.J. Kurfurst[1], J.A. Hunter[1]

Nearshore sediment assemblages occurring off the coast of the southern Beaufort sea are made up of a seaward thickening wedge of recent transgressive muds, underlain by a complex sequence of submerged terrestrial sediments. These materials display high spatial and temporal variability in geotechnical and geothermal properties. In some instances, sediments may be inherently unstable in both a geothermal and physical sense. Extensive geological investigations have been carried out in this environment in the vicinity of northern Richards Island. These studies concentrated on establishing a regional framework for the area considering aspects such as coastal geology, rates of coastal erosion and deposition, sediment transport and geothermal regime. Detailed geotechnical investigations have also been carried out along two thermally and lithologically diverse onshore/offshore transects to document in situ conditions in shallow nearshore areas with water depths less than 4 m.

[1] Terrain Sciences Division

ENGINEERING GEOLOGY CONSTRAINTS ASSOCIATED WITH OFFSHORE OIL AND GAS DEVELOPMENT IN THE CANADIAN ARCTIC

S. Blasco[1]

A wide range of seabed geotechnical and geological conditions is being investigated to facilitate safe and efficient offshore hydrocarbon development in the Canadian Arctic. The use of bottom founded drilling structures to cope with the ice dominated environment has required an expanded knowledge of seabed conditions from the onset of offshore drilling. Unlike in southern areas, Arctic offshore development must contend with subsea permafrost, hydrates, ice scouring, coastal stability, aggregate sources, and pingo-like features. The presence of multilayered ice bearing permafrost to depths of 700 m below seabed makes it difficult to detect drilling hazards and predict the properties of subsea ice-bearing sediments. Year to year mapping of gouges carved into the seafloor by mobile sea-ice indicates that as much as 90% of the seabed in water depths of 14 to 22 m may be rescoured in as little as forty years. An understanding of the surficial geology of the shelf has led to the identification of the above constraints, has allowed for the prediction of seabed conditions in poorly known areas, and may in the future establish limits on the extent or severity of geotechnical and geological problems facing offshore Arctic exploration and production.

[1] Atlantic Geoscience Centre, Dartmouth

MINERALS-RELATED RESEARCH IN YUKON AND NORTHWEST TERRITORIES BY THE GEOLOGICAL SURVEY OF CANADA IN 1989

C.W. Jefferson[1]

Thirty of 90 northern field projects carried out by the GSC in 1989-90 are minerals-related, comprising studies of deposits, bedrock and surficial environments. Distribution is: Yukon (5); Districts of Mackenzie (13), Keewatin (7) and Franklin (5). Northern MDAs have enhanced field-based research by direct funding, by shifting expertise to the North and by increasing the scope of on-going A-base activities. Structural studies and research on U-Pb, $^{207}Pb/^{204}Pb$, Sm/Nd, Rb/Sr and light stable isotopes are enhancing our understanding of a spectrum of northern deposits (mainly gold) and the mineralizing processes they record. Geoscientists with expertise in base metals are renewing their detailed mapping and geochemical documentation of SEDEX deposits in Yukon, and MVT and VMS deposits in N.W.T. Uranium and PGE studies continue across the Territories. Geophysical and geochemical exploration technologies are being researched and successfully demonstrated.

[1] Mineral Resources Division

POSTERS

THE HURWITZ GROUP, HAWK HILL OUTLIER, DISTRICT OF KEEWATIN N.W.T.: FACIES CHANGES IN AN EARLY PROTEROZOIC FOREDEEP, NAPPE TECTONICS AND IMPLICATIONS FOR GOLD

L.B. Aspler[1], T.L. Bursey[1]

The Hurwitz Group represents aborted rift and cratonic basin sedimentation interrupted by Trans-Hudson Orogen-related forebulge emergence and foredeep drowning. Lateral facies changes in shoaling-upward sequences indicate lateral variation in amplitude of multiple forebulge-foredeep pairs. NE-and E-trending cleavage-bearing folds cross NW-trending folds, generating domes and basins. Flexural slip of Hurwitz rocks over basement is indicated by: sheared basement-cover contacts; deflection of basement fabrics; opposing vergence of chloritic shear zones and minor thrusts on opposite fold limbs; and convergent minor fold fans (competent units) and divergent cleavage fans (incompetent units). Oblique-slip cross-faults and fractures in the Kinga Formation are consistent with heterogeneous strain in flexural slip. Sites of pyrite-arsenopyrite-calcopyrite include: sheared Hurwitz-basement contacts (along contacts and in fractures that cut Kinga Formation quartz arenites) similar to the past gold-producer near Cullaton Lake; the Watterson Formation near cross-faults (fracture fills and carbonate replacements) and the top of the Ameto Formation (pre-compaction concretions).

[1] Mineral Resources Division

A contribution to the Canada-Northwest Territories Mineral Development Agreement

ARCHEAN POLYMETALLIC BASE METAL DEPOSITS WITHIN THE CAMERON RIVER AND BEAULIEU RIVER VOLCANIC BELTS YELLOWKNIFE SUPERGROUP, N.W.T.

D. Atkinson[1]

The Archean Cameron and Beaulieu River volcanic belts, 100 km east-northeast of Yellowknife, consist of thick accumulations of mainly basaltic to andesitic subaqueous flows, gabbroic sills and felsic volcanic complexes that built up above water level. These belts are wrapped around extensive granitic and gneissic complexes and overlain by turbidites of the Burwash Formation. During hiatii in deposition of the volcanics, characterised by compositional transition, polymetallic (Zn, Pb, Cu, Ag, Au) volcanogenic massive sulphides were deposited. Discoveries in 1987 and 1988 include Sunrise and Bear and other discoveries include XL, XLX and OK at Turnback Lake.

Concordant sulphide lenses within felsic fragmental rocks and volcaniclastic sediments are associated with chert and carbonate exhalites, graphitic argillites and rhyolite domes and are typically structurally complex. Geologic reserves at Sunrise, the largest deposit outlined to date, is 1.87 million tonnes of 13% combined Zn-Pb, 404.6 g/t silver and 0.96 g/t gold.

[1] Indian and Northern Affairs Canada, Yellowknife

MOUNT MYE, YUKON, POLYMETALLIC SILVER-TIN BRECCIAS: A NORTHERN EXAMPLE OF BOLIVIAN PRECIOUS-METAL DEPOSITS?

S.B. Ballantyne[1], D.C. Harris[1]

The Mount Mye – Cody Ridge breccia zones or veins are located east of Faro, Yukon in the mid-Cretaceous Anvil Batholith (NTS 105K).

Microprobe and SEM studies have documented repeated brecciation of early quartz veins with later introduction and microbrecciation of quartz-chalcedony, rhodochrosite (banded-colloidal to crystalline) and the polymetallic mineral assemblage which includes pyrite, non-silver-bearing galena, Fe-rich sphalerite, arsenopyrite, stannite, needle cassiterite, canfieldite, silver-bearing tetrahedrite, diaphorite, semseyite, miargyrite, pyrargyrite and acanthite.

Perhaps the first equivalents of southern Bolivian Ag-Sn deposits to be recognized in Canada, the fracture controlled mineralization may have formed as a consequence of caldera development of coeval South Fork volcanics or repeated seismic movements related to regional extensional tectonism along the Tintina Trench fault system.

Anomalous Sn, Sb, Mn, Zn, Pb, As and Ag are distinctive features of National Geochemical Reconnaissance stream sediment data for the area.

[1] Mineral Resources Division

FACTORS CONTROLLING STYLE OF CONTINENTAL RIFTING : INSIGHTS FROM GEODYNAMIC MODELLING

G. Bassi[1], B.C, Nichols[1]

Passive continental margins, formed by lithospheric stretching and rifting, display a large variety of tectonic styles. Our interest lies in determining what properties of the lithosphere and what stress and strain boundary conditions control this regional variability and the siting of rupture.

We use a thermo-mechanical model of lithosphere extension based on a finite-element program. The lithosphere is described as a three-layer medium undergoing elastic, plastic and temperature-dependent viscous deformation. We discuss how local crustal thickness variations control the geometry and timing of necking for a large set of end-member rheologies, geotherms, and extension rates. When a velocity boundary condition is applied, the required extensional forces are evaluated and compared to estimates of plate driving forces.

This kind of study will allow us to put constraints on the amount of crustal thinning across passive continental margins (to be compared to deep seismic sections) and hence highlights differences in the history of vertical motions at the surface and marginal basin evolution.

[1] Atlantic Geoscience Centre, Dartmouth

CRETACEOUS COLD-SEEP COMMUNITIES – PALEO-GAS SEEP INDICATORS

B. Beauchamp[1]

The presence of Cretaceous cold-seep communities in the Canadian Arctic indicates that hydrocarbon-rich fluids seeped to the surface at some times and that oil or gas may still be present in the subsurface. Such communities have recently been documented from Ellef Ringnes and Prince Patrick islands where they comprise local mass occurrences of serpulid worm tubes and bivalves contrasting with the fossil-poor surrounding strata. The fossils are contained in an isotopically-light ($\delta^{13}C$ = -25 to -50) authigenic carbonate matrix whose precipitation was driven by the chemosynthetic bacterial oxidation of methane. The communities formed in a relatively deep and cold water setting, adjacent to synsedimentary normal faults that likely tapped methane, hydrogen sulphide and possible liquid hydrocarbons from an unknown subsurface source. These compounds were needed to fuel the bacteria which in turn fed the higher life forms.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

PERMAFROST AND TERRAIN STUDIES USING REMOTE SENSING, RICHARDS ISLAND, N.W.T.

J.R. Bélanger[1], S.R. Dallimore[1], P.A. Egginton[1]

A pilot study utilizing Thematic Mapper imagery to characterize Richards Island and the lower Mackenzie delta was completed in summer 1989.

Thermal imagery defined broad zones which correspond to known variation in surficial materials and mean annual ground temperatures.

Changes in radiance values were field checked against a number of site specific variables along a number of transects. Although there was some scatter in the data, higher (warmer) values were generally associated with highland areas, deeper thaw depths and/or sands and gravels. Changes in lake surface temperatures across the area correlated well with changes in radiance. These associations suggest that the major zonation reflects real climatic variability across this area – variability that is due primarily to the cooling influence of the Beaufort Sea on low lying coastal areas.

[1] Terrain Sciences Division

METALLOGENIC CONCEPTS TO AID EXPLORATION FOR THE GIANT OLYMPIC DAM-TYPE DEPOSITS AND THEIR DERIVATIVES IN CANADA

R.T. Bell[1], S.S. Gandhi[1]

The giant Fe-Cu-U-Au-Ag-REE Olympic Dam deposit in South Australia shares many features with other monometallic and polymetallic deposits such as Kiruna in Sweden and Pea Ridge in Missouri. These deposits belong to a clan that includes magnetite-rich veins, breccia-fillings, disseminations and skarns, in and adjacent to porphyrites.

Most of the deposits are related to ensialic, post-tectonic, rhyolite-dominated sequences, differing from subduction-related, andesite-dominated magmatic arcs. Their parent magmas were probably generated by crustal underplating. The most favourable conditions for the formation of these magmas developed with gradual decline in secular radiogenic heat which about 1.9 Ga ago led to major cratonization. Significant transfer of uranium to near-surface environments at this time marks an important episode in uranium metallogeny.

Discovery of the Olympic Dam deposit resulted from the search for a progenitor of Cu (+U+Fe) deposits in younger Adelaidean diapirs. As such these specific younger deposits are termed "derivative". Some deposits in the African Copperbelt and Wernecke Mountains in Yukon are of this type.

[1] Mineral Resources Division

GRAVITY INTERPRETATION OF THE BLATCHFORD LAKE INTRUSIVE COMPLEX

T.C. Birkett[1], W.D. Sinclair[1], D.G. Richardson[1]

Interpretation of a gravity survey of the Blatchford Lake Intrusive Complex is constrained by surface geology and measured rock densities. The intrusive complex is a thin tabular body composed of mafic and felsic intrusive rocks. Early intrusive phases are mafic in composition and underlie the western lobe of the complex. Here, granitic rocks of the western lobe intruded the gabbroic rocks and overlie them. The eastern lobe of the complex, comprising the Grace Lake and Thor Lake phases, was emplaced later than the rocks of the western lobe, and was not associated with mafic intrusive rocks. The Grace Lake Granite in this portion of the complex is up to 1 km thick. A relatively narrow mafic root underlies the western lobe to a depth of some 4 km. The major portion of the complex is floored at a depth of 1.5 to 1 km.

[1] Mineral Resources Division

PROGRESS IN MODELLING FAULT-BOUNDED EXTENSIONAL BASINS

R. Boutilier[1], C.E. Keen[1]

A dynamical model for lithospheric extension and the formation of rifted sedimentary basins is presented. Numerical calculations were based on a finite-element software package and performed on a Cray supercomputer. Both thermal and mechanical effects are considered in the formulation. A temperature-dependent rheology which includes elastic-plastic and viscous behavior is used. The main difference between this and other numerical models of the lithosphere which incorporate the dynamics of extension is that we have included a very narrow "fault-like" weak zone in our model. Motion along this zone in the upper crust is accompanied by the development of necking instabilities in the lower lithosphere. The result is a region of extension which combines aspects of both the "pure" and "simple" shear models which are currently used to describe extensional features. We present these results and examine the effects of changing extension rates, rheology, and thermal gradients on the calculated geometry of the rift.

[1] Atlantic Geoscience Centre, Dartmouth

POTENTIAL FIELD DATA: A GUIDE FOR EXPLORATION IN THE ABITIBI GREENSTONE BELT

J. Broome[1], E.J. Schwarz[1], M.D. Thomas[1]

The Abitibi greenstone belt is extensively covered by glacial overburden. Gravity and magnetic potential field signatures provide a means of probing beneath it and significantly improving knowledge of bedrock geology. This is a vital contribution to mineral exploration. Various maps can be derived from fundamental potential field data sets, each of which may enhance particular features of the geophysical field, e.g. map of the first vertical derivative and horizontal gradient. Further enhancement may be achieved by portraying maps in different formats such as

grey-tone, colour or shaded images. Comparison of geological boundaries on the 1983 MERQ-OGS (1:500 000) map of the Abitibi belt with geophysical images reveals discrepancies in several areas: new areas of potential interest for base metal exploration are thus defined. Gold exploration may also benefit from structural information derived from magnetic and gravity maps: fault-bounded, lozenge-shaped crustal blocks in the southern half of the belt may reveal themselves in geophysical images of the northern half where widespread overburden hampers geological mapping.

[1] Continental Geoscience Division

REGIONAL ANALYSIS OF FRACTURES IN QUARTZ ARENITES OF THE KINGA FORMATION (EARLY PROTEROZOIC HURWITZ GROUP), HAWK HILL-MOUNTAIN-GRIFFIN LAKES AREA, DISTRICT OF KEEWATIN N.W.T.: IMPLICATIONS FOR GOLD

T.L. Bursey[1], L.B. Aspler[1]

Kinga Formation quartz arenites are intensely fractured and lack a penetrative cleavage, in contrast to basement rocks which shorten by deflection of Archean fabrics, and overlying slates and dolostones which bear a pressure solution cleavage related to E and NE-trending "D_2" folds that cross NW-trending "D_1" folds. The fold sets represent dome and basin basement-cover interfolding from flexural slip. Fracture orientations are not uniform regionally but reflect heterogeneous strain of D_1 and D_2 structures. Where D_2 folds are predominant, fracture sets are consistent with shortening across F_2 limbs and outer arc extension in hinge zones. Similarly, fracture patterns indicate shortening across well-developed D_1 structures. Where both D_1 and D_2 structures are prominent, fracture patterns are complex and sets related to both are developed. The fractures are sites of pyrite-arsenopyrite-calcopyrite, similar to the past gold-producer near Cullaton Lake; we suggest a genetic relationship between folding, fracturing and mineralization.

[1] Mineral Resources Division

Contribution to the Canada-Northwest Territories Mineral Development Agreement

ACCESS TO ARCTIC DATA VIA THE CANADIAN GEOSCIENCE DATA DIRECTORY AND THE ARCTIC ENVIRONMENTAL DATA DIRECTORY

R.B. Butterfield[1], P.B. Charlesworth[1], D.R. Posson[2]

The Geological Survey of Canada is currently creating an inventory of all digital or potentially digital GSC datasets that might possibly be useful to others. Contributions are also being received from the provincial geological surveys. This inventory, called the Canadian Geoscience Data Directory, can be searched for items of interest in many different ways including by keyword, by geographical location, by organization, and by author. The long term plan is to link it to a graphical interface using the GIS product SPANS.

The US Geological Survey has had a similar inventory, the Earth Science Data Directory (ESDD), for several years. They have recently created the Arctic Environmental Data Directory (AEDD) in response to Global Change initiatives by starting with a subset of ESDD and adding relevant directory entries from other agencies including the GSC. The functionality of both of these directories as sources of information about the existence of arctic data will be demonstrated.

[1] Geoscience Information Division
[2] US Geological Survey, Reston, Virginia

DETAILED AIRBORNE RADIOMETRIC, MAGNETIC AND ELECTROMAGNETIC SURVEY AND PRELIMINARY GROUND FOLLOW-UP OF THE RELIANCE AREA, N.W.T.

B.W. Charbonneau[1], S.S. Gandhi[1], D.R. Lentz[1], S.M. Roscoe[1]

A detailed airborne survey of an area straddling the boundary of the Archean and Proterozoic terranes near Reliance at the northeast end of Great Slave Lake, was carried out in 1988 and published in 1989 as GSC Open File 1988.

The survey, partly covering an area proposed as a National Park, revealed distinctly anomalous zones of U, Th, U/Th ratio and total counts, strongly magnetic zones, and weak electromagnetic anomalies.

Ground follow-up conducted in 1989 revealed coarse garnetiferous granites characterized by high U/Th ratio, and also a Th-rich subporphyritic granite forming a large circular pluton in the Archean terrane. This circular body coincides with a magnetic anomaly, and is bounded by a ring fracture occupying a topographic low, which has an airphoto expression as a semicircle approximately 33 km in diameter. Exposures on the ring fracture show brecciated granite with carbonate, quartz, hematite and sericite. It is conceivable that a deep-seated intrusion (possibly peralkaline) has caused the ring fracture.

[1] Mineral Resources Division

GOLD-RICH SKARNS OF THE CANADIAN CORDILLERA

K.M. Dawson[1]

Five types of skarn gold deposit are recognized in the Canadian Cordillera:

1. Skarns mined for Au alone have high Au, As, Bi and Te, low base metals, a higher clastic component in host rocks and more mafic associated intrusions relative to other skarn gold subtypes (i.e. Hedley, Tillicum Mountain, Quesnel River and Dividend-Lakeview).

2. Porphyry Cu, Au skarns are large, low in Au grade, and rich in andradite, diopside, disseminated Cu sulphides, magnetite and hematite (i.e. Ingerbelle, Galore Creek, Cariboo Bell and Craigmont).

3. Cu, Au skarns are distinguished from porphyry Cu, Au skarns by lack of Cu and Mo sulphides in the more mafic-associated intrusions and smaller, more massive and Au-rich orebodies (i.e. Greenwood District, White Horse Copper Belt).

4. Fe, Au skarns are associated with large calcic magnetite skarns in which Au is concentrated with erratically-distributed Fe and Cu sulphides (i.e. Coast Copper, Marble Bay, Oro Denoro, Emma).

5. Zn, Pb skarns, more commonly enriched in Ag than Au, include Midway, YP and Ray.

[1] Mineral Resources Division

REGIONAL METALLOGENY OF THE CRATON AND ACCRETED TERRANES OF THE CANADIAN CORDILLERA

K.M. Dawson[1]

In the geologically diverse Canadian Cordillera, each terrane preserves a stratigraphic record different from those of neighbouring terranes. Characteristic suites of mineral deposits, as integral parts of their host terranes, reflect fundamental differences in their depositional environments.

Metallogenic analysis of craton, pericratonic and accreted terranes of the Canadian Cordillera demonstrates a consistent relationship between the lithotectonic character of host terranes and the type and composition of their typical suites of mineral deposits.

Present knowledge of the time of tectonic, plutonic and metallogenic events, although imperfect, allows classification of mineral deposition according to the accretionary history of the host or immediately adjacent terrane.

Pre-accretionary mineral deposits are predominantly stratiform types, hosted by sedimentary and volcanic strata. Accretionary deposits are minor, mainly due to the difficulty in ascribing the generation of a plutonic suite and attendant mineralization to a specific accretionary event. The majority of granitoid-related porphyry, skarn and vein deposits are post-accretionary.

[1] Mineral Resources Division

IMPROVED METHODS FOR TRACE ELEMENT ANALYSIS BASED ON FLOW INJECTION

N. De Silva[1], G.E.M. Hall[1], G. Gauthier[1], J.C. Pelchat[1]

Analysis of complex matrices such as geological materials and seawater demands the capability of determining low levels of analytes of interest in the presence of high concentrations of matrix elements. Their physical, chemical and spectroscopic interferences can lead to significantly poor detection limits, accuracy and precision of the results. Simple remedial approaches to correct for these interferences become impractical or ineffective due to the complexity of the samples of geochemical interest.

Chelating resins can be used to preconcentrate and isolate analytes from the matrix for improving detection limits by orders of magnitude. Analytical methods are being developed at the GSC for automated preconcentration of trace elements using chelating resins and miniature flow systems coupled with Inductively Coupled Plasma Emission (ICP-ES) and Mass-Spectrometry (ICP-MS). Major advantages of these flow injection techniques over the conventional methods are: (a) low sample and reagent consumption (b) better detection limits (c) easy automation (d) high sample throughout (e) reduced contamination.

[1] Mineral Resources Division

DEEP SEISMIC REFLECTION STUDIES IN THE BEAUFORT-MACKENZIE BASIN

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

One thousand kilometres of deep seismic reflection data have been collected to date in the Canadian Beaufort Sea and Mackenzie Delta region. Seven hundred and fifty kilometres of the seismic data were collected in 1986 and 1987 and have since been processed, interpreted and released as an open file. The most recent data collection (in September 1989) consisted of 250 km of 16 to 24 second marine reflection profiling in the Herschel Island area of the southwestern Beaufort Sea.

The deep reflection seismic data are providing important information on the deep structure and tectonic evolution of the petroleum-resource rich Beaufort-Mackenzie Basin. The seismic data have provided new images of a number of geological features, including Paleozoic compressional structures within the Arctic Platform, Cretaceous extensional and rift structures along the southeastern basin margin, transitional and oceanic crust basinward of the rift margin and intra-basin, detached, Tertiary faults and folds.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

CRETACEOUS-TERTIARY SEQUENCE STRATIGRAPHIC ANALYSIS IN THE BEAUFORT-MACKENZIE BASIN

J. Dixon[1], J.R. Dietrich[1], D.H. McNeil[1]

Conventional lithostratigraphic analysis of Upper Cretaceous to Holocene strata in the Beaufort-Mackenzie Basin can be applied to the succession at the basin margins, where alternating sandstone- and shale-dominant intervals are present. However, on a basin-wide scale this approach fails to provide realistic and useful stratigraphic units. With hundreds of thousands of kilometres of reflection seismic and over 250 wells available it was decided to use seismic/depositional sequence analysis.

Using a modified sequence analysis approach, the Upper Cretaceous to Holocene succession was divided into eleven basin-wide sequences. The methodology relies upon the identification of various types of erosional and depositional surfaces, the two most prominent being unconformities and flooding surfaces. Problems identifying the conformable surface equivalent to a basin-margin unconformity have been encountered. In parts of the basin, flooding surfaces are the most prominent feature of a sequence and have been used as sequence boundaries. The nature of sequence boundaries from various positions within the basin will be illustrated.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

TERRAIN EVALUATION OF THE MACKENZIE VALLEY TRANSPORTATION CORRIDOR

A. Duk-Rodkin[1], O.L. Hughes[1]

This project involves the preparation of surficial geological maps of the Mackenzie Valley transportation corridor and adjacent parts of Mackenzie and Richardson mountains. The first

stage of the project (1986-1990) includes 16 full color "A-series maps" of which 10 are in press and 4 in the critical reading stage. These maps replace the terrain maps from the central part of the Mackenzie transportation corridor, released as an open file during the period 1970-1974. The second stage of the project, now being planned, would include mapping of areas to the south and west.

The maps show the distribution of seven basic terrain types with numerous subtypes. The geological and engineering properties of terrain types are known from field observations and geotechnical data from thousands of borehole records obtained by industry and government, while locating proposed pipelines and highways. The maps provide necessary information for preliminary evaluation of pipeline and highways routes in terms of terrain suitability and availability of construction materials, for the initial selection of sites for airstrips, permanent camps, river ports, and evaluation of drilling conditions prior to seismic surveys.

The maps also show major aspects of the glacial history of this region such as the all-time limit of the Laurentide Ice Sheet, retreatal positions and related glacial features. The spatial interrelationships between Laurentide and montane glacial deposits of different ages are also revealed in those maps where portions of the Mackenzie Mountains are included.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

MULTIDISCIPLINARY RESEARCH IN THE INTERMONTANE ZONE, ELLESMERE ISLAND, N.W.T.

S.A. Edlund[1], B.T. Alt[1], K.L. Young[1]

The anomalously warm, well vegetated intermontane zone of central Ellesmere Island is one of the Arctic regions selected by Terrain Sciences as a Global Change observatory. Massive buried ground ice bodies there make some surficial materials thaw-sensitive. The extremely warm summer of 1988 caused some of this ice to melt and triggered large numbers of detachment slides, rapid retreat of slump scarps and other unexpected hydrological phenomena. During the wet, cool summer of 1989 no additional slides were triggered and the region experienced a different stream and soil hydrological regime.

An automatic weather station at Hot Weather Creek monitors air and soil conditions for many studies, including regional and local climate, phenological and geomorphic process studies.

Slope and stream hydrology studies also include detailed monitoring of local air and soil moisture and temperature. Regional and local vegetation patterns are being documented. Additional studies in progress include estimates of sediments displaced by slides and sensing of ice bodies with ground probing radar.

[1] Terrain Sciences Division

PAST AND FUTURE ACTIVE LAYER DEPTHS, MACKENZIE DELTA, WESTERN ARCTIC

P.A. Egginton[1], S.R. Dallimore[1]

Complex ice wedges with multiple tiers or growth stages are abundant and commonly exposed along the Beaufort Sea coast. Typically a tertiary wedge extends from the base of the current active layer to the top of a secondary wedge. This position marks an older deeper active layer, approximately 50% deeper than the current one. Clearly, the tertiary wedges are or have formed under cooler summer conditions than those associated with the deeper active layer. Since the tertiary wedges are quite thin (<5 cm), this cooling is a quite recent event possibly associated with a cooling of about 2°C which commenced in the 1940s. This can be interpreted in reverse and provides proxy information on the probable impact on active layer thickness of a summer warming of 2°C. Warming of this magnitude within the next 100 years has been suggested by Global Circulation Models (GCMs).

[1] Terrain Sciences Division

UTILIZATION OF GAMMA RAY SPECTROMETRY IN MULTI-ELEMENT MINERAL EXPLORATION

K.L. Ford[1], B.W. Charbonneau[1], R.B.K. Shives[1]

The systematic acquisition of high sensitivity, quantitative, airborne gamma ray spectrometric (AGRS) data by the Geological Survey of Canada has helped to expand the role of gamma ray spectrometry to include applications to regional and detailed bedrock and surficial geological mapping, environmental studies and multi-element mineral exploration.

Mapping of the variations in the absolute and relative proportions of the three radioelements K, U, and Th offers assistance to exploration for many commodities, most obviously U, but also, when used as pathfinders, for Sn-W, rare and high technology metals. In special cases the radioelements can also point to precious and base metal mineralization when their concentrations and ratios have been modified by the mineralizing process thereby altering the normal radioelement signature of the host lithology.

Although AGRS surveys are useful in most geological environments, they generally work best in granitic and gneissic dominated terranes where radioelement concentrations and contrasts are strong and aeromagnetic patterns may not be as well defined. Consequently the two techniques have a complimentary relationship.

[1] Mineral Resources Division

LAKE SEDIMENT GEOCHEMISTRY, CONTWOYTO LAKE, N.W.T.

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

A detailed centre-lake bottom sediment survey was carried out in the Lupin gold mine area of Contwoyto Lake, N.W.T. to evaluate this exploration technique for gold mineralization in rocks of the Yellowknife Supergroup in a tundra environment.

Assessment of the geochemical data for gold and associated pathfinder indicates that the Lupin gold mine and other gold occurrences are clearly identified demonstrating the useful exploration potential of the lake bottom sediment survey method.

[1] Mineral Resources Division

DECIPHERING LATE TERTIARY EVENTS IN THE ARCTIC: THE BEAUFORT FORMATION ON PRINCE PATRICK ISLAND, N.W.T.

J.G. Fyles[1], J.V. Matthews, Jr.[1], T. Brent[1], J.R. Devaney[1], L.O. Ovenden[1]

In its "type" area on eastern Prince Patrick Island, the Beaufort Formation is an unlithified, sandy braided river deposit forming a single lithostratigraphic unit a few tens of metres thick. It contains unaltered wood, moss and fine plant materials that have yielded macrofossils of about 200 species of vascular plants, mosses, and insects. This unit probably originated during the

early Pliocene (based on dates from Meighen Island) when the area supported coniferous forest, and mean July temperature was at least 9°C warmer than present. West of the outcrop belt described above, exposures are rare but seismic and well data reveal a wedge of sand and gravel thickening northwestward across the island to several hundred metres. Specific age and environments represented by these subsurface beaufort strata are unknown. They are displaced by north- to northeast-stroking faults recorded on the surface by lineaments.

[1] Terrain Sciences Division

POTENTIAL FOR OLYMPIC DAM-TYPE Cu-Au-U-Fe DEPOSITS IN THE GREAT BEAR MAGMATIC ZONE, DISTRICT OF MACKENZIE, N.W.T.

S.S. Gandhi[1], R.T. Bell[1]

The Olympic Dam deposit in South Australia is a giant Cu-Au-Ag-U-REE-Fe(oxide) deposit hosted by breccia in an anorogenic, felsic volcano-plutonic setting of Helikian age. The Great Bear magmatic zone has the following features favourable for occurrence of large deposits of this type:

1. Dominantly felsic volcanic sequences deposited in Late Aphebian post-tectonic continental environment.
2. Metallogenic signatures of the felsic magmatism in the form of numerous copper, iron(oxide) and uranium occurrences.

Examples of the Olympic Dam-type deposits in the magmatic zone are the Sue-Dianne deposit (8 million tonnes; 0.8% Cu; some Au and U), and Mar and Damp prospects, in rhyodacite ignimbrite breccias with magnetite-specularite matrix. The magmatic zone also hosts many magnetite-apatite-actinolite veins that are comparable to the much larger iron deposits of the Kiruna and Bergslagen districts in Sweden and in the St. Francois Mountains of Missouri. These iron deposits of Late Aphebian and Helikian age have been interpreted as variants of the Olympic Dam deposit.

[1] Mineral Resources Division

THE EASY INTEGRATION OF DATASETS IN ARC/INFO-FIRST STEP FOR ANALYSIS AND INTEGRATION

J.E. Glynn[1], D. Ellwood[1], P.B. Charlesworth[1]

The Geological Survey of Canada collects and archives numerous geographically referenced digital datasets. These datasets include aeromagnetics, airborne radiometrics, gravity, geochemistry, geology, mineral deposits, and bibliographic data. A project is currently under development to provide a user interface to input these datasets into Arc/Info with a simple menu-driven package. It will also be possible to import Surveys and Mapping 1:250 000 digital topographic data and the National Atlas Information System 1:7 500 000 coverages of Canada into Arc/Info using this system. This package will facilitate the use of geographic information system technology by the scientific community within GSC by allowing scientists to concentrate on analysis rather than on data conversion. This project will also simplify the export of these datasets from Arc/Info to other GIS packages such as SPANS.

[1] Geoscience Information Division

THE SEARCH FOR SPATIAL CORRELATIONS BETWEEN SEISMICITY AND DRAINAGE PATTERNS IN THE WEST-QUEBEC SEISMIC ZONE: A COMPUTER DEMONSTRATION ON THE "SPANS™" GEOGRAPHIC INFORMATION SYSTEM

A.K. Goodacre[1], G.F. Bonham-Carter[1], D.F. Wright[1], M. Lamontagne[1], B.A. Grover[1]

It is generally believed that most earthquakes in eastern Canada are caused by the failure of crustal rocks along pre-existing zones of weakness. In practice, the actual identification of a particular zone of weakness with a given seismic event is rendered difficult partly because of statistical uncertainties in locating seismic events but also because of a surfeit of possible geological and geophysical indicators of crustal zones of weakness. With the aid of the Spatial Analysis System (SPANS™) we are applying the "weights of evidence" statistical modelling approach to the problem to see whether indicators such as drainage patterns, geological rock types, total field magnetic anomaly, etc., can be reasonably used to predict seismicity within our study area. This area lies mainly within the Ottawa-Grand Remous-Mont Tremblant triangle and was chosen to provide the most accurate epicentral locations available with standard regional seismic stations. Our preliminary results indicate that seismicity in the study area is associated with stream linears striking in a north-northeast direction and at least one specific rock unit consisting of Helikian monzonite.

[1] Geophysics Division

PETROLEUM SOURCE ROCK POTENTIAL OF CENTRAL SVERDRUP BASIN

F. Goodarzi[1], T. Gentzis[1], A.F. Embry[1]

A detailed organic petrological and Rock-Eval pyrolysis study of core and cuttings samples from the Mesozoic of Lougheed Island in central Sverdrup Basin was performed.

The Murray Harbour Formation (Cape Caledonia Member) and the Hoyle Bay Formation (Eden Bay Member), both part of the Middle-Upper Triassic Schei Point Group, are by far the most widespread source rocks in central Sverdrup Basin. They contain predominantly Type I kerogen consisting of marine algae (*Tasmanites*), dinoflagellate cysts, and amorphous fluorescing matrix (bituminite) and have high HI values (up to 553 mg HC/g Corg). These formations are in the mature zone of hydrocarbon generation and have been deposited in a marine shelf environment under anoxic conditions.

The Barrow, Jameson Bay and Ringnes formations contain an admixture of Type II/III kerogen, are marginally mature and have limited oil-generating potential. The McConnell Island, Deer Bay and Christopher formations contain mainly immature to marginally mature Type III kerogen and thus are not considered as source rocks in this area.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

ATLANTIC GEOSCIENCE CENTRE CORING ON THE CANADIAN ICE ISLAND

M.E. Gorveatt[1], M. Chin-Yee[1], D. Mosher[1], G. Sonnichsen[1], S.A. Thibaudeau[1], P.J. Mudie[1]

In 1984, the Polar Continental Shelf Program began to build a camp on a three-by-seven kilometer iceberg which had calved from the Ward Hunt ice shelf on northern Ellesmere Island. In 1985, the Canadian Department of Energy, Mines and Resources, with the assistance of the Engineering and Technical Service Division of the Department of Fisheries and Oceans, developed,

built and installed a sediment sampling system near this camp. This sampling system has developed and evolved into a substantial sediment sampling facility. This facility now consists of a winch, gantry and ice melting system capable of taking piston cores to a water depth of 4000 m.

[1] Atlantic Geoscience Centre, Dartmouth

GEOLOGY OF MELVILLE AND ADJACENT SMALL ISLANDS, CANADIAN ARCTIC ARCHIPELAGO: A NEW 1:250 000 SCALE MAP

J.C. Harrison[1]

Some of the results of field operations (1984, 1985, 1987) on the fourth largest of the Queen Elizabeth Islands are summarized on a new 1:250 000 scale open file geology map of Melville Island (in two sheets with separate legend). The map area (42 149 km^2) encompasses the northern exposed limit of the Arctic Platform, the entire exposed width of the Franklinian Mobile Belt and the southern portion of the Sverdrup Basin. As well as outlining the surface distribution of Lower Ordovician to Tertiary strata and shallow crustal structure, the new map also reveals the location of hydrocarbon seeps and coal.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

GSC GRAVITY MAPPING PROGRAM IN THE ARCTIC

D.B. Hearty[1], R.V. Cooper[1], D.W. Halliday[1], R.A. Gibb[1]

The Gravity Mapping Program in the Canadian Arctic was initiated in 1958 and has progressed steadily for thirty years with logistic support supplied by the Polar Continental Shelf Project. Gravity-bathymetry surveys of the Arctic Channels were made in cooperation with the Canadian Hydrographic Service. Approximately 85% of the Arctic landmass and 60% of the offshore areas are covered to regional-reconnaissance standards (6/15 km station spacing). Gravity data has been collected using a variety of transportation modes, gravity instruments and navigation systems. Water depths have been acquired using through-the-ice acoustic sounders and land elevations using altimeters. Gravity mapping progress is shown as a mosaic comprising different colours for each year of survey. Survey areas were selected on an opportunity basis governed by location of Decca stations and hydrographic priorities. The results of 30 years of mapping are shown on a Bouguer anomaly map.

[1] Geophysics Division

THE MAPPING OF GROUND ICE IN NORTH AMERICA

J.A. Heginbottom[1], D.G. Harry[1]

Ground ice mapping in Canada is being undertaken both as part of systematic terrain and surficial geology mapping programs, and by specific investigations of selected areas to determine the characteristic forms of occurrence and quantities of ground ice in particular geological and geomorphic settings. Two new maps have recently been produced as results of this work.

1. A map of ground ice regions for North America. Nine regions are recognized, associated with distinctive suites of bedrock geology, Quaternary history, surficial geology, hydrology and climate.
2. A 1:1M scale map of permafrost and ground ice conditions in northwestern Canada. On the map, the extent of permafrost is classified in a six step scale, while ground ice content is classified in an eight step scale. Ground ice form and associated surficial geological conditions are described in the map legend.

[1] Terrain Sciences Division

THE SLAVE PROVINCE – THELON TECTONIC ZONE BOUNDARY FROM AN INTEGRATED GEOLOGICAL, GEOPHYSICAL, GEOCHRONOLOGICAL, AND GEOCHEMICAL PERSPECTIVE

J.B. Henderson[1], E. Hegner[1], P.H. McGrath[1], R.J. Theriault[1], O. van Breemen[1]

A new 1:250 000 geological map (combined Healey Lake (76B) and Artillery Lake (750) map areas) of part of the boundary area between the eastern Archean Slave Province and the early Proterozoic Thelon Tectonic Zone of the northwestern Churchill Province that lies between the McDonald and Bathurst faults is presented. U-Pb (zircon and monazite) indicate that activity within the Thelon Tectonic Zone and its juxtaposition with the Slave Province took place between 2.0 and 1.9 Ga while the Nd signature indicates the presence of a large Archean component. Distinctive regional gravity and magnetic anomaly patterns together with Rb-Sr geochronological and geological data indicate the central Slave Province along with part of the western 2.0-1.9 Ga Thelon Tectonic Zone was indented along the Bathurst and McDonald faults into the northwestern Churchill Province at about 1.74 Ga. Commodities of potential economic interest that have attracted interest include gold, lead, copper, zinc and nickel.

[1] Continental Geoscience Division

BEAUFORT SEA COASTAL ZONE – NORTHERN OIL AND GAS ACTION PROGRAM

P.R. Hill[1], A. Héquette[1], S.R. Dallimore[2], R.B. Taylor[3]

The coastal zone is a critical area of concern in planning for the production and associated facilities for the transport of Beaufort Sea oil and gas from offshore to southern markets. Under the Northern Oil and Gas Action Program which existed from 1984 to 1988, a large-scale research program was carried out to provide public information on the geological and geotechnical processes occurring along this permafrost coast. Project D1 was designed to (1) measure rates of coastal erosion and deposition, (2) map and characterize the physical properties of nearshore and onshore deposits, and (3) examine the geomorphic and sedimentological processes, and the geohazards related to sea ice, waves and storm surges, permafrost and ground ice. The shallow marine surveys and beach process studies were completed through the Atlantic Geoscience Centre and the onshore surficial mapping program was done through the Terrain Sciences Division. A concerted effort is now required to quantify and amalgamate the onshore and offshore field observations made during the four year program.

[1] Hill Geoscience Research, Halifax
[2] Terrain Sciences Division
[3] Atlantic Geoscience Centre, Dartmouth

SEDIMENTARY HOSTED NICKEL-ZINC MINERALIZATION IN THE SELWYN BASIN, YUKON

L. Hulbert[1], C. Grégoire[1], D. Paktunc[1], G. Abbott[1], R. Cathro[1]

A thin bed of stratiform Ni-Zn sulphide mineralization has been discovered at the base of a thick shale sequence in a Devonian to Permian age syncline within the Selwyn Basin.

The sulphide mineralization contains consistently high Ni values in the 2.3 to 7.8 percent range with corresponding zinc values of 0.29 to 1.3 percent. Selenium (610-2400 ppm), As (1900-4200 ppm), Mo (1411-2968 ppm), U (15-107 ppm) and Ba (1900-3800 ppm) are present in abnormal concentrations. The Platinum Group Elements are also anomalous and in excess of that found in typical Sudbury ores. The Rhenium concentrations associated with the nickel mineralization range from 9.6 to 61 ppm which appear to be the highest values recorded for nickel sulphide mineralization of any type to date.

Isotopic and mineralogical studies have clearly shown that the Ni-enriched sulphide horizon is distinct from that of other sulphide-rich horizons in the sedimentary sequence.

1 Mineral Resources Division

MODELLING HYDROCARBON GENERATION IN THE BEAUFORT-MACKENZIE BASIN

D.R. Issler[1], L.R. Snowdon[1]

Rock-Eval pyrolysis is a rapid geochemical technique for characterizing the quantity, type and thermal maturity of organic matter. When sediment samples are heated in a pyrolysis oven, they undergo thermal cracking which yields principally hydrocarbons and CO_2. A parallel, first-order kinetic model was developed to describe the hydrocarbon evolution curves resulting from laboratory-based pyrolysis. Kinetic parameters were determined for Upper Cretaceous to Oligocene Type III organic matter from the Beaufort-Mackenzie Basin by optimizing experimental data. These kinetic parameters were incorporated into a one-dimensional, finite-element model which simulates the subsidence and thermal history of sediments at point locations in the Beaufort-Mackenzie Basin. From a comparison of model predictions with observational constraints, we can conclude the following: (1) The same set of kinetic constants (activation energies and frequency factors) can be used for all the rock units examined. (2) Rapid Plio-Pleistocene sedimentation has buried marginally mature/immature sediments to at least 5 km (-maximum offshore drilled depth) even though bottomhole temperatures approach 140°C.

1 Institute of Sedimentary and Petroleum Geology, Calgary

U-Pb GEOCHRONOLOGY, Nd MODEL AGES AND TECTONICS OF THE EASTERN ARCTIC CANADIAN SHIELD

G.D. Jackson[1], T. Frisch[1], E. Hegner[1], P.A. Hunt[1]

Northern Baffin Island consists largely of Archean rocks of the 2.7-2.9 Ga (U-Pb zircon) Committee Fold Belt overprinted by Aphebian tectonism. Southern Baffin Island lies within the late Aphebian Baffin Orogen, composed of the Cumberland Batholithic Complex and three bordering fold belts, probably formed during coeval collision of three sialic blocks.

Rocks from northern Baffin Island yield Nd-T_{DM} ages of 2.8 to 3.3 Ga. Nd model ages of granitoid rocks from southern Baffin range from 2.3 to 3.5 Ga. These, together with U-Pb zircon ages of 1.8-1.9 Ga for the Cumberland Complex and intrusive relations indicate extensive reworking of Archean material during late Aphebian tectonism.

The shield terranes of the Boothia Uplift, eastern Devon Island and southeastern Ellesmere Island are all granulite belts but differ in important respects. Lithostructural trends are north on Boothia Peninsula and Somerset Island, east on Devon and north on Ellesmere. On Boothia Peninsula, Nd model ages of basement are 2.2-2.3 Ga in the extreme west and 2.8-3.0 Ga to the east. Intrusions yield Nd model ages of 2.4 Ga and a U-Pb zircon age of ca. 1.95 Ga. On Devon Island, Archean rocks form a significant part of the crust (Nd model age 2.2-2.8 Ga, U-Pb age 2.5 Ga). The Ellesmere Island block appears to consist entirely of Proterozoic (Nd model age 2.1-2.3 Ga) crust intruded and metamorphosed ca. 1.91-1.96 Ga (U-Pb zircon).

1 Continental Geoscience Division

STRUCTURE, STRATIGRAPHY AND FACIES CHANGES IN AURIFEROUS CHEMICAL SEDIMENTARY ROCKS OF NORTHEASTERN SLAVE PROVINCE, DISTRICT OF MACKENZIE, N.W.T.

C.W. Jefferson[1], S. Fumerton[2], K. Hudson[3], R. Lustwerk[1], M.B. Lambert[1], R.A. Olson[4]

Three lithostratigraphically distinct iron-rich sedimentary sequences punctuate volcanic and turbiditic strata. Sequence A marks temporary cessation of volcanism and partial reworking of volcanic protoliths in the Back River Complex. Sequence B continuously separates domal volcanic piles from overlying turbidites. Sequence C is hosted by turbidites with spatially-associated volcaniclastics and is widely distributed in the northeastern Slave Province. All sequences contain slate and laterally varied iron-formation facies. Sequences A and B begin respectively with calcite- and dolomite-cemented volcanic breccia and grit. Stromatolites and oolites of sequence B are located above rhyolite domes. Sequence C oxide facies are strongly magnetic; silicate and sulphide facies weakly so. Quartz veins and alteration transect many competent rocks in the region; gold is restricted to some structurally-complex and sulphidic parts of iron-rich strata.

1 Mineral Resources Division
2 Chevron Minerals Canada Ltd., Timmins
3 Sirius Energy Corp. Ltd., Calgary
4 Trigg Woollett Olson & Assoc. Ltd., Edmonton

NON-RENEWABLE RESOURCE ASSESSMENT OF THE SOUTH NAHANNI RIVER AREA, DISTRICT OF MACKENZIE – NEW Zn-Pb POTENTIAL AND LOST GOLD FOUND?

C.W. Jefferson[1], W.A. Spirito[1], S.M. Hamilton[1], T.D. Bird[1], F.A. Michel[1], D. Paré[1], K.M. Dawson[1]

This assessment is based on regional and follow-up data:

1. digitally compiled and locally updated 1:250 000 maps,
2. a metallogenic map relating minerals to nine rock-packages,
3. digital geochemical maps based on spatial-statistical analysis of stream silts and heavy mineral concentrates (HMCs),
4. geochemistry and statistical analysis of spring waters, and
5. compilation and analysis of hydrocarbon exploration data.

High mineral potential was confirmed in much of the Ragged Ranges and low-to-moderate hydrocarbon potential under Tlogotsho Plateau. Unexpected high resource potential was indicated for:

a) gold by HMCs from gravels and silts in a 100 km north-trending zone from Mattson Creek to Tetcela River in Nahanni Karst, and

b) zinc-lead by silt and spring waters in Meiller River valley.

1 Mineral Resources Division

ELECTROMAGNETIC STUDIES ALONG THE LITHOPROBE SOUTH 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], D.I. Gough[3]

As part of the LITHOPROBE Southern Cordilleran transect investigations, a novel combination of Transient ElectroMagnetic (TEM) sounding and natural-source Magneto Telluric Profiling (MT) surveys were performed successfully from June to October 1989. The electromagnetic profiles extend from the Valhalla Gneiss Complex to the Coast Plutonic Complex and were designed as reconnaissance tools for studying the crustal and upper mantle properties across southern British Columbia. Striking changes in the data were observed as the survey crossed tectonic boundaries suggesting structural control of conductivity anomalies. The reconnaissance surveys have been augmented by detailed profiling over the seismic "bright spot" observed at approximately 15 km depth on line 15. Interpreting the shallow TEM survey will permit more reliable information from greater depths to be extracted from the MT data. These surveys also offer the exciting opportunity to improve further the interpretation of the lower crust's composition and state by incorporating structural constraints from seismic refraction and reflection surveys. Preliminary results of both surveys will be presented.

1 Continental Geoscience Division
2 Pacific Geoscience Centre, Sydney
3 University of Alberta, Calgary

DIGITAL MAPS OF SURFICIAL GEOLOGY IN HUDSON BAY

H. Josenhans[1], J. Zevenhuizen[2], J. Peters[3]

Mapping of the surficial marine geology of Hudson Bay is being completed in preparation for the Frontier Geoscience Program sponsored Hudson Bay Basin Atlas. A detailed interpretation of 6800 line kilometres of high resolution seismic reflection and sidescan sonograms together with over 40 000 line kilometres of 3.5 kHz subbottom profiler data collected in Hudson Bay resulted in a series of preliminary hand drawn 1:500 000 maps. This series consists of the following maps: acoustic facies outcrop, geomorphic features, glaciomarine sediment distribution, moraines and paleochannels. These maps as well as bathymetric data, seismic control, sample control, sample attributes data, and geographic information were digitized. A hard copy 1:2 000 000 series of maps was computer generated and a comprehensive series of digital attribute drawing files was established.

The hard copy maps will be distributed as a GSC open file and will also be available in a digital format as AutoCAD drawings. A free standing Geographic Information System application, called inFOcus, designed to run on MS-DOS computers, will enable non technical users to view, overlay and plot the full suite of interpretive maps in conjunction with data attributes. Additional data, such as bedrock and structural maps, geotechnical, geochemical and micropaleontology information can be added when they become available.

1 Atlantic Geoscience Centre, Dartmouth
2 Orca Marine Geological Consultants, Halifax
3 Earth & Ocean Research Ltd., Dartmouth

GRAVITY STUDIES IN THE KIRKLAND LAKE-NORANDA REGION

P. Keating[1]

The gravity data from the Kirkland Lake-Noranda region have been reprocessed: the Bouguer anomaly map, the first and second vertical derivative maps and an apparent density map have been used to interpret the gravity field in this region. It was found that the Bouguer anomaly can be mostly explained by density structures located within the first 5 km of the crust. Vertical derivative maps helped to better locate some geological contacts and the apparent density map allowed to easily distinguished between thin and thick batholiths. Analysis of a detailed profile in the Rouyn-Noranda area showed that steeply dipping north reflectors observed by seismic reflections correspond to a north dipping density structure.

1 Geophysics Division

AUTOMATED INTERPRETATION OF MAGNETIC VERTICAL GRADIENT ANOMALIES

P. Keating[1], M. Pilkington[1]

An interpretation method based on the linearization of the equations of the magnetic vertical gradient anomalies due to dipping dykes or contacts has been developed. It can be used to interpret isolated anomalies or profile data in a Werner style deconvolution. Since the method is non-iterative, it is rapid and whole surveys are easily processed. It can be used to obtain initial estimates for subsequent, more detailed, non-linear least-squares modelling.

Modelling has demonstrated that the estimation of depth, the thickness and the location of the source bodies are reliable, even in the presence of high levels of noise. Interpretation examples from an airborne magnetic vertical gradient survey in the Abitibi Belt (Val d'Or, Quebec) are presented to illustrate the use of the method.

1 Geophysics Division

SIGNIFICANCE OF INTERRELATIONSHIPS AMONG GOLD, SULPHUR AND ARSENIC IN EXPLORATION FOR A VARIETY OF GOLD DEPOSIT TYPES

J.A. Kerswill[1]

The occurrence of iron sulphides and arsenopyrite in many gold deposits suggests that both sulphur and arsenic could be useful ore guides. For example, in the Tundra deposit, Courageous Lake area, N.W.T., gold is strongly correlated with arsenic but only moderately correlated with sulphur. However, in certain deposit types, sulphur is more reliable than arsenic as an indicator of gold potential. This is particularly true in stratiform ores hosted by iron formation (BIF), such as Lupin and Homestake, in which arsenopyrite is restricted to alteration zones adjacent to late quartz veins but gold and pyrrhotite are more widely distributed in thin but laterally continuous units of sulphide-BIF. In the turbidite-hosted deposits of Nova Scotia, arsenopyrite is typically abundant in and around syn- to post-folding quartz veins, but much of the gold occurs with iron sulphides in pre-folding bedding-parallel veins. Different interrelationships among gold, sulphur and arsenic in gold deposits reflect the variety of processes which have contributed to gold concentration.

1 Mineral Resources Division

REGIONAL GEOLOGIC SETTING OF GOLD MINERALIZATION IN THE CONTWOYTO – NOSE LAKES AREA, N.W.T.

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

Gold mineralization in the Contwoyto-Nose Lakes area of the central Slave Province occurs primarily in turbidite-hosted iron formation (Lupin-type mineralization). Iron formation is best preserved in the biotite- to sillimanite-grade metaturbidites that core a low-grade zone between domains of injection migmatite and granoitoid intrusions. Regional structural analysis of the host turbidites has demonstrated that these rocks are deformed by four sets of Archean folds but that the resultant, complex interference patterns are at least locally predictable. The form of the low-grade zone is a result of originally shallow- or moderate-dipping isograds being folded about NE- and NW-striking, upright cross-folds. Intense regional shortening, calc-alkaline magmatism, and abundant quartz veining about which there has been some mobilization of gold accompanied the thermal peak of metamorphism. Geochemical studies of the igneous rocks suggest that the area evolved in a general magmatic arc setting.

1 Continental Geoscience Division
2 Queen's University
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ARCTIC CLIMATE AND ICE CAPS PAST AND PRESENT

R.M. Koerner[1], J. Bourgeois[1]

Ice cores from the Queen Elizabeth Islands ice caps give detailed information about the climate and how it has changed over the last 100 000 years although some of the cores are only 127m long between the surface and bedrock. This compares to a similar time period covered by over 2000m of core in southern Greenland (Dye-3).

The changes between ice deposited during the last interglacial, the last glacial period and the present interglacial period are quite distinct. The last interglacial period was the warmest and shows the highest concentrations of pollen grains and the least negative (warmest) oxygen isotope values. Our work strongly suggests that the Archipelago may have been glacier free at this time. The glacial period has high micro-particle and ion concentrations but fewer pollen grains as a consequence of high atmospheric turbidity and greater distances from vegetation sources due to the presence of the Laurentide Ice Sheet to the south of the Queen Elizabeth Islands. The stable isotope values at this time suggest temperatures several degrees colder than today. The Holocene ice layer record in the cores shows it was warmest at the beginning of this period 9000 years ago and coldest from 2500 years ago until the middle of the last century. Since then, there has been a warmer period which is often considered to be a product of human activity.

This same 100 year period bears witness to human activity in the increasing level of certain acids in the uppermost 30m of snow and firn at the tops of the ice caps.

1 Terrain Sciences Division

STRUCTURE, STRATIGRAPHY AND FACIES CHANGES IN VOLCANIC AND SEDIMENTARY ROCKS OF THE BACK RIVER COMPLEX, N.W.T.

M.B. Lambert[1], G.H. Burbidge[2], C.W. Jefferson[3], C. Beaumont-Smith[4], R. Lustwerk[3]

Volcanic and sedimentary facies bordering this Archean, calc-alkaline stratovolcano record transitions from subaerial lavas, domes and related clastic aprons and alluvial fans of the emergent edifice through shallow marine conglomerates, oolitic/stromatolitic carbonates, and a rhyolitic fan delta, to deeper water volcaniclastic turbidites and crystal tuffs. Amalgamated sandy turbidites occupy submarine fan channels directed radially away from the volcano.

Iron-bearing sedimentary sequences form: 1) sulphidic calcite-cemented volcaniclastics, magnetitic chert and slate within the volcanics; 2) cherty iron-formation (IF), including oolitic/stromatolitic carbonate, magnetite-, sulphide- and siderite-chert, sulphidic volcaniclastics, graphitic slate, and stratabound auriferous quartz veins between the volcanic pile and overlying greywacke-turbidites; 3) argillitic to cherty magnetite- and sulphide-IF, graphitic slate near or laterally equivalent to volcaniclastics within the greywacke-turbidites.

The volcanic complex was a competent mass enclosed by less competent turbidites which record four deformational events.

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3 Mineral Resource Division
4 Department of Geology, University of New Brunswick, Fredericton

SEDIMENTOLOGICAL EVALUATION OF THREE ARCHEAN METAQUARTZITE AND CONGLOMERATE-BEARING SUCCESSIONS, SLAVE PROVINCE, N.W.T.

D.G.F. Long[1], R.J. Rice[2], W.K. Fyson[2], S.M. Roscoe[3]

Phyllite, submature metaquartzite, and polymictic orthoconglomerate occur in an areally restricted submarine fan system near Newbigging Lake in the southern part of the Point Lake supracrustal belt. The Beniah Formation, examined near the southwest part of Beniah Lake, contains phyllite, supermature metaquartzite and minor beds of oligomictic conglomerate deposited on a shallow shelf. The Beaulieu Rapids Formation, 30 km south of Beniah Lake, including metaquartzite, polymictic orthoconglomerate, phyllite and minor oligomictic conglomerate, represents a subaerial alluvial fan system.

Heavy mineral concentrations in the Beniah and Beaulieu Rapids formations are pyritic and slightly auriferous and uraniferous. The less mature clastic metasedimentary rocks near Newbigging Lake, deposited in a submarine fan environment, apparently lack such concentrations.

1 Department of Geology, Laurentian University, Sudbury
2 Ottawa-Carleton Geoscience Centre, Ottawa
3 Mineral Resources Division

EARLY PROTEROZOIC COLLISIONAL TECTONICS IN THE HINTERLAND OF THE CAPE SMITH BELT, NORTHERN QUÉBEC: ACCRETION OF HIGH GRADE, PLUTONIC AND VOLCANO-SEDIMENTARY THRUST SHEETS

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

Mapping to the north of the Cape Smith Belt has shown that plutonic-supracrustal terranes are accreted to the thrust belt along early Proterozoic thrust faults. The Archean Superior Province, characterized by layered tonalite gneisses, forms a parautochthonous footwall to the belt. The basal Cape Smith Belt thrust sheets are overrun by the amphibolite grade Narsajuaq terrane, which contains a layered tonalite-diorite succession intruded by plutons of quartz diorite, tonalite and granite, and subsequently by peridotite sills. The granulite grade Sugluk terrane structurally overlies the Narsajuaq terrane, and is marked by tonalites and granites intruding highly deformed

sequences of metasedimentary and metaplutonic (tonalite-diorite) rocks. Both terranes record complex deformation histories, with pre-accretion fabrics variably reworked during their emplacement in the thrust belt. Geoscientific studies north of the Cape Smith Belt enable structural controls on known Cu-Ni-PGE deposits to be better understood and the pre-thrusting geography of the belt to be reconstructed.

1 Continental Geoscience Division

BEDROCK GEOLOGY OF HUDSON STRAIT

B. MacLean[1], M.A. Miller[2], G.L. Williams[1]

The first in situ bedrock in Hudson Strait was obtained through a shallow corehole drilling program using **CSS Hudson** in 1985. The fourteen cores are predominantly tan or grey limestones, with argillaceous limestone and sandstone occurring in the eastern part of the strait. Lithologically the rocks can be correlated with Lower Paleozoic strata on Southampton and adjacent islands and in the Premium Homestead Akpatok L-26 well on Akpatok Island in Ungava Bay. The size of the cores necessitated the use of microfossils for determining the precise age of the rocks. Conodonts from two of the six stations examined indicated an undifferentiated Middle to Upper Ordovician sequence. Samples from seven of the twelve stations yielded uncompressed and thermally unaltered acritarchs and chitinozoans, with fragments of graptolite periderm, melanosclerites and scolecodonts. Diagnostic palynomorphs include: the aritarchs *Baltisphaeridium, Excultibrachium, Peteinosphaeridium, Polyancistrodorus* and *Rhopaliophora*; and the chitinozoans *Desmochitina* sp. cf. *D. lata, D. minor, D. rugosa, Conochitina micracantha* and *Tanuchitina* sp. These microfossils indicate an Ordovician age for all the samples. In addition, the presence of the chitinozoan *Hercochitina* suggests a Late Ordovician (Caradoc to Ashgill) age and affinities with coeval assemblages from the U.S. Midcontinent and eastern North America. The palynomorph assemblages from the tan limestones differ slightly from those of the grey limestones. This observed relationship of the assemblages to the lithology may reflect differential water depths control.

1 Atlantic Geoscience Centre
2 Amoco Production Co. Research Center, Tulsa

MARINE GEOLOGICAL AND GEOTECHNICAL STUDIES OF INTERISLAND CHANNELS IN THE CANADIAN ARCTIC ARCHIPELAGO

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

Seabed geology and geotechnics of interisland channels of the Canadian Arctic Archipelago were studied under the Northern Oil and Gas Action Program (NOGAP).

This work provided regional data on the occurrence, composition, and competence of the main sediment units: information relevant to seabed engineering, environmental assessment, and to the knowledge of conditions during the late Quaternary.

Because it is a polar land mass, and an area of mixing between Arctic and Atlantic ocean waters, the Arctic Archipelago is a pivotal area in developing an understanding of global change.

Ice allows only variable access to channels in the east for three to four weeks each year, while permanent to semi-permanent ice conditions prevail to the north and west.

Studies were accomplished by shipborne programs, seismic surveys from small boats in leads in the ice, and by through-ice sediment sampling.

Although much has been accomplished, many Arctic interisland channels still remain geologically unknown. Because of difficult and uncertain ice conditions, the need for a long lead time in advance of data requirements cannot be over emphasized.

1 Atlantic Geoscience Centre, Dartmouth

ARCTIC OCEAN MAGNETIC DATA COMPILATION

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

In early 1989, a major compilation project was initiated at the Atlantic Geoscience Centre with the aim of creating a digital data base of coherent magnetic observations from the Arctic and North Atlantic oceans and adjacent continental regions.

In its current mode, the project is assembling data from a variety of international sources. In 1990, the data will be reviewed for accuracy, adjusted if necessary, and merged to create a grid of anomaly values over oceanic and continental areas. The work is being carried out at the Atlantic Geoscience Centre, but organizations that contribute data to the project are encouraged to participate directly in any aspect of the work by sending their staff to the Centre for hands-on involvement in data processing and for scientific consultation.

This poster illustrates the present status of data acquisitions in the Arctic Ocean by showing the locations of magnetic observations that have been assembled so far, as well as a preliminary plot of the magnetic anomaly field derived from those unadjusted data. Data have been assembled over significant oceanic regions in a sector sweeping westward from 20°E to 160°W, and ranging from 60°N to the Pole.

1 Atlantic Geoscience Centre

CANADA'S POLAR-8 ICEBREAKER: KEY TO GSC'S FUTURE ARCTIC MARINE GEOSCIENCE RESEARCH

K.S. Manchester[1], W.A. McCloy[2]

The Canadian Coast Guard Polar-8 Icebreaker has been designed to be fully capable of performing specific operational missions in the Canadian Arctic on a year round basis.

Significant in it's operational performance requirements is the ability to maintain continuous progress at a ship speed in excess of three (3) knots through a 10/10 cover of consolidated pack ice having a uniform thickness of 2.44 m and with 7/10 multiyear ice and a snow cover of 0.3 m.

The icebreaker has also been designed so as to be fully capable of providing a platform for Arctic seas scientific studies, surveys and data collection for the Coast Guard and other government agencies such as the Geological Survey of Canada. The poster describes the facilities included in the Polar-8's design to support the conduct of future Arctic marine geoscience research.

1 Atlantic Geoscience Centre
2 Canadian Coast Guard

REGIONAL HEAVY MINERAL GEOCHEMISTRY IN THE LOWER ST. LAWRENCE (APPALACHIAN) REGION OF QUEBEC

Y.T. Maurice[1]

As part of the Eastern Quebec Development Plan (1983-1989), the Geological Survey of Canada conducted a regional heavy mineral geochemical survey in a relatively unexplored part of the Quebec Appalachians. The area surveyed was

approximately 8400 km² and included parts of Kamouraska, Témiscouata, Rivière-du-Loup and Rimouski counties.

The results show a 30 km-long zone of unusually high tungsten, lead, antimony and silver, with some mercury, copper and tin values near the villages of l'Esprit-Saint an Trinité-des-Monts. This unexpected anomaly seems to follow a major fracture zone in Cambro-Ordovicien sediments and probably signals the presence of a hydrothermal system in the area. The zone was the focus of significant staking and mineral exploration activity during the summer of 1989, following the release of the data in GSC Open File 2036.

Other interesting results include a series of barium, lead and zinc anomalies that form arcuate patterns in the northern part of the survey area. Most of the anomalies occur within 20 or 30 km of the sub-economic barite-lead deposit at Saint-Fabien and could indicate an extension to the known mineralization.

1 Mineral Resources Division

REMOTE SENSING AND FIELD MAPPING OF TERTIARY FAULTS, SOUTHEASTERN ELLESMERE ISLAND, ARCTIC ARCHIPELAGO; BASEMENT SLIP AND COVER RESPONSE

U. Mayr[1], A.V. Okulitch[1]

On southeastern Ellesmere Island, Precambrian basement is overlain by 6000 m of Paleozoic carbonates with 2 evaporite units. Aerial photographs showed lineaments, anticlines, grabens, and normal and detachment faults. Field mapping showed that these features were part of a strike-slip and extension fault regime interpreted to be related to NW-trending rifting in Baffin Bay. The lineaments are SW trending dextral strike-slip faults. N-S folds and minor reverse and detachment faults are consistent with dextral transpression and transtension. E-trending normal faults are a branch from the main rift, controlled by basement fabric.

The lower structural package below the lower evaporite remained attached to the basement, while the middle and upper packages separated by the upper evaporite, were folded and faulted. Away from the zone of dextral strike-slip, only NW-trending grabens parallel to the primary rift are present. The complex response of cover results from differing interactions, at various levels, among competent and incompetent strata, variable basement fabric and the superimposition of Tertiary rifting and strike-slip faulting.

1 Institute of Sedimentary and Petroleum Geology, Calgary

QUATERNARY LANDFORMS AND SEDIMENTS, BLUENOSE LAKE – BERNARD HARBOUR AREA, NORTHWEST TERRITORIES

I. McMartin[1], D.A. St-Onge[1]

Intensive field studies and airphoto interpretation has indicated that Late Wisconsinan ice reached the eastern slopes of the Melville Hills just west of Bluenose Lake. Deglaciation from this position to Coronation Gulf has been subdivided into four major retreat phases. These are defined by distinct flow patterns identified from drumlins, flutings and striae, and by ice frontal positions associated with morainic ridges and other ice contact features. The downwasting ice mass gradually retreated from the Melville Hills area and formed distinct lobes flowing northwestward into Dolphin and Union Strait and westward into Richardson River and Rae River basins. Eventually the sea penetrated along a corridor which opened between the ice mass and the mainland extending as far as the upper reaches of the Richardson River. Rapid calving into this water body generated numerous minor surges and changes in iceflow direction. The rapid collapse of the Coronation Gulf ice mass resulted in the production of vast quantities of icebergs which scoured the floor of the shallow sea.

1 Terrain Sciences Division

TERTIARY FOSSIL FORESTS OF THE ARCTIC ARCHIPELAGO

N.J. McMillan[1], R.L. Christie[1]

The term "fossil forest" refers to groups or clusters of more or less upright stumps of trees consisting of dried out original wood or petrified wood. Four Lower Tertiary sites on Ellesmere Island contain fossil forests. They are at Vesle and Strathcona Fiords, Judge Daly Promontory, and Hot Weather Creek area, 20 km east of Eureka. A fifth site is situated 10 km northeast of Geodetic Hills on Axel Heiberg Island. The fossil flora are dominated by Redwood. Trunks range from 30 cm to 2.5 m situated 4 m to 5 m apart. Underbrush was dense with ferns. leaf litter is well preserved on a soil which may have been a podzol where drainage was good. Elsewhere the soil is glei where free land drainage was impended. Two sites, Hot Weather Creek and Geodetic Hills, contain well in excess of 20 forest stratigraphic levels.

Studies reveal the environment was moist and warm temperate in the Arctic during the 40-65 Ma span. Amber and resin are widespread, fossil forest fires are well preserved.

1 Institute of Sedimentary and Petroleum Geology, Calgary

RECENT ADVANCEMENTS IN APPLIED PALEONTOLOGY – EXAMPLES FROM THE BEAUFORT-MACKENZIE BASIN OF ARCTIC CANADA

D.H. McNeil[1]

Paleontology has much to offer in deciphering Arctic history, particularly when integrated with other geotechniques. It has provided a means for dating sediments, correlating sections locally and regionally, and interpreting environments of deposition. To cite a particular example, integration of biostratigraphic data with seismic data in the Beaufort-Mackenzie Basin has produced results that are more informative and reliable than either technique can produce in isolation. To cite another example, the organic and mineral matter of fossils have potential to be diagenetically altered in a predictable manner. A new method, developed from Beaufort-Mackenzie Basin data, uses agglutinated foraminifers as indicators of organic maturity level and burial diagenesis. This method produces fast and inexpensive organic maturity data for assessing hydrocarbon generation potential.

1 Institute of Sedimentary and Petroleum Geology, Calgary

HIGH RESOLUTION SEISMIC REFLECTION PROFILES ACROSS THE KAPUSKASING STRUCTURE

B. Milkereit[1], D. White[1], J.A. Percival[1], K. Vasudevan[2], P.C. Thurston[3]

A high resolution seismic reflection survey was carried out in June 1989 as a preliminary site survey for the Canadian Continental Drilling Program (CCDP). The objective of the study was to obtain high quality reflections and velocity information from shallow depths in an effort to identify lithological and/or structural controls. The data collected had moderate signal-to-noise ratios at frequencies 50 to 130 Hz. Processing steps included first break analysis and spectral balancing. Refraction static corrections were determined from the detailed shallow velocity structure obtained by applying an iterative tomographic inversion method to the first break travel times. All stacked sections show a

transparent zone near the surface and a sudden increase in coherent reflected energy at 750 to 900 m depth. The data confirm the overall gentle NW-dip of shallow reflectors seen on the LITHOPROBE profiles which project to about 4 km SE of the surface location of interlayered mafic gneiss, paragneiss and tonalitic gneiss.

1 Continental Geoscience Division
2 Lithoprobe Seismic Processing Facility
3 Ontario Geological Survey, Toronto

A GEOPHYSICAL LOOK AT THE CRUST BENEATH THE INTRA-CRATONIC WILLISTON BASIN

P. Morel-à-l'Huissier[1], A.G. Green[1], A.G. Jones[1], M.D. Thomas[1], M. Drury[1], J.A. Majorowicz[1], T. Latham[1]

The nature of the crust beneath sedimentary basins, particularly intracratonic ones has a significant impact on the evolution of such basins and their enrichment in hydrocarbons. In recent years, a number of studies have led to new views on the nature of the crust in the region of the Williston basin. The structural character of the Precambrian basement is revealed in images of gravity and magnetic potential field anomalies. The interpretation of several seismic refraction surveys collected by the Canadian COCRUST group indicated the presence of a lower crustal high velocity (>7.0 km/s) layer overlying a relatively flat Moho. More recent COCORP seismic reflection data collected in Northern Montana, closer to the depocentre, suggest that this high velocity layer may be coincident with a zone of strong reflectivity at the base of the crust. To date, it is not yet clear if this lower crustal layer is associated with the Williston basin or with the underlying Trans-Hudson Orogen or both. A major conductivity anomaly with its upper surface at 10 km depth (the North American Central Plain anomaly) and spatially associated with the Trans-Hudson Orogen has been found to coincide with a N-S trending high heat flow anomaly. The latter anomaly seems to have some bearing on the distribution of the oil fields which are also related to the internal structures of the basin, some of which apparently are influenced by basement features.

1 Continental Geoscience Division

FROM THE PACIFIC TO THE ATLANTIC: A TRANSECT OF THE NORTH AMERICAN CONTINENT NEAR THE CANADA-U.S. BORDER - GSC AND USGS PARTICIPANTS

P. Morel-à-l'Huissier[1]

Over the past decade, several major multidisciplinary geoscience surveys have been conducted within approximately 200 km of the Canada-U.S. border, and several more are currently underway or in an advanced state of planning. By integrating the information discerned from this rapidly growing data base with existing knowledge contained in published geological maps, it will be possible to construct a three-dimensional image of the Earth's crust contained in a 5000-km-long corridor that extends across the entire North American continent. The Global Geoscience Transect along this corridor, referred to here as CANUST (CANada-US Transect), is at a very early stage of preparation. Total field magnetic, vertical gradient magnetic, Bouguer gravity and horizontal gradient gravity maps for the complete transect will be displayed. By 1991, it is anticipated that approximately 70% of the transect will have been surveyed by multichannel seismic reflection methods and approximately 85% will have been surveyed by seismic refraction methods. Electrical conductivity data will be available for most of the western portion of the transect, but such information for the central and eastern portions is expected to remain relatively sparse. Data that will be incorporated in CANUST are in the process of being compiled at the appropriate scales; some data have still to be collected. The status of three large regions of the transect are displayed.

1 Continental Geoscience Division

MARINE GEOLOGY OF THE CANADIAN POLAR MARGIN EAST OF BORDEN ISLAND

P.J. Mudie[1], S.A. Thibaudeau[1], F.E. Cole[1], F.J. Hein[2], K. Louden[2], L. Mayer[2], N.A. Van Wagoner[3]

Surficial sediments on the Canadian polar margin have been sampled and mapped using the Canadian Ice Island as a platform for continuous bathymetric surveys, shallow seismic profiling, seabed photography, dredges and coring. Regional coverage was extended by helicopter flights and sampling through frozen leads. Five Late Quaternary sedimentary sediment facies are correlatable over the inner shelf. Outer shelf and upper slope have <10 cm of Holocene calcareous mud over massive gravelly muds of Late Wisconsinan age. Lithofacies, microfossils, and palynomorphs reflect fluctuations in ice over over a full glacial ocean during late glacial and postglacial Holocene time. There is no clear evidence from sediments, geotechnical or heat flow data for grounded Wisconsinan ice on the polar margin. Synsedimentary fault structures suggest recent isostatic adjustment or tectonism. Sporadic influxes of ice rafted detritus give an average sedimentation rate of 1 cm/1000 years. Siliceous demosponges form living reef mounds, with a zonation suggesting 20-60 m of sea level change or recent climate change. Late glacial units contain organic carbon and nitrogen redeposited during glacial retreat. These units overlie Tertiary bedrock of Paleocene (Eureka Sound Formation) or Neogene (Beaufort Formation) age.

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3 Acadia University, Wolfville

ARCTIC CANADA'S CHANGING MAGNETIC FIELD

L.R. Newitt[1]

As in other regions of the Earth, the Canadian Arctic experiences gradual changes in the magnetic field, known as secular variation. There are only a few locations in the Arctic where repeat observations allow us to determine the secular variation for more than a few decades in the past. Observations made at the International Polar Year (1882-83) stations show the magnitude of the secular variations at three widely separated locations over the past 150 years or so. The secular variation results in the slow motion of the North Magnetic Pole, where the magnetic field is vertical. Since the beginning of the century, the pole has moved approximately 800 km north-west. Solar activity also causes the Earth's magnetic field to change, much more rapidly. In the high Arctic the magnetic declination may change by more than 20° on a typical summer's day.

1 Geophysics Division

THE NEW YELLOWKNIFE SEISMIC ARRAY

R.G. North[1], P.W. Basham[1]

The original (1963) array consisted of 18 seismometers installed in surface vaults at intervals of 2.5 km along lines running exactly east-west and north-south. It provided high quality data for the detection, location and identification of underground nuclear explosions and for related research. A site just west of Yellowknife was chosen because of its geological uniformity and low microseismic and cultural noise levels.

Ageing equipment led to decreasing array reliability, and there have been considerable advances in seismological techniques and computer and communications technology since 1963. The array was completely modernised in 1989 by the refurbishment of the short-period array and the addition of a four-element broadband array. Data from the new array is sent over a dedicated satellite link to Ottawa, where sophisticated processing is applied to produce a near real-time bulletin of worldwide earthquakes and nuclear explosions. All data is archived onto optical disk and made available to scientists worldwide.

[1] Geophysics Division

CANADA/USSR, 1:6 000 000 SCALE, CIRCUMPOLAR BEDROCK GEOLOGY MAP OF THE ARCTIC

A.V. Okulitch[1], B.G. Lopatin[1], H.R. Jackson[1] C.G. Currie[1]

This map is a product of the Canada/USSR Agreement on Scientific Cooperation in the Arctic. The Geological Survey of Canada and the All-Union Research Institute of the Geology and Mineral Resources of the World's Oceans shared data, collecting techniques and hypotheses. For marine areas, Soviet compilers used geophysical and well data and geomorphological studies of the seafloor. Canadian compilers used magnetic anomalies, basin margin stratigraphy and heat flow data to determine ages of basins, and adjacent continental geology, seismic surveys and shallow cores. Some of the resulting differences in interpretation were resolved but fundamental disagreement about ocean crust genesis remains.

The map provides data for modelling the evolution of the circum-Arctic region and guidance for resource evaluation. Ocean basin deposits contain information about past global climates and crustal plate motions.

This map was published in three months through cooperation among staff of the Geological Survey of Canada in Halifax, Calgary and Ottawa, and a contracted computer graphics firm in Montreal.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

STRUCTURAL EVOLUTION OF THE ARCTIC ARCHIPELAGO

A.V. Okulitch[1], H.P. Trettin[1], J.C. Harrison[1], U. Mayr[1]

The evolution of the Arctic Archipelago began with formation of the Archean-Aphebian basement. Aelikian rifting produced mafic intrusions and flows and peri-cratonic coarse clastics. Hadrynian rifting, dyke swarms and flows preceded unconformable deposition of Paleozoic sediments.

Accretion of exotic Pearya by sinistral transpression occurred in the Late Silurian and N-trending basement fabric responded to Caledonian compression in the Siluro-Devonian to form several uplifts. Devonian clastic wedges from the Caledonian orogen prograded across the region. The Devono-Carboniferous Ellesmerian Orogeny terminated deposition.

Carboniferous to Permian rifting initiated the Sverdrup Basin which filled with 15 km of clastics up to the Cretaceous. Jurassic-Cretaceous rifting affected the NW margin of the basin during opening of the Arctic Ocean. Carboniferous evaporites formed diapirs throughout the Mesozoic.

Intraplate deformation in the eastern Archipelago during Paleogene seafloor spreading in the Labrador Sea formed the Eurekan Orogen. Neogene to Holocene clastics were deposited during continued opening of the Arctic Ocean.

[1] Institute of Sedimentary and Petroleum Geology, Calgary

EVIDENCE OF CONTEMPORARY CLIMATE CHANGE IN THE MACKENZIE VALLEY, N.W.T.

Permafrost Research Section[1],
Atmospheric Environment Service[2],
Indian and Northern Affairs Canada

Many global change scenarios predict that a pronounced warming may result over the next several decades in the Canadian Arctic. The impacts of a possible warming of several degrees on the permafrost environment have important implications for both existing and planned northern engineering projects. Possible impacts include increased depth of seasonal thaw, long term degradation of permafrost, with increased thaw settlement in ice-rich terrain and mass movements of thaw-sensitive slopes. Although a change in permafrost temperature may be expected as a result of a secular change in air temperature, the relationship between ground temperature and air temperature is not straightforward due to complex surface energy exchange processes. The magnitude, extent and rate of permafrost response to climate change are therefore not simple to predict. A cooperative project was thus established in 1986 in order to examine and better understand permafrost and climate relationships along the Mackenzie Valley corridor. Several instrumented sites have been established and gradually equipped with AES automatic weather stations and GSC/INAC deep ground temperature boreholes. Analysis and monitoring of ground temperature and climate data will provide both information on recent surface temperature changes and on the ground thermal response to current local climate trends. Analysis of existing air temperature data from standard meteorological stations yields statistically significant increases of about 1 K in the past 50 years. A preliminary examination of ground temperature profiles from the Norman Wells, Gibson Gap, and Wrigley areas provides evidence of recent surface temperature increases.

[1] Geological Survey of Canada
[2] Environment Canada

REGIONAL LAMPROITE-MINETTE VOLCANISM IN THE THELON HINTERLAND: VOLCANIC SUCCESSIONS AND TECTONICS IN THE DUBAWNT LAKE AREA, N.W.T.

T.D. Peterson[1]

Two km of lamproite-minette lavas and pyroclastic rocks (1.85 Ga lower Dubawnt Group: Christopher Island Formation [CIF]) occur within fault-bounded basins in the Dubawnt Lake area. The felsic-mafic-felsic sequence overlies an erosional unconformity with little intervening sediment. Olivine minettes (lamproites) occur within the mafic flows but do not have the unusually low Al contents of diamond-bearing lamproites. Dubawnt Lake is 100 km ESE of the projected intersection of the brittle Bathurst and Macdonald faults, formed at the completion of the Slave-Churchill collision at ≈1840 Ma. Pre-, syn-, and postvolcanic non-dilational brittle faults at Dubawnt Lake are conjugate (240° and 300°), and parallel to the Bathurst and Macdonald faults. The faults provided fractures for feeder dikes and rotated crustal blocks up to 70°. Younger strike-slip, dilational faults indicate a phase of dextral transpression.

There is a strong global association between earlier or concurrent subduction, transpression/strike-slip faulting, and lamproite-minette volcanism, and the CIF has been correlated

with the Slave-Churchill collision and previous subduction of oceanic crust at ≈1960 Ma beneath the Thelon Arc. Lithospheric shortening during transpression may have caused uplift and progression from non-dilational to dilational faulting, with volcanism triggered by tectonic uplift of lithosphere containing hydrously metasomatized mantle.

1 Continental Geoscience Division

USE OF DIGITAL GROUND PROBING RADAR SOUNDING IN ARCTIC GEOMORPHOLOGY AND PERMAFROST ENGINEERING

J.A. Pilon[1], M. Allard[2], R. Lévesque[2], J. Kasper[2]

As technological development takes place, digital ground probing radar is increasingly used in surveys and projects where stratigraphic, textural and structural information is to be obtained from soil depths ranging from the near surface down to a few tens of meters. We present here three examples of radar profiles in different Quaternary sediments and permafrost features. First a series of profiles across a peat plateau in Kangiqsualujjuaq show the variation in the concentration of segregated ice within the permafrost feature in parallel with the topographical variation of the ground surface. A second set of profiles across a pattern of tundra polygons on an alluvial terrace in Salluit shows the distribution of relatively small ice wedges beneath the surface. A third example is a 1.3 km long profile surveyed at the location of a new airstrip near Tasiujaq before construction. The sub-horizontal stratigraphy of the post-glacial marine and alluvial sediments, including an ice rich silty layer at a depth of 1 to 2.5 m shows up very clearly on the ground penetrating radar data.

1 Terrain Sciences Division
2 Centre d'études nordiques, Université Laval

MARINE GEOLOGY OF THE ARCTIC: THE CANADIAN COMPILATION FOR THE CANADA - USSR QUATERNARY MAP OF THE ARCTIC

D.J.W. Piper[1], P.J. Mudie[1], R.J. Fulton[2]

This poster highlights the compilation of Canadian marine data in the Arctic Archipelago and the polar continental shelf. Knowledge of some areas is sufficient to prepare a 1:5 000 000 map, but in many areas data is almost completely lacking. Even improved bathymetric data has been of value in developing geological interpretations. Chronological data remains sparse, making geological correlations difficult.

1 Atlantic Geoscience Centre, Dartmouth
2 Terrain Sciences Division

INITIATION OF NATKUSIAK FLOOD BASALT VOLCANISM: EVIDENCE FROM THE UPPERMOST SHALER GROUP, VICTORIA ISLAND, N.W.T.

R.H. Rainbird[1], A.N. LeCheminant[1], L.M. Heaman[1]

Stratigraphic and sedimentological investigations suggest relative contemporaneity between deposition of the uppermost Shaler Group and initiation of the Franklin-Natkusiak magmatic episode. Evidence that initiation of magmatism coincided with uplift of the sedimentary basin (Amundsen Embayment) is recorded by features such as erosional unconformities and extension-related block faulting. Differential uplift may have been responsible for regionally restricted deposition of the Kuujjua Formation, a lenticular-shaped quartz arenite body which caps the sedimentary sequence. Facies analysis, as well reveals an upsection transition from marine to terrestrial depositional environments and a major influx of terrigenous detritus just prior to eruption of the Natkusiak flood basalts. Soft-sediment deformation features, attributed to frequent earthquake activity and perhaps to magma emplacement itself, are ubiquitous and indicate that the uppermost sediments were unlithified at the time of Natkusiak magmatism.

These relationships imply that a precise upper age limit for sedimentation in the Amundsen Embayment can be obtained through U-Pb geochronology of diabase sills emplaced into the Kuujjua Formation and lowermost flood basalts. Preliminary analyses of baddeleyite separates from three different sills provide an age of 720-725 Ma.

1 Continental Geoscience Division

ACCESS NORTH: GSC GATEWAYS TO NORTHERN GEOSCIENCE LITERATURE

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

GEOSCAN is our national bibliography for the Earth sciences. This automated data base provides bibliographic, geographic and subject access to publicly available geoscience literature concerning the Canadian landmass and offshore regions. GEOSCAN is cooperatively produced through indexing contributions from fourteen participating geoscience organizations including a professional society, a university and government organizations at both the federal and provincial levels. The Geological Survey of Canada coordinates the activities of this indexing network and provides computer resources in support of this project. The GEOSCAN network presents an excellent example of federal/provincial cooperation and can serve as a model for other similar ventures.

The GEOSCAN "gateway" provides cost effective and timely access to the geoscience literature of Canada's northern regions. The northern component of GEOSCAN contains approximately 20 000 bibliographic references and this data set includes publications, theses, maps and unpublished industry-generated mineral assessment reports. This wealth of northern geoscience information is available to the Canadian public primarily through published bibliographies and individualized online retrievals by GSC Library staff. In addition, downloads of large data sets in a machine-readable format of the client's choice can be accommodated. GEOSCAN supports and stimulates northern research and exploration programs by providing a unique "gateway" to the geoscience literature of the region.

1 Geoscience Information Division

MAGMATISM AND METAMORPHISM IN THE THELON TECTONIC ZONE, N.W.T.: EVIDENCE FROM ION PROBE AND SINGLE ZIRCON U-Pb ANALYSES

J.C. Roddick[1], O. van Breemen[1]

The Thelon Tectonic Zone (TTZ) contains granitoid gneisses and migmatitic supracrustal rocks produced by the Proterozoic collision of the Archean Slave Province with the Churchill Province. Previous multi-grain U/Pb zircon analyses indicated tectonic events in the interval 2.4 to 1.9 Ga but did not resolve their precise timing. New ion probe and single zircon analyses resolve these events. A tonalitic granulite gneiss, from the southern end of the TTZ, contains zircons with 2.3 Ga cores, 2.15 Ga euhedral mantles and minor outer metamorphic overgrowths at 1.95 Ga. Some 250 km to the north, two igneous intrusions were emplaced at 1.98 Ga. Subsequently, they were affected by syntectonic partial melting and granulite metamorphism at 1.9 Ga. The timing of high grade metamorphism appears to be

locally variable, with apparently three events in the TTZ occurring between 1.95 Ga and 1.87 Ga.

1 Continental Geoscience Division

STATE OF THE ART ANALYSIS OF GEOLOGICAL MATERIALS BY X-RAY FLUORESCENCE

R.M. Rousseau[1]

During the last three decades, X-ray fluorescence (XRD) analysis has undergone a spectacular evolution from all points of view: sample preparation, XRF spectrometers, methods and software.

Samples for XRF analysis can be prepared in the form of a fused disk or of a pressed pellet.

Wavelength dispersive spectrometers are very stable, very sensitive and completely computer controlled, making them very easy to use.

The author has proposed a fundamental algorithm to convert measured intensities into concentrations and it uses theoretical influence coefficients to correct for matrix effects.

The use of this algorithm requires very complex calculations which must be done by a computer. The author has written a program, named CIROU, to perform this task.

The program is very easy to use. It is a step-by-step guide to routine XRF analyses using a main menu bar containing six major options, which provide several other options inside a pull-down window system.

1 Mineral Resources Division

NEW FINDINGS RELATING TO THE STRATIGRAPHY AND STRUCTURE OF THE HUDSON PLATFORM

B.V. Sanford[1], A.C. Grant[2]

Marine and onshore investigations of the Hudson Platform in 1985, 1986, 1987 and 1988 have necessitated major revisions to the geology of this broad region of northeastern Canada. The new data provide particularly good resolution of subsurface structures and improved knowledge of the areal distribution of Ordovician to Devonian rock units both in onshore and offshore regions of the platform. Important new findings also relate to the identification and mapping of Cretaceous rocks in central Hudson Bay and in the deeper channels of eastern Hudson Strait, Evans Strait and Foxe Channel. Field investigations on southwestern Baffin Island and subsurface studies of the Hudson Bay Lowlands provide an improved lithostratigraphic classification of the Ordovician succession, and a better definition of the stratigraphic position and distribution of "oil shale" units that occur within that system. To clarify the stratigraphy, a number of new names are proposed for Ordovician rock units in Foxe Basin and the Akpatok Island region of the Ungava Basin.

1 Continental Geoscience Division
2 Atlantic Geoscience Centre, Dartmouth

THE CANADIAN ICE ISLAND RESEARCH STATION – UPDATE ON THE DRIFT TRACK, PROJECTS AND FACILITIES

M. Schmidt[1]

Since calving from the Ward Hunt Ice Shelf in 1982 the Ice Island has drifted along the Arctic continental shelf providing a base from which to conduct geological, geophysical, oceanographic, meteorological, ice properties and related fieldwork. The Polar Continental Shelf Project has established an extensive infrastructure on the island and has in the last five years gained valuable knowledge in erecting and maintaining structures on an ice platform. In the fall of 1988 the island drifted into the mouth of the Peary Channel; in August 1989 it began a slow southerly drift down the channel. Until 1989 the island's drift was influenced by the oceanic currents and prevailing winds as they affected the entire ice pack. The projected course through the Arctic Islands will likely be governed by the intra-island currents, winds and the short season of "open water" from August through November.

1 Geophysics Division

EVOLUTION OF ESKER SYSTEMS, KEEWATIN ICE SHEET

W.W. Shilts[1], J.M. Aylsworth[1]

Most of the northwestern Canadian Shield is covered by an integrated pattern of relatively continuous eskers radiating outward from the area of the Keewatin Ice Divide. Eskers formed where surface drainage plunged through crevasses or moulins some distance from the backwasting glacier edge, incorporating basal sediment from a broad zone adjacent to the esker tunnel. The integrated pattern suggests that the tunnels, although short at any given time, must have migrated by thermal erosion headward, following the trace of the late glacial drainage net on the surface of the largely stagnant ice sheet. Many eskers are flanked by glaciofluvial outwash terraces – remnants deposited by braided meltwater streams flowing across a temporary ice floor. We suggest that thin (<25 m) masses of ice were left behind in depressions as the ice front retreated, probably due to the insulating effects of basal debris melting out of the surface of downwasting, stagnant ice.

1 Terrain Sciences Division

GRAVITY-DENSITY MODELS OF THE QUEEN ELIZABETH SHELF OFF AXEL HEIBERG AND ELLESMERE ISLANDS

L.W. Sobczak[1], D.M. Henderson[1], D. O'Dowd[1]

The structure of the Queen Elizabeth shelf and slope northwest of Axel Heiberg and Ellesmere islands has been analyzed along seismic refraction lines. Gravity-density analysis constrained by seismic refraction depths indicates a major sedimentary sequence varying in thickness from 3 km to 15 km. The lower portion, consisting of the Sverdrup and Franklinian basins, has in places been thermally metamorphosed and intruded by mafic rocks. Areas thus affected are usually outlined by positive enhanced isostatic gravity anomalies (EIA). Unmetamorphosed counterparts have a negative gravity signature. These straddle the Sverdrup Rim and extend southward from it to occupy the western Sverdrup Basin within the Queen Elizabeth Islands, where significant deposits of hydrocarbons, largely in the form of natural gas, have been found. Similar hydrocarbon prospects are proposed for the offshore regions associated with negative EIA.

A shallow, high velocity zone, detected along a seismic refraction profile normal to the shoreline and interpreted by seismologist as the expression of uplifted faulted blocks of the Franklinian Basin, is here interpreted largely in terms of a wall of migrated evaporites which may contain some mafic intrusions of Eurekan age. These proposed evaporites are also detected as a wider high velocity zone along a line parallel to the shore. The high velocity zones along both lines coincide with the same gravity gradient.

1 Continental Geoscience Division

LITHOPROBE COAST TO COAST – HIGHLIGHTS FOR 1989

C.P. Spencer[1], A.G. Green[1], R.M. Clowes[2], F.A. Cook[3], G. Quinlan[1]

LITHOPROBE is a multi-disciplinary project investigating the lithosphere beneath Canada. It has recently completed two major seismic reflection surveys, one in southwestern British Columbia and the second in Newfoundland.

The B.C. survey involved the collection of 950 km of 18s Vibroseis data supplemented by two special projects. Near Powell River, data were shot to allow imaging of structures as deep as 85 km, and on the west side of Arrow Lake, south of the Monashee Mountains, data were recorded using an areal configuration designed to image structures in three dimensions. Highlights of this survey include a spectacular series of reflections from the south end of the Monashees, and dipping events seen at 15s two way travel time recorded near the coast.

The Newfoundland survey included 650 km of "normal" seismic acquisition together with a 16 km "high resolution" survey across the Buchan's ore body financed jointly by LITHOPROBE and BP. These surveys have been especially successful at imaging near surface structures to tie in with geological mapping.

We shall present seismic sections showing the most important features of both these datasets.

1 Continental Geoscience Division
2 University of British Columbia, Vancouver
3 University of Calgary, Calgary

MARINE TRANSGRESSION OR SHORELINE EMERGENCE? – EVIDENCE IN SEABED AND TERRESTRIAL GROUND TEMPERATURES OF CHANGING RELATIVE SEA LEVELS, ARCTIC CANADA.

A.E. Taylor[1]

In some Arctic regions, Holocene sea level changes have left a strong thermal signature on deep ground temperatures that are measured today. Surface temperature changes of the order of 10-15°C accompanied marine regression due to uplift in some regions, and marine transgression due to rising of relative sea levels in others. As offshore areas emerged from sub-sea to Arctic sub-aerial conditions, or as terrestrial areas were inundated, strong thermal transients propagated into the ground.

Today, along emergent coasts of the Canadian Arctic Archipelago, measured temperature-depth gradients are large and positive but decrease to normal values at several hundred metres depth. The temperature profiles clearly lie between equilibrium states typical of marine and terrestrial environments. In the offshore permafrost of the Canadian Beaufort Sea, the few available deep temperature measurements lie within a few degrees of 0°C, approaching thermal equilibrium only at the seabed. These two contrasting environments are modelled by several classical techniques.

The characteristic ground temperature profile measured in such coastal areas is a direct thermal-physical consequence of changes in relative sea level, not a proxy record.

1 Terrain Sciences Division

MODERN COASTAL ENVIRONMENTS AND PROCESSES OF BYLOT AND NORTHEASTERN BAFFIN ISLANDS, N.W.T.

R.B. Taylor[1], J.P.M. Syvitski[1]

Modern coastal deposits were examined between 1979 and 1987 at three glacial valleys along eastern Bylot Island. Each deposit exhibited a different sediment character and beach morphology both in an alongshore and across shore direction. At two of the sites there was evidence of older beach deposits which suggested that these shores are in a transgressional stage. At the northern valley the older, slightly raised, beach ridges are truncated or incorporated into the modern beach whereas at the southern valley the modern storm ridge has been built to more than 1.0 m above the older beach surface.

The modern beach is composed of marine reworked outwash deposits with high concentrations of heavy minerals. The beach varies from 20-140 m in width, and from low, wave overtopped, well mixed sand and gravel or sand deposits, to higher crested, well defined decoupled shore deposits with a gravel storm ridge fronted by a low gradient sandy lower foreshore. Shallow coring, and mapping of sediment facies at sections cut through the barrier during the lateral migration of stream outlets has provided an insight into the sedimentation patterns and the processes that presently modify these shores.

1 Atlantic Geoscience Centre, Dartmouth

GRAVITY SURVEYS IN SUPPORT OF LITHOPROBE SOUTHERN CORDILLERA TRANSECT, KAMLOOPS REGION

M.D. Thomas[1], D.W. Halliday[1], J.M. Moore[1], B. Grover[1]

LITHOPROBE-related gravity measurements 1 to 3 km apart were made along traverses in the Intermontane (IB) and Omineca Crystalline (OCB) belts in the summer of 1989. A traverse along seismic reflection line 19 within the OCB realized the objective of making detailed, i.e. closely spaced, measurements along all seismic lines. Other traverses investigated specific geological targets within the IB near Kamloops, in an area between line 19 and more southerly seismic lines. The new gravity data together with older regional data define a prominent -25 mGal amplitude anomaly over the largely granitic central Nicola Horst. In contrast traverses across the NE margin of the granitic Wild Horse Batholith reveals it to be associated with a weak gravity signature. Considering that nearby rocks of the Nicola Group may be thrust eastward over the Chipperon Group the gravity data suggest that the Wild Horse Batholith exists as a thin thrust wedge. Gravity models of these and other bodies are presented and discussed in terms of regional tectonics.

1 Continental Geoscience Division

SELECTED PHANEROZOIC LITHOFACIES MAPS, ARCTIC ISLANDS AND NORTH GREENLAND

H.P. Trettin[1], A.F. Embry[1], U. Mayr,[1], W.W. Nassichuk[1]

The Early Cambrian to Early Tertiary evolution of the Arctic Islands and related parts of North Greenland is depicted in 20 generalized maps, showing a total of 15 lithofacies, with brief interpretative notes. The lithofacies maps are supplemented by stratigraphic and tectonic diagrams.

1 Institute of Sedimentary and Petroleum Geology, Calgary

THE MARG Zn-Pb-Cu-Ag-Au MASSIVE SULPHIDE DEPOSIT: A NEW DISCOVERY, SELWYN BASIN

R.J.W. Turner[1], G. Abbott[2]

The Marg Zn-Pb-Cu-Ag-Au volcanogenic massive sulphide deposit is located 40 km NE of Keno City, Yukon within a south-dipping imbricate thrust array of black carbonaceous, siliceous phyllite, quartz-sericite-chlorite-carbonate schist, and quartzite of Early Mississippian age. Indicated and inferred reserves are 1 922 000 tonnes grading 1.97%Cu, 5.19% Zn, 2.72% Pb, 1.97 opt Ag, and 0.03 opt Au. The sulphide body is an isoclinal fold above a northerly directed thrust fault. A linear paleo-vent complex is characterized by a ferroan carbonate-rich massive pyrite sulphide body with high Cu/Pb, Zn/Pb and Ag/Pb ratios and 'footwall' quartz phenocryst-bearing ferroan carbonate-quartz-sericite-pyrite schists. The sulphide body is zoned outward to a quartz-pyrite and outermost massive pyrite. Major sulphides are pyrite, sphalerite, galena and chalcopyrite with minor tetrahedrite and arsenopyrite. Altered 'footwall' volcanic rocks away from the paleo-vent are sericite-quartz or chlorite-quartz schists.

1 Mineral Resources Division
2 Indian and Northern Affairs Canada, Whitehorse

THE JASON STRATIFORM Zn-Pb-Ag-BARITE DEPOSIT: EXHALATIVE AND REPLACEMENT PROCESSES ALONG A DEVONIAN SYNDEPOSITIONAL FAULT

R.J.W. Turner[1], B.E. Taylor[1], W.D. Goodfellow[1]

Stratiform sulphide-barite lenses occur within a debris apron of diamictite, conglomerate and siltstone adjacent to a Late Devonian syndepositional normal fault. Isopachs of diamictite form lobes that thin away from the fault. Laminated barite, chert, sphalerite, galena and pyrite which form the bulk of the lenses are replaced adjacent to the fault by massive, vein and breccia ferroan carbonate, galena, pyrite and pyrrhotite that represent the upflow zone of a reduced, sulphur deficient, Co_2-rich hydrothermal fluid. Replacement sulphides tend to have higher $\delta^{34}S$ then laminated sulphides (8.5 to 23.5 versus 4.0 to 14.5) due to reduction of barite or introduction of heavy hydrothermal sulphur. High $\delta^{18}O$ (6.2 to 14.1‰) calculated for the hydrothermal fluid suggests a very evolved basinal and metamorphic fluid. Initial strontium ratios in barite indicate deposition from an isotopically homogenous fluid distinct from seawater such as a ponded brine pool.

1 Mineral Resources Division

THE STRUCTURES OF THE ALPHA RIDGE, ARCTIC OCEAN AND ICELAND-FAEROE RIDGE, NORTH ATLANTIC OCEAN: COMPARISONS AND IMPLICATIONS FOR THE EVOLUTION OF THE CANADA BASIN

J.R. Weber[1]

Comparison of the Alpha Ridge with the Iceland-Faeroe Ridge reveals remarkably similar morphological, geological and geophysical characteristics and implies that the two ridges may have been formed by the same tectonic processes. It is postulated that in the Late Jurassic, the Alaska North Slope rotated away some 35° from the Arctic Islands, leaving behind the Northwind Ridge as a shear margin. In early Cretaceous, rotation around Mackenzie Delta continued involving the whole Alaska-Siberian plate, including a continental Chukchi Borderland and Mendeleev Ridge, moving away from the Canadian polar margin. The Icelandic hot spot, then located under Ellesmere Island, channeled plume material into the spreading centre, forming the Alpha Ridge. Channeling and spreading stopped in late Cretaceous after a rotation of 35°. The Arctic Ocean's oldest sediment core was recovered from the Ellesmere end of the Alpha Ridge, thus supporting the hypothesis of the Alpha Ridge formation by seafloor spreading.

1 Geophysics Division

EARTHQUAKE ACTIVITY IN THE NORTHERN ARCTIC

R.J. Wetmiller[1], J.A. Drysdale[1], R.B. Horner[1]

Earthquake activity in Canada north of 60°N is remarkable for the variety of geological terrains in which it occurs. Moderate-to-large earthquakes have occurred in the St. Elias Mountains, the Richardson Mountains, the Beaufort Sea and the Arctic Ocean, the Mackenzie Mountains, the Sverdrup Basin, in Baffin Bay and on Baffin Island. The largest earthquake north of the Arctic Circle (magnitude 7.3) took place in Baffin Bay in 1933. the Strongest earthquake ground shaking ever recorded (>2g) was experienced in the Mackenzie Mountains in 1985.

The Geological Survey of Canada operates seismograph stations across northern Canada to study this activity including one of the first stations established in the Arctic at Resolute Bay. The Survey has carried out a number of important field studies of northern earthquakes and has derived seismic zoning maps for northern Canada which help ensure the safe and orderly development of northern resources.

1 Geophysics Division

VIDEO

AN AERIAL VIEW OF THE COASTLINE OF JONES SOUND, N.W.T.

D. Frobel[1], R.B. Taylor[1]

In 1983, an aerial video survey was completed along 1135 km of the coastline of Jones Sound. The survey was part of a larger scale marine and coastal geological program completed in conjunction with the Canadian Hydrographic Service from the ship **CCS Baffin**. Eight video tapes (totalling 410 minutes) illustrating the coastline have been released as GSC Open File 1079. This presentation is the introductory tape from that Open File. It presents a brief overview of the history and general physiography of Jones Sound, examples of its coastline and a review of the processes that presently modify it. In addition the tape provides an outline of the information contained on the remainder of the video tapes in GSC Open File 1079.

1 Atlantic Geoscience Centre, Dartmouth

AUTHOR INDEX

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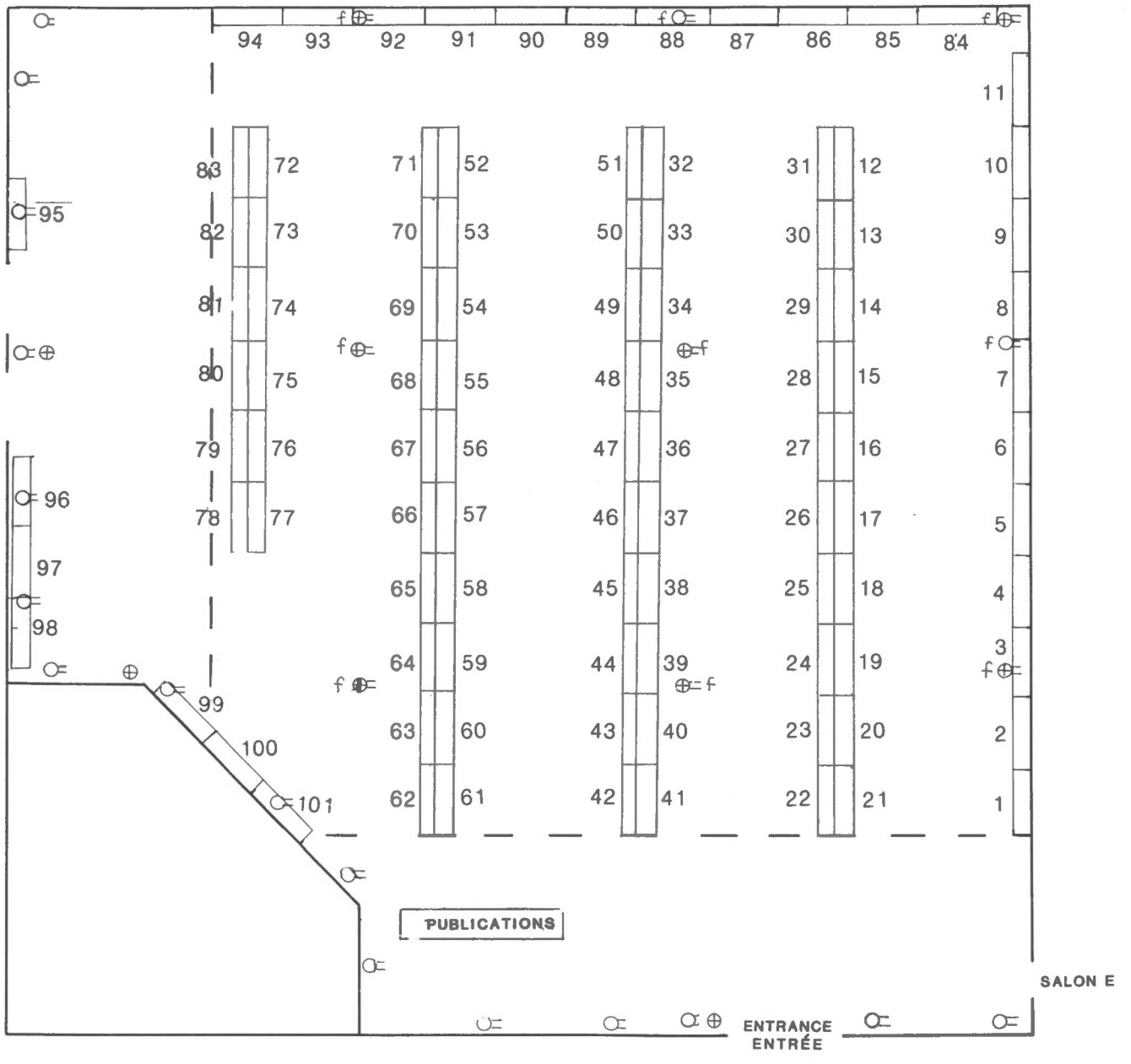

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