

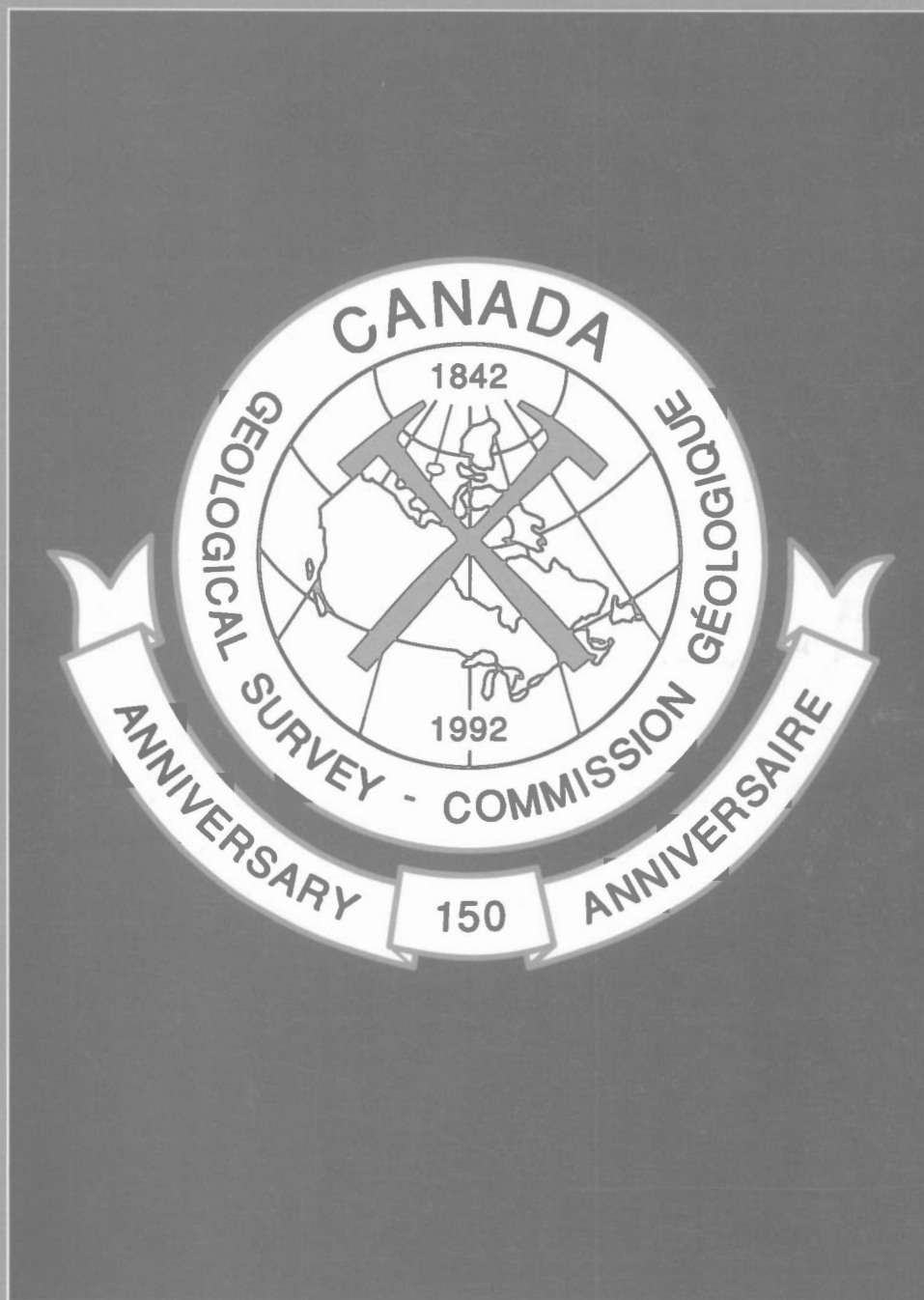
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ABSTRACTS



Energy, Mines and
Resources Canada

Energie, Mines et
Ressources Canada

Canada

THE ENERGY OF OUR RESOURCES

THE POWER OF OUR IDEAS

PLEOCHROIC GREEN BIOTITE: AN INDICATOR OF OXIDATION ASSOCIATED WITH GOLD MINERALIZATION, KIRKLAND LAKE, ONTARIO

A.E. Lalonde¹, D.G. Rancourt², E.M. Cameron³

Numerous recent studies have demonstrated that the fluids responsible for the gold mineralization in the Kirkland Lake area were strongly oxidizing. Evidence in support of this includes fractionation of sulphur isotopes, occurrence of minute barite-celestine phases, and other mineralogical or geochemical indicators that, in general, are not readily accessible to explorationists. It would therefore be useful to seek simple, inexpensive and yet reliable indicators of the oxidizing alteration associated with the Kirkland Lake deposits. The occurrence of hydrothermal biotite with an unusual green pleochroism in many of the felsic porphyritic rocks hosting the mineralization may prove to be such an indicator. The green pleochroism in biotite is known to be caused by high magnesium and ferric iron (Fe^{3+}) contents, compositional features that both indicate crystallization under highly oxidizing conditions. This project is aimed at documenting the occurrence of green-pleochroic hydrothermal biotite in the igneous rocks associated with the gold deposits in the Kirkland Lake area, and assessing its usefulness as an indicator of oxidizing alteration. This will involve principally the chemical analysis of biotite samples, the determination of $\text{Fe}^{3+}/\text{Fe}^{2+}$ values by Mössbauer spectroscopy and the quantification of pleochroism by optical spectrophotometry.

¹ Department of Geology, University of Ottawa, Ottawa

² Department of Physics, University of Ottawa, Ottawa

³ Mineral Resources Division, Ottawa

Geological Survey of Canada

CURRENT ACTIVITIES FORUM

19-20 January 1993

Place:

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

Non-Technical Event:

An informal get-together with cash bar on
Tuesday, 19 January from
16h30 to 19h30 in hall A.

Popular Lecture:

At 19h30 on the evening of Monday, 18 January
Steven M. Blasco will present a talk entitled
"Exploring the wreck of the Titanic: science through collaboration"

Scientific Displays:

Over 125 displays will be on view
after the lecture in Hall A

PROGRAM

TUESDAY, 19 January 1993

09h00 Introduction
E.A. Babcock, R.P. Riddihough

LUNCH

09h20 Industrial participation in the national geophysics programs of the GSC
M.J. Berry

09h40 Equipment and technical development for industrial applications in engineering geophysics
J.A.M. Hunter

10h00 **Coffee Break**

10h30 New perspectives on the geological evolution of the Slave Province: results from the NATMAP Slave Province Project
J.E. King, M. Stubbley, V. Jackson, D. Baril, the NATMAP Slave Province Working Group

10h50 Integrated studies of paleomagnetism and U-Pb geochronology of mafic dyke swarms and their use in paleocontinental reconstructions
K.L. Buchan, J.K. Mortensen, R.E. Ernst, K.D. Card, J.A. Percival

11h10 The Montauban group and La Bostonnais complex: arc magmatism ca. 1.4 Ga in the Grenville Province, Quebec
L. Nadeau, O. van Breemen

11h30 A collaborative, multidisciplinary investigation of the Archean and Early Proterozoic geology of northern Torngat orogen, Labrador, Quebec and N.W.T.
M. Van Kranendonk, R.J. Wardle, D.J. Scott, F.C. Mengel, L. Campbell, L. Godin, D. Bridgwater, T. Rivers, S. Schwarz

14h00 NATMAP Shield Margin Project: understanding the Flin Flon-Snow Lake Belt (Manitoba and Saskatchewan) through integrated multi-disciplinary and multi-institutional studies
S.B. Lucas, J. Broome, P.G. Lenton, D.J. Thomas, I. McMartin, P.F. Williams, the NATMAP Shield Margin Project Working Group

14h20 A new perspective of the Trans-Hudson Orogen
D. White, A.G. Jones, S.B. Lucas

14h40 Clastic glacial dispersal and pedogenic enrichment of gold in tills of the Eastmain greenstone belt, James Bay Region
M. Parent

15h00 Validation of General Circulation Models through the use of geological information: a GSC-CCC-RSC co-operative program
J.V. Matthews, Jr., H. Jetté

15h20 Evidence for large prehistoric earthquakes and tsunamis in southwestern British Columbia
J.J. Clague

15h40 Taking GPS to the top of Canada
M. Schmidt

WEDNESDAY, 20 January 1993

09h00 GSC studies of in-situ stress in sedimentary
basins and their applications
J.S. Bell

09h20 Characterization of the coal and coal bed
methane resource potential of Nova Scotia
J.D. Hughes, D.J. MacNeil

09h40 Evaluation of coalbed methane "resource",
Gulf of St. Lawrence region
A.C. Grant

10h00 **Coffee Break**

10h30 GEOSCAN: a unique partnership in
delivering geoscience information
B.B. Blair, J. Gillespie, C. Patey

10h50 Federal-Provincial cooperation in geoscience
surveys
M.E. Cherry

11h10 Volcanic response planning: a federal-
provincial, multi-agency initiative
C.J. Hickson

11h30 National native home radon survey –
maximizing resources through radon potential
assessment
**B.W. Charbonneau, R.L. Grasty,
W. Cocksedge, W. Rankin,
W. Tostowaryk, M. Rahman**

LUNCH

14h00 Magmatism and gold at Kirkland Lake,
Ontario
**G.S. Levesque, A.E. Lalonde,
E.M. Cameron**

14h20 Pb-Zn deposits of the Lower Windsor: if
carbonates could talk...
M. Savard

14h40 Transgressive peridotite pipes in the Caribou
Hill mafic layered intrusions, Mount Peyton
Complex, central Newfoundland: analogues
of Bushveld platiniferous dunite pipes?
O.R. Eckstrand, E.H. Cogulu

15h00 Geology of the Port aux Basques area,
Newfoundland
C.R. van Staal, S. Lin

15h20 Giant impacts: consequences for biological
extinctions, global environments, and ore
formation
W.D. Goodfellow

TALKS

INDUSTRIAL PARTICIPATION IN THE NATIONAL GEOPHYSICAL PROGRAMS OF THE GSC

M.J. Berry¹

The GSC undertakes several geophysical programs that are national in scope. Among these are programs in Aeromagnetism, Gravity, Seismology, Geomagnetism and Geodynamics. Industrial participation differs in each of these, but is important in them all. Participation includes direct contribution of funds for surveys, monitoring and research, purchase of data, provision of services, and the undertaking of surveys and observatory operations by contract. In 1992-3 contributions in cash or kind amounted to 15% of total budget, rising to 24% when contributing funds from the U.S.A. are included. \$1.5 million was contracted back to Canadian Industry for scientific data collection. This degree of industrial participation provides one measure of the value of the GSC's geophysical programs to Canada.

¹ Geophysics Division, Ottawa

EQUIPMENT AND TECHNICAL DEVELOPMENT FOR INDUSTRIAL APPLICATIONS IN ENGINEERING GEOPHYSICS

J.A.M. Hunter¹

Terrain geophysics and geothermal section of the Terrain Sciences Division has been engaged in the development of various equipment and techniques related to engineering, groundwater, and environmental geophysical problems. These developments are often related to and in support of GSC core activities projects, but are also initiated by requirements by industry. Close co-operation with Canadian industry has resulted in rapid technology transfer to enhance the Canadian industry competitive edge. Funding for such programs has come from various sources including GSC A-base, Energy R&D, and the Industrial Partners Program.

In the past 10 years notable developments include:

1. The evolution of shallow high resolution seismic reflection technique, equipment, and computer software
2. The developmental support of deep penetration ground probing radar equipment
3. The design and testing of deep-tow marine seismic refraction technique
4. The vertical seismic array concept and initial testing
5. The commercialization of the Russian capacitive-coupled high frequency electrical resistivity system and technique.

The GSC expertise provides the vital link between both inhouse and international applied research and the Canadian engineering geophysical industry. It is hoped that the GSC will be able to continue to provide leadership and guidance to Canadian companies in an increasingly competitive global market.

¹ Terrain Sciences Division, Ottawa

NEW PERSPECTIVES ON THE GEOLOGY OF THE SLAVE PROVINCE: RESULTS FROM THE NATMAP SLAVE PROVINCE PROJECT

J.E. King¹, M. Stubbley², V. Jackson³, D. Baril¹ and the NATMAP Slave Province Working Group

Bedrock mapping and associated multidisciplinary studies, recently enhanced through GSC NATMAP funding and the Canada-N.W.T Mineral Initiative, have provided new insight into the geological framework of the Slave Province (N.W.T.). Detailed study of lithologic distribution documented a greater areal extent of Yellowknife Supergroup (ca. 2.65-2.7 Ga), as well as new locations of probable pre- and post-Yellowknife Supergroup assemblages. On-going geochronological studies will test interpreted age relations. In addition, previously known and newly recognized fault zones were extended and their kinematic and temporal evolution are being analysed. Although not yet fully tested with isotopic methods, it appears that the Slave Province experienced significant post 2.6 Ga brittle-ductile faulting.

Digital storage of geological, geophysical, remote sensing, mineral inventory, and other data types will facilitate the utilization of GIS-type analysis in evaluating the geological evolution of the Slave Province.

¹ Continental Geoscience Division, Ottawa

² Canada-GNWT Mineral Initiatives Office, Yellowknife

³ Geology Office, DIAND, Yellowknife

INTEGRATED STUDIES OF PALEOMAGNETISM AND U-Pb GEOCHRONOLOGY OF MAFIC DYKE SWARMS AND THEIR USE IN PALEOCONTINENTAL RECONSTRUCTIONS

K.L. Buchan¹, J.K. Mortensen¹, R.E. Ernst², K.D. Card¹,
J.A. Percival¹

In the past Precambrian continental reconstructions based on paleomagnetism have not been reliable, due to an inability to accurately date paleomagnetic poles. To solve this problem, the first systematic attempt to integrate paleomagnetic and U-Pb geochronological studies is being undertaken on mafic dykes of the Canadian Shield. An emphasis is placed on sampling for both studies at the same sites, and on conducting paleomagnetic field tests to establish if the magnetic remanence is primary. Additional constraints are provided through restoration of the pre-tectonic geometry of dyke swarms.

Data are being collected in two widely separated areas of the Superior Province with distinctly different Archean structural trends, the southern portion of the province and the Minto block to the northeast. Preliminary results demonstrate that no relative rotation of these areas has occurred since 2220 Ma and probably since 2450 Ma.

¹ Continental Geoscience Division, Ottawa

² Ottawa-Carleton Geoscience Centre, University of Ottawa, Ottawa

THE MONTAUBAN GROUP AND LA BOSTONNAIS COMPLEX: ARC-MAGMATISM CA. 1.4 GA IN THE GRENVILLE PROVINCE, QUEBEC*

L. Nadeau¹, O. van Breemen²

Montauban group and La Bostonnais complex in the Portneuf-St.Maurice region of Quebec are interpreted as the remnants of a ca. 1.4 Ga magmatic arc. They represent a lithologically distinctive belt, less than 20 km wide, which extends northward for more than 150 km from the southern edge of the Grenville province.

Montauban group is dominated by siliciclastic metasedimentary rocks with subordinate metavolcanic rocks, mainly tholeiitic pillow basalt and felsic tuff. The calc-alkaline La Bostonnais complex comprises tonalite and quartz-diorite with subordinate diorite and gabbro. All of these meta-igneous rocks show REE and trace element distributions characteristic of arc-related rocks. U-Pb dating of igneous zircons from a felsic tuff unit provides an age ca. 1.45 Ga for the Montauban group. In accordance with cross-cutting field relationships, this age is slightly older than the two ca. 1.40 Ga zircon ages obtained from La Bostonnais complex.

¹ Quebec Geoscience Centre, Sainte-Foy

² Continental Geoscience Division, Ottawa

* Bilingual presentation

A COLLABORATIVE, MULTIDISCIPLINARY INVESTIGATION OF THE ARCHEAN AND EARLY PROTEROZOIC GEOLOGY OF NORTHERN TORNGAT OROGEN, LABRADOR, QUEBEC AND N.W.T.¹

M. Van Kranendonk², R.J. Wardle³, D.J. Scott⁴, F.C. Mengel⁵, L. Campbell⁶, L. Godin, D. Bridgwater⁵, T. Rivers, S. Schwarz

University research geologists from Canada, the U.S.A. and Denmark have joined a three-year Newfoundland-GSC mapping project in northern Labrador, Quebec and Northwest Territories to fully assess the tectonic history of high-grade Archean and Lower Proterozoic rocks in northern Torngat orogen. This collaborative research includes U-Pb geochronology, thermobarometric studies of metamorphic mineral assemblages, chemical analyses, Pb-Pb and Sm-Nd isotopic studies, and detailed studies of the structure and metamorphism of key deformation areas and rock units.

Results to date show that Archean gneisses of Nain Province in the east and of Rae Province in the southwest, were intruded by Early Proterozoic, calc-alkaline meta-igneous rocks dated as between ca. 1.91-1.86 Ga. Subsequent deformation and granulite- to amphibolite-facies metamorphism occurred from between ca.

1.84-1.71 Ga during formation of the Abloviak shear zone and subsequent regional folding and shearing along the Komaktorvik zone.

¹ Canada-Newfoundland Agreement on Mineral Development

² Continental Geoscience Division, Ottawa

³ Newfoundland Department of Mines and Energy, St. John's

⁴ Université du Québec à Montréal, Montréal

⁵ Geological Museum, University of Copenhagen, Copenhagen

⁶ Department of Geological Sciences, University of Colorado, Boulder

NATMAP SHIELD MARGIN PROJECT: UNDERSTANDING THE FLIN FLON-SNOW LAKE BELT (MANITOBA AND SASKATCHEWAN) THROUGH INTEGRATED MULTI-DISCIPLINARY AND MULTI-INSTITUTIONAL STUDIES^{1,2}

S.B. Lucas³, H.J. Broome³, P.G. Lenton⁴, D.J. Thomas⁵, I. McMartin⁶, P.F. Williams⁷, and the NATMAP Shield Margin Project Working Group

The NATMAP Shield Margin Project is focused on the Cu-Zn-Ni-Au-rich Flin Flon-Snow Lake-Hanson Lake Belt and its sub-Paleozoic continuation in Manitoba and Saskatchewan, and involves over 50 participants from government surveys, research councils, universities and the minerals industry. Three major bedrock geological compilation projects, each spanning the Manitoba-Saskatchewan border were initiated in 1992. Detailed analysis of the high resolution aeromagnetic data, combined with gravity data and the results of systematic drillcore "mapping", has generated a new map for the sub-Paleozoic portion of NTS 63K. Compilation maps are being transferred into the central GIS/database for the project and integrated with other datasets (e.g., LandSat and radar imagery, geochronological and isotopic results, gravity, magnetics). Nd/Sm isotopic study of Flin Flon and Snow Lake stratigraphy indicates that massive sulphide-bearing volcanic sequences have distinctive Nd-isotopic profiles. Quaternary geoscience studies have focused on regional mapping, airphoto/satellite image interpretation, compilation, and till geochemistry and provenance studies.

¹ Contribution to the Canada-Manitoba Partnership Agreement on Mineral Development, 1990-95

² Contribution to the Canada-Saskatchewan Partnership Agreement on Mineral Development, 1990-95

³ Continental Geoscience Division, Ottawa

⁴ Manitoba Geological Services Branch, Manitoba Mines and Energy, Winnipeg

⁵ Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Regina

⁶ Terrain Sciences Division, Ottawa

⁷ Dept. of Geology, University of New Brunswick, Fredericton

A NEW PERSPECTIVE OF THE TRANS-HUDSON OROGEN

D.White¹, A.G. Jones², S.B. Lucas²

LITHOPROBE has collected >800 km of seismic reflection data and 110 magnetotelluric (MT) soundings along a continuous E-W transect that extends westward from the Superior craton across the Early Proterozoic Trans-Hudson Orogen to the Hearne craton. The

seismic sections are dominated by strong eastward-dipping reflections. In the western part of the Orogen a reversal in reflection dip defines a crustal-scale culmination, which on geological and geochronological grounds appears to be cored by Archean rocks. Previous notions on the evolution of the Orogen must be reassessed since well-defined packages of Proterozoic rock dip beneath both Archean cratons to lower crustal depths, suggesting "thick-skinned" imbrication of Proterozoic rocks against the cratonic margins and precluding any simple extensions of the cratons beneath the Orogen.

The MT profile spatially correlates the North American Central Plains conductor with the Rottenstone-South Indian domain. A second thin crustal conductor was imaged which correlates with the Flin Flon-Snow Lake belt and may be related to the "TOBE" feature observed at the Canada-U.S. border.

Our interpretation concludes that the seismic images across the Orogen primarily represent structures generated during the terminal continent-island arc-continent collision rather than pre-collisional tectonic structures.

¹ Geophysics Division, Ottawa

² Continental Geoscience Division, Ottawa

CLASTIC GLACIAL DISPERSAL AND PEDOGENIC ENRICHMENT OF GOLD IN TILLS OF THE EASTMAIN GREENSTONE BELT, JAMES BAY REGION*

M. Parent¹

During a drift prospecting project in a region underlain by Archean amphibolites, analysis of the <0.063 mm fraction of till has led to the identification of a 4 km-long and 500 m-wide gold dispersal train. The dispersal train is aligned parallel to the regional ice-flow direction (240°) and occurs together with dispersal trains consisting of pathfinder elements (As, Sb) and granules (4-8 mm) derived from the sulphide-rich amphibolites which host the gold-rich veins.

Detailed sampling of trenches excavated in an area of auriferous till provides a record of rapid clastic dilution downglacier from the mineralized veins. Vertical profiles show gold enrichment by differential eluviation in the Ae horizon of podzols developed on auriferous till. This eluvial enrichment by a factor of 3 to 4 was somewhat unexpected; indeed it is one of the first times, if not the first, that the relative immobility of gold is so distinctly recorded in soil profiles from a boreal environment.

¹ Quebec Geoscience Centre, Sainte-Foy

* Bilingual presentation

VALIDATION OF GENERAL CIRCULATION MODELS THROUGH THE USE OF GEOLOGICAL INFORMATION: A GSC-CCC-RSC CO-OPERATIVE PROGRAM

J.V. Matthews, Jr.¹, H. Jetté¹

General Circulation Models (GCMs) are the primary method for assessing the future climatic impact of rising levels of atmospheric greenhouse gases. Virtually all GCMs replicate modern climate, suggesting they can accurately forecast future climate. Another test of their "robustness" is the ability of GCMs to simulate past climate.

To this end, modelers from the Canada Climate Centre (CCC) recently met with "paleo-proxy-data" experts to begin a test of the ability of the Canadian GCM to simulate climate 6000 years ago (6ka). The Ottawa workshop, jointly sponsored by the GSC, CCC, and Royal Society of Canada (RSC), under each's Greenplan and/or Global Change program, is part of the international Paleoclimate Model Intercomparison Project. Future meetings will deal with climate of other key intervals (6ka, 18ka, 125ka).

¹ Terrain Sciences Division, Ottawa

EVIDENCE FOR LARGE PREHISTORIC EARTHQUAKES AND TSUNAMIS IN SOUTHWESTERN BRITISH COLUMBIA

J.J. Clague¹

Co-operative research, involving the Geological Survey of Canada, the British Columbia Geological Survey, universities, and the private sector, is being carried out to document large prehistoric earthquakes in southwestern British Columbia. Recently, evidence has been found on western Vancouver Island and near Vancouver for such earthquakes. The sequence of sediments underlying tidal marshes at Tofino and Ucluelet indicates that western Vancouver Island subsided suddenly during a great subduction earthquake, some time within the last 1000 years. This earthquake was accompanied by a tsunami much larger than the one in 1964 that caused over \$20 million damage to coastal communities on western Vancouver Island. The uppermost sediments of the Fraser River delta, just south of Vancouver, are cut by sand dykes and sills that were emplaced less than 2000 years ago when subsurface sand layers liquefied during an earthquake. These liquefaction features could be products of one or more subduction earthquakes in the eastern North Pacific or smaller quake(s) centred near Vancouver.

¹ Terrain Sciences Division, Vancouver

TAKING GPS TO THE TOP OF CANADA

M. Schmidt¹

The Logan '92 Expedition was undertaken by the Royal Canadian Geographical Society in partnership with the Geological Survey of Canada, the Surveys, Mapping and Remote Sensing Sector (EMR) and the Canadian Parks Service. Using the Global Positioning System (GPS) the expedition measured the height of Mt. Logan, placed several survey markers to be used for monitoring crustal motion and undertook to collect rock samples for providing further insight into the historical rate of uplift of the Mt. Logan massif. Two GPS receivers were employed on the mountain to survey the summit and position a marker placed in the vicinity of the summit. The data were validated on a computer prior to leaving the summit area. Simultaneous GPS observations were made at two base stations. In addition to the GPS data collected on the expedition the final data reduction utilized GPS data from four permanent GPS trackers yielding a height for Mt. Logan of 5 959 m, ± 3 m. Most of this uncertainty stems from the uncertainty in the value for the geoidal undulation in this region.

¹ Pacific Geoscience Centre, Sidney

GSC STUDIES OF IN-SITU STRESS IN SEDIMENTARY BASINS AND THEIR APPLICATIONS

J.S. Bell¹

During the past decade, GSC scientists have documented and compiled information on the state of stress in many of Canada's sedimentary basins. regional syntheses have been completed in western Canada, the beaufort Basin, the Scotian Shelf, the Grand Banks and the Labrador Shelf. In-situ Stress information has been gathered also in central Canada, the Arctic Islands, Hudson Bay and other locations. No direct stress measurements have been undertaken by the GSC. Instead, magnitude and directional information has been obtained by studying oil industry well logs and drilling records, analyzing earthquake first motions and hydraulic fracture pressures, and through compiling published information. The results form an impressive body of subsurface in-situ stress data that is referred to by the oil and mining industries, by waste disposal planners and by earthquake risk assessors. This information is summarized in the GSC's national stress database and has contributed to the World Stress Map.

¹ Institute of Sedimentary and Petroleum Geology, Calgary

CHARACTERIZATION OF THE COAL AND COAL BED METHANE RESOURCE POTENTIAL OF NOVA SCOTIA

J.D. Hughes¹, D.J. MacNeil¹

Although coal has been mined in Nova Scotia for centuries, its role in energy production in the province has expanded rapidly since the late seventies, and it continues to be a significant employer in Cape Breton. In recent years the production of methane gas from coal beds has become economic in some areas of the United States and has spurred interest in coal bed methane in Nova Scotia. The tragic explosion in the Pictou Coalfield in May has underscored the need for detailed information on the geological and technological characteristics of these resources.

To assess the potential of Nova Scotia's coals for both conventional and nonconventional uses, the Geological Survey of Canada and Nova Scotia Department of Natural Resources have been compiling all available geological, coal rank and compositional information through the Canada-Nova Scotia Mineral Development Agreement. These data, which represent more than a century of geological exploration and mining, have been incorporated into comprehensive three-dimensional computer models which are used to quantify coal volumes according to economic, technological and geological characteristics. In addition to calculation of resource volumes, a wide variety of cross-section, map and other displays illustrate the depositional and structural setting of these can be generated to deposits.

The geological computer models developed for the Pictou and Cumberland coalfields will be used in fiscal 93-94 to locate drilling targets on the highest potential coal bed methane reservoirs in the Pictou and Cumberland coalfields. Detailed testing of cores from these holes will be used to determine the economics of producing methane from these coalfields, and hence define the potential of coal bed methane as an alternative energy resource for Nova Scotia.

¹ Institute of Sedimentary and Petroleum Geology, Calgary

EVALUATION OF COALBED METHANE "RESOURCE", GULF OF ST. LAWRENCE REGION

A.C. Grant¹

Geophysical data, drilling results and geological observations from the Gulf of St. Lawrence region have been synthesized to assess the extent and character of Upper Carboniferous Coal Measures. Information regarding thickness, rank and gas content of these Coal Measures has been incorporated in this synthesis to derive a speculative, but conservative estimate of the coalbed methane "resource". For the area of Coal Measures mapped within the Gulf of St. Lawrence region the estimated volume of methane is 2.16 billion m³ (76.3 trillion ft³). The calculated resource "on land" beneath central and eastern Prince Edward Island is about one-tenth of this volume (.216 billion m³ or 7.6 trillion ft³).

¹ Atlantic Geoscience Centre, Dartmouth

GEOSCAN: A UNIQUE PARTNERSHIP IN DELIVERING GEOSCIENCE INFORMATION

B.B. Blair¹, J. Gillespie², C. Patey²

GEOSCAN is Canada's national earth science database. It provides bibliographic, geographic and subject access to publicly available geoscience literature concerning the Canadian landmass and offshore regions. Indexed by geoscience professionals using a standard approach to record creation, GEOSCAN contains almost 150 000 records and adds about 7 000 each year.

GEOSCAN represents a unique partnership of 16 Canadian geoscience organizations. Participating organizations include two federal departments, all ten provincial governments, a professional society and a university.

In addition to providing record data to the system, our partners also serve as an access network for clients across the country. GEOSCAN's client base encompasses all facets of the Canadian geoscience community: industry, academia, and government.

The presentation provides two different views of this co-operative program: GEOSCAN from the GSC perspective and GEOSCAN through the eyes of a provincial partner, the Newfoundland Department of Mines and Energy.

¹ Geoscience Information and Communications Division

² Newfoundland Department of Mines and Energy, St. John's

FEDERAL - PROVINCIAL COOPERATION IN GEOSCIENCE SURVEYS

M.E. Cherry¹

Canada's geological surveys today face common pressures and concerns which affect all aspects of program planning and implementation. These pressures and concerns were discussed at a recent meeting of the National Geological Surveys Committee, with the objective of developing a framework for increased co-operation among the federal, provincial and territorial surveys. The meeting resulted in two significant agreements. Participants agreed on new procedures to better integrate GSC programs with provincial/territorial priorities and needs, based in part on the experience provided by existing successful collaborations such as

MDAs, EXTECH and NATMAP. As well, agreement was reached on substantive collaboration in responding to the challenges of constrained budgets and the conflicting demands for traditional and new programs. Specific action plans for each of these broad agreements, to which all participants committed, will ensure the expansion of existing partnerships and provide for the establishment of new collaboration.

¹ Federal-Provincial/Territorial Liaison Office, Ottawa

VOLCANIC RESPONSE PLANNING: A FEDERAL-PROVINCIAL, MULTI-AGENCY INITIATIVE

C.J. Hickson¹

In December 1990 the near fatal encounter of an airliner with volcanic ash in Alaska triggered worldwide concern for better reporting of volcanic ash plumes. The Canadian Airline Pilots Association (CALPA) approached the GSC to determine Canada's readiness to deal with a volcanic emergency. In Canada, volcanoes occur in British Columbia and Yukon and range in size from small basaltic cinder cones to large strato volcanoes. In addition, the proximity of active volcanoes to the south (Cascade Volcanoes) and north (Aleutian Volcanoes), makes the threat of ash entering Canadian air space a very real one. In response, representatives from Transport Canada - Air Navigation (TC-AN), Atmospheric Environment Service (AES), Emergency Preparedness Canada (EPC), Yukon Emergency Measures Organization (YEMO), British Columbia provincial Emergency Program (PEP), Royal Canadian Mounted Police (RCMP), in addition to the GSC gathered together to form a network to respond and report volcanic activity. The system has been called into action twice in the last year, when eruptions from Mount Spurr sent ash into Canadian air space.

¹ Cordilleran Division, Vancouver

NATIONAL NATIVE HOME RADON SURVEY - MAXIMIZING RESOURCES THROUGH RADON POTENTIAL ASSESSMENT

B.W. Charbonneau¹, R.L. Grasty¹, W. Cocksedge², W. Rankin²,
W. Tostowaryk², M. Rahman²

Health and Welfare Canada wished to assess the potential risks from radon in native homes across Canada. On the basis of airborne gamma ray survey data, geology and geochemistry, 41 communities of high radon potential and 16 communities of low potential were selected for sampling. None of the homes in communities of low radon potential had radon levels above 400 Bq/m³ whereas a significant number of homes in several communities of high radon potential were above the Canadian guidelines of 800 Bq/m³. Based on the results of the study, Health and Welfare Canada initiated a follow-up program to measure all communities where homes were likely to exceed the Canadian guidelines of 800 Bq/m³.

¹ Mineral Resources Division, Ottawa

² Health and Welfare Canada, Ottawa

MAGMATISM AND GOLD AT KIRKLAND LAKE, ONTARIO

G.S. Levesque¹, A.E. Lalonde¹, E.M. Cameron²

One of the world's largest concentrations of gold deposits is located along the major, east-trending Larder Lake-Cadillac fault, which extends 250 km from Kirkland Lake to Val d'Or. In the Kirkland Lake area this fault is expressed as a broad deformation zone known as the Kirkland Lake- Larder Lake fault zone (KLF). Syenitic and granitic magmatic suites are closely associated with the fault zone and its gold deposits. Whole rock geochemistry, mineral chemistry and petrography indicate a common source for the two suites in the upper mantle, with the granitic magmas likely having resulted from contamination of syenitic melts. On the basis of mode of emplacement, magmatic oxidation, and petrogenic evolution, three distinct magmatic domains have been identified, only one of which is spatially related to the gold.

¹ Ottawa-Carleton Geoscience Centre, University of Ottawa, Ottawa

² Mineral Resources Division, Ottawa

Pb-Zn DEPOSITS OF THE LOWER WINDSOR: IF CARTONATES COULD TALK...*

M. Savard¹

Carbonates from the Carboniferous Windsor Group of the Maritimes Basin host numerous important Pb-Zn occurrences. The objectives of three ongoing regional studies at QGC are to document the nature, path and evolution of the successive fluids that affected host rocks and produced the mineral occurrences.

1) Microthermometry, geochemistry, diagenetic clay and organic matter studies of massive dolostones will allow the documentation of regional paleoflows around the Gays River deposit; 2) The geochemical study of brachiopods is aimed at isolating the isotopic signal of ancient marine waters to better establish a relational basis for characterization of post-marine fluids; and 3) Preliminary results at the Jubilee deposit link mineralization to normal faulting; a systematic isotopic survey along a regional extensional detachment fault will help to evaluate large scale controls on fluid migration.

¹ Quebec Geoscience Centre, Sainte-Foy

* Bilingual presentation

TRANSGRESSIVE PERIDOTITE PIPES IN THE CARIBOU HILL MAFIC LAYERED INTRUSION, MOUNT PEYTON COMPLEX, CENTRAL NEWFOUNDLAND: ANALOGUES OF BUSHVELD PLATINIFEROUS DUNITE PIPES?

O.R. Eckstrand¹, E.H. Cogulu²

The reported presence of layering in mafic rocks of the southwestern portion of the Mt. Peyton complex in the Dunnage Zone, central Newfoundland, led to recognition of a layered intrusion (informally named "Caribou Hill intrusion") comprising cyclically layered gabbro-norite and olivine gabbro-norite, and a lowermost pyroxenite unit. This eastwardly dipping sequence is transected by at least three ultramafic pipes, each consisting of a coarse grained feldspathic peridotitic core enveloped in a very coarse

grained pyroxenitic sheath. The pipes range in diameter from 10 to >250 m. No sulphides were observed. These pipes bear strong resemblance to dunite pipes in the Bushveld complex of South Africa that were mined for platinum. Disappointingly, analyses of 12 samples yielded only low, non-anomalous PGE values. However other undiscovered peridotite pipes with more significant PGE contents may exist elsewhere in the Caribou Hill intrusion, whose full extent has not yet been determined.

¹ Mineral Resources Division, Ottawa

² Minerco Ltd., Ottawa

GEOLOGY OF THE PORT AUX BASQUES AREA, NEWFOUNDLAND

C.R. van Staal¹, S. Lin¹

The enigmatic Port aux Basques gneiss in southwestern Newfoundland is bounded to the west by the volcanosedimentary Windsor Point Group and to the east by Middle Ordovician rocks of the Bay du Nord Group. Both boundaries are characterized by major shear zones: the mainly dip-slip Cape Ray fault zone in the west and the Bay Le Moine strike slip fault in the east. The Port aux Basques gneiss has been divided into three units: the Grand Bay Complex, the Port aux Basques Complex and the Harbour Le Cou Group. These three units are separated from each other by major fault zones. The Grand Bay Complex and Harbour Le Cou Group correlate best with rocks of the Exploits part of the Dunnage Zone, whereas the Port aux Basques Complex has been correlated with the Gander Zone. If the correlation is correct, all tectonostratigraphic subdivisions of the Central Mobile Belt are preserved in southwestern Newfoundland.

¹ Continental Geoscience Division, Ottawa

GIANT IMPACTS: CONSEQUENCES FOR BIOLOGICAL EXTINCTIONS, GLOBAL ENVIRONMENTS AND ORE FORMATION

W.D. Goodfellow¹

It is inescapable that the earth has been bombarded by large meteorites throughout geological time. In the Phanerozoic the estimated frequency of impact by bodies of 5 km-diameter or larger is about one every 10 Ma. The estimated energy released from a major impact would have global catastrophic consequences for the atmosphere, hydrosphere and biosphere. For example, the energy released from a 10 km-diameter asteroid travelling at a velocity of 20 km. s⁻¹ that impacts into an ocean 4 km deep is 2.6×10^{30} ergs (6.2×10^7 Mt TNT equivalent). The effects of such an impact are: (1) a large, heated mass of low-density air with peak temperatures of 20 000° K would form adjacent to the Earth's surface and cause wild fires; (2) an enormous tsunami would propagate outward with a wave height comparable to the ocean's depth generating high energy sedimentary deposits; (3) earthquakes of magnitude 12.4 on the Richter scale would be produced; (4) 105 km³ of excavated rock and 9×10^{13} t of vaporized asteroid, crust and ocean would be lofted altitudes up to 100 km; (5) condensed vaporized material and fine ejecta dust would remain suspended in the atmosphere long enough to circle the globe, block out sunlight, cool the Earth's surface, disrupt the food chain and cause extinctions of up to 80% of the total biomass, e.g., the K-T extinction; (6) shock heating of the atmosphere would form nitrogen compounds that cause acid rain, inhibit photosynthesis and deplete the ozone layer; and (7) magma would upwell into the crust causing volcanism, hydrothermal activity and the formation of magmatic and hydrothermal deposits (e.g., Sudbury).

¹ Mineral Resources Division, Ottawa

POSTERS

GEOSCIENCE SURVEYS

GEOCHEMICAL SURVEYS IN NOVA SCOTIA USING SPRUCE BARK

S.W. Adcock¹, C.E. Dunn¹, W.A. Spirito¹

Analysis of ashed outer bark from red spruce (*Picea rubens*) from 500 sites within 5000 km² of southwestern Nova Scotia outlines areas of relative element concentrations: notably Sn, Ta, W, Rb, Cs, Cu and U near East Kemptville. Weak Au enrichment occurs with As, Sb, and Se near an aeromagnetic anomaly northwest of Liverpool, and near Big Gull Lake. Around Yarmouth, Co and Cr are enriched over the White Rock Formation.

A similar survey covering 4000 km² in southeastern Cape Breton Island used bark from black spruce (*Picea mariana*). Gold enrichment occurs near the Stirling mine. There is a linear trend of U, Th, Hf, and REE enrichment along the contact between rocks of Carboniferous and early Palaeozoic age. Pb, As, Co, Cr, Fe, Mo, W, Be, Li, and REE are enriched over Morien Group sediments east of Sydney.

¹ Mineral Resources Division, Ottawa

ARCHEAN AND PROTEROZOIC GEOLOGY OF THE PADLEI BELT, DISTRICT OF KEEWATIN, N.W.T.¹

L.B. Aspler², J.R. Chiarenzelli³, T.L. Bursey⁴

Henik Group volcano-sedimentary subunits are intruded by Archean granitoids. Completion of mapping in the Padlei belt and preliminary petrography confirm that rocks previously mapped as Montgomery Group (unconformably between the Henik and Hurwitz groups in its type-area) are within the lower Hurwitz Group. The lower Hurwitz Group defines a conformable onlap sequence of radial basin expansion. The Padlei Formation forms lenses filling paleovalleys. The Maguse Member represents fluvial, eolian and lacustrine sedimentation; near the base, interbedding of discontinuous pyritic quartz-pebble layers and pyrite-free redbed arkoses and quartz-pebble layers suggests deposition at the oxyatmoverion transition. Abrupt transition from shallow-water quartz arenites (Whiterock Member) to deep-water mudrocks and arkoses (Ameto Formation) is attributed to intraplate stress-induced deepening and arching. Northwest-trending folds and northwest-vergent thrusts and folds in basement and cover give rise to dome and basin interference. Highest gold values are in basement pyritic-chert horizons and lower Maguse quartz pebble conglomerates.

¹ Contribution to the Canada-N.W.T. Minerals Initiative 1991-96

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NEW INTEGRATED APPROACH TO INTERPRETING WIDE-ANGLE SEISMIC DATA

I. Asudeh¹, C. Zelt¹, S. Guest², M. Galbraith³

Processing packages are commercially available for seismic reflection data that incorporate recent advances in seismic theory and computing hardware. These packages have become a necessary tool in the analysis of reflection data permitting timely presentations of seismic and geological interpretations.

No comprehensive interpretational package exists for refraction/wide-angle reflection data since wide-angle methods have primarily been used as an academic research tool rather than an industry surveying technique. Consequently, considerable resources are expended to independently develop new interpretation software, or to modify and learn existing programs. This increases interpretation time and limits the scope of interpretations by the local environment.

We are developing an integrated interpretation package to allow rapid, state-of-the-art interpretation of wide-angle data. The design links various data formats and modelling tools under a common user interface and graphics display. Modelling elements include 2D traveltimes inversion and 3D anisotropic modelling. The package will be independent of experimental scale permitting a wide-range of applicability.

¹ Continental Geoscience Division, Ottawa

² Department of Geological Sciences, Queen's University, Kingston

³ Seismic Images Software Ltd., Calgary

GIS DIGITAL DATA INTEGRATION FOR GEOLOGICAL MAPPING: SATELLITE AND GEOPHYSICAL IMAGERY IN THE WINTER LAKE - LAC DE GRAS AREA, N.W.T.

D. Baril¹, A.N. Rencz², P.H. Thompson¹

This study demonstrates the utility of integrating digital data from LANDSAT TM imagery, aeromagnetic surveys, and reconnaissance geological maps as an aid to new regional bedrock mapping (NATMAP) in the Slave Structural Province. Processing of LANDSAT data was designed to enhance structural features and rock outcrop. Aeromagnetic data and derived shaded-relief images emphasize possible relations to surface geology. These data were combined with reconnaissance geology data on an image analysis system and displayed using an intensity-hue-saturation (IHS) colour system. Processed imagery were transferred to a GIS for overlaying of ancillary data (geological contacts and data from field surveys) and map composition (UTM grid, scale bars and labelling).

Combination of three data sets across the map area reveal variations in the quality of outcrop and discordance between structures on LANDSAT imagery, aeromagnetic anomalies, and lithological contacts derived from previous bedrock mapping. These integrated data assist in definition of an optimum distribution and density of traverses and they aid extrapolation of contacts and structures both between traverses and in areas of poor outcrop.

The ability to combine and query all existing data sets within the GIS is very useful to improve the knowledge of the area and to plan further field surveys.

¹ Continental Geoscience Division, Ottawa

² Mineral Resources Division, Ottawa

ARCHEAN AND PROTEROZOIC DEFORMATION IN GRANITOID-GNEISS TERRANE OF THE NORTHWESTERN SLAVE PROVINCE, HEPBURN ISLAND, N.W.T.

C.T. Barrie¹, S.J. McEachern¹

Three Archean and one Proterozoic deformation events have effected the medium grade granitoid-gneiss terrane in the northwestern Hepburn Island map sheet. D1 deformation produced rootless isoclinal folds, now preserved within low strain windows between D2 northwest-trending high strain zones. F2 folding created steeply southwest-plunging folds at all scales. The third Archean event strongly transposed the earlier fabrics, resulting in N-trending gneiss tectonites with isoclinal fold axes parallel to subhorizontal stretching lineations, and dominantly dextral transpressive mylonitic textures near the greenstone belt contact. Proterozoic deformation is documented near the N-trending contact between Proterozoic Epworth Group strata and Archean basement. The Epworth Group was compressed against and locally under the basement, with horizontal shortening from tens to hundreds of metres. Reverse faults at the contact and locally within the basement are displaced by conjugate faults that parallel those of the Wopmay Orogen to the west.

¹ Continental Geoscience Division, Ottawa

NATMAP SHIELD MARGIN PROJECT: NEW PERSPECTIVES ON THE FLIN FLON-SNOW LAKE BELT, MANITOBA AND SASKATCHEWAN, AND ITS SUB-PALEOZOIC CONTINUATION^{1,2}

H.J. Broome³, S.B. Lucas³, P.G. Lenton⁴, D.J. Thomas⁵,
I. McMartin⁶, P.F. Williams⁷, the NATMAP Shield Margin
Project Working Group

The NATMAP Shield Margin Project is focused on the Cu-Zn-Ni-Au-rich Flin Flon-Snow Lake-Hanson Lake Belt and its sub-Paleozoic continuation in Manitoba and Saskatchewan, and involves over 50 participants from government surveys, research councils, universities and the minerals industry. Three major bedrock geological compilation projects, each spanning the Manitoba-Saskatchewan border were initiated in 1992. Detailed analysis of the high resolution aeromagnetic data, combined with gravity data and the results of systematic drillcore "mapping", has generated a new map for the sub-Paleozoic portion of NTS 63K. Compilation maps are being transferred into the central project GIS/database and integrated with other maps and raster images (e.g., LandSat, radar, gravity, magnetics, detailed maps) and point-

source databases (e.g., geochronology, isotopes, geochemistry, structure, metamorphism). Significant progress has been made with design and implementation of the central GIS/database facility, including development of the database structure and interfacing with the GSC's digital map production/archiving group.

¹ Contribution to the Canada-Manitoba Partnership Agreement on Mineral Development, 1990-95

² Contribution to the Canada-Saskatchewan Partnership Agreement on Mineral Development, 1990-95

³ Continental Geoscience Division, Ottawa

⁴ Manitoba Geological Services Branch, Manitoba Mines and Energy, Winnipeg

⁵ Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Regina

⁶ Terrain Sciences Division, Ottawa

⁷ Dept. of Geology, University of New Brunswick, Fredericton

SIGNIFICANCE AND POPULARIZATION OF MAGMATIC INTRACRUSTAL EVENTS IN THE METASEDIMENTARY BELT OF QUEBEC

L. Corriveau¹, D. Morin², P. Tremblay¹

At the eastern margin of the Central Metasedimentary Belt (CMB) of Quebec (Grenville Province), lit-par-lit injections of monzonite and diorite (metre to kilometre in thickness) are intercalated with porphyroclastic paragneisses and other mylonites of amphibolite facies. Evidence for assimilation, magma mixing, syntectonic emplacement, and skarn formation is common. To the east, this magmatism formed 15 km² sheet complexes and farther east, in the Morin terrane, homogeneous plutons up to 300 km². These observations suggest that magma emplacement was structurally controlled. Computer-assisted mapping has also uncovered a series of net-veined lamprophyric dykes in granulite facies orthogneiss. Furthermore, 1350 exotic xenoliths were described. This work indicates that spinel-, garnet- and mica-clinopyroxenite, mylonites and eclogitic (?) garnet-bearing gneisses were present under the Central Metasedimentary Belt during the emplacement of the host ultrapotassic lamprophyre. Petrological studies and popularization of these magmatic events are on their way.

¹ Quebec Geoscience Centre, Sainte-Foy

² Laval University, Quebec

SUPERCONDUCTING GRAVIMETRY: CANADIAN UNIVERSITIES AND THE GSC

P.N. Courtier¹, D.J. Crossley², A. Lambert¹

The Canadian Superconducting Gravimeter Installation (CSGI) is a joint project of several Canadian Universities and the GSC. The gravimeter was purchased through an NSERC Major Equipment Grant (plus a yearly NSERC Infrastructure Grant) and is operated jointly by the Geophysics Division and McGill University. The gravimeter is located at Canada's fundamental gravity reference

station near Gatineau, Quebec. The high-quality, three-year record of gravity variations obtained to date has wide application to a variety of geophysical problems of interest to the University research community, including the dynamical behaviour of the liquid part of the Earth's core, long-period seismometry, high-precision Earth tide studies and mass redistribution in the atmosphere. The data provide the GSC with a continuous, stable gravity baseline used in the application of high-precision gravimetry to the study of vertical crustal motions.

¹ Geophysics Division, Ottawa

² McGill University, Montreal

APPLICATION OF FIELDLOG SOFTWARE TO STRUCTURAL ANALYSIS IN THE BATHURST MINING CAMP, NEW BRUNSWICK¹

J. de Roo², C.R. van Staal³, B. Brodaric³

This paper presents results of structural mapping of the Bathurst Mining Camp in the Appalachians of New Brunswick. The study area comprises Middle-Late Ordovician volcanogenic rocks (the Tetagouche and Fournier Groups) and older turbiditic rocks (Miramichi Group). These units are exposed as pods of weakly deformed rocks that are encased in mostly steeply dipping mylonites, phyllites and schists. The overall structure is complex as a result of polyphase (D₁ - D₄) deformation, as revealed at various scales by multiple folding, cleavage development and kinking.

Structural data were digitized by means of customized software (FIELDLOG) and then exported to AUTOCAD. This enabled us to compute maps of the Bathurst Camp and plot D₁ - D₄ structural elements such as foliations and lineations separately. The result expands our understanding of the small-scale deformations to the regional scale and confirms that the major folds of the area are D₄ structures.

¹ Contribution to the Canada-New Brunswick Cooperation Agreement on Mineral Development, 1990-1995.

² Quebec Geoscience Centre, Sainte-Foy

³ Continental Geoscience Division, Ottawa

AEROMAGNETIC SURVEYS, 1992-93: JOINT VENTURES, INTERNATIONAL COLLABORATION AND MDAS

R. Dumont¹, F. Kiss¹, P. Stone¹, K. Anderson¹, F. Dostaler¹,
D. Jobin¹, D.J. Teskey¹, P.J. Hood, R.A. Gibb¹

In 1992, the second phase of the joint industry/government aeromagnetic program in Saskatchewan and Manitoba was flown. The survey contributes to mapping the Precambrian basement beneath the Phanerozoic cover, hydrocarbon exploration, and kimberlite exploration. The third and final phase of the British Columbia-Alberta industry-government joint venture was also flown. Here emphasis was on the eastern margin of the Cordillera to help determine the deep structure of the Precambrian basement for mapping purposes and hydrocarbon exploration. Compilation of MDA gradiometer surveys designed to assist detailed mapping and mineral exploration in the Cape Breton Highlands, Nova Scotia, Magaguadavic Lake, New Brunswick, Talbot Lake, Manitoba and Grassberry Lake, Saskatchewan was completed. A further high sensitivity MDA aeromagnetic survey was flown in the Cypress

Hills area of southeastern Alberta. The third and final phase of a CIDA-sponsored aeromagnetic survey of Zimbabwe was also completed to GSC standards.

¹ Geophysics Division, Ottawa

PRELIMINARY REPORT ON THE GEOLOGY OF THE MUGFORD GROUP VOLCANICS, NORTHERN COASTAL LABRADOR¹

M.A. Hamilton²

The Mugford Group is one of three principal Lower Proterozoic supracrustal successions in northern Labrador, deposited unconformably on amphibolite-facies Archean orthogneisses of the Nain craton. The group consists of two main mafic volcanic units, separated by a thin tuff, which overlie subordinate basal siliciclastic sediments. Detailed sampling for petrological, geochemical and Nd, Sr and Pb isotopic investigations was carried out in pillowed and massive flows and breccias of the lower volcanic unit, crystal-rich and mafic members of the middle tuff, and in pyroclastic agglomerates, breccias and massive flows of the upper volcanic unit. Pegmatitic zones in gabbroic sills present in the basal sedimentary units were sampled for U-Pb geochronology in order to determine a precise age for early Proterozoic volcanism in northern Labrador. An ultramafic sill is found to be more laterally extensive than previously known. A possible minor vent source is identified high in the lower volcanic unit.

¹ Contribution to the Canada-Newfoundland Cooperation Agreement on Mineral Development, 1990-1994.

² Continental Geoscience Division, Ottawa

GRAVITY SURVEY OF THE CANADIAN CORDILLERA: CANADA-U.S. COLLABORATION

D.B. Hearty¹, D.W. Halliday¹, D. Seemann², R.A. Gibb¹

In a major co-operative effort, Geophysics Division, Pacific Geoscience Centre, Geodetic Survey Division (SMRS), Mapping and Charting Establishment (DND) and the U.S. Defense Mapping Agency (DMA), have completed the regional gravity survey of parts of northern British Columbia, southern Yukon Territory, and western Northwest Territories. Approximately 3600 gravity observations, with a spacing of 10-12 km, covering thirty 1:250 000 map sheets, were collected in years one and two of a three year program. The cost of the survey was shared by GSC and DMA in the ratio of 1:3 and DND has provided field personnel, logistical support, and management of the field project. The data will be included in the National Gravity Mapping Data Base, and will contribute to DMA requirements for gravity data in North America, to studies of resource potential and geological structure in the Cordillera, and to a better determination of the geoid for the surveying industry in British Columbia.

¹ Geophysics Division, Ottawa

² Pacific Geoscience Centre, Sidney

REGIONAL GEOLOGY, STRUCTURE AND MINERAL DEPOSITS OF THE ARCHEAN SWAYZE GREENSTONE BELT, SOUTHERN SUPERIOR PROVINCE, ONTARIO

K.B. Heather¹

The Swayze Project area encompasses about 12 000 km² southwest of Timmins centred on the Swayze greenstone belt (SGB), and includes a significant proportion of the surrounding granitoid terranes. The SGB is the westward extension of the Abitibi greenstone belt and has high potential for mesothermal Au, VMS Cu-Zn-Pb, mafic and ultramafic intrusion hosted Ni-Cu-PGE and komatiitic Ni-Cu deposits, as well as a wide variety of industrial minerals and building stones. The program consists of reconnaissance, synoptic-style lithological and structural mapping augmented by geochemical and geochronological work, with emphasis on better understanding of the complex tectonic history of the region and its relationship to the various mineral deposit types. Preliminary results include: (a) additions and modifications to the previous geological maps both within the greenstone belt and the surrounding granitoids; (b) an interpretation of the structural chronology and its influence on the present distribution of lithologies; and (c) implications of (a) and (b) for mineral exploration.

¹ Continental Geoscience Division, Ottawa

THE CHARACTER OF THE CHICKXULUB, MEXICO: THE K/T KILLER CRATER

A. Hildebrand¹, M. Pilkington¹, G. Penfield², R.A.F. Grieve¹, A. Camargo³, D. York⁴, P. Smith⁴, R. Bottomley⁴, B. Robertson¹

The approximately 180 km-diameter Chicxulub crater represents the largest known impact in the Phanerozoic and probably caused the Cretaceous-Tertiary (K-T) boundary extinctions. Buried on the Yucatán Peninsula, Mexico, and undisturbed tectonically since its formation, this comparatively young and well preserved peak-ring crater allows study of the cratering process at a large scale. Half covered by water, the crater is amenable to the complete spectrum of exploration techniques including shipborne geophysics and land-based drilling. Chicxulub's ejecta is also known globally allowing detailed study of impact ejecta processes. The impact-modified rocks cause high-amplitude magnetic and gravity field anomalies that reveal some crater features which are generally consistent with those of other terrestrial craters. ⁴⁰Ar-³⁹Ar dating supports a K-T formation age for the crater. Petrographic studies confirm impact characteristics of breccias and melt rocks in the crater including shock deformation and superheating.

¹ Geophysics Division, Ottawa

² Carson Aerogravity Division

³ Petróleos Mexicanos, Mexico

⁴ University of Toronto, Toronto

GEOLOGY OF THE SOUTHERN WINTER LAKE GREENSTONE BELT, CENTRAL SLAVE PROVINCE, N.W.T.^{1,2}

R.B. Hrabi³, H. Helmstaedt³, J.E. King⁴

The lowest exposed stratigraphic unit along the eastern margin of the southern Winter Lake greenstone belt (NTS 86A) is composed of felsic metavolcanic rocks. These are overlain by pillowed

komatiitic basalt (12-18% MgO) and by discontinuous units of orthoquartzite or conglomerate. Mafic metavolcanic rocks overlie these rocks. Along most of the west margin of the belt mapped to date, the mafic metavolcanic rocks are generally the lowest exposed units and are overlain by a coarsening upward succession of metasedimentary rocks. Mafic metavolcanic rocks occur again, structurally above the metasedimentary rocks but ambiguous facing directions make the stratigraphic relationship uncertain. The first-order synclinal structure of the greenstone belt is complicated by a zone of strong foliation development, interpreted to be a fault, which cuts the hinge of the fold, contributing to the angular truncation of the upper part of the metasedimentary section against stratigraphically lower mafic metavolcanic rocks.

¹ Canada-NWT Mineral Initiative 1991-1996

² NATMAP Slave Province Project

³ Queen's University, Kingston

⁴ Continental Geoscience Division, Ottawa

GEOPHYSICAL INTERPRETATION OF THE CHIBOUGAMAU PLUTON, QUEBEC

P. Keating¹, R.A. Daigneault², D.J. Dion³, R. Morin³

The region of the Chibougamau Pluton, located 500 km north of Montreal, contains many polymetallic orebodies and has been extensively studied during the last forty years. The study area is part of the Chibougamau-Matagami greenstone belt. A new high resolution helicopter-borne aeromagnetic and electromagnetic survey covers NTS sheet 32 G/16, i.e. the major part of the pluton. This new data set is used to refine the geological map of the pluton and the adjacent area, as part of the pluton is covered by Lake Chibougamau. It is also entirely covered by a high precision gravity survey that is used to help interpret the structure at depth. From the interpretation of these various data sets, we conclude that the Chibougamau syncline has a depth extension of about 5 km. Comparison with various geological models show that the model proposed previously in 1990 by Daigneault and Allard agree with the data.

¹ Geophysics Division, Ottawa

² Université du Québec à Chicoutimi, Chicoutimi

³ Ministère de l'Énergie et des Ressources, Charlesbourg

NEW PERSPECTIVES ON THE GEOLOGICAL EVOLUTION OF THE SLAVE PROVINCE: RESULTS FROM THE NATMAP SLAVE PROVINCE PROJECT

J.E. King¹, M. Stubbley², V. Jackson³, D. Baril⁴, the NATMAP Slave Province Project Working Group

Bedrock mapping and associated multidisciplinary studies, recently enhanced through GSC NATMAP funding and the Canada-Northwest Territories Mineral Initiative, have provided new insight into the geological framework of the Slave Province (N.W.T.). Detailed study of lithological distribution documented a greater areal extent of Yellowknife Supergroup (ca. 2.65-2.7 Ga), as well as new locations of probable pre- and post-Yellowknife Supergroup assemblages. On-going geochronological studies will test interpreted age relations. In addition, previously known and newly recognized fault zones were extended and their kinematic and

temporal evolution are being analyzed. Although not yet fully tested with isotopic methods, it appears that the Slave Province experienced significant post 2.6 Ga brittle-ductile faulting.

Digital storage of geological, geophysical, remote sensing, mineral inventory, and other data types will facilitate the utilization of GIS-type analysis in evaluating the geological evolution of the Slave Province.

¹ Continental Geoscience Division, Ottawa

² Canada-GNWT Mineral Initiative Office, Yellowknife

³ Geology Office, DIAND, Yellowknife

LABRADOR GEOSCIENCE: INTEGRATION AND USE OF VARIED REGIONAL GEOLOGICAL AND GEOCHEMICAL DATASETS

R.A. Klassen¹, P.W.B. Friske², R.W. Wardle³

During the past decade, geoscience surveys of Labrador have led to revision of bedrock geology maps, and have defined regional geochemical variations within lake sediments and till. Much of the work has been carried out as a part of Canada-Newfoundland Mineral Development Agreements with the goal of providing a framework for mineral exploration. In glaciated terrain, however, interpretation of regional geochemical surveys in terms of bedrock composition and mineral exploration is not a straightforward task. Although geochemical analyses of surficial sediments can reflect regional variations in bedrock composition, they can also reflect glacial transport and dispersal, and postglacial modification by physical and chemical transport processes. A geoscience dataset for Labrador is being compiled within a Geographic Information System (GIS) that includes bedrock geology and mineral occurrences (Wardle), ice flow directions, till lithology, and till geochemistry (Klassen), and lake sediment geochemistry (Friske). The integrated dataset will be interpreted in terms of bedrock geology and the potential significance and geochemical surveys for exploration.

¹ Terrain Sciences Division, Ottawa

² Mineral Resources Division, Ottawa

³ Newfoundland Department of Mines and Energy, St. John's

STROMATOLITES OF AN ARCHEAN STRATOVOLCANO, SLAVE PROVINCE, N.W.T.

M.B. Lambert¹

Ten stromatolite localities, discovered in the Back River volcanic complex, all occur at the boundary between ca. 2692 Ma felsic dome/flow complexes of the Thlewycho sequence (representing the stratovolcanos main constructional phase) and overlying turbiditic sedimentary rocks of the Beechy Lake Group, Yellowknife Supergroup.

Stromatolites form 10-200 cm thick beds of cryptogalaminites that locally overgrew blocks in carbonate cemented breccia. Although growth forms include laterally linked domes and bun shapes, stromatolites generally form wavy layers of low synoptic relief. No original microfossils have been identified.

Stratigraphy seaward from felsic domes comprises carbonate cemented dome-flanking breccia, stromatolitic and oolitic carbonate, pebbly rhyolite volcanite, banded iron-formation and turbidites. The carbonate marks the interval where life flourished in an Archean sea that lapped onto active domes along the shallow flanks of an emergent volcano.

¹ Continental Geoscience Division, Ottawa

NATMAP SHIELD MARGIN PROJECT: INTERPRETATION OF THE SUB-PALEOZOIC BEDROCK GEOLOGY FOR THE CORMORANT LAKE AREA, MANITOBA, BASED ON DRILL CORE AND POTENTIAL FIELD DATA

A.D. Leclair¹, H.J. Broome¹, S.B. Lucas¹, M.D. Thomas¹,
R.A. Stern¹

A fundamental component of the NATMAP Shield Margin Project is the development of an interpretive geological map for the sub-Paleozoic continuation of the Flin Flon Belt in Manitoba and Saskatchewan. Detailed analysis of the high resolution total field and vertical gradient aeromagnetic data, integrated with the regional gravity data, led to the development of a preliminary pseudo-geology map for the sub-Paleozoic portion of NTS 63K. A systematic relogging program of Precambrian core recovered by industry in the course of mineral exploration south of the shield margin has been initiated by the Geological Survey of Canada to provide critical "ground truth" constraints necessary for the interpretation of the sub-Paleozoic geology derived from this combined potential fields study. Drillcore mapping, coupled with isotopic, geochronological, rock property and metamorphic studies of the drillcore, have enabled regional correlations of major tectonostratigraphic units to be made between the exposed Flin Flon Belt and the buried Precambrian rocks.

¹ Continental Geoscience Division, Ottawa

THRUSTING OF LATE ORDOVICIAN TO EARLY SILURIAN OVERLAP SEQUENCES AND UPPER DEVONIAN EXTENSIONAL DENUDATION, CAPE BRETON ISLAND, NOVA SCOTIA¹

G. Lynch²

Upper Ordovician to Lower Silurian calc-alkaline pyroclastic rocks in western Cape Breton occur as part of a vast Appalachian overlap sequence deposited unconformably on accreted terranes. Early thrusting and isoclinal folding have affected overlap sequences and basement slivers. Later reverse faults of Acadian age are defined by thick mylonite zones and telescoping of high and low-grade metamorphic domains.

The Margaree Shear Zone is a major low-angle extensional fault complex in the southwestern Cape Breton Highlands consisting of thick shallow-dipping mylonite overprinted by cataclastic horizons and chloritic breccia. The shear zone crosscuts and transports low grade volcanic rocks of the Upper Devonian Fisset Brook Formation in its hangingwall, and juxtaposes them against exhumed medium

to high grade metamorphic rocks in the footwall, including rocks of the overlap assemblage and mylonitic gneiss. Shear sense indicators suggest transport of the upper plate to the south and west.

¹ Contribution to Canada-Nova Scotia Cooperation Agreement on Mineral Development 1990-1992. Project C1.212 funded by the Geological Survey of Canada

² Quebec Geoscience Centre, Sainte-Foy

THE AINSLIE DETACHMENT – FIELD AND GEOPHYSICAL EVIDENCE OF CARBONIFEROUS LOW-ANGLE EXTENSIONAL FAULTING IN NOVA SCOTIA

G. Lynch¹, P.S. Giles²

Regionally extensive shear with fault breccia occurs near the base of the Lower Carboniferous Windsor Group in western Cape Breton Island and in central Nova Scotia, forming a broad detachment with underlying strata and basement. The shear zone is characterized by the development of planar lamination, carbonate dissolution, and the inclusion of boudinaged bedding segments as rotated augen. Sheath folds are locally abundant, and late-stage kink bands overprint the laminated fabric. Thick zones of fault breccia straddle portions of the detachment and contain blocks of underlying units as well as sheared limestone. Significant stratigraphic omissions across fault splays in the overlying Windsor Group suggest that low-angle faulting occurred within an extensional regime. Recumbent folds affecting the Windsor Group indicate that the basin is partly allochthonous above the detachment. Younger unconformable terrigenous clastic sediments of Westphalian age were deposited during listric normal faulting above the detachment. Shallow-dipping seismic reflectors are interpreted to be the geophysical manifestation of low-angle extensional faults.

¹ Quebec Geoscience Centre, Sainte-Foy

² Atlantic Geoscience Centre, Dartmouth

COMPILATION OF MAGNETIC DATA: AN EXAMPLE OF INTERNATIONAL COLLABORATION

R. Macnab¹, J. Verhoeff¹

Initiated in 1989, the project to compile the magnetic data in the North Atlantic and Arctic oceans has grown into a major International effort, with more than 40 data contributing organizations from 15 different countries. Of the total data base, about 30% is of Canadian origin and the rest comes from 'in kind' contributions from Industry, Foreign Geological surveys, Universities and other organizations. The compilation part of the project is scheduled to be finished in early 1993, and several follow-up projects are under discussion with different partners. By bringing together Canadian and foreign investigators throughout its history, the project has served as an efficient channel for communication and joint action with numerous international colleagues. The importance of the database and the relevance of associated expertise have been recognized in a number of international initiatives which have sought the involvement of the project team.

¹ Atlantic Geoscience Centre, Dartmouth

REGIONAL GEOCHEMISTRY IN THE SAINTE-JUSTINE-SAINTE-PAMPHILE AREA, BEAUCE REGION, QUEBEC

Y.T. Maurice¹

Results of a fourth contiguous heavy mineral geochemical survey in the Estrie-Beauce region in southern Quebec are presented. The area studied includes the northeastern parts of the Serpentine belt (Caldwell Group), the Saint-Victor Synclinorium (Magog Group), the Notre-Dame Mountain belt (Rosaire Group and the Sutton-Bennett schists), and the Gaspé-Connecticut Valley Synclinorium (Saint-Francis Group).

Southeasterly oriented chromite dispersal patterns are seen originating from small ophiolite bodies; they are likely related to the last major movement of the Laurentide ice sheet. There are also several anomalous zones of lead, nickel, arsenic, barium, and REEs. The Au-Ag anomalies, however, are the most noteworthy. As could be expected, several such anomalies occur in the gold dispersal corridor of the Chaudière valley. Other less predictable Au-Ag anomalies appear to follow a stratigraphic horizon within the Magog Group between Lac Etchemin and Lac Frontière. One of these corresponds to the Bellechasse gold prospect, southeast of Saint-Magloire.

¹ Mineral Resources Division, Ottawa

NEW MODELS FOR THE DARNLEY BAY, N.W.T., GRAVITY ANOMALY

P.H. McGrath¹, H.J. Broome¹, J. Klein²

The 130 mGal, Bouguer Gravity Anomaly located at Darnley Bay 400 km east of the Mackenzie River Delta, Northwest Territories, is one of the largest gravity anomalies in Canada. Its amplitude and areal extent requires the source body to be of crustal dimensions, and of basic composition. The anomaly-producing body is covered sedimentary strata, and is probably related to either the Franklin, 0.72 Ga, or Mackenzie, 1.27 Ga, igneous events. A coextensive magnetic anomaly suggests that the body is elongated NE-SW, and covers an area 50 by 37 km. A seismic reflector at 1.15 to 1.35 seconds indicates a near horizontal upper surface. Assuming a velocity of 4.6 km, a depth estimate of 2.6 to 3.1 km is obtained for the reflector. To the southeast of the main anomaly-producing body, a secondary, possibly independent, body with a diameter of 12 km produces similar gravity and magnetic anomalies suggesting that the two bodies are of a common origin.

¹ Continental Geoscience Division, Ottawa

² Cominco Exploration, Vancouver

QUATERNARY GEOLOGY STUDIES IN THE EASTERN NATMAP SHIELD MARGIN PROJECT AREA

I. McMartin¹, J.R. Bélanger¹, P. Rummel²

Fieldwork in the eastern part of the NATMAP Shield Margin Project area (63 J, O) has documented a zone of confluent late glacial ice flow. Detailed mapping of ice movement indicators suggests that the confluence occurred along a NE-SW trending zone mostly south of the Shield margin. This zone is characterized by an abrupt clockwise rotation of ice flow from the SW (Keewatin lobe ice?) to

the WSW, deflected by a dominant ice flow from a more easterly source (Hudson lobe ice). North of the Shield margin, the ice flow was also deflected but more gradually from the SSW to the SW. In this area, which is underlain by a segment of the Flin Flon-Snow Lake greenstone belt, early results on till composition indicate that glacial dispersal trains parallel the main and earlier regional ice flow towards the SSW and that they were not significantly influenced by the late shift in ice flow direction. Other late glacial erosion features also indicate that the westerly flowing ice later overrode the "Keewatin ice" along the Shield margin area.

Digital surficial map compilation, aided by LandSat TM imagery interpretation, has been undertaken and represents one of the core activities within the NATMAP Shield Margin Project.

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² Physical Sciences Division, University of Toronto, Toronto

REFLECTIVITY OF ARCHEAN CRUST FROM SURFACE SEISMIC AND BOREHOLE GEOPHYSICAL STUDIES

B. Milkereit¹, D. White¹, E. Adam¹

As part of the Lithoprobe Abitibi-Grenville transect, broadband seismic reflection surveys were conducted across the Sudbury Structure and various greenstone belts of the Superior Province in Ontario and Quebec. The primary objective of the surveys was to delineate lithology and structure at depth. To calibrate the seismic data, a program of rock property measurements has been completed using six up to 2000 m deep boreholes. Density logs and velocities determined from full waveform sonic logs provide the most direct link between the in situ rock properties and the observed seismic reflection data. Results indicate that the effects of macroscopic fracturing are only important to a depth of 300 m and lithological variations within the crust are the primary cause of reflections observed on the seismic reflection profiles.

¹ Continental Geoscience Division, Ottawa

ICE-FLOW PATTERNS AND QUATERNARY STRATIGRAPHY IN THE PETITE RIVIÈRE DE LA BALEINE REGION, NORTHERN QUEBEC

M. Parent¹, S.J. Paradis¹

Striated bedrock surfaces were investigated at about 150 sites over an area of about 15 000 km² in the Petite rivière de la Baleine region. Regional ice-flow was towards WNW (285°). However, at a few sites along the shore of Hudson Bay, there are small surfaces in sheltered position relative to the main ice-flow where striations towards NW and N have been preserved. This older ice-flow event may tentatively be related to ice-streaming in Hudson Strait. Along the shore, most of the striated surfaces record a late-glacial reorientation of ice-flow towards SW, presumably in response to the development of a calving bay or ice-streaming in southern Hudson Bay.

In Quaternary sections located below marine limit (Tyrrell Sea), thick marine sequences of fossiliferous silt and clay locally overlie glacio-marine sediments, consisting mainly of coarse grained subaquatic outwash and thick sandy silt rhythmites. Clay silts

deposited during the deep-water marine phase are in turn locally overlain by littoral and deltaic sediment bodies of variable thickness, formed during Tyrrell Sea regression.

¹ Quebec Geoscience Centre, Sainte-Foy

ARCHEAN UNCONFORMITY IN THE VIZIEN GREENSTONE BELT, MINTO BLOCK, UNGAVA, QUEBEC

J.A. Percival¹, K.D. Card¹, J.K. Mortensen¹

Detailed mapping in structural panel B of the Vizien greenstone belt has revealed a steeply dipping angular unconformity between mafic dyke-bearing tonalitic basement of 2940 Ma age and a younger, variably foliated, lower amphibolite facies sequence of conglomerate, greywacke and volcanic rocks with a maximum age of 2708 Ma (U-Pb zircon age from granite cobble). A regolith of quartz-muscovite grit beneath the unconformity is overlain by a sedimentary succession up to 170 m thick of lower pebble and boulder conglomerate and upper thick-bedded greywacke. The sedimentary unit is overlain by a 280-m-thick assemblage of volcanic and intrusive rocks including a conformable lower mafic unit and possibly allochthonous upper ultramafic unit. The unconformity-bound package is the youngest of at least three discrete supracrustal assemblages juxtaposed in the Vizien belt that include >2940 Ma enclaves in tonalitic basement and 2724 Ma rhyolite in a mafic-to-felsic sequence of Panel A.

¹ Continental Geoscience Division, Ottawa

MAGNESIOCHROMITE IN LAMPROITIC ROCKS, DISTRICT OF KEEWATIN, N.W.T.

T.D. Peterson¹

Magnesiochromite with high Cr/Al is an important mantle mineral, occurring as inclusions in diamond and also as phenocrysts in lamproitic and kimberlitic carrier magmas. The transitional lamproite-minette rocks of the 1.84 Ga Christopher Island Formation (CIF) contain phlogopitite xenoliths with high-Cr chromite and also chrome diopside; the xenoliths are considered to be high-pressure lamproitic cumulates or veins of metasomatized mantle. The chromite usually has high Mg/Fe but when associated with sulphides (pentlandite-pyrrhotite) is rich in Fe, Mn, and Zn, similar to sulphide-chromite inclusions in diamonds from Koidu, Sierra Leone. Textures indicate an igneous origin, sometimes with strong Fe-Mg zoning but no Cr-Al zoning. The geochemistry of the CIF indicates an origin in old, depleted lithospheric mantle, a favourable environment for diamonds. Although the phlogopitite xenoliths have little diamond potential, they indicate that appropriate conditions may have existed within the Churchill Province for diamond-bearing rocks to occur.

¹ Continental Geoscience Division, Ottawa

COMPUTATIONAL DRAPING AS A MEANS OF GETTING MORE OUT OF MAGNETIC DATA

M. Pilkington¹, W.R. Roest¹

Expanding the magnetic field intensity measured at a constant altitude in a Taylor Series allows us to efficiently continue such a field onto any given arbitrary surface. This is particularly useful for draping of constant altitude aeromagnetic surveys in areas of rugged topography. A synthetic data example shows that convergence of the series is slowest in areas of high vertical gradients, usually associated with magnetic body edges, and large (downward) continuation distances. We use the Taylor Series method to drape data from a constant barometric altitude survey from central British Columbia onto a surface with a constant terrain clearance. This survey is then joined to an adjacent survey flown at a mean terrain clearance of 305 m. The resolution and amplitudes of the two surveys are seen to be comparable and results in a more coherent and informative combined data set than when no computational draping is done.

¹ Geophysics Division, Ottawa

REFINED CORRELATION OF NEOPROTEROZOIC STRATIGRAPHY IN NORTHWESTERN CANADA

R.H. Rainbird¹, L.M. Heaman, C.W. Jefferson²,
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Recent detailed stratigraphic studies of the Shaler Group in northwestern Canada along with improved dating of mafic igneous rocks that intrude these strata allows extension and refinement of pre-existing correlation schemes.

The Glenelg, Reynolds Point, Minto Inlet and Wynniatt formations of the lower Shaler Group are divisible into several members that are recognized in several isolated inliers, which are thought to have formed a contiguous depository, the Amundsen Basin. Some of the member boundaries mark basin-wide transgressive events, which are traceable southwestward into the Mackenzie-Selwyn Basin and perhaps farther westward into the northeastern Brooks Ranges of Alaska.

Neoproterozoic plate reconstructions and sedimentation style suggest that the Amundsen Basin was part of an intracratonic depression that rifted apart to form the proto-Pacific Ocean at the end of the Proterozoic. This interpretation is supported by the preservation of Shaler Group-like sequences in several Neoproterozoic basins in central and southern Australia.

¹ Continental Geoscience Division, Ottawa

² Mineral Resources Division, Ottawa

THE OCEAN FLOOR BY NUMBERS: A HIGH RESOLUTION DIGITAL AGE MAP

W.R. Roest¹, R.D. Müller², J.-Y. Royer³, L. Gahagan⁴,
J.G. Sclater²

The age of the ocean floor is an important parameter in many studies, including plate kinematics, studies of plate-driving forces, mantle dynamics, and paleo-oceanography. Using a self-consistent set of global magnetic isochrons and reconstruction poles, a high resolution age grid for the ocean floor was created with a gridnode

interval of 5 arcminutes. The age at each gridnode was determined by interpolation between adjacent isochrons in the direction of spreading. To obtain ages for the large regions between the oldest magnetic isochrons and the continental margins, the ages of passive continental margin segments were estimated from geological data and published plate models. An uncertainty value for each grid node was also calculated, based on the distribution and ages of the magnetic anomaly picks. In addition, grids with directions of spreading and spreading velocities were constructed. Maps produced from these derived grids clearly illustrate the dynamic character of seafloor spreading.

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² Scripps Oceanographic Institution, La Jolla

³ Laboratoire de géodynamique, CEROV, Villefranche sur Mer

⁴ Institute for Geophysics, University of Texas at Austin, Austin

ISOTOPES AND THE ANCESTRY OF CANADA'S PACIFIC MARGIN

G.M. Ross¹, M.E. Villeneuve², R.R. Parrish², R.J. Thériault²,
D. Winston³

The structurally imbricated wedge of sedimentary and accreted terranes of the Canadian Cordillera obscure the age and character of the underlying Precambrian basement. Isotopic investigation of autochthonous basement in western Canada, allochthonous basement exposed in structural culminations in the Cordillera and the provenance signatures of sedimentary rocks in the Cordillera allow for reconstruction of basement domains of western Canada. Key results are the recognition of a ca. 1845 Ma belt of granitic rocks that truncate domains of the autochthon, the extension of ca. 1790 Ma granites into the Cordillera (related to terminal assembly of Laurentia) and, via analysis of detrital minerals, the characterization of a cryptic, non-North American crustal block removed during younger rifting. The reconstructed domains differ substantially from those of the autochthon and continental interior. They provide new insights on both the Precambrian tectonic history of western Canada and the identity of the rifted conjugate margin (Australia) to Canada's Pacific rim.

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² Continental Geoscience Division, Ottawa

³ Department of Geology, University of Montana, Missoula

KINEMATICS AND TECTONIC IMPLICATIONS OF HIGHLY STRAINED ROCKS OF THE KRAMANITUAR COMPLEX, BAKER LAKE AREA, N.W.T.

M. Sanborn-Barrie¹

Granulite-grade plutonic and sedimentary rocks of the Kramanituar complex generally record strong to intense degrees of strain, although moderate strain is preserved in coarse grained gabbroic anorthosite in the central part of the complex. An increase in strain from the centre of the complex culminates in kilometre-wide zones of ultramylonite which appear to define boundaries to the complex.

Movement on these shear zones is consistent with uplift of granulite-grade material relative to amphibolite-grade rocks that envelop the complex, however, it remains to be demonstrated whether finite strain recorded by these zones can account for the

juxtaposition of disparate metamorphic terrains, or whether these shear zones are relatively late structures that transect a previously assembled metamorphic terrain.

¹ Continental Geoscience Division, Ottawa

NORTHERN MELVILLE PENINSULA: AN INTEGRATED DATABASE

M. Schau¹, L. Dredge², A. Rencz³, C. Chung³

Northern Melville Peninsula is ideally situated for relating remotely sensed data sets to rocks and surficial materials because there is very little vegetative cover. Over the last decade or so, several datasets have been accumulated for the region and the work of integrating these multidisciplinary sets has begun. Several prepared digital images prepared from these databases illustrate interactions between remotely sensed and continuous data sets collected using radar, TM, aeromagnetic, gamma-ray methodologies as well as in situ data sets such as gravity, surficial geology and bedrock geology, and geochemistry of lake sediment and water as well as clay portions of tills. A portion of the map area is shown in 3-D to illustrate geology superposed on the surface as rendered by radar images, as well as a view showing the masking effect of marine clays and a thin cover of Paleozoic carbonates on the pronounced geophysical signals of the crystalline bedrock.

¹ Continental Geoscience Division, Ottawa

² Terrain Sciences Division, Ottawa

³ Mineral Resources Division, Ottawa

MULTICHANNEL SEISMIC SURVEY IN THE NEWFOUNDLAND BASIN: A CANADIAN-FRENCH COLLABORATION

S.P. Srivastava¹, K.C. Coflin¹, J.-C. Sibuet²

During a joint GSC-IFREMER cruise to the Newfoundland Basin on board *CSS HUDSON* about 3500 km of multichannel seismic data were collected. The purpose of the cruise was two fold: one, to carry out detailed surveys at three of the sites in the northern part of the Newfoundland Basin where drilling has been proposed as part of the Ocean Drilling Program, and two, to map the subsurface structure across the continental margin north and south of Flemish Cap. Both of these objectives were successfully accomplished.

The data were acquired using IFREMER system which consisted of a 96 channel streamer and several arrays of air guns. Acquisition parameters were tuned to optimize data quality depending upon the geological objectives. A unique feature of this program was processing of data onboard within 3 days of acquisition. Altogether 60% of the data collected was processed during the cruise.

The poster shows a layout of the various components of the system used together with samples of the data collected. Preliminary examination of the data shows the existence of remarkable differences in the subsurface structures across the margin south and north of Flemish Cap.

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² IFREMER, Brest

ISOTOPIC STUDIES IN THE NATMAP SHIELD MARGIN PROJECT AREA

R.A. Stern¹, E.C. Syme², A.H. Bailes², A.G. Galley³,
D.J. Thomas⁴, S.B. Lucas¹, A.D. Leclair¹

The goal of the isotopic and geochronological components of the NATMAP Shield Margin Project is to provide new constraints on the origin of the Early Proterozoic Flin Flon-Hanson Lake-southern Kiseeynew domains. The isotopic study is emphasizing the measurement of Nd- and Sr-isotopic compositions of a wide range of supracrustal and igneous rock specimens, obtained through extensive collaboration with other working groups. As a result of the Nd-isotopic study, it is suggested that the volcanic arcs were influenced at a relatively early stage by much older crust, probably Archean in age. Additionally, the Nd-isotopic study has revealed that the economically-important massive sulphide-bearing volcanic sequences near Flin Flon and Snow Lake have distinctive isotopic profiles, which provide additional criteria for stratigraphic correlations and resource evaluation. New U-Pb zircon ages are being determined, and, in combination with existing ages, constitute a project-wide geochronological database.

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² Manitoba Energy and Mines, Winnipeg

³ Mineral Resources Division, Ottawa

⁴ Saskatchewan Geological Survey, Regina

STRUCTURE AND TECTONIC HISTORY OF THE UVAUK GABBRO-ANORTHOSITE-GRANULITE COMPLEX, GIBSON LAKE AREA, DISTRICT OF KEEWATIN, N.W.T.

S. Tella¹, M. Schau¹, A.E. Armitage², B.C. Loney³

The complex consists of an Archean (?) layered gabbro-mafic granulite-anorthosite suite interlayered with quartzo-feldspathic granulites deformed and metamorphosed at mid-crustal levels. It forms a rootless, ENE-trending triangular segment (30 x 20 km) of straight gneisses, the boundaries of which are marked by ultramylonites. The eastern margin is defined by shallow, west-dipping ultramylonites, and the northern and southern margins converge and terminate to the west where mylonitic fabrics dip steeply south. The complex is interpreted as an allochthonous remnant of a granulite grade ductile strain zone that overlies lower grade autochthonous gneisses.

The Uvauk complex may be linked with other lithologically and tectonically similar high-strain zones: Kramanituur to the west, Hanbury Island and Daly Bay to the east. Collectively they define a discontinuous, sinuous deformation zone of Archean age; our observations do not support the existence of the proposed Proterozoic suture, the Snowbird Tectonic Zone, in this area.

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² Laurentian University, Sudbury

³ Carleton University, Ottawa

ROCK PROPERTIES AND GRAVITY AND MAGNETIC INVESTIGATIONS IN THE FLIN FLON-SNOW LAKE BELT, MANITOBA AND SASKATCHEWAN

M.D. Thomas¹, C. Dyck², E.I. Tanczyk¹, A.R. Norman²,
R.P. Williams¹, B. Williamson³

One of the subjects of gravity and magnetic studies supporting ongoing programs (Lithoprobe, NATMAP, Mineral Development Agreements) within the Trans-Hudson Orogen is the Flin Flon - Snow Lake Belt and its buried extension under adjacent Phanerozoic sedimentary cover. Gravity and magnetic anomalies associated with a number of geological units permit investigation of subsurface geometries, which in turn provide constraints for structural and tectonic interpretations. Examples include: gravity highs coinciding with Amisk Group volcanics and with a layered mafic-ultramafic intrusion along the western shores of Reed Lake; a gravity low associated with the Reed Lake granite; magnetic highs over Missi Group metasediments and volcanic units within the Amisk Group. To constrain interpretation of the anomalies, rock samples, including oriented drill cores, were collected to determine density, magnetic susceptibility and remanent magnetization. In situ measurements of magnetic susceptibility were also made. Preliminary results of these investigations are presented.

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² University of New Brunswick, Fredericton

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REGIONAL MAPPING OF THE WINTER LAKE-LAC DE GRAS AREA (NATMAP): IMPLICATIONS FOR ORIGIN, EVOLUTION, AND ECONOMIC POTENTIAL OF THE CENTRAL SLAVE PROVINCE, N.W.T.

P.H. Thompson¹, D.A. Ross², E. Froese¹, J.A. Kerswill³,
M. Peshko⁴

Winter Lake - Contwoyto Lake and Courageous Lake - Lac de Gras supracrustal domains with high potential for gold and base metals are connected by metasedimentary and mafic/felsic metavolcanic rocks, previously mapped as granitoid.

A sequence dominated by metavolcanic rocks commonly occurs between a heterogeneous granitoid complex predominant in the central part of the area and metasedimentary rocks and younger, homogeneous granitoids to the north and east. Metamorphosed mafic dykes cross-cutting gneissosity indicate parts of the complex are basement to supracrustal rocks.

Synchronous with ductile deformation, low-P/high-T isograds cross the complex and are cut by late granites. Structural geometry reflects a combination of basin formation and three main phases of ductile deformation related to shortening and thickening of the crust.

Extensive potential basement rimmed by volcanic belts and abundance of granitic rocks support a model that involves overthickening of previously-thinned sialic crust in an intraplate tectonic setting.

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³ Mineral Resources Division, Ottawa

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GEOLOGY, STRUCTURAL DEVELOPMENT, AND U-Pb GEOCHRONOLOGY OF THE EARLY PROTEROZOIC BURWELL DOMAIN, NORTHERN TORNGAT OROGEN, LABRADOR, QUEBEC, AND N.W.T.¹

M.J. Van Kranendonk², D.J. Scott³, L. Godin, R.J. Wardle⁴,
F.C. Mengel⁵, L. Campbell⁶

Northern Torngat orogen comprises re-worked Archean Nain gneisses in the east and Lower Proterozoic meta-igneous rocks interlayered with metapelites in the west. Voluminous diorite-tonalite-granite rocks that intruded Nain orthogneisses have been dated as *ca.* 1.91-1.86 Ga. Farther west, charnockitic rocks dated as *ca.* 1.89 Ga intrude Tasiuyak paragneiss and Archean Rae orthogneisses.

Burwell domain rocks are bounded to the south by the sinistral Abloviak shear zone (ASZ) and deformed by the amphibolite-facies Komaktorvik zone (KZ) in the east. The ASZ was tightly folded from its original orientation, causing the formation of a ≤ 2 km wide dextral mylonite along its northern contact through flexural slip. Structural considerations suggest that folding of the ASZ was contemporaneous with formation of the KZ and the dextral mylonite. U-Pb results suggest that granulite-facies metamorphic conditions existed at *ca.* 1.84 Ga, followed by amphibolite facies from *ca.* 1.79-1.71 Ga.

¹ Contribution to the Canada-Newfoundland Agreement on Mineral Development

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⁴ Newfoundland Department of Mines and Energy, St. John's

⁵ Geological Museum, University of Copenhagen, Copenhagen

⁶ Department of Geological Sciences, University of Colorado, Boulder

U-Pb AGES FROM HEPBURN ISLAND AND WINTER LAKE-LAC DE GRAS NATMAP PROJECTS, NORTHERN AND CENTRAL SLAVE PROVINCE, N.W.T.

M.E. Villeneuve¹, C.T. Barrie¹, J.R. Henderson¹, R.B. Hrabí²,
C. Relf³, P.H. Thompson¹

Ages are presented from the northernmost (Hepburn Island) and central (Lac de Gras) parts of the NATMAP Slave Province projects.

Hepburn Island: 3 volcanic rocks (including one from the High Lake Belt) are all 2.69 Ga; 3 dated intrusives fall between 2.58 and 2.61 Ga; a preliminary detrital age on a syenite boulder suggests correlation with younger Slave granites. An orthogneiss-tectonite, previously interpreted as Proterozoic, must be older than a crosscutting late-deformational pegmatite which contains 2.64 Ga titanite.

Winter Lake-Lac de Gras: a syenitic, strongly magnetic intrusion (about 2.6 Ga) and a rhyolite porphyry (2.73 Ga) intrude Courageous Lake mafic volcanics. A granodiorite dyke, crosscutting deformed amphibolites near Lake Providence, is 2.75 Ga. The last two dates indicate that this map area may contain one of the oldest volcanic/supracrustal belts in Slave Province.

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A NEW PERSPECTIVE OF THE TRANS-HUDSON OROGEN

D. White¹, A.G. Jones¹, S.B. Lucas¹

Lithoprobe has collected >800 km of seismic reflection data and 110 magnetotelluric (MT) soundings along a continuous E-W transect that extends westward from the Superior craton across the Early Proterozoic Trans-Hudson Orogen to the Hearne craton. The seismic sections are dominated by strong eastward-dipping reflections. In the western part of the orogen a reversal in reflection dip defines a crustal-scale culmination, which on geological and geochronological grounds appears to be cored by Archean rocks. Previous notions on the evolution of the orogen must be reassessed since well-defined packages of Proterozoic rock dip beneath both Archean cratons to lower crustal depths, suggesting "thick-skinned" imbrication of Proterozoic rocks against the cratonic margins and precluding any simple extensions of the cratons beneath the orogen.

The MT profile spatially correlates the North American Central Plains conductor with the Rottenstone-South Indian domain. A second thin crustal conductor was imaged which correlates with the Flin Flon-Snow Lake belt and may be related to the "TOBE" feature observed at the Canada-U.S. border.

Our interpretation concludes that the seismic images across the orogen primarily represent structures generated during the terminal continent-island arc-continent collision rather than pre-collisional tectonic structures.

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WHERE PETROLOGY MEETS GEOPHYSICS: NUMERICAL SIMULATIONS OF MELT PRODUCTION, COMPOSITION AND EMPLACEMENT AT RIFTED MARGINS

M-C. Williamson¹, R.C. Courtney¹, C.E. Keen¹, S.A. Dehler

The eastern Canadian continental margin is one of the best studied examples of rifted margins in the world. It is therefore ideal ground to examine the relationship between deformation and magmatism in an extensional setting.

We calculate the volume and composition of melts generated by adiabatic decompression of the mantle during rifting. Trace element data are obtained for a range of lithospheric stretching factors and mantle potential temperatures, given a set of initial conditions that include the number and duration of rifting episodes, mode of extension, pre-rift lithospheric thickness, properties of the mantle, composition of the source, and nature of the pooling regime. The poster illustrates a comparison of the synthetic data with an integrated database from several Mesozoic rift basins located offshore Eastern Canada. The results allow new constraints to be placed on variations in the duration of rifting, thermal regime of the mantle and extensional styles along the margin.

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GEOLOGY OF THE MANITOUWADGE AREA, NORTHWESTERN ONTARIO

E. Zaleski¹, V.L. Peterson¹

The Cu-Zn deposits of the Manitouwadge greenstone belt lie within an upper amphibolite-facies, highly deformed remnant of supracrustal rocks near the Wawa-Quetico subprovince boundary. The belt includes mafic and felsic volcanic and volcanoclastic rocks, altered rocks and iron-formation. Mineralization is associated with iron-formation and altered rocks. Three alteration types, characterized by metamorphic assemblages, include: 1) orthoamphibole-garnet-cordierite, 2) muscovite-sillimanite or sillimanite-garnet-biotite±cordierite, and 3) hornblende-garnet±epidote±diopside. Previous workers have suggested that this belt is an overturned nappe structure, subsequently refolded to its present synformal shape. Repetition of units across contacts marked by mylonitic gneiss and truncations could be related to early thrusts associated with nappe formation. Subsequent folding produced strong northeasterly-plunging mineral lineations and the dominant foliation. Later dextral motion resulted in the map-scale synformal shape of the belt, localized kink folds and crenulation cleavage.

¹ Continental Geoscience Division, Ottawa

MINERALS

SULPHUR ISOTOPE ANALYSIS USING THE MILES LASER MICROPROBE

G. Beaudoin¹, B.E. Taylor¹

The GSC MILES laser microprobe permits high spatial resolution sampling of mineral for stable isotope analysis. For sulphur isotope ratio measurements, SF₆ gas is produced by melting sulphide in F₂ atmosphere using the energy of a CO₂ laser. SF₆ is purified by cryogenic distillation and introduced in a high-sensitivity mass spectrometer for sulphur isotope ratio measurement.

High-spatial resolution is achieved with a small diameter laser beam, producing a cylindrical crater of 130 µm diameter and depth in a polished slab of pyrite, for example. The surface of a grain can be effectively channel-sampled by making several overlapping craters, without isotope effect. The isotopic composition of minerals in contact, and isotopic zonations in minerals can now be determined. Small samples of powdered pyrite (less than 1 mg) can also be analyzed. Stoichiometric reaction is consistently achieved, and the accuracy of ³⁴S measurements is good and the precision is better than 0.2‰. Using MILES, the sulphur isotope stratigraphy of bedded sulphides from the Sullivan deposit, British Columbia, will be investigated.

¹ Mineral Resources Division, Ottawa

THREE COMPONENT MAGNETOMETER BOREHOLE MEASUREMENTS AT THE STRATMAT MAIN ZONE MASSIVE SULPHIDE DEPOSIT, NEW BRUNSWICK¹

G.R. Bernius², C.J. Mwenifumbo², P.G. Killeen², G. Ascough³

Borehole three-component magnetometer and magnetic susceptibility measurements were made at the Stratmat Main Zone massive sulphide deposit in New Brunswick with the IFG Corp. multiparameter and orientation probes. Both probes have three orthogonally placed fluxgate sensors that measure the X', Y' and Z' components of the earth's magnetic field and two tilt sensors that measure the probe's rotation and dip. The total magnetic field, and the borehole dip and azimuth are calculated from these parameters.

Measurements were made in six boreholes to evaluate the feasibility of using borehole magnetics to detect and delineate offhole magnetic sources associated with economic mineralization. The data indicate that three-component borehole magnetometer measurements can be used to detect magnetic sources. Magnetic susceptibility measurements help to distinguish the responses from offhole and inhole sources. Examples of borehole survey data will be presented to illustrate the results of measurements with both probes.

¹ Canada-New Brunswick Mineral Development Agreement, Project C1.124 Borehole Geophysics

² Mineral Resources Division, Ottawa

³ Norenda Exploration Co. Ltd.

LOW LEVEL PGE ANALYSIS ON THE SUDBURY IGNEOUS COMPLEX AND ITS COUNTRY ROCKS

G. Chai¹, O.R. Eckstrand¹, D.C. Gregoire¹

Samples from both the Sudbury Igneous Complex (SIC) and its country rocks have been analyzed by ICP-MS to determine their PGE concentrations. Except for the Nipissing diabase dykes, all the country rocks contain very low PGE (Pt 2.6-5.3 ppb, Pd <3.9 ppb, Ir 0.02-0.15 ppb and Ru <0.01-0.15 ppb). The dominant rock type in contact with the Sudbury Igneous Complex is the Archean gneiss, it contains 5 ppb Pt, 2.2 ppb Pd, 0.065 ppb Ir, and 0.02 Ru. The Nipissing diabase contains 20.2 ppb Pt, 19.3 ppb Pd, 0.08 ppb Ru, and 0.06 ppb Ir. The SIC samples have a large range of PGE concentrations (0.4-12.4 ppb Pt, 0-7.4 ppb Pd, 0.025-2 ppb Ir, and 0-0.1 ppb Ru). Pt increases from felsic norite of the lower zone to near the transitional zone and decreases sharply in the granophyre of the upper zone, Pd seems to decrease from the lower zone upwards, whereas Ir roughly increases from the lower zone to the upper zone. Three conclusions can be made at this stage: 1) It is not likely that the impact melting of the Sudbury regional rocks had formed the SIC and its sulphide ores because PGE in the SIC rocks are higher or at the same level as its country rocks; 2) granophyre cannot be formed from an individual batch of magma by melting of the crustal rocks, but is the result of magma differentiation as it is much depleted in PGEs compared to any of its country rocks; 3) The higher Ir content of the granophyre may be the result of contribution from the nearby Huronian rocks.

¹ Mineral Resources Division, Ottawa

STATISTICAL SEPARATION OF GEOCHEMICAL ANOMALY FROM BACKGROUND, MITCHELL-SULPHURETS MINERAL DISTRICT, BRITISH COLUMBIA

Q. Cheng¹, F.P. Agterberg², S.B. Ballantyne²

Lithogeochemical data (major oxides and trace elements) from 1066 surface bedrock samples from an area of approximately 120 km² in the Mitchell-Sulphurets mineral district provide the basis for geomathematical studies. Porphyry Cu and Au mineralization and related alteration types have affected different parts of the study area. One goal of the geomathematical studies is to develop a method to distinguish between anomalous samples corresponding to mineralization and background samples from unaltered parts of the area.

This poster shows results obtained by using spatial statistics and power law theory which take account of the values of the samples and their spatial distribution characteristics. For comparison, results obtained by weights of evidence and other statistical methods to separate geochemical anomalies from background including probability plots are also shown.

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² Mineral Resources Division, Ottawa

TILL GEOCHEMISTRY OF THE BIG BALD MOUNTAIN AREA, NEW BRUNSWICK¹

A. Doiron², É. Boisvert²

A drift prospecting project is underway in the Big Bald Mountain region (21 O/1) in the north of the Miramichi Highlands. Cambro-Ordovician rocks of the Tetagouche Group occupy the northern part of the study area. Those rocks constitute the southern limit of a felsic volcanic complex which hosts Zn-Pb-Cu massive sulphides of the Bathurst-Newcastle district. Geochemical analyses of trace elements of silt-clay fraction (<63 µm) of till outlined an anomalous site with high concentrations for 22 of the 34 analyzed elements, including lead, copper and zinc. This site is located a few kilometres west of known mineral occurrences (Chester-Clearwater and Bellechasse-Sheephouse Brook: Cu,Zn,Pb,Ag,Au). The site, which is up-ice of those occurrences, indicates another mineralized source area for the lead, copper and zinc enrichment not yet identified.

¹ Contribution to Canada-New Brunswick Cooperation Agreement on Mineral Development 1990-1995, a subsidiary agreement under the Economic and Regional Development Agreement. Project C1.125 funded by the Geological Survey of Canada.

² Quebec Geoscience Centre, Sainte-Foy

STRUCTURAL EVOLUTION OF THE CAPE RAY FAULT ZONE, SOUTHWESTERN NEWFOUNDLAND¹

B. Dubé², K. Lauzière²

Along Cape Ray Fault zone (CRFZ), two distinct structural domains occur, separated by a strike slip fault. South of the strike slip fault, the rocks are transformed into LS and L>>S tectonites and are characterized by dip slip motion and polyphase deformation. Near the contact with the Port aux Basques Complex, these rocks

correspond to mylonites characterized by reverse-oblique movement. North of the strike slip fault, the deformation is medium strain and dominated by subhorizontal elongation.

The strike slip fault separating these two domains corresponds to a mylonite zone containing sub-horizontal to oblique stretching lineations. Local non-coaxial deformation suggests both dextral and sinistral motion.

The two different movements mapped along Cape Ray Fault Zone may reflect strain increments and partitioning, during one progressive transpressive event or, two different faulting events with tectonically juxtaposed lithological assemblages of probably different ages.

¹ Contribution to Canada-Newfoundland Cooperation Agreement on Mineral Development 1990-1994 a subsidiary agreement under the Economic and Regional Development Agreement. Project C1.124 funded by the Geological Survey of Canada.

² Quebec Geoscience Centre, Sainte-Foy

PRELIMINARY REPORT ON DIAGENESIS AND MINERALIZATION OF THE JUBILEE Pb-Zn DEPOSIT, NOVA SCOTIA

F. Fallara¹, S.J. Paradis², M. Savard²

The Jubilee stratabound Zn-Pb deposit in Cape Breton Island is hosted by brecciated Carboniferous limestone of the Lower Windsor Group. The base of the Windsor Group consists of limestone cyanobacterial laminites overlain by interbedded limestone and evaporite of the Macumber Formation followed by a massive anhydrite cap.

The Jubilee deposit contains reserves of 900 000 tonnes grading 5.2% Zn and 1.4% Pb over thicknesses of 7.6 to 9.4 m in the brecciated limestone. The mineralization, which occurs as cavity and breccia fillings, replacement of limestone fragments, and veins, consists of pyrite, sphalerite, and galena, with minor amounts of marcasite, chalcopyrite, and barite. A spatial relationship was observed between the mineralized breccia and Jubilee Fault which appears to be a synsedimentary fault active during deposition of the Windsor Group.

The relationship between mineralization and paragenesis of the carbonate minerals indicates that mineralization post-dated the fibrous brownish calcite cement and mostly pre-dated the coarse xenomorphic white calcite.

¹ Laval University, Quebec

² Quebec Geoscience Centre, Sainte-Foy

ORE MINERALOGY AND PARAGENESIS OF GOLD OCCURRENCES RELATED TO THE ROCKY BROOK-MILLSTREAM FAULT, NEW BRUNSWICK¹

S. Faure², A. Tremblay³, B. Dubé³

In New Brunswick, several gold occurrences are known along the Rocky Brook-Millstream (RBM) fault in the Bathurst and Upsalquitch Forks areas. These gold showings are found as extensional or shear veins within Silurian to Devonian sedimentary and intrusive rocks. Based on the mineralogy and on the nature of host-rocks and structural settings, these gold showings can be

classified into two main types: 1) auriferous quartz-sulphide veins, and 2) auriferous quartz veins. The first type, common in the Bathurst area, shows significant Au-Ag levels and consists mainly of arsenopyrite- and pyrite-rich veins. The second type is made up of gold-bearing, quartz-arsenopyrite or quartz-pyrite veins.

Variations of vein mineralogy and structure along the strike of the Rocky Brook-Millstream fault can be attributed either to the nature of hosting rocks, the role of adjacent intrusives bodies, or the structural level of emplacement of ore-forming fluids.

¹ Contribution to Canada-New Brunswick Cooperation Agreement on Mineral Development 1990-1995, a subsidiary agreement under the Economic and Regional Development Agreement. Project C1.122 funded by the Geological Survey of Canada

² Laval University, Quebec

³ Quebec Geoscience Centre, Sainte-Foy

GAMMA RAY SPECTROMETRY AS AN INDICATOR OF VMS MINERALIZATION IN THE ROBERT'S ARM AND TULKS VOLCANIC BELTS, NEWFOUNDLAND

K.L. Ford¹

Combined airborne gamma ray spectrometric/magnetic/VLF-EM surveys with line spacings of 1 and 0.5 km were flown over the northern parts of the Robert's Arm and Tulks volcanic belts respectively.

Ground gamma ray spectrometry and bedrock sampling were conducted in July 1992 to relate airborne patterns to geology and known volcanogenic massive sulphide (VMS) mineralization.

Preliminary results show that the widespread quartz-sericite+K feldspar alteration at Pilley's Island is apparent on the regional (1 km) airborne data and can be quantitatively mapped with in situ spectrometry. Potassium concentrations measured by in situ spectrometry show a 2 to 4 times enrichment in altered felsic volcanics and a 5 to 10 times enrichment in altered mafic volcanics. Airborne results from the Tulks survey show elevated potassium levels associated with many known VMS deposits; in situ spectrometry indicates a 2 to 3 times enrichment of potassium in altered felsic volcanics associated with the VMS mineralization. Various felsic volcanic units appear to have distinct radioelement signatures which may aid in detailed mapping.

¹ Mineral Resources Division, Ottawa

RESEARCH WITH ROPOS: NEW DISCOVERIES IN THE MIDDLE VALLEY AND MEGAPLUME HYDROTHERMAL AREAS, JUAN DE FUCA RIDGE

J.M. Franklin¹, I.R. Jonasson¹, R. Embly¹, V. Tunnicliffe², K. Juniper³

A deep-water Remotely Operated Vehicle (ROPOS=Remotely Operated Platform for Ocean Science) was successfully used to obtain biological, geological and vent fluid samples at two hydrothermal vent sites on the Juan de Fuca Ridge in June-July of 1992. This effort marks the first successful ROV-returned samples from a mid-ocean ridge. The ROPOS, which is owned and operated by the Department of Fisheries and Oceans, Canada, made ten dives, with over 60 hours of total bottom time, at two vent areas; the

sediment-hosted Middle Valley area on the northern Juan de Fuca Ridge, and the volcanic-hosted North Cleft site on the southern end of the ridge. At the Middle Valley site, several new vent sites were mapped and sampled. All of them emitted clear, metal-poor fluids of up to 242°C and were depositing almost pure anhydrite mounds. Extensive high-heat flow areas around the vents supported dense communities dominated by *Calymene* and *Solemya* species of bivalves. The ROPOS also performed another first (for ROVs) at Middle Valley when it connected to an instrument package at one of the holes drilled in 1991 (858G) and dumped the 8-month time series of down-hole temperature and pressure data to a PC on board the surface vessel. Less time was available for work on the Cleft site, but several dives here returned the full suite of biological, geological and vent fluid samples and gave valuable experience of working in this more difficult type of environment. The mapping around one of the major vents (Monolith) showed that there was almost continuous venting for about 50 m along the same major fissure/fault system. The first experiences with the ROPOS in 1992 are laying the groundwork for a more extensive scientific program planned for 1993.

¹ National Ocean and Atmospheric Administration

² University of Victoria, Victoria

³ Université de Québec à Montréal, Montreal

HYDROTHERMAL FLUID-SEDIMENT INTERACTION AND MASSIVE SULPHIDE FORMATION: RESULTS OF LEG 139 DRILLING, MIDDLE VALLEY, NORTHERN JUAN DE FUCA RIDGE

W.D. Goodfellow¹, J.M. Franklin¹, R. Zierenberg²,
M.I. Leybourne¹, J.M. Peter¹

Middle Valley, northern Juan de Fuca Ridge, is a sedimented rift that has been intruded by hydrothermally altered and veined tholeiitic sills. Hydrothermal fluids discharge through brecciated and hydrothermally altered sediments at Bent Hill (BH) and the Area of Active Venting (AAV). AAV is an area of high acoustic reflectivity (due to alteration) that consists of several active anhydrite chimneys venting 184°C to 274°C fluids. BH is a sediment hill with an inactive sulphide mound near its southern margin, and an active sulphide mound venting 265°C fluids farther to the south. More than 96 m of clastic sulphides that display textures commonly found in sulphide chimneys were drilled during Leg 139 making BH one of the largest modern seafloor sulphide deposits. Metal contents range up to 11.2 wt.% Zn and 1.2 wt.% Cu; Pb, Ag and Au contents are minor. Sulphide textures and isotope (Pb, S, C, O and Sr) compositions indicate that BH formed at the seafloor from high-temperature basalt-equilibrated fluids that were modified by reaction with the underlying sedimentary pile.

¹ Mineral Resources Division, Ottawa

² U.S. Geological Survey, Menlo Park

RADAR DATA FOR GEOLOGICAL APPLICATIONS: GSC/CCRS STOREFRONT PROJECT OFFICE

D.F. Graham¹, A. Rencz¹, V.H. Singhroy¹

In 1990, within Energy Mines and Resources, the Geological Survey of Canada (GSC) and the Surveys, Mapping and Remote Sensing (SMRS) an agreement was made to operate an image processing facility at 601 Booth Street. The purpose of the facility

was to process digital remote sensing data. The intent was to introduce these new technologies to the GSC's Ottawa-based scientists and to encourage new applications of remote sensing in the geosciences. The facility is jointly supported by SMRS (Canada Centre for Remote Sensing) and GSC (Mineral Resources Division) with an official opening in January 1992.

The facility serves to demonstrate to geologists the various types and uses of remotely sensed data. Through the development and production of enhanced digital products using remotely sensed data, the facility provides assistance in geological mapping studies. Training in the manipulation of remotely sensed data on an image analysis system has given geologists an understanding of image enhancement methodologies.

Projects are proposed through activities of the Geological Survey and the interests of individual geologists. Approval of each project is based on the project's applicability of remotely sensed data (particularly radar data).

Project activities of the past year demonstrated that radar data (both airborne and satellite) have an important role in structural interpretation and Quaternary Mapping, by using different viewing geometries. Surface roughness and topographic change detected by radar sensors provides supplemental information as an image base for integrated image products.

Project activities have yielded data integration methodologies and an evaluation of ERS-1 data for geological applications which has benefited the Non-Renewable Resources Group at the Canada Centre for Remote Sensing.

¹ Mineral Resources Division, Ottawa

AN IMPACT MODEL OF THE SUDBURY STRUCTURE, ONTARIO

R.A.F. Grieve¹, D. Stöffler², A. Deutsch²

The spatial relations of shock and impact-related features indicated that the original Sudbury Structure was about 200 km in diameter. Given the preserved supracrustal lithologies within the Sudbury Basin, logic dictates that a massive impact melt sheet must be present at the Sudbury Structure, with the only viable candidate being the Sudbury Igneous Complex (SIC). The major, trace and isotopic geochemistry of the SIC and the overall stratigraphy of the Sudbury Structure are consistent with the SIC being part of an impact-melt system with an original volume $>10^4$ km³, as is required in such a large impact event. In the model, the ores are crustal in origin, which is indicated by their isotopic composition. Observations at the Sudbury Structure fit within current knowledge of cratering mechanics and suggest that previous complex hybrid impact-igneous models can be discarded.

¹ Geophysics Division, Ottawa

² University of Münster, Münster

MINOR ELEMENTS IN IRON FORMATIONS: GUIDELINES TO REGIONAL METALLOGENY

G.A. Gross¹

Similar patterns in element distribution and correlation are found in samples of iron-formation from Algoma, Lake Superior and Recent seafloor depositional environments. Typical elements derived from hydrothermal sources such as Au, Ag, Cu, Zn, Pb, Ni, Sn, W, F, Ba, appear to have been adsorbed in the smectite clays and amorphous iron and manganese oxides of the protolithic sediments and retained in them during consolidation and metamorphism. Iron-formations have long been recognized as sensitive indicators of the physical and chemical environments in which they formed. The nature of their depositional environments is reflected in their lithological facies and in the distribution and correlation patterns of their minor elements. The minor elements may also indicate the nature of the hydrothermal systems that contributed to the formation of these hydrolithic sediments and provide a key to understanding their metallogeny and that of the great variety of syngenetic metalliferous facies associated with them. Iron-formations can provide useful stratigraphic marker beds in the exploration of associated facies rich in manganese, non-ferrous and precious metals, and rare earth elements.

¹ Mineral Resources Division, Ottawa

GEOLOGY AND MINERAL OCCURRENCES OF THE SOUTHERN PART OF HIGH LAKE GREENSTONE BELT, NORTHERN SLAVE PROVINCE, ONTARIO¹

J.R. Henderson², M.N. Henderson³, J.A. Kerswill³, Z. Arias⁴,
D. Lemkow², R.J. Rice⁴, T.O. Wright⁶

Supracrustal rocks near Hood River are mainly basalt and andesite with little felsic material, and subordinate metagreywacke. Further north, but south of James River, basalt is abundant along the western margin of the north-striking belt, and rhyolite is abundant in the centre. A characteristic lithofacies associated with felsic volcanic rocks is thin bedded sulphidic-graphitic slate and grey siltstone. Magnetite-chert iron formation and carbonaceous limestone also form part of this facies.

The volcanic rocks extruded *ca.* 2.69 Ga, and are surrounded by granitoids that intruded *ca.* 2.60 Ga. D₁ tilting and folding were followed by D₂ folding overprinted by a pervasive D₃ cleavage. Andalusite, cordierite and biotite porphyroblasts, developed in the central part of the area, postdate D₁ and predate D₃.

The area contains several gold and base metal prospects, including the gold-and arsenopyrite-rich Flood Zone on the Ulu property (BHP Minerals Canada Ltd.)

¹ Contribution to the Canada-N.W.T. Minerals Initiative 1991-96

² Continental Geoscience Division, Ottawa

³ Mineral Resources Division, Ottawa

⁴ Queen's University, Kingston

⁵ U.S. National Science Foundation

⁶ Carleton University, Ottawa

IS NICKEL IN CHROME PYROPE GARNET A VALID DIAMOND EXPLORATION TOOL?

B.A. Kjarsgaard¹

Calibration of the Ni thermometer has been independently tested by comparing equilibration temperatures of peridotite xenoliths from Somerset Island, N.W.T. with Ni temperatures derived from analysis of garnets by proton microprobe from the same xenoliths. Results agree with the original observations that Ni content is strongly temperature dependent. Large (to 238°C) temperature differences exist between the Ni thermometer and the two pyroxene thermometer of Finnerty and Boyd (1987) which was used as the reference ('true') temperature. However, Ni temperature correlates well ($\pm 80^\circ\text{C}$) with the two pyroxene thermometer of Brey et al. (1991) suggesting a revision of the current calibration of the Ni thermometer is feasible. A new calibration will be presented based on a worldwide xenolith database. Inherent assumptions implicit in the use of Ni thermometry in diamond exploration are examined; these assumptions produce major drawbacks to the reliable application of the Ni thermometer.

¹ Mineral Resources Division, Ottawa

GEOCHEMISTRY AND PETROGENESIS OF MAFIC AND ULTRAMAFIC GRANULITES FROM THE GRENVILLE PROVINCE TO THE SOUTHEAST OF VAL D'OR, QUEBEC

M.R. Laflèche¹, T.C. Birkett¹

Mafic and ultramafic granulites within the parautochthonous belt (Group I) of the Grenville Province near Val d'Or, include rocks with chemical compositions typical of upper Archean greenstone belts: komatiites, picrites, high Mg and high Fe tholeiites. These rocks display chemical signatures typical of magmatic rocks related to incompatible elements slightly depleted asthenospheric mantle sources.

Within the adjacent allochthonous, possibly monocyclic portion of the Grenville, metamorphosed continental tholeiites (Group II) dominate. These rocks have chemical characteristics of tholeiites derived from lithospheric metasomatized sources. Calc-alkalic andesitic amphibolites (Group III), which outcrops in the vicinity of Group II tholeiites, display chemical compositions typical of modern calc-alkalic andesites related petrogenetically to eclogitic mafic sources in subduction zone.

These geochemical and petrological observations suggest that the metamorphosed mafic and ultramafic rocks represents diachronous (Late Archean to late Proterozoic) magmatic events related to different geodynamic environments.

¹ Quebec Geoscience Centre, Sainte-Foy

**CHARACTER, DISTRIBUTION, AND ORIGIN OF
HYDROTHERMAL ALTERATION FEATURES AT THE
BRUNSWICK NO. 12 DEPOSIT, BATHURST,
NEW BRUNSWICK**

D.R. Lentz¹, W.D. Goodfellow²

At the Brunswick No. 12 massive sulphide deposit, four alteration zones have been recognized. The most distal alteration facies (zone 4) is manifested by the replacement of K-feldspar phenoclasts in the crystal-rich tuffs by chessboard albite, phengite, Mg chlorite, and quartz. These rocks are slightly enriched in Na, Fe, Mn, S, CO₂, base metals, and possibly Mg, and depleted in K, Ca, Ba, and Sr. Zone 3 alteration (proximal-distal) is characterized by the replacement of albite by Fe-Mg chlorite, phengite, and quartz. This zone is enriched in Fe, Mn, S, CO₂, and base metals at the expense of Na, Ca, K, Ba, Rb, Sr, and La. The Fe/(Fe+Mg) ratio, amount of chlorite and sulphide veins/disseminations increase toward the vent facies alteration zone (zone 2). Pervasive, Fe-rich chloritic and heterogeneous silicic alteration is intimately associated with the sulphide stringer zone (vent-proximal; zone 1). The sulphide vein networks are well preserved in the silicified zones, which behaved more competently than other footwall rocks during deformation. The various types of alteration reflect the interaction of buoyant, high-temperature, weakly acidic, Fe-rich fluids with the keratophyric altered footwall units.

¹ Mineral Resources Division, Bathurst

² Mineral Resources Division, Ottawa

**REDBED COPPER IN THE 1.83 Ga BAKER LAKE
GROUP, DUBAWNT SUPERGROUP, DISTRICT OF
KEEWATIN, N.W.T.**

A.R. Miller¹

In the central Churchill Province, the northeast-trending Angikuni sub-basin is composed of continental fluvial conglomeratic to arkosic strata, alkaline mafic volcanic rocks and derived volcanoclastic rocks of the Baker Lake Group. The basement immediately adjacent to this basin along its northwestern margin consists of mylonitic greenschist-grade Archean volcanic rocks and intrusive granodiorite to quartz monzonite. A paleosol, up to 2 m thick and locally preserved beneath the basal Baker Lake Group, records an interval of tectonic stability in the Trans-Hudson Orogen hinterland prior to Baker Lake Group sedimentation. The lower non-volcanic-bearing equivalents of the South Channel and Kazan formations, fine basinwards, to the southeast and are overlain by Christopher Island Formation mafic volcanic flows, lapilli tuff and tuffaceous arkose. Stratigraphically controlled chalcocite and digenite are disseminated in carbonate- and chlorite-altered arkose and is confined to the disconformity between lower non-volcanic-bearing Kazan and volcanic and volcanic-bearing Christopher Island Formation strata.

¹ Mineral Resources Division, Ottawa

**GEOLOGY OF THE HENINGA LAKE SYENITIC
COMPLEX, HENIK LAKES AREA, DISTRICT OF
KEEWATIN, N.W.T.**

A.R. Miller¹, P.A. Cavell²

In 1973 Ridler identified an alkaline complex apparently overlain unconformably by sediments of the Hurwitz Group and interpreted the intrusion as Archean.

Mapping in 1992 and initial petrography indicate a different relationship between a syenite intrusion and sediments. The sediments, drab greenish grey pyritic sericitic arenite are correlated with the Montgomery Lake Group. In the study area arenite was intruded by and thermally metamorphosed by the syenite intrusion.

The intrusive complex has three principal rock types: (1) a main massive equigranular hornblende+biotite syenite, transitional to (2) a trachytoid megacrystic feldspar syenite and (3) a late fine grained granite which cuts (1) and (2). The granite is restricted in area to the contact between the intrusion and Archean metabasaltic country rock.

Geochronological studies, in progress, should establish a lower limit for Montgomery Lake, Padlei and Hurwitz Group sedimentation in the Churchill Province, north of 60°.

¹ Mineral Resources Division, Ottawa

² Department of Geology, University of Alberta, Calgary

**HYDROTHERMAL SEDIMENTS ASSOCIATED WITH
MASSIVE SULPHIDE MINERALIZATION IN THE
BATHURST CAMP, NORTHERN NEW BRUNSWICK**

J.M. Peter¹, W.D. Goodfellow¹

In the Bathurst area, iron-formation (IF) is spatially and temporally associated with massive sulphide mineralization (e.g., Brunswick #6 and #12 and Austin Brook deposits). This IF is being examined for along-strike variations in texture, mineralogy, and geochemistry. Sulphide, carbonate, oxide, and silicate facies are recognized. IF from the Brunswick #12 deposit and vicinity shows variations in barium and Fe_{total}/Mn ratio that can be used as indicators of proximity to sulphide mineralization. Bulk geochemistry and statistical methods have been used to determine the relative importance of hydrothermal, clastic, and hydrogenous components. Rare earth element patterns of IF resemble those of high-temperature hydrothermal solutions discharging at vents on the modern ocean floor. Carbon isotope analyses of siderite and calcite in IF are consistent with a mixed carbon source from organic matter, seawater and/or marine carbonate. Sulphur isotope analyses of bulk sulphides within IF range are very similar to Brunswick #12 ore and may reflect mixed Ordovician seawater sulphate and magmatic sulphur sources.

¹ Mineral Resources Division, Ottawa

GLACIAL HISTORY AND PRELIMINARY INTERPRETATION OF TILL GEOCHEMISTRY, CENTRAL BRITISH COLUMBIA

A. Plouffe¹, S.B. Ballantyne²

During the last glaciation, ice flow patterns over the central portion of British Columbia were influenced by ice emanating from three major accumulation zones: Coast, Skeena and Cariboo mountains. According to Pleistocene sediments stratigraphy and relative ages of glacial striations and grooves, ice from the Coast and Skeena mountains coming from the W and NW, first invaded the area, and was later deflected to the NE and N by ice from the Cariboo Mountains. These ice flow directions are used to interpret the till geochemistry of the area.

A total of 576 till samples collected over the study area are being analyzed for a series of elements. Even if all geochemical results are not available to date, certain correlations are already evident, including: (1) a strong association of Ni, Cr and Co anomalies with ultramafic rocks, (2) high uranium values down-ice from the Germansen Batholith, and (3) maximum Hg concentrations down-ice from the Pinchi Lake Fault.

Other current research includes study on till lithologies and heavy minerals concentrates.

¹ Terrain Sciences Division, Ottawa

² Mineral Resources Division, Ottawa

MAJOR LITHOLOGIES AND ALTERATION OF THE AJAX EAST OREBODY, A SUB-ALKALIC CU-AU PORPHYRY DEPOSIT, KAMLOOPS, SOUTH CENTRAL BRITISH COLUMBIA

K.V. Ross¹, K.M. Dawson², C.I. Godwin¹, L. Bond³

The Ajax East pit, in the Afton mine district, on the southwestern side of the sub-alkalic Iron Mask batholith, was developed on copper-gold mineralization located 600 m east of the Ajax West pit. Porphyry style mineralization, mainly pyrite and chalcopyrite is located at the intersection of two dioritic phases of the Iron Mask pluton.

Pit mapping at 1:750 scale and logging of representative drill core sections in 1992 resulted in the recognition previously of nine major lithologies and a revised chronological order: (1) Nicola volcanics, (2) picrite, (3) hybrid diorite, (4) hybrid diorite, (5) Sugarloaf diorite, (6) pyroxene gabbro, (7) monzonite dykes, (8) syenite dyke and (9) quartz-eye latite dykes.

Intense albitization in the Sugarloaf diorite is related both spatially and temporally to mineralization. Potassic alteration is most intensely developed in the relatively mafic hybrid diorite and Nicola volcanic units and also related to mineralization.

¹ Mineral Resources Division, Vancouver

² Mineral Deposits Research Unit, University of British Columbia, Vancouver

³ Afton Operating Corporation, Kamloops

LITHOCHEMISTRY OF GOLD IN Mn- AND S/CORG-RICH CHERTY ARGILLITE, LOON BAY, NEWFOUNDLAND

A.L. Sangster¹

At Loon Bay in the northern Dunnage zone, Newfoundland, mafic volcanic rocks are overlain by a thick section of Mn-rich metasedimentary rock (deposited as Mn-carbonate) that grades upwards into cherty, sulphidic, carbonaceous argillite. Pyrrhotite, rather than pyrite, is the dominant sulphide present. A transition zone 40 m thick from Mn-rich and S- and C_{org}-poor rock to Mn-poor and S- and C_{org}-rich rock contains unusual anomalous gold values as great as 40 ppb (5 to 40 ppb), compared to backgrounds of <2 ppb in other areas. Gold is highest in lithologies that contain the most pyrrhotite.

These relationships suggest that gold concentration has been influenced by a change in marine environment from mildly reducing conditions, which result in the precipitation of Mn carbonate, to highly reducing conditions that favour the diagenetic stability of pyrrhotite rather than pyrite. Preliminary evaluations of discrimination diagrams (SiO₂ vs. Al₂O₃; U vs. Th, Al-Fe-Mn; and Fe/Ti vs. Al/(Al+Fe+Mn)) suggest that the rocks have been subjected to complex interaction of both hydrogenous and hydrothermal processes.

¹ Mineral Resources Division, Ottawa

DRIFT COMPOSITION OF THE RED LAKE-WOMAN LAKE AREA, NORTHWESTERN ONTARIO

D.R. Sharpe¹

Quaternary sediments sampled in the Red Lake-Woman Lake area, till, and glaciofluvial deposits, derive from ice-flow to southwest or west. At the Bruce Mine, 10 m of till occur on rock whereas most of the area shows <1 m. Drift samples contain mainly local rock debris (>90%) in both pebble and in sand fractions. Some rock fragments derive from the Hudson Bay Lowland several hundred kilometres to the northeast.

The nonmagnetic heavy mineral concentrate from oxidized samples is dominated by common minerals. Scheelite ranged from 1-125 grains per gram counted. Unoxidized samples may contain roughly 5-75% sulphides in addition to the above mineral suite. Visible gold grains, from 0.020 to 0.35 mm in size, were obtained throughout the area in till and sand samples; background gold counts are several grains. The shape and surface morphology of the gold grains indicate transport distances of 100-1000 m, for most grains. No kimberlite indicator minerals (pyrope garnets, chrome diopside or magnesian ilmenite) were found. Neutron activation analyses of gold in heavy mineral concentrates reach values of several thousand ppb which may be correlated with gold grains counts.

Surface soil sampling accesses locally derived till. The geochemistry of surface samples differs from unweathered sulphide-bearing till in areas of buried till. Glaciofluvial sediment is a viable sampling medium for heavy minerals.

¹ Terrain Sciences Division, Ottawa

ENVIRONMENT

BASELINE SAMPLING IN GREAT WHALE, QUEBEC, AND SURROUNDING AREAS – A COLLABORATIVE EFFORT

C. Amos¹, B. MacLean¹, I.A. Hardy¹, J. Zevenhuizen²

A comprehensive high resolution survey and geological sampling program was recently conducted in the vicinity of Great Whale and surrounding areas in James Bay/Hudson Bay, August 1992. A detailed inventory of seabed and nearshore geological conditions in the region of the projected outfall for James Bay II involved the participation of several organizations including Hydro Quebec, Laval, Acadia, Dalhousie Universities together with the Department of Fisheries and Oceans, Inland Water Division and Department of Energy Mines and Resources, Atlantic Geoscience Centre, and Quebec Geoscience Centre, St. Foy. Samples and underway geophysical data collected to serve as baseline information, for environmental and later post development have been processed and curated at the Core Repository, Atlantic Geoscience Centre. This arrangement has provided easy access by these collaborators and proper maintenance for these holdings. This poster will describe the participation of these groups and the efforts they have made to define the limits for this baseline study.

¹ Atlantic Geoscience Centre, Dartmouth

² Orca Marine Geological Consultants, Halifax

PEATLAND DISTRIBUTION, MACKENZIE VALLEY, AND GEOPHYSICAL CASE STUDY, FORT SIMPSON, N.W.T.

J.M. Aylsworth¹, B.J. Todd¹, I.M. Kettles¹

Within the Mackenzie Valley region the presence or absence of permafrost is mirrored by the occurrence of peat bogs or fens. The distribution of fen and peat bogs in this region has been mapped at a scale of 1:1 000 000. The compilation, based on existing surficial geology maps, extends from the Beaufort Sea south to the Territorial border, an area of about 265 000 km². Permafrost conditions vary, with ground temperatures ranging from -10°C in the north to 0°C or higher in parts of the southern area. In addition the occurrence and thickness of permafrost is extremely variable locally in the southern part of the valley lying within the discontinuous permafrost zone.

Within the discontinuous permafrost zone, a small area in the Martin River drainage basin west of Fort Simpson was selected for detailed study. This study area, underlain by lacustrine silt and sand, consists of peat plateau and adjacent fen. Electromagnetic techniques were used to map conductivity. The interpreted EM data demonstrate not only the presence or absence of permafrost, but the upper and lower boundaries of frozen ground. On the peat plateau, active layer thickness was confirmed using a frost probe.

¹ Terrain Sciences Division, Ottawa

GEOMAGNETIC HAZARDS TO POWER SYSTEMS AND PIPELINES: COLLABORATIVE VENTURES WITH INDUSTRY

D.H. Boteler¹, R.L. Coles¹

During geomagnetic disturbances the variations of the magnetic field induce electric currents in power systems and pipelines. These geomagnetically induced currents cause a variety of problems ranging from pipeline corrosion and monitoring problems to transformer damage and power system blackouts. Increasing problems due to system changes and the recent high levels of geomagnetic activity have led to an increased awareness by industry of the "geomagnetic dimension" of their operations. This has led to a number of collaborative ventures with the GSC to evaluate the extent of the problem, forecast critical conditions, and to devise engineering solutions.

¹ Geophysics Division, Ottawa

CO-OPERATIVE WORK IN THE HIGH ARCTIC INTEGRATED RESEARCH AND MONITORING AREA (IRMA)

J. Bourgeois¹, S.A. Edlund¹, R.M. Koerner¹, D.A. Fisher¹, B.T. Alt¹, M. Garneau², B. Peters³, C. Labine⁴, S.D. Robinson⁵, M.-K. Woo⁶, P. Hamilton⁷, W.H. Pollard⁸, A.G. Lewkowicz⁹

GSC's high arctic IRMA has two major thrusts: the snow and ice component of glaciology section, which covers a broad range of environmental issues and includes both spatial and temporal variations of the intensity of modern high arctic pollution and a glacial record of climatic fluctuations over the past 100 000 years. In the Holocene, this climatic record has seasonal resolution using melt records for a summer temperature proxy and stable isotopes for an annual one. This component provides a regional framework for the terrestrial studies centred at Hot Weather Creek, where the terrain is extremely sensitive to climatic fluctuations. Links between modern and past climates, geomorphic processes, and biological processes are being studied by scientists from government, industry, and universities. Together these two studies aid in furthering our understanding of the impacts and magnitude of climate variability, and providing tools to better reconstruct past environments and predicting future responses to climatic change in the High Arctic.

¹ Terrain Sciences Division, Ottawa

² Quebec Geoscience Centre, Sainte-Foy

³ Canada Climate Centre

⁴ Campbell Scientific

⁵ Queen's University, Kingston

⁶ McMaster University, Hamilton

⁷ CMN

⁸ McGill University, Montreal

⁹ University of Toronto, Toronto

POSSIBLE HEALTH EFFECTS OF NATURAL AND ARTIFICIAL SOFTENING OF GROUNDWATERS USED FOR DRINKING WATER SUPPLIES

D.R. Boyle¹

Softened drinking water has been implicated as a possible factor in causing hypertension, various types of heart disease, and, more indirectly through greater mobilization of metals, certain neurological diseases. As a result of complex cation exchange processes, hard groundwaters can be very quickly softened in a variety of geological environments. These softened waters are bicarbonate-rich, display high Ca/Ca+Mg ratios, and, with few exceptions, show strong enrichments in F, with concentrations commonly above safe levels for human homeostatic functioning.

Waters can also be softened artificially, generally to negate adverse effects of hard water on laundry and plumbing fixtures. These waters are, however, almost completely devoid of the essential elements Ca and Mg.

During a recent groundwater study in the Maritime Provinces, 98% of households with water softeners used the softened waters for drinking and about 10% of the households were drinking naturally softened groundwaters with above recommended levels of F.

¹ Mineral Resources Division, Ottawa

CANADA'S FIRST BURIED OIL PIPELINE IN PERMAFROST: JOINT GOVERNMENT AND INDUSTRY ENVIRONMENTAL AND GEOTECHNICAL RESEARCH AND MONITORING

M.M. Burgess¹

The Norman Wells Pipeline, the first completely buried oil pipeline in Canada's discontinuous permafrost zone, began operation in 1985. The uniqueness of the project led to the signing of an Environmental Agreement between the pipeline owner, Interprovincial Pipe Line Company Ltd., (IPL) and the Department of Indian and Northern Affairs (INAC). As a result INAC, with the co-operation of the Geological Survey (GSC), initiated a Permafrost and Terrain Research and Monitoring Program (PTRM) in 1983. The GSC provides expertise on geothermal and geomorphic aspects, and maintains a network of instrumented study sites.

As new environmental, engineering and safety issues have been identified, the PTRM program has responded and, as required, involved additional collaborators. These include Agriculture Canada, the National Research Council, Bruce Geotechnical Consultants, the University of British Columbia, and Nixon Geotech. A priority concern of the last two years has been the stability of wood chip insulated permafrost slopes. The PTRM program is co-operative with IPL's Geotechnical Monitoring program and joint geotechnical review meetings are held annually.

¹ Terrain Sciences Division, Ottawa

MACKENZIE DELTA TRANSECT: RESULTS FROM THE GSC-INDUSTRY COOPERATIVE DEEP DRILLING PROGRAM

S.R. Dallimore¹ (co-ordinator)

In March and April 1992 more than thirty scientists from three divisions of the GSC, Shell Canada Resources and Imperial Oil Resources participated in a multidisciplinary study of the geology and permafrost conditions of the Mackenzie Delta. Continuously cored boreholes, the deepest of which reached 420 m, were completed in the vicinity of three major hydrocarbon fields. Electromagnetic and seismic surveys were also conducted between the boreholes in an attempt to link the geology and permafrost conditions. In addition to providing information on geotechnical conditions in the Mackenzie Delta area, preliminary data from this study have revealed important information about the Quaternary geology and associated permafrost evolution.

Composite borehole logs, with field laboratory data and *in situ* testing data, demonstrate the complexity of the stratigraphy in the area. The principle features visible on these logs include; i) correlation of a major regional talik zone with a highly saline silt/clay sequence identified between 60 m and 80 m depth in each borehole, ii) observations of high water contents and ice-bonding at relatively great depths suggesting that permafrost aggraded contemporaneously with sediment deposition and has been subsequently buried and preserved, iii) identification of regional erosional unconformity and an underlying diamicton at 200 to 300 m depth thought to be an early Quaternary glacial sequence, and iv) observations of high methane concentration throughout the sequence with confirmed visible gas hydrate.

¹ Terrain Sciences Division, Ottawa

THE INTERNATIONAL GEOCHEMICAL MAPPING PROJECT - ENVIRONMENTAL BASELINES FOR THE WORLD

A.G. Darnley

The Geological Survey of Canada has been a pioneering organization in the development and application of geochemical mapping techniques for more than 30 years. The energy crisis of 1973 provided the opportunity to launch a National Geochemical Reconnaissance program in Canada and similar projects began in other countries.

Initiated as an aid to mineral exploration, geochemical maps, including radiometric surveys, are now recognised as providing essential information with expanding economic and environmental implications.

Geochemical maps are the least complete of basic earth science datasets anywhere. The natural environment contains all elements of the periodic table, but no region has a comprehensive geochemical inventory; there is useful information for <20% of the world's land surface.

The International Geochemical Mapping project was launched in 1988 under GSC leadership to assess, demonstrate and recommend methods suitable for global geochemical mapping. Recommendations will be published in 1993. It is sponsored under the IUGS/UNESCO International Geological Correlation Program.

TWENTY YEARS OF COOPERATIVE SURFICIAL OFFSHORE GEOLOGICAL RESEARCH BETWEEN THE ATLANTIC GEOSCIENCE CENTRE, INDUSTRY AND GOVERNMENT – SOUTHEAST CANADIAN OFFSHORE

G.B.J. Fader¹, R.O. Miller¹

A regional, systematic study of the surficial geology (sediments and shallow bedrock) of the Scotian Shelf began in the late 1960s with the production of the first formal maps and reports. This coincided with initial industrial petroleum exploration off eastern Canada and the Geological Survey was poised to provide information on seabed conditions related to anchoring of oil rigs, seabed structures and sediment transport. This relationship quickly developed to include co-operative surveys by industry and government and the provision of advice on diverse issues and projects. Examples include fibre optic telecommunication and electrical transmission cable routes, dredging for supertanker transit, search and recovery for lost ships and airplanes, geological foundation conditions for bridge construction and seabed assessment for optimized bottom fishing. Unusual projects included the recovery of illegal drugs, the testing of secret military hardware and the assessment of right whale bites. The systematic and regional approach to offshore surficial studies has permitted us to respond, on short notice, to an unlimited variety of requests for information, assistance and co-operative research.

¹ Atlantic Geoscience Centre, Dartmouth

HOW OFTEN HAVE EARTHQUAKES BROKEN THE SURFACE OF THE CANADIAN SHIELD?

C. Fenton¹, J. Adams¹, A. Brown², S. Halchuk¹, M. Cajka²

Earthquakes that ruptured to the surface, such as Cadoux and Tennant Creek (Australia) and Ungava (Quebec) show that Precambrian shields are prone to rare, but potentially damaging, large earthquakes. In collaboration with AECL, the rates of seismicity for stable cratons worldwide were calculated to compare with earthquake activity recorded in northern Ontario over the last decade. Based on normalized seismic energy release rates the Canadian Shield should have experienced about 200 surface-rupturing earthquakes since the last glaciation. Work in Sweden and Scotland shows surface ruptures have been relatively common in the postglacial period. However, the poor expression of surface rupture accompanying the 1989 Ungava earthquake, the only surface rupture so far known from the Canadian Shield, suggests that the evidence for prehistoric ruptures may be cryptic.

¹ Geophysics Division, Ottawa

² Atomic Energy of Canada Limited, Ottawa

CURRENT COOPERATIVE INITIATIVES BETWEEN THE ANALYTICAL METHOD DEVELOPMENT SECTION AND THE DEPARTMENT OF THE ENVIRONMENT

G.E.M. Hall¹, A. Mudroch², K. Lum³

One half of this poster describes the results to date of a multidisciplinary study (led by A. Mudroch) of the environmental impacts of abandoned mine tailings at Wells, B.C. Waste from the hard-rock operations at the Cariboo Gold Quartz and Island

Mountain Mines, active during the period 1934-1967, together with placer sediments displaced from Lowhee Creek during the 'gold rush' of the last century, occupies about 25 hectares at the north end of Jack of Clubs Lake. The tailings themselves, lake sediment, lake and stream waters, seeps, and vegetation have been sampled in detail in August 1992 in an attempt to estimate and predict under different conditions the mobility, forms and fate of metals (e.g., As, Hg) present and to recommend remedial measures aimed at improving the quality of surface and groundwater, soil and vegetation.

The second part of the poster describes areas of analytical research being undertaken by the Section to support joint investigations with the St. Laurent Centre (K. Lum) in various projects designed to further our understanding of processes occurring in the surficial environment. For example, the capability of ultratrace detection of metals and metalloids and identification of their particular species is required to model their distribution, mode of transport and fate in major river systems such as the St. Lawrence.

¹ Mineral Resources Division, Ottawa

² National Water Research Institute, Burlington

³ Centre Saint-Laurent, Montreal

COLLABORATION AMONG THE GSC, THE BRITISH GEOLOGICAL SURVEY (BGS), AND THE PRAGUE GEOLOGICAL SURVEY (PGS) ON GEOCHEMICAL PROJECTS RELATED TO ENVIRONMENTAL AND PRECIOUS METAL STUDIES

G.E.M. Hall¹, C.E. Dunn¹, W.B. Coker¹, W.W. Shilts¹,
E.M. Cameron¹, P.R. Simpson², J. Pasava³

Of the numerous co-operative activities amongst the GSC, BGS and PGS, the transfer and application of new analytical methodologies designed for the ultra trace detection of elements in both solid and aqueous media have predominated to date. Application of the GSC method to detect As and Sb in stream and lake waters to sites in Newfoundland, North Wales and Scotland has proven effective in outlining undisturbed areas of gold potential (confirmed by independent methods) and in identifying locations affected by previous mining operations. Another GSC development to detect Pt and Pd to 0.1 and 0.4 ppb, respectively, is producing exciting results in a stream sediment survey in Scotland. The new realm of cost-effective spatial analysis at ppb levels offered by the unique laser ablation ICP mass spectrometer at the BGS is being evaluated in a GSC project to identify Au distribution in various sulphide phases. These projects are discussed in this poster, together with a progress report on research undertaken by the GSC and PGS in black shale environments.

¹ Mineral Resources Division, Ottawa

² British Geological Survey

³ Geological Survey, Prague

FRASER DELTA SLOPE INSTABILITY: EVIDENCE FROM MARINE GEOLOGICAL AND GEOPHYSICAL SURVEYS

B.S. Hart¹, J.V. Barrie¹

Scientists at the Pacific Geoscience Centre, in collaboration with co-workers at the Atlantic Geoscience Centre and Cordilleran Division, have initiated a multi-year, multi-component study of the

Fraser Delta slope. We have identified complex patterns and styles of sedimentation, erosion and substrate failure. Instability occurs on a variety of spatial and temporal scales. Portions of the slope adjacent to present or former river mouth positions are the site of submarine channel and failure complexes. Failure in these settings is primarily due to sediment loading accompanying rapid deposition of river-borne detritus. Larger failure complexes, tens of metres thick and covering several tens of square kilometres remain somewhat enigmatic. Rapid sedimentation and progradation of the delta, abundant interstitial gas in the sediments and regional seismic activity could all have played a role in destabilizing the slope.

¹ Pacific Geoscience Centre, Sidney

PALEOCLIMATE MODELLING INTERCOMPARISON PROJECT (PMIP)

H. Jetté¹, representing PMIP Workshop membership

Simulations of present and future climates have been performed by various global circulation models (GCMs). There are significant differences amongst the outputs produced by these models. The paleoclimate modelling intercomparison project (PMIP) was envisaged as a means of investigating the differences between and the performances of the various GCMs. Paleoclimatic data can be derived from the paleoenvironmental (i.e. geological) record. These data offer a unique opportunity to test model results, when sufficiently quantitative and globally distributed paleo-data are available. The terrestrial data coverage is plentiful and often well dated for the last 18 000 years and 6000 years BP has been chosen as the first targeted time slice for a comparison between models. Close collaboration is planned between modellers and data analysts.

¹ Terrain Sciences Division, Ottawa

VOLUME AND FREQUENCY OF HOLOCENE SLOPE FAILURE DEPOSITS FROM QUEEN CHARLOTTE SOUND, BRITISH COLUMBIA

H.W. Josenhans¹

The steep western margins of Goose Island, Middle and Laskeek Banks of the Queen Charlotte Sound largely comprise prograded littoral sands and gravels. One such feature on Middle bank was seismically surveyed and sampled in detail in June 92. This deposit reaches a thickness of 75 m, extends 17 km along the western margin of Middle bank and prograded up to 8 km seaward. Previous studies suggested this feature was formed between approximately 12 and 10.6 ka when sea level was at least 110 m below present. The shoreface of this deposit presently dips at 10 degrees. At least 20 slump deposits are recognized seismically, at the toe of the slope. The largest slump extends 3 km from the shoreface, 4 km along shore and has an average thickness of 5 m. Cores recovered from these deposits suggest that the failure grade from debris flows proximal to the slope to turbidites distally.

¹ Pacific Geoscience Centre, Sidney

APPLICATION OF BOREHOLE GEOPHYSICS TO LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT STUDIES AT PORT HOPE, ONTARIO

P.G. Killeen¹, K. Pflug¹, C.J. Mwenifumbo¹, R.L. Zelmer², B.A. McCallum²

The Geological Survey of Canada (GSC) R&D logging system was used to make borehole geophysical measurements in holes drilled at the Port Hope Landfill site by the Low-Level Radioactive Waste Management Office (LLRWMO) of Atomic Energy of Canada Limited. The objective was to determine the extent of low-level radioactive waste for remedial action.

Gamma ray spectral logging was found to be the most useful measurement for this application. The gamma data were successfully used to determine the location and thickness of contaminated layers, and to identify their gamma ray source type. A series of experiments was conducted to evaluate the effects of radon contamination on the accuracy of the definitions of contaminated layers. Based on the GSC logging results, recommendations were made regarding drilling and logging protocol for assessing other contaminated sites.

Several examples illustrating the use of gamma ray spectral logging and detection of radon contamination will be presented.

¹ Mineral Resources Division, Ottawa

² Atomic Energy of Canada Limited, Ottawa

EFFECTS OF THE 1925 CHARLEVOIX-KAMOURASKA EARTHQUAKE, QUEBEC

M. Lamontagne¹, M. Cajka², J. Drysdale¹, A. Bent¹

The strongest earthquake to occur onshore in eastern Canada this century was the magnitude 6.2 event that occurred March 1, 1925 in the Charlevoix-Kamouraska region of the Lower St. Lawrence River. This event caused considerable property damage in several communities over a wide distance range along the St. Lawrence River and was felt over an area of approximately 2 million km². It occurred in what is now recognized as the most active seismic zone in eastern Canada and was one of a series of strong earthquakes that have shaken the region since the settlement of the St. Lawrence Valley. Analyses of historical photographs and documents combined with modern modelling techniques have provided a better understanding of this earthquake and its seismotectonic environment.

¹ Geophysics Division, Ottawa

² Atomic Energy of Canada Limited, Ottawa

REGIONAL DIFFERENCES IN PAST CLIMATIC CHANGE IN CANADA

T.J. Lewis¹, K. Wang¹

We have analyzed thermal data collected from many boreholes across Canada to infer past climatic changes. Most of the boreholes were originally drilled for mineral exploration; many companies have co-operated in allowing us to gather thermal data and make thermal measurements on their core samples. We have found that clearing and associated development in forested areas cause the ground surface temperature to increase at mid-latitudes. In central and eastern Canada the ground surface temperature over a century

ago was 1 to 2 degrees below the long term average over hundreds of years. This was followed by a subsequent warming, consistent with meteorological observations. In western Canada, no significant climatic warming over the last century is indicated by underground temperatures nor by studies on tree rings and meteorological observations. However, over the same time period glaciers have been retreating. These differences may be related to the fact that climate in the two regions is controlled by two separate atmospheric circulation systems.

¹ Pacific Geoscience Centre, Sidney

PRELIMINARY RESULTS OF MORPHO-SEDIMENTOLOGICAL STUDY OF INTERTIDAL AND SUBTIDAL ZONES OF MANITOUNUK SOUND, HUDSON BAY

Y. Michaud¹, M. Ruz², C. Amos³, J. Zevenhuizen⁴,
T. Sutherland⁵, B. Ardiles⁶

Field work carried out in the summer of 1992 in the Grande rivière de la Baleine region, Hudson Bay, provided basic geoscience information on the stratigraphy, sediment dynamics and microfauna of Manitounuk Sound. This joint project by QGC and AGC, also involves the participation of several Canadian universities (Laval, Dalhousie, Acadia and INRS) and Hydro-Québec via the Industrial Partnership Program. The purpose of this project is to gather a geoscience database on the Quaternary geology and geological and geochemical processes active on terrestrial, coastal and marine environments of this region.

Preliminary results from sampling and seismic programs, performed in intertidal and subtidal zones of the Manitounuk Sound, suggest that little net sedimentation occurs on tidal flats whereas in the subtidal zone localized deposits of greater than 30 m thick of postglacial to recent sediments occur in the deep basin areas and off Boat Opening.

¹ Quebec Geoscience Centre, Sainte-Foy

² Centre d'études nordiques, Université Laval, Québec

³ Atlantic Geoscience Centre, Dartmouth

⁴ Orca Marine Geological Consultants, Halifax

⁵ Dalhousie University, Halifax

⁶ Acadia University, Wolfville

JOINT CANADA-RUSSIA ARCTIC AGREEMENT: ENVIRONMENTAL ISSUES

W.W. Nassichuk¹, D.A. Dodin², D.N. Skibo¹, Y. Bordukov²

1. Mortality statistics for northern Siberia between 1960 and 1980 are considered higher than the norm for the Commonwealth of Independent States and may be related to nuclear testing conducted in Novaya Zemlya. If this correlation is valid, then it may be reasonable to presume that life in other parts of the circum-Arctic world was also affected by those tests.

2. Heavy metals: extraordinary care is taken by Canadian mining corporations to prevent the movement of heavy metals into the Arctic Ocean environment and Russia is anxious to achieve the same objective. Along with Norwegian and Russian agencies the Survey has participated in the collection of several hundred

samples of sediments from the Barents Sea to determine specific concentrations of heavy metals, radionuclides and organic compounds on the seabed.

¹ Institute of Sedimentary and Petroleum Geology, Calgary

² VNIOkeangeologia, St. Petersburg

COLLABORATIVE OPERATION OF THE CANADIAN NATIONAL SEISMOGRAPH NETWORK

R.G. North¹, P.S. Munro¹

The National Seismograph Network, now being completely modernized, provides rapid information on earthquakes both inside and outside Canada, as well as the fundamental data needed for research into their causes and effects. Roughly one third of the operating cost of the network is borne by outside agencies, either through direct funding or through the provision of data communications. At a number of sites, particularly in the Arctic, GSC data communications facilities are shared with other government agencies, with considerable cost savings.

¹ Geophysics Division, Ottawa

MANIPULATION AND PRESENTATION OF GEOPHYSICAL SURVEY DATA USING DIGITAL TECHNIQUES

D.R. Parrott¹, M. Adams¹, R.C. Courtney¹, R. Currie¹,
D. Heffler¹, B. Nichols¹, D. Pass¹, R. Currie²

The Digital Initiative, a joint project of the Atlantic Geoscience Centre and the Pacific Geoscience Centre of the Geological Survey of Canada, has recently developed digital techniques for the acquisition, processing and display of sidescan sonar and high resolution seismic data. The project provides a basis for improved capability in the use of digital techniques on high speed computer workstations for mapping and understanding near-surface sediments in Quaternary marine environments. A Graphical User Interface provides an intuitive operating environment for the application of digital data manipulation and presentation. This approach has been applied in a variety of study areas including the Fraser River delta, Great Lake and the Grand Banks of Newfoundland.

¹ Atlantic Geoscience Centre, Dartmouth

² Pacific Geoscience Centre, Sidney

A TEXTURAL STUDY OF THE CLAY-RICH LAYERS IN THE VENICE LAGOON, ITALY

J.B. Percival¹, M. Bonardi²

Within the unconsolidated Quaternary sand, silt and clay sediment sequence in the Venice lagoon is an overconsolidated calcareous mud layer called "caranto". This layer, at a depth of 10 to 20 m below sea level, forms the last continental deposit before the Holocene-Flandrian transgression. The purpose of this cooperative study was to characterize the mineralogical and textural components of the caranto layer and compare these to other overlying and underlying clay-rich layers. The clay-rich layers are similar in that they are all composed of poorly sorted, subrounded to subangular, fine silt- to fine sand-sized detrital grains of calcite, dolomite, quartz, feldspar, mica, chlorite and rock fragments. These grains are

supported by a clay-rich matrix of the same composition. Although calcite and Fe-oxide cements occur in minor amounts in the caranto samples, compaction appears to relate to alignment of phyllosilicates.

¹ Mineral Resources Division, Ottawa

² Consiglio Nazionale delle Ricerche, Venice

MODIFICATION OF LOCAL SEAFLOOR ENVIRONMENTS BY AQUACULTURE OPERATIONS: TEMPORAL CHANGES REFLECTED BY BENTHONIC FORAMINIFERA ASSEMBLAGES

C.T. Schafer¹, D.B. Scott², F.S. Medioli²

The impact of aquaculture by-products such as fish food, faecal material or antibiotics on the seafloor environment is a problematic question faced by many aquaculturists. Lack of "baseline data" makes it difficult to determine if significant environmental impact has occurred.

Research has shown that benthonic foraminifera are sensitive to the type of conditions that may develop beneath an aquaculture site. For example, there is one estuarine species that is sensitive to above-average suspended particulate matter concentrations, a possible problem at some aquaculture sites. Their fossil remains provide a proxy record of historical environmental variation.

Initial findings of this three year government/university collaboration indicate that, while there is certainly evidence of increased organic matter loading to seafloor sediments, the foraminiferal faunas show little change following the placement of either salmon cages or mussel lines.

¹ Atlantic Geoscience Centre, Dartmouth

² Centre for Marine Geology, Dalhousie University, Halifax

APPLICATION OF GROUND ELECTROMAGNETIC TECHNIQUES IN POLLUTION MONITORING AND ENVIRONMENTAL INVESTIGATIONS

A.K. Sinha¹

An experimental survey using two ground electromagnetic(EM) systems(Geonics EM-34 and Protem-47) was conducted near Copper Cliff, west of Sudbury, to map the movement of acid mine drainage from a tailing pond. The tailings are fine- to medium-grained sand containing mostly waste silicate host rock, and include 1-5% sulphides and 3-6% carbonates. The oxidation of sulphide minerals results in generation of acid, decreasing the pH of the water and mobilizing trace metals. This results in high concentration of metals in groundwater, posing a health risk.

Lower pH values result in higher electrical conductivity of groundwater, which can be detected by ground EM surveys. EM soundings can also map the bedrock topography, which controls the movement of water. The surveys, performed on six lines to determine the depths to different interfaces and map the conductive plume, proved that the methods can be used successfully for these purposes.

¹ Mineral Resources Division, Ottawa

MEASURING COASTAL EROSION IN THE BEAUFORT SEA: GEOGRAPHIC VARIABILITY AND CLIMATE CHANGE IMPLICATIONS

S. Solomon¹, D.L. Forbes¹

As part of a GSC project to evaluate the potential impacts of climate change in the Mackenzie Corridor, surveys and vertical air photography to provide data on coastal retreat were undertaken at 14 sites around the Beaufort Sea coast during the summer of 1992. This presentation focuses on four sites illustrating a range of physiographic, geological and oceanographic settings and erosional processes. These factors determine the present rates of erosion and will influence the spatial distribution of climate change effects. Recent typical retreat rates at the sites are 1-2 m/a at Kay Point (Yukon coast), 5-6 m/a near Ellice Island on the Mackenzie Delta front, 6 m/a at North Head (Richards Island), and -1.5 m/a at Tuktoyaktuk. Enhanced erosion due to a warming climate may result from the impacts on sea ice distribution, wind-generated waves, and water levels, among other factors.

¹ Atlantic Geoscience Centre, Dartmouth

GEOPHYSICAL AND GEOTECHNICAL SITE INVESTIGATIONS OFFSHORE, EASTERN CANADA - GSC COLLABORATION WITH THE OIL AND GAS INDUSTRY

G.V. Sonnichsen¹, H.A. Christian¹, D.R. Parrott¹, K. Moran¹, R.C. Courtney¹

Understanding seabed sediments and processes affecting their stability is essential to the cost-effective design, construction and operation of oil production and transportation facilities. The GSC, through funding provided by the Panel of Energy Research and Development (PERD), supports research which aims to reduce costs and uncertainties related to seabed stability issues. One research direction is to provide regional and complementary geological, geophysical and geotechnical information to industry site investigations (e.g. Hibernia, Terra Nova, and the Scotian Shelf). This has proven to be a very constructive means of accessing otherwise prohibitively expensive data. Subsequent analyses and interpretation by the GSC provides industry with benefits in long term research, independent interpretation and insights that provide a regional geological perspective to a very restricted site investigation. Examples will be used to show the range of co-operative activities, from short-term technological applications to long-term analysis and interpretation of site data.

¹ Atlantic Geoscience Centre, Dartmouth

SEISMIC MONITORING OF ROCKBURST ACTIVITY IN CANADIAN MINES: PAST AND PRESENT

R.J. Wetmiller¹, W. McNeil¹, C. Galley², M. Plouffe²

Rockbursts – the spontaneous expulsion or collapse of rock into mine workings – are always associated with seismic events although many studies have shown that the amount of seismic energy released is not necessarily related to the size of the rockburst. In 1988, in Canada rockburst problems in hardrock mines in one province alone, Ontario, are estimated to have resulted in an economic loss of about 3% of the provinces's total annual mining production or

approximately \$200 million. In 1958, one outburst in a coal mine in Springhill, Nova Scotia killed 75 of the miners and closed the mine. Past large rockbursts in Canadian mines have been recorded on the National Seismograph Network, providing a unique history of the activity. Presently CANMET is sponsoring extensive detailed monitoring of mining-induced seismicity both within individual mines and around major mining districts like Sudbury.

¹ Geophysics Division, Ottawa

² CANMET, Ottawa

ENERGY

BIOFILMS AND HEAVY OIL: ORIGIN, BIODEGRADATION, AND IMPLICATIONS FOR RECOVERY

H.J. Abercrombie¹, P.W. Brooks¹, M.G. Fowler¹,
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It has long been recognized that heavy soils and bitumens found in Cretaceous rocks of the Western Canada Sedimentary Basin formed by microbial degradation of precursor light oils. Conventional models attribute the origin of these biodegraded oils to the actions of free-floating (planktonic) bacteria. Recognition of the importance of biofilms in natural systems has shown the planktonic model to be inadequate; bacteria colonize surfaces where the bacteria and their extracellular products together form the biofilm. This implies that biofilms play an important role in the origin and biodegradation of heavy oils. It is proposed that the biofilms are responsible for the simultaneous trapping and biodegradation of oil. Experimental data support the biofilm model and imply layering of oils of differing viscosities at the pore scale. Selective recovery of low viscosity oils may be possible.

¹ Institute of Sedimentary and Petroleum Geology, Calgary

² Van Elsberg Geological Consultants, Calgary

³ Alberta Research Council, Edmonton

⁴ Department of Microbiology, University of Calgary, Calgary

⁵ CANMET, Devon

OIL AND GAS EXPLORATION PLAYS OF MAINLAND NORTHWEST TERRITORIES AND YUKON

T.D. Bird¹, G.R. Morrell², P.R. Price², D.R. Smith³, M.C. Fortier⁴

Oil and gas plays of the northern extension of the Western Canada Sedimentary Basin, in the mainland portion of the Northwest Territories and eastern Yukon are described. Maps illustrate hydrocarbon occurrence by physiographic region, from 60° to 68°N. Because of difficult operating conditions and remoteness from petroleum development in Alberta and British Columbia, the area has been penetrated by fewer than 1000 exploratory wells: 26 of these have been classed as discoveries. Oil resources total 39 million cubic metres (246 million barrels) in three discoveries of which 16 million cubic metres have been produced from the Norman Wells field. Gas resources of 27.2 billion cubic metres (960 billion cubic feet) are distributed in the remaining discoveries.

Existing discoveries are classified into eight highly immature exploration plays. A number of conceptual plays are also described: these plays contain no discoveries and represent geological hypotheses. This work, done in concert with National Energy Board, in consultation with Energy Sector and Indian and Northern Affairs, forms the basis for an appraisal of undiscovered resources as part of the continuing Western Canada assessment program.

¹ Institute of Sedimentary and Petroleum Geology, Calgary

² National Energy Board

³ Energy Sector, Energy, Mines and Resources Canada, Ottawa

⁴ Indian and Northern Affairs, Ottawa

DINOFLAGELLATE DIVERSITIES, EXTINCTIONS, SEA-LEVEL CURVES, AND OTHER SUCH THINGS

R.A. Fensome¹, A. MacRae¹, G.L. Williams¹

The development of a palynological database (PALYLIT) in conjunction with seven major oil companies, has provided a powerful research tool. PALYLIT contains information from more than 17 000 publications and is the basis of our plots of dinoflagellate diversities through time, the plots being based on more than 52 000 biostratigraphic records. It is by far the largest paleontological database used to establish diversity curves. The appearance and rapid diversification in the Late Triassic to Middle Jurassic indicate a successful adaptive radiation for the dinoflagellates. Maximum diversities were attained in the Maastrichtian and Eocene with about 700 known species. There was a significant decline between the Maastrichtian and Paleocene and a dramatic decline from Eocene to Recent times. Correlation of the diversity curves with the sea-level curves of Haq et al. (1987) seem to indicate some striking similarities, even with third order cycles. Initial comparison with other data sets such as extinction plots and paleotemperature curves show promise for new avenues of research.

¹ Atlantic Geoscience Centre, Dartmouth

OFFSHORE NEWFOUNDLAND: HYDROCARBON POTENTIAL - CASE STUDY OF TWO WELLS

D.N. Skibo¹, J.S. Bell¹

Models of hydrocarbon generation history are given for two wells, Hibernia K-18 and Terra Nova K-08. Four major topics are considered: 1) source rock characterization, 2) source rock maturation, 3) hydrocarbon generation and 4) hydrocarbon expulsion.

1. Results from GSC and other studies (Rock Eval pyrolysis, GC/MS, %R_o and additional methods) are summarized and integrated with the other three topics.

2. Subsidence histories are re-evaluated using porosity and thermal conductivity systematics calculated from well-log and lithological data and are compared to results obtained using commercial modelling software.

3. Kinetic models of hydrocarbon generation derived from published hydrous pyrolysis studies are investigated. Results for two models of overpressuring and hydrocarbon expulsion are compared.

4. Uncertainties in model calculation of hydrocarbon generation and expulsion (quantities, type and timing) are summarized and discussed in terms of biostratigraphic uncertainties and limitations in knowledge of the chemical, physical and geological processes involved in basin analysis.

¹ Institute of Sedimentary and Petroleum Geology, Calgary

HYDROCARBON CHARGE MODELS OF EAST COAST BASINS: A MID-TERM REPORT OF A JOINT INDUSTRY, GOVERNMENT AND UNIVERSITY PROJECT

M.A. Williamson¹

Accumulations of oil and gas are a result of the dynamic interaction of a complex sequence of physical and chemical processes operating within the framework of a basins geodynamic evolution and sediment infill/structural history. The last 10 years has seen the development of numerically based basin analysis efforts, of varying sophistication, that aim to reduce these complexities to a set of more easily imaged concepts and models. The Hydrocarbon Charge Modelling Project, an initiative co-ordinated through the Atlantic Geoscience Centre, is tasked to develop such models for the Sable and Jeanne d'Arc basins offshore eastern Canada. The project, which is maturing into a truly collaborative, multidisciplinary effort, has attracted scientific and funding contributions from the Petroleum Industry, Academic and Government sectors. Underpinning science activities are discussed with reference to their impact on planned integrated products. The latter will be discussed in terms of their utility to exploration companies in their efforts to reduce risk.

¹ Atlantic Geoscience Centre, Dartmouth

GEOSCIENCE INFORMATION

EVOLUTION OF PRESENTATION TECHNIQUES FOR AIRBORNE GEOPHYSICAL DATA

Airborne Geophysics Section¹

Since the GSC airborne gamma ray spectrometry (AGRS) program began in 1969, more than half a million line kilometres of radiometric, magnetic and VLF data have been collected. During the same period, rapid evolution of computer systems has had a significant influence on methods of data acquisition, processing and presentation.

Display techniques for AGRS data have evolved from simple monochrome line contours to more exotic full colour images. However, the shifting role of AGRS from uranium reconnaissance to geological mapping and environmental monitoring has furthered the need for better tools for the display and interpretation of radiometric data. In recent years, the development of innovative colour schemes has contributed to the usefulness of radiometric data; PC display software has provided the geologist with tools for viewing and manipulating digital data in the field.

¹ Geophysics Division, Ottawa

PEN COMPUTERS FOR THE FIELD AND AUTOMATED SURFICIAL GEOLOGY MAP PRODUCTION

J.R. Bélanger¹, M. Howard¹, R. Laframboise¹, A. Moore¹,
A. Prigent¹

Terrain sciences Division is relying on cutting-edge technology to automate its field operations and map production. Portable computers and GIS software are used during field operations to record field observations and trace geological boundaries. These operations rely on a GIS called *FieldNotes™* which operates within *Windows* and can be used with a mouse or a pen when operating within *Pen Windows*. Digital base maps and air photos (registered to the base maps) are entered in the GIS so the user can record point data or line features directly on the base maps in UTM coordinates. Similarly, database information can be imported directly in the GIS for interactive queries or to enter new information.

Once in the office the information gathered in the field is downloaded in a more powerful GIS (such as ArcInfo) for further processing and production of preliminary maps. The digital information is then passed to GIC Division for final map production.

¹ Terrain Sciences Division, Ottawa

GEOSCAN: COLLABORATING TO BUILD A NATIONAL BIBLIOGRAPHY FOR THE EARTH SCIENCES

B.B. Blair¹, A.G. Kopf-Johnson¹, J.C. Caron¹

GEOSCAN is Canada's national bibliography for the earth sciences, providing bibliographic and subject access to almost 150 000 documents. Co-ordinated by the Geological Survey of Canada, GEOSCAN is co-operatively produced through the activities of federal and provincial geological surveys, a university library and one professional society. Public access to GEOSCAN is available through these participating agencies and GSC staff may access GEOSCAN through the GSC Network.

Through collaborative projects with companies in the private sector, the Provincial Geological Surveys, and the Mineral Policy and the Geological Survey of Canada sectors of Energy, Mines and Resources, the GEOSCAN database continues to disseminate a wealth of valuable geoscience information. From inclusion in geographic information systems and compact discs to basic searches, GEOSCAN provides researchers with a gateway to accessing a collection of geoscientific knowledge. GEOSCAN continues to support and stimulate research and exploration programs and preserve the GSC's mandate to acquire, interpret, and make geoscience information available to all.

¹ Geoscience Information and Communications Division, Ottawa

NATIONAL SEISMIC DIGITAL LIBRARY: HUSKY FRONTIER GEOPHYSICAL DATA LIBRARY

K.C. Coflin¹, K.D. McAlpine¹, M.E. Enachescu², J.R. Hogg³

An extensive digital geophysical database has been donated to the Geological Survey of Canada by Husky Oil and Petro-Canada. Primarily but not exclusively covering the eastern frontier basins this material consists of approximately 65 000 magnetic tapes having an estimated acquisition cost greater than \$100 million. Both raw and

processed seismic reflection and refraction, gravity and magnetic surveys make up the data base collected between the late 1960s and the mid 1980s. This information was previously available only in hard copy from the federal-provincial regulatory agencies and the companies were concerned that the scientific value of the digital data may be lost if not made accessible to Canadian researchers. To ensure the continuous development of new ideas and the data's integrity, agreements for the non-commercial rights to the data were made. The Geological Survey of Canada gains a unique data library putting it on an equal technological foundation with industry.

¹ Atlantic Geoscience Centre, Dartmouth

² Husky Oil Operations, Calgary

³ Petro Canada Resources, Calgary

ON DEMAND RETRIEVAL OF GSC OPEN FILE DIGITAL PRODUCTS FOR CLIENTS

K. Gareau¹, S.B. Ballantyne², M.-F. Dufour¹

In an effort to broaden the scope of services offered to clients, the GSC is looking into setting up a new group within its Geoscience Information and Communications Division (GICD) responsible for the on-demand retrieval of digital open file material prepared by GSC scientists. This user-pay system would allow prospective clients to purchase GSC data released in digital form only as GSC Open Files. Authors are realizing the enormous demand that such requests place on the system, both in terms of human resources and, more importantly, the time needed to respond to them. A centralized retrieval system for clients is being considered, staffed by GICD personnel, as a service to both the GSC's internal and external clients.

¹ Geoscience Information and Communications Division, Ottawa

² Mineral Resources Division, Ottawa

GEOLOGICAL MAP PRODUCTION WITH A GEOGRAPHIC INFORMATION SYSTEM

G. Labelle¹

The Geoscience Information and Communication Division (GICD), Cartography Section together with the Computer Technology Section will demonstrate how the Digital Cartography Unit is using ARC/INFO 6.0.1 to produce NATMAP products and Colour Open Files on 400 dpi electrostatic plotters and the cooperative (GICD, CGD) production routines (AML) they have put into place to produce these maps quickly. The demonstration will include actual production routines running on a Sparc2 work station with ARC/INFO and the production techniques used to produce large format pre-press film on the Scitex from ARC/INFO Postscript files. Our poster will present NATMAP plots, Open file plots and large format pre-press film.

¹ Geoscience Information and Communications Division, Ottawa

GEOPHYSICAL DATA CENTRE (GDC): COLLABORATING WITH CLIENTS

J. Tod¹, R. Dumont¹, K. Anderson¹, I. Butt¹, J. Janveau¹,
L. Lawley¹, W. Miles¹

The GDC, in collaboration with the Provinces, is compiling the regional aeromagnetic surveys of Canada into a contiguous grid, sampled at 200 m. Using the existing 812.8 m grid as a reference datum, profile data of adjacent surveys have been levelled and gridded. High sensitivity, detailed surveys have been levelled to the same datum. To date, processing for the Maritime Provinces, Ontario, Manitoba and Saskatchewan has been completed.

New data are now released under a cost-saving "Maps-on-demand" system. A digital file is prepared and maps plotted only when requested, as in the recent release of the Bouguer gravity anomaly map for Yukon Territory.

Digital data are now available in formats compatible with commercial interpretation packages and can be obtained on various media: 9-track, Exabyte, cartridge, floppy, Internet.

Arrangements are being made to license private companies to sell aeromagnetic data to the private sector and thus broaden the distribution.

¹ Geophysics Division, Ottawa

PROGRESS ON THE DESIGN AND IMPLEMENTATION OF THE NATMAP DIGITAL DATA MANAGEMENT SYSTEM

D. Viljoen¹, B. Brodaric¹, H.J. Broome¹, D. Garson², D. Baril¹

One of the principal goals of each project in the NATMAP program is the construction of a digital geoscience database incorporating both new and existing data. Many themes are being integrated including geology, geophysics, geochronology, geochemistry, quaternary geology, radiometric data, satellite imagery, and airborne radar. GIS (Geographic Information System) and RDBMS (Relational Database Management System) software are being used to store and relate the data so that it is all accessible in real-time through the GIS. Data collected digitally in the field can be easily incorporated into the data management system for rapid production of maps. Database integrity and consistency are assured by data verification techniques and use of standardized legend, symbols, projection, and coordinate system. The digital data management system provides the potential for multi-disciplinary analysis, multi-theme compilations, and rapid data exchange with interested parties irrespective of their hardware and software configurations.

¹ Continental Geoscience Division, Ottawa

² Mineral Resources Division, Ottawa

THE NEW GEOSCIENCE INFORMATION CENTRE: LOOKING TOWARDS THE FUTURE

J. Wilks¹, L. Simpson¹, J.C. Caron¹

To improve focus on client needs and to take advantage of technology changes and new information requirements of the Canadian geoscience community, the Geological Survey of Canada Library and the National GEOSCAN Centre have been consolidated to form the new "Geoscience Information Centre". Designed to provide the geoscience community with a single contact point for their geoscience information needs, the new Centre integrates the delivery of traditional library-based services with the development and marketing of new, technology-driven information products and services. While supporting the core Library and GEOSCAN programs, the new unit provides greater emphasis on special collections, database and product development and the technical inquiries service.

The development of a highly motivated, service-oriented information unit that provides a complete range of geoscience information from one source will result in an organization that is better suited to meet client needs in the 1990s.

¹ Geoscience Information and Communications Division, Ottawa

GIS DATA INTEGRATION FOR EXTECH - PHASE 2

D.F. Wright¹, G.F. Bonham-Carter¹, A.H. Bailes², A.G. Galley¹

During the initial stages of the Exploration Science and Technology (EXTECH) program, regional data for the Snow Lake area, including bedrock geology, airborne gravity, airborne magnetics and mineral deposits were entered into a digital database in a Geographic Information System (GIS). These multilayered data were used to develop and apply spatial modelling methods to evaluate volcanic massive sulphide potential for this area.

During the course of the EXTECH program a number of new data layers have been collected through the co-operation of the Geological Survey of Canada, Manitoba provincial survey and exploration companies operating in the region. The data now available for modelling are: 1) updated geology at 1:20 000 and 1:10 000 scales; 2) lake sediment geochemistry; 3) till geochemistry; 4) airborne radiometric and VLF data; 5) ground mapped zones of hydrothermal alteration; 6) LandSat TM coverage; 7) airborne radar and 8) structural data.

Phase 2 of the GIS data integration component of EXTECH has involved the entry of these new data into the digital GIS database and using it to refine the models developed during the initial phase of EXTECH to evaluate the volcanic massive sulphide potential for the Snow Lake area.

¹ Mineral Resources Division, Ottawa

² Manitoba Energy and Mines, Winnipeg

OTHER CONTRIBUTIONS

BRITISH COLUMBIA GEOLOGICAL SURVEY BRANCH'S ECONOMIC GEOLOGY PROGRAM (BRITISH COLUMBIA GEOLOGICAL SURVEY BRANCH)

D.V. Lefebure¹

The B.C. Geological Survey Branch is developing mineral deposit profiles and grade and tonnage data in collaboration with the USGS and the GSC. These profiles are needed for a quantitative assessment of the province's mineral endowment.

Andre Panteleyev is producing descriptions and models of intrusion-related transitional copper-gold deposits on Vancouver Island and along the Taseko River. George Simandi is completing an extensive magnesite study in southeastern British Columbia and has started a flake graphite study. The ophiolite-hosted lode gold model developed by Chris Ash is being applied to Cache Creek Group rocks near Fort St. James. More than 650 skarns have been classified and their MINFILE descriptions upgraded as part of Gerry Ray's provincial skarn project. Dani Alldrick is completing work in the Sulphurets and Iskut River areas. Danny Hora is coordinating a study of talc deposits hosted by Cambrian dolomites in the Rockies. The integrated Sullivan-Aldridge project relies on co-leader, Trygve Höy, for his regional expertise, particularly in the Sullivan area.

¹ Economic Geology Section, British Columbia Geological Survey Branch, Victoria

GEOLOGICAL SETTING OF PROTEROZOIC VMS DEPOSITS AT SNOW LAKE, MANITOBA (MANITOBA GEOLOGICAL SURVEYS BRANCH)

A.H. Bailes¹, A.G. Galley²

Seven past and presently producing volcanogenic massive sulphide (VMS) deposits occur within two of five recognized volcanic cycles within the Lower Proterozoic Amisk Group (1892 ± 4 Ma) at Snow Lake. Three deposits, all copper-rich, occur within a felsic extrusive complex within a thick sequence of first cycle arc tholeiite basalt and basaltic andesite. The remaining deposits, all zinc-rich, occur within felsic sequences at the top of the third volcanic cycle.

VMS deposits are spatially associated with two large synvolcanic tonalite intrusions, the Sneath Lake pluton (1886+17/-19 Ma) accompanying cycle one volcanism and the Richard lake tonalite (1889+8/-6 Ma) accompanying cycle three. Nd-Sm isotopic studies on Snow Lake rhyolite units that host base metal deposits, and on associated synvolcanic tonalite plutons, indicate that all these rocks are isotopically primitive. This suggests that there could be a correlation between mantle-derived felsic magmas and the generation of Cu-Zn base metal deposits.

¹ Geological Services Branch, Manitoba Energy and Mines, Winnipeg

² Mineral Resources Division, Ottawa

**ELBOW LAKE PROJECT: COMPUTER-ASSISTED
1:20 000 GEOLOGICAL MAPPING IN THE FLIN FLON
BELT, MANITOBA (MANITOBA ENERGY AND
MINES/NATMAP PROJECT)**

E.C. Syme¹, J.B. Whalen², P.G. Lenton¹, L. Chackowsky¹

The Elbow Lake area comprises 250 km² within the Lower Proterozoic Flin Flon metavolcanic belt, 65 km east of Flin Flon, Manitoba. Responsibility for mapping in the Elbow Lake area is divided between Manitoba Energy and Mines (Syme: supracrustal rocks) and the Geological Survey of Canada (Whalen: granitoid plutons). Supracrustal rocks in the Elbow Lake area are metamorphosed to greenschist facies mineral assemblages, and include Amisk Group metavolcanic rocks with back-arc/ocean floor and island arc affinity and a large synvolcanic layered gabbro - ultramafic complex. The supracrustal rocks are centred on Elbow Lake and are surrounded by 5 polyphase calc-alkaline granitoid plutons.

A 1:20 000 coloured preliminary map was produced jointly in Manitoba and Ottawa, within 3 months of the conclusion of 1992 fieldwork. Data were collected in the field using the Manitoba GEODATA system, maps were digitized in Manitoba using PAMAP GIS software, and colour production of the map was performed using ARC/INFO in Ottawa.

¹ Geological Services Branch, Manitoba Energy and Mines, Winnipeg

² Continental Geoscience Division, Ottawa

**1:250 000 SCALE BEDROCK GEOLOGY COMPILATION
FOR THE CORMORANT LAKE AREA (MANITOBA
GEOLOGICAL SURVEYS BRANCH/NATMAP PROJECT)**

W. Weber¹, D. Lindal¹, E.C. Syme¹, A.H. Bailes¹,
H.V. Zwanzig¹, D.C.P. Schledewitz¹, H.P. Gilbert¹,
D.J. Thomas², B.A. Reilly², K.E. Ashton², W.L. Slimmon²,
S.B. Lucas³, A.D. Leclair³, H.J. Broome³, M.D. Thomas³

Lower Proterozoic rocks of the Flin Flon belt are flanked to the north by the Kisseynew belt and to the south by <100 m Paleozoic limestones. The Amisk Group metavolcanic rocks are subdivided into the highly tectonized Mystic Lake Assemblage, the Athapapuskow Lake Assemblage of MORB affinity and the 1.89 Ga Flin Flon Assemblage of arc/tholeiite affinity. Plutonic rocks are grouped into synvolcanic and younger intrusions (1.85-1.83 Ga). Missi Group continental rocks are in structural/unconformable contact with the Amisk Group and older intrusions.

The principal elements of the sub-Paleozoic extension of Precambrian rocks are: a fault-bounded belt of greenstones, correlative with the Athapapuskow Assemblage; linear sequences of intercalated metavolcanic and metasedimentary rocks intruded by several plutons, largely correlative with the Flin Flon Assemblage; a heterogeneous gneiss complex of variably-deformed plutonic rocks interlayered with mafic, calcareous, psammitic and pelitic rocks; and a large (60 x 25 km) late-tectonic granite batholith.

¹ Geological Services Branch, Manitoba Energy and Mines, Winnipeg

² Saskatchewan Geological Survey, Regina

³ Continental Geoscience Division, Ottawa

**GEOLOGICAL STUDIES SOUTH OF THE BRUNSWICK
MINES AREA, BATHURST CAMP, NORTHERN NEW
BRUNSWICK (NEW BRUNSWICK GEOLOGICAL
SURVEYS BRANCH)**

J.P. Langton¹

The Brunswick Project is part of an ongoing provincially-funded study attempting to determine the stratigraphic and depositional setting, and three-dimensional geometry of the Bathurst Camp in northern New Brunswick. To date, the project has involved a study of the structure, petrography and chemical composition of rocks in the area south of the Brunswick No. 6 and No. 12 massive sulphide deposits. The area has been re-interpreted using the latest stratigraphic and structural interpretations of the Bathurst Camp geology. The Brunswick Horizon lies at or near the contact between pyroclastic/epiclastic rocks of the Nepisiquit Falls Formation and rhyolites and related volcanoclastic rocks of the Flat Landing Brook Formation. Recent results on the chemical composition of these two formations indicate that they may be distinguished on the basis of heavy rare-earth-element concentrations.

¹ Geological Surveys Branch, New Brunswick Department of National Resources and Energy, Bathurst

**EASTERN CHURCHILL (RAE) PROVINCE TRANSECT,
WESTERN LABRADOR: STRUCTURAL,
METAMORPHIC, AND INTRUSIVE RELATIONS
(NEWFOUNDLAND GEOLOGICAL SURVEY BRANCH)**

D.T. James¹

In 1992, a 1:100 000-scale mapping program was initiated in the Eastern Churchill (Rae) Province - an area which consists of Archean and Lower Proterozoic crustal components and forms the metamorphic - plutonic hinterland to the Early Proterozoic New Québec Orogen. The study area occupies a significant position because it contains the tectonic boundary with the foreland (New Québec Orogen), is intruded by anorogenic Middle Proterozoic plutons, is contiguous with Labradorian-age rocks to the south, and is transected by the Grenville Front.

Mapping concentrated on the metasedimentary and variably metamorphosed granitoid rocks and included mafic dykes. Field relations suggest that medium- to high-grade metamorphism and concomitant deformation of the supracrustal and granitoid rocks were approximately synchronous with the intrusion of megacrystic granite and charnockite belonging to the ca. 1.84 - 1.81 Ga De Pas batholith.

Structures are generally northwest- to northeast-trending and are locally overprinted by regionally persistent north-striking shear zones.

¹ Geological Surveys Branch, Newfoundland Department of Mines and Energy, St. John's

**RELATIONSHIPS OF ORDOVICIAN AND SILURIAN
ROCKS IN CENTRAL NOTRE DAME BAY,
NEWFOUNDLAND (NEWFOUNDLAND GEOLOGICAL
SURVEY BRANCH)**

B.H. O'Brien¹

In the Newfoundland Appalachians, Dunnage Zone rocks, originating at peri-Gondwanan and lower paleolatitudes and ranging in age from Tremadoc to Ludlow, are preserved in the north-central Exploits Subzone. Lower Ordovician rocks include subduction-related arc volcanics with associated VMS mineralization, later alkali gabbro sills, and ophiolites and arc tonalites, first deformed in the Ordovician.

Middle Ordovician strata, which are interpreted as an overstep sequence above these Lower Ordovician rocks, comprise variably thick, siliciclastic and epiclastic turbidites interstratified with hemipelagic cherts, rift-related volcanics and gabbro feeders, all formed within a back-arc environment. The olistostromal Dunnage Mélange of Tremadoc - Llandeilo age, while crosscut by alkali gabbros of presumed early or mid-Ordovician age, contains exotic blocks of recycled tectonic melange, possibly related to subduction-driven accretion.

Upper Ordovician and Silurian strata, which accumulated in small, dynamic, marine and terrestrial basins following a trans-Iapetus high-stand of sea level, vary in facies and thickness across an emergent ridge situated near the Dunnage Mélange. Where olistostromal deposits predominate in the Ashgill - Llandovery succession, erosional disconformities locally separate such strata from older rocks. Deformed dyke swarms and sheet intrusions, occupying major fault zones and hosting gold mineralization, are possibly related to bimodal mafic and felsic volcanics underlying redbeds of presumed Llandovery - Ludlow age.

¹ Geological Survey Branch, Newfoundland Department of Mines and Energy, St. John's

**ARCHEAN TO PROTEROZOIC DEFORMATION IN THE
NORTHWEST SLAVE PROVINCE (GOVERNMENT OF
THE NORTHWEST TERRITORIES, ENERGY MINES
AND PETROLEUM RESOURCES, CANADA-NWT
MINERAL INITIATIVES OFFICE)**

C. Relf¹

The ca. 2.69 Ga Aniak River volcanic belt in the northwestern Slave Province consists of mafic to felsic volcanic rocks that are structurally underlain by a large syn-volcanic igneous complex and intruded by numerous late Archean granites. Layers of polymictic conglomerate occur locally within the belt, and are interpreted to lie unconformably above the volcanic rocks.

Field relationships suggest that the igneous complex occupies the core of a doubly-plunging antiform which deforms bedding and two cleavages. Structures which predate the (F₃) antiform include a strong bedding-parallel foliation with related folds (S₂ and F₂), and an early cleavage (S₁) preserved locally between S₂ surfaces. Numerous brittle to ductile faults overprint these Archean structures, including several east-over-west thrusts which have the same orientation and kinematics as Proterozoic thrusts farther west.

Absolute ages of these deformation events are currently being tested with U-Pb and Ar-Ar geochronology.

¹ Minerals Initiatives Office, N.W.T. Department of Energy, Mines and Petroleum Resources, Yellowknife

**AN OVERVIEW OF THE GEOLOGY AND MINERAL
DEPOSIT STUDIES OF THE MEGUMA TERRANE,
SOUTHERN NOVA SCOTIA (NOVA SCOTIA
DEPARTMENT OF NATURAL RESOURCES)**

D.J. Kontak¹, M.C. Corey¹, M.A. MacDonald¹, R.F. Mills¹,
G.A. O'Reilly¹, P.K. Smith¹, A.K. Chatterjee¹

The geology of southern Nova Scotia (Meguma Terrane) is dominated by lower Paleozoic metaturbiditic sedimentary rocks of the Meguma Group and Late Devonian (ca. 370 Ma) peraluminous granites: minor amounts of Silurian-Devonian metasedimentary and metavolcanic rocks also occur. The occurrence of high-grade ortho- and paragneisses outcropping in the Liscomb Complex and granulite-facies xenoliths and carbonatized ultramafic rocks of mantle origin in 370 Ma calc-alkaline lamprophyres indicate the nature of the basement and crust-mantle transition zone beneath the Meguma Zone. The deformational history of the region is complex and protracted, extending from 400 Ma to 300 Ma. This is particularly evident in the southwest, where recent work has documented the extent of previously unrecognized ductile and brittle-ductile deformational fabrics. The aforementioned rocks are overlain by terrestrial and marine sediments of Carboniferous age.

Mineralization types, which are the focus of continuing studies, include: (1) mesothermal Au and epigenetic Pb-Zn in the Meguma Group, (2) Sn-W-U-Ag-Cu-Zn-Pb-Mn-Au in greisenized granites (370 Ma) and associated skarns, (3) carbonate-hosted Zn-Pb-Ag-Ba and sandstone-hosted Cu-Ag-U deposits (Carboniferous), (4) Li-Be pegmatites (Devonian?), and (5) placer Au in shallow marine environments.

The poster summarizes recent work on the aforementioned projects and integrate the data into a model for the geological evolution of southern Nova Scotia.

¹ Nova Scotia Department of Natural Resources, Halifax

**TECTONIC ASSEMBLAGE MAP OF ONTARIO
(ONTARIO GEOLOGICAL SURVEY)**

Staff of the Ontario Geological Survey¹

A map of Ontario has been produced to show the distribution of Precambrian tectonic assemblages and plutonic suites, and Paleozoic and Mesozoic depositional sequences. This map, at a scale of 1:1 000 000, is part of a folio of new geological and geophysical maps accompanying a volume on the geology of Ontario published during the past year. The tectonic assemblage map is complemented by a set of 4 charts that display the spatial and temporal relationships of the assemblages, dated plutonic units and depositional sequences in Ontario. The sites of age determination (principally U/Pb) are located on the map and numbered to correspond to the units represented on the time-space charts. A complete list is also provided

of the ages determined and their source references. These charts summarize the main Precambrian magmatic events and pulses of Paleozoic/Mesozoic sedimentation and erosion in Ontario.

¹ Ontario Geological Survey, Sudbury

VOLCANISM AND TYPICAL MINERAL DEPOSITS, VAL D'OR FORMATION, QUEBEC (QUEBEC, MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES)

F. Chartrand¹, J. Moorhead¹

The Val d'Or Formation, stretching 60 km from Val d'Or 60 km to the east to Pershing Batholith in northwest Quebec, consists of interstratified lavas and volcanoclastic rocks. Within the formation lies the central Pyroclastic Belt (CPC), composed of approximately 50% andesitic to rhyolitic pyroclastic rocks, 45% andesitic to rhyolitic lavas, 5% sills and dykes, and minor quantities of chemical sediments. The CPC is intruded by several pre-kinematic plutons such as the Bourlamaque Batholith and Bevecon Pluton. However, recent studies suggest that the volume of pyroclastic rocks has perhaps been over-estimated and that the porphyric lavas, autoclastic breccias, hyaloclastic rocks, and epiclastic rocks make up a significant proportion of this volume. This belt hosts VMS deposits of the Val d'Or area.

Units of mafic and intermediate lava (basalt and andesite) generally consist of massive lava flows and pillowed lavas capped by breccia flows. Felsic lava flows (dacite and rhyolite) tend to form small lenticular masses surrounded by breccia belts, lava lobes, and hyaloclastic rocks.

The pyroclastic rocks form tabular and lenticular deposits. The most common types of pyroclastic rocks are polygenic block tuff and polygenic lapilli tuff. Ash tuff, chert, and pyritous exhalite interstratified with units of lava and pyroclastic rocks are found locally. The exhalites are usually deposited at the end of volcanic cycles. Most of the VMS deposits of the CPC are located along these exhalite strata.

¹ Ministère de l'Énergie et des Ressources du Québec, Quebec

STUDIES IN THE WESTERN GRENVILLE OF QUEBEC HAVE LED TO TWO NEW STRUCTURAL INTERPRETATIONS (QUÉBEC, MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES)

K.N.M. Sharma¹

1. The **Baskatong-Désert Lineament**, a major zone of determination corridor several kilometres wide is defined by the Baskatong-Dozois Terrane to the north, and the Pythonga Terrane to the south.
2. Observations in gneissic terranes along the western side of **Cayamant Lineament**, reveal that during the thrusting episode that carried the metasedimentary rocks of the Monocyclic Belt to the west or northwest over adjacent gneissic complexes, these complexes did not remain passive but were involved in the thrusting episode. Observations have helped establish that the synonymous terms "MBBZ" or "CMBBZ", as defined and explained, are proving inadequate. To better constrain the

existing tectonic links between the metasedimentary rocks and the gneissic complexes, use of the following two terms is therefore suggested:

"**Limit of the Monocyclic Belt**" - this term should apply solely to the limits of the main body of the Monocyclic Belt.

"**Monocyclic Belt Foreland Zone**" - this term applies to all the gneisses within the gneissic complexes terrane that have been subject to intense strain and synchronous transport along with the overlying metasedimentary rocks during the main thrusting episode normally attributed to the Grenvillian orogenic cycle.

¹ Ministère de l'Énergie et des Ressources du Québec, Quebec

GEOLOGICAL SETTING OF GOLD MINERALIZATION, SANTOY LAKE AREA, GLENNIE DOMAIN, TRANS-HUDSON OROGEN, SASKATCHEWAN (SASKATCHEWAN GEOLOGICAL SURVEY)

G.D. Delaney¹, K.E. Derocher², S.A. Cutler³, K. Kyser²

Several significant structurally controlled gold showings have recently been discovered in the Pine Lake greenstone belt near "Santoy lake", located approximately 8 km east of the presently producing Seabee Mine. Supracrustal rocks within the belt are subdivided into two assemblages which have been variably deformed and metamorphosed. Assemblage A is mafic and intermediate volcanoclastic and sedimentary rocks; Assemblage B is volcanoclastic and sedimentary rocks including conglomerate, which in part of the area occurs at the contact with Assemblage A. Near the Seabee mine, Assemblage B lies unconformably on an older synvolcanic intrusive complex dated at 1889 ± 8.7 Ma. The conglomerate is intercalated with felsic volcanics from which zircons have yielded a U-Pb age of 1838 ± 2 Ma. Evidence for an unconformity between assemblages A and B is equivocal. Granitoid veins and lenses invaded the supracrustal rocks prior to deformation, and subsequent to the first deformation a granite and associated pegmatites including a rare element suite were intruded. Three episodes of deformation, corresponding to regional D₂ to D₄ events, affected the Santoy lake area. The pre-D₂ mineralization is in high strain zones in volcanics of Assemblage A near the contact with Assemblage B. Sulphides and gold occur in fractures and along contacts of quartz veins as well as in adjacent sheared and altered rocks.

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RECONNAISSANCE DIAMOND INDICATOR MINERAL SAMPLING IN SASKATCHEWAN (SASKATCHEWAN GEOLOGICAL SURVEY)

F.J. Swanson¹, M.R. Gent¹

Evaluation of results of glacio-fluvial, till and bedrock sampling for diamond indicator minerals by Saskatchewan Energy and Mines and the Saskatchewan Research Council indicates the presence of minerals of kimberlitic affinity throughout a large area in central, eastern and southern Saskatchewan. Three areas with abundant

kimberlitic garnets and chrome diopside have been identified in central-southern Saskatchewan. Physical mineral characteristics including grain size, morphology and colour as well as the presence of chrome diopside suggest that each of these areas includes or is in close proximity to more than one pipe of kimberlitic affinity. Results of testing of interpreted near-source samples for indicator minerals indicates that effective use of heavy mineral sampling for diamond exploration must include evaluation of both the fine- and coarse-grained (0.71 to +2.00 mm) fractions.

Significant occurrences of ruby and sapphire varieties of corundum, some of gem quality, have been identified in a number of overburden samples. Their distribution pattern suggests that several igneous rock sources may be present in southern Saskatchewan.

¹ Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Regina

TECTONOSTRATIGRAPHIC ASSEMBLY OF THE AMISK GROUP, FLIN FLON-AMISK LAKE AREA, SASKATCHEWAN (SASKATCHEWAN GEOLOGICAL SURVEY)

D.J. Thomas¹, B.A. Reilly¹, W.L. Slimmon¹

A provisional subdivision of the Amisk Group is proposed in the Flin Flon - Amisk Lake area. Several distinct volcanotectonic assemblages based on chemical and physical characteristics of the sequences are recognized: (1) a mature tholeiitic to calc-alkaline island arc setting comprising mafic to felsic subaqueous and subaerial rocks intruded by high level subvolcanic felsic intrusions (west Amisk Lake), (2) a tholeiitic, ocean floor or back-arc spreading setting of mafic subaqueous flows (east Amisk Lake and West Arm, Schist Lake), and (3) a tholeiitic oceanic island arc assemblage of subaqueous to subaerial mafic to felsic flows and tuffs (Flin Flon - Phantom Lake).

Preliminary investigations indicate that these contrasting volcanic environments are tectonically discordant, bounded by zones of brittle-ductile shearing and alteration which predate deposition of the Missi Group and emplacement of some of the major plutons. This structural event is tentatively interpreted as a period of early thrusting within the Amisk Group.

¹ Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Regina

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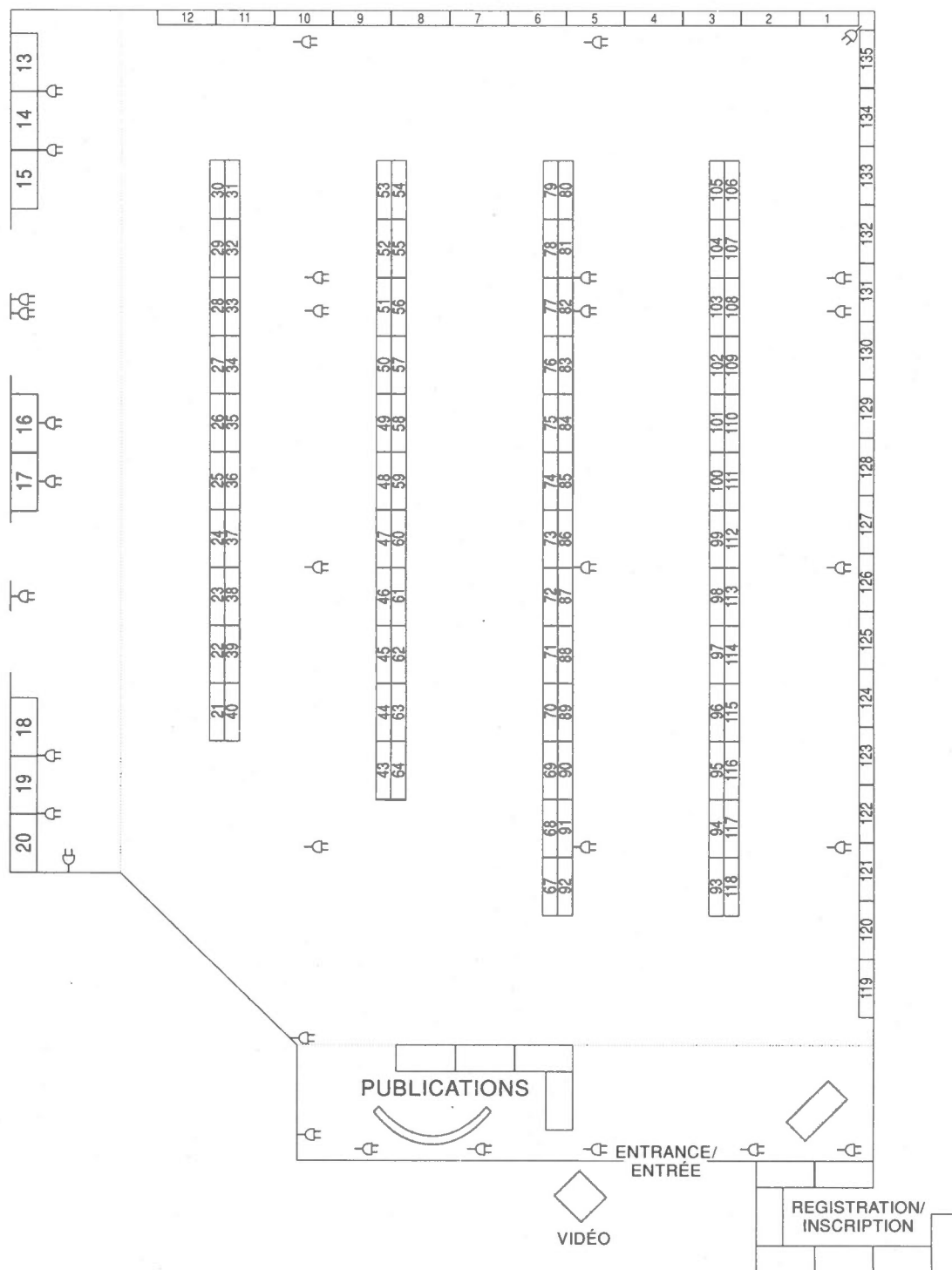
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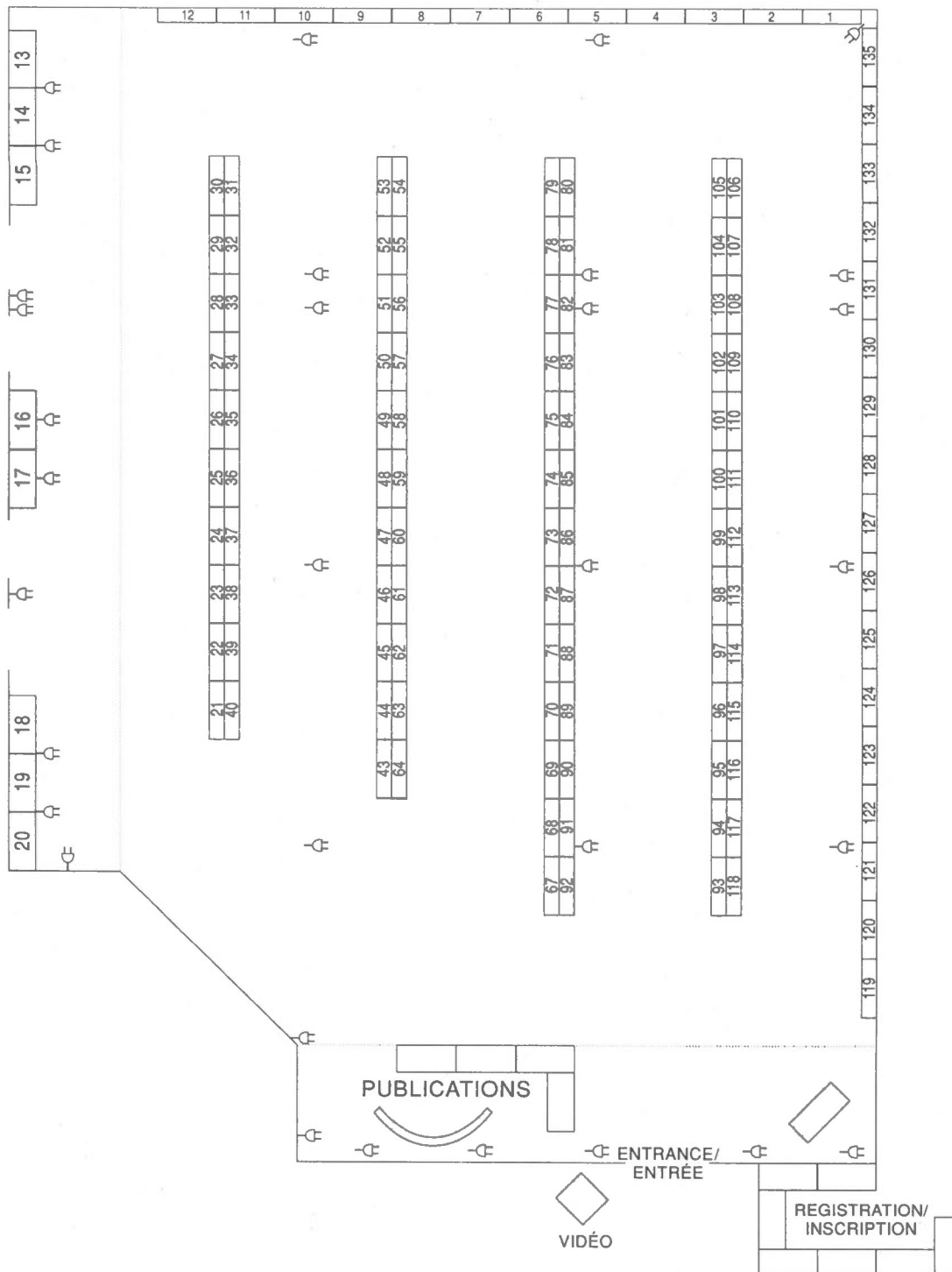
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