

INVITATION

We live in times of rapid and far reaching change. Technological revolution, escalating environmental problems that don't recognize political boundaries, spiralling populations, a shifting world economic order that is bringing about a globalization of the mineral industry ... these are just a few of the changes we are experiencing, and they have implications at every level of our global society.

For the geosciences, radical departures from the old ways of working are evolving as a result. There is a growing demand for non-traditional types of geoscientific information, especially linked to environmental questions. Technological innovation, such as we are seeing come out of Lithoprobe, is opening up new and exciting ways to study the Earth as have never been available before. Fast-breaking developments in information systems are catalyzing new applications and connecting diverse specialists.

"New Directions for Geosciences" is the theme for FORUM '95. Through talks and poster presentations highlighting current GSC research we will show how the geosciences are adapting to today's rapid technological and societal changes, and how they are changing fundamentally as a result.

Please join us for what should be a very exciting event.

E.A. (Ken) Babcock
Assistant Deputy Minister
Geological Survey of Canada

INVITATION

Nous sommes au coeur d'une époque marquée par des changements rapides et profonds. La révolution technologique, les problèmes environnementaux qui surgissent à une vitesse effarante et qui ne connaissent pas les frontières, la population croissante, une économie mondiale en mutation qui se dirige vers une globalisation de l'industrie des minéraux ... Voilà seulement quelques exemples des changements que nous vivons, lesquels ont des répercussions à tous les niveaux de notre société.

Dans le domaine géoscientifique, tout cela se traduit par la modification radicale des anciennes méthodes de travail. Il existe une demande grandissante pour l'information géoscientifique non traditionnelle, tout particulièrement à composante environ- nementale. Les innovations technologiques, comme celles dérivant des travaux menés dans le cadre du projet Lithoprobe, donnent lieu à de nouvelles façons d'étudier la Terre, à du jamais vu. Les progrès prodigieux dans les systèmes d'information font figure de catalyseurs; ils débouchent sur de nouvelles applications et sur la multidisciplinarité.

Dans cette foulée, le thème du FORUM 1995 est le suivant : Nouvelles orientations des sciences de la Terre. Les conférences et les présentations visuelles mettant en relief les travaux en cours de la CGC viendront démontrer comment les sciences de la Terre se transforment complètement dans ce contexte de révolution technologique et sociétale.

Joignez-vous à nous pour un événement qui s'annonce palpitant.

E.A. (Ken) Babcock
Sous-ministre adjoint
Commission géologique du Canada

CURRENT ACTIVITIES FORUM

16-18 January 1995

Place

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

Registration:

We encourage you to pre-register for the meeting by:
filling out and returning the enclosed registration form by mail
or by fax to the FORUM Secretariat (see below for address and fax
number).

Or electronically by:

accessing the NRCan Bulletin Board (World <%2>Wide Web
[HTTP://WWW.EMR.CA/](http://WWW.EMR.CA/) or Internet <%-3> by using a gopher client to
access GOPHER.EMR.CA).

On site registration is also possible.

GSC employees can register by using the network version of Q&A
and accessing P:\PUBLIC\FORUM\FORUMREG.DTF or for Mac users by
e-mailing D. Bouchard with your name as it is to appear on the
name tag and your phone number.

Non-Technical Event

An informal get-together with cash bar will take place on Monday
January 16th, from 16h30 to 19h30 in hall A.

Popular Lecture

At 19h30 on the evening of Monday, 16 January, Richard Grieve
will present a talk entitled: "Is the Sky Falling?
Extraterrestrial Impacts and Earth History"

Scientific Displays and Posters

Over 130 displays and posters will be on view after the Monday
evening lecture in Hall A.

Participants are responsible for their own meals and
accommodations.

For further information

FORUM Secretariat
Geological Survey of Canada
601 Booth St., Rm 205
Ottawa, Ontario K1A 0E8
Tel.: (613) 992-5265

PROGRAM/PROGRAMME

MONDAY, January 16/LUNDI, 16 janvier

13:30

Opening remarks/Mot d'ouverture

E.A. (Ken) Babcock

13:40

New directions in effective geological mapping

A.C. Colvine

13:50

Greenstone-granite terranes of the northern Goudalie domain,
northeastern Superior Province, Quebec

J.A. Percival, T. Skulski, S. Lin, K.D. Card

14:10

1.5-1.0 Ga tectonic evolution of the Grenville orogen in the St.
Maurice region: arc-magmatism, continental collision, anorogenic
(?) plutonism, and extension

L. Nadeau, O. van Breemen, D. Corrigan, P. Brouillette

14:30

New insights into the Appalachian orogen from geology and
geochronology along the Cape Ray Fault, southwest Newfoundland

B. Dubé, K. Lauzière, G.R.Dunning, C. Roddick

14:50

Prairie NATMAP: geological and hydrogeological mapping

R.J. Fulton, G. Matile

15:10

Break/Pause

15:30

Mapping below the Phanerozoic cover: implications for tectonic
evolution and economic potential of the Flin Flon Belt, eastern
Trans-Hudson Orogen

A.D. Leclair, S.B. Lucas, R.A. Stern, H.J. Broome, D. Viljoen

15:50

Anatomy of the Flin Flon greenstone belt: diverse crustal
assemblages and their accretionary history

S.B. Lucas, R.A. Stern

16:10

Advances in understanding of the geological history and mineral potential of the Archean Slave Province: synthesis of Slave NATMAP results

J.E. King, M.E. Villeneuve

TUESDAY, January 17 MARDI, 17 janvier

9:00

EXTECH II: a new multidisciplinary and integrated project on the development of exploration models and technology in the Bathurst mining camp, New Brunswick
W.D. Goodfellow

9:20

The origin of the Paleoproterozoic Onaping Formation and Errington and Vermillion Zn-Cu-Pb massive sulphide deposits, Sudbury, Ontario
H.L. Gibson, S.F. Gibbins, J.A. Stoness, M.J. Gray, J.J. Paakki, D. Rogers, D.E. Ames, I.R. Jonasson

9:40

Discovery of old northwestward glacial flow in the James Bay Basin: implications for mineral exploration and ice sheet - modelling
J.J. Veillette

10:00

Break/Pause

10:30

"Prairie-type" brine-associated Au-Ag-Cu mineralization in the Western Canada Sedimentary Basin
H.J. Abercrombie, R. Feng

10:50

GSC's program in geoscience information
A.E. Bourgeois

11:00

Geological map production using a GIS
G. Labelle, V. Dohar

11:20

New ways of delivering geoscience data (using current state of the art technology)
P.B. Charlesworth, J.E. Glynn

11:40

LUNCH/DINER

13:30

The GSC's environmental geoscience program: moving towards the future

J.-S. Vincent

13:40

Snow and ice chemistry reveals spatial and temporal patterns of pollution in the circumpolar High Arctic

R. Koerner

14:00

Definitely not pollution: Canadian geological setting for native element assemblages of endogenic and exogenic origins

S.B. Ballantyne, D.C. Harris, A. Panteleyev, S.F. Sabag

14:20

Project Hudsonie - a regional study in environmental geodynamics and geochemistry in the Grande-Baleine region, northern Quebec

M. Parent, C. Bégin, Y. Michaud, S.J. Paradis, M.R. La Flèche, M.-H. Ruz, É. Boisvert

14:40

Geoscience and global change of the Palliser Triangle, southern Prairies

D.S. Lemmen, R.E. Vance, S.A. Wolfe

15:00

1994 survey of the Lake Winnipeg environment: a multi-agency co-operative project

B.J. Todd, C.F.M. Lewis, L.H. Thorleifson, E. Nielsen, L. Lockhart

15:20

Great Lakes: applying marine geoscience to environmental problems

S.M. Blasco

WEDNESDAY, January 18 MERCREDI, 18 janvier

9:00

Working with clients and partners - a renewed focus for GSC

D. Harry, D.S. Reade, R.F.J. Scoates

9:10

Marine geoscience: present highlights and future developments in
Canada's ocean territories

D.B. Prior

9:30

Law of the sea: use of geoscience in defining new resources and
boundaries

R.F. McNab

9:50

Beyond an attractive map: new directions for magnetic data

W.R. Roest, M. Pilkington, P. Keating

10:10

Computer-based technologies for geological/economic analysis of
coalfields and other layered deposits

D. Hughes

10:30

Offshore energy: Where? When? Why?

K.D. McAlpine

10:50

GSC's Program in energy-exploration innovation and resource
assessment

G. Mossop

POSTER PRESENTATIONS/EXPOSITIONS VISUELLES

SURVEYS/LEVÉS

Petrogenesis of the Moyie Sills, southeastern British Columbia:
implications for the early tectonic setting of the Middle
Proterozoic Purcell Basin
H.E. Anderson, W.D. Goodfellow

Metamorphic map of the Canadian Shield: summary of recent
progress
R.G. Berman

Thematic structural studies in the Slave Structural Province:
preliminary results and implications for the Yellowknife domain
W. Bleeker, C. Beaumont-Smith

Quaternary geology from Lac Batiscan to Portneuf, Quebec:
practical applications
A. Bolduc

Testing the integrity of subregions of Laurentia in the
Proterozoic with paleomagnetism and high-precision dating
K.L. Buchan, J.K. Park, S.S. Harlan, J.K. Mortensen, R.F. Emslie,
J.C. Roddick, K.D. Card, J.P. Hodych

Tectonic-metallogenic and mineral deposit maps of the Superior
Structural Province
K.D. Card, R.A. Frith, K.H. Poulsen

Airborne gamma-ray spectrometer-magnetic-VLF survey of
polymetallic mineralization in Mazenod Lake area, southern Great
Bear Magmatic Zone, Northwest Territories
B.W. Charbonneau, S.S. Gandhi, R.J. Héту, P. Holman, N. Prasad

1:1 000 000 geological compilation of the eastern central
Superior Province, Quebec
A. Ciesielski, R.A. Frith

High resolution seismic reflection images of parasitic folding in
the Meguma, Renfrew, Nova Scotia
K. Coffin, M. Salisbury, P. Smith, P. Giles

St. Lawrence River gravity survey aids Charlevoix study
R.V. Cooper, M. Lamontagne, J. Halpenny

Nd isotopic evidence for sources of granites, northern Slave

Structural Province, Northwest Territories
(Territoires du Nord-Ouest)
A.M. Davis, E.J. Krogstad

Probing the lower crust: U-Pb geochronology and isotopic studies
of lower crustal xenoliths entrained in alkaline intrusions: an
example from southern Alberta
W. Davis

Crustal structure in the Grenville Province near the Manicouagan
Reservoir, Quebec
D. Eaton

Lithoprobe seismic reflection profiling in Alberta
D. Eaton, B. Milkereit, G. Ross

A new vital tool for effective marine geological studies: swath
bathymetry from Halifax Harbour
G.B. Fader, R.O. Miller

Cambria Icefields geology: update on Industry/GSC 1:50 000
mapping in northwest British Columbia
C. Greig, K. Bull, D. Green, R.G. Anderson

GSC developments aid airborne gravity system
J. Halpenny, G. Zhang

Mapping altered rocks using Landsat TM, geophysical, and
geochemical data: Bruce Jack Lake area, British Columbia
J.R. Harris, A.N. Rencz, B. Ballantyne

Overview of the geology and mineral occurrences of the High Lake
greenstone belt, Slave Structural Province, Northwest Territories
J.R. Henderson, M.N. Henderson, J.A. Kerswill, M. Villeneuve,
C.A. Petch, J.F. Dehls, M.D. O'Keefe

Influence of the buried Chicxulub crater on regional groundwater
flow, Yucatan, Mexico
A.R. Hildebrand, M. Pilkington, C. Ortiz-Aleman, R.E. Chavez, M.
Connors

Geology of the Winter Lake supracrustal belt
B. Hrabi, M.E. Villeneuve, W.J. Davis, H. Helmstaedt, J.E. King

Cape Breton Island to Newfoundland fibre optic cable route survey
l'île du Cap-Breton et Terre-Neuve

H. Josenhans, J. Zevenhuizen

An overview of the occurrence and distribution of kimberlites in
Canada

B.A. Kjarsgaard

Revised geology, north Lac de Gras area, Northwest Territories:
implications for diamond and gold exploration

B.A. Kjarsgaard, R.N. Spark, J. Jakop

Petrophysics of tight rocks for mineral and hydrocarbon
exploration, and for environmental and structural studies

T.J. Katsube, M.A. Williamson, D. Issler, M. Salisbury,
B.A. Kjarsgaard

Recent results from electromagnetic studies in the Western Canada
Basin

R.D. Kurtz, D.E. Boerner, J.A. Craven, F.W. Jones

A new regional tectonic framework for the Flin Flon-Hanson Lake
belt and its sub-Phanerozoic extension, eastern Trans-Hudson
Orogen

A.D. Leclair, D. Viljoen, S.B. Lucas, R.A. Stern, H.J. Broome

Neotectonics of the Great Lakes: stratigraphy and structural
features of sediments

C.F.M. Lewis, S.M. Blasco, B. Todd, G. Cameron

New 1:250 000 map of Cape Breton Island and tectonic revision,
Magdalen Basin NATMAP project

G. Lynch, P.S. Giles, T. Houlahan

Surficial geology of the southeastern part of Prairie NATMAP area

G. Matile, L.H. Thorleifson

Terrain dynamics and Quaternary geology on the east coast of
Hudson Bay

Y. Michaud, C. Bégin, M.-H. Ruz, M. Parent, S.J. Paradis,
É. Boisvert

Seismic image of an Early Proterozoic rift basin

B. Milkereit, J. Wu

Probing the three-dimensional nature of the Sudbury Structure

B. Milkereit, J. Wu, J. Cowan

Structural synthesis (1:250 000) of the La Tuque (31P) and Shawinigan (31I) areas, Grenville Province
L. Nadeau, P. Brouillette

Airborne geophysical surveys in the Chapais-Chibougamau area
G.J. Palacky, F. Kiss, D. Lefebvre, D.J. Dion

Transect through the Indin Lake greenstone belt: journey to the midcrust of the Slave craton
S.J. Pehrsson, G. Grant, J.B. Henderson, H. Helmstaedt, J.E. King

New occurrences of lamproitic rocks in the Churchill Province: olivine-rich dykes and phreatomagmatic centres
T. Peterson, D. Hogarth

1:50 000 combined bedrock/surficial geology mapping of the northern Minto Inlier Ni-Cu-PGE prospect, Victoria Island, Northwest Territories
R.H. Rainbird, D.A. Hodgson

Quaternary geology of the Inman River area, Northwest Territories
D.A. St-Onge, I. McMartin

Large-scale fluid infiltration and re-equilibration of Archean basement granulites during Paleoproterozoic continental underthrusting, Ungava Orogen, Quebec
M.R. St-Onge, O. Ijewliw

Ocean Drilling Program proposal-Northwest Atlantic Margin Project: high resolution record of sediment fluxes to the northwest Atlantic Ocean Basin
C.T. Schafer et al.

Geology and U-Pb geochronology in the vicinity of Ege Bay, Baffin Island, Northwest Territories
R.J. Scammell, K.M. Bethune

Magnetic signature of Lac à l'Eau Claire crater, Quebec: modification of regional trends
R.G. Scott, M. Pilkington, E.I. Tanczyk

Magmatic and structural evolution of Archean granite: greenstone belts in the Goudalie Domain, northeast Superior Province
T. Skulski, S. Lin, J.A. Percival, K.D. Card, P. Winsky

Tectonostratigraphy and tectonic history of the Paleoproterozoic

Flin Flon Belt

R.A. Stern, S.B. Lucas, E.C. Syme

Surficial geology of the Viriden area, Prairie NATMAP project

C. Sun, R.J. Fulton, A. Blais

High resolution aeromagnetic survey of the Interior Plateau,
British Columbia, 1993-94

D.J. Teskey, P. Stone, R. Dumont, F. Kiss, K. Anderson, R.A. Gibb

Gravity and magnetic models for the Churchill- Superior boundary
zone, Manitoba

M.D. Thomas, E.I. Tanczyk

Geology and mineral potential of the Winter Lake-Lac de Gras
area, central Slave Province, Northwest Territories

P.H. Thompson, J.A. Kerswill, E. Froese

Thermal properties of rock units in the Winter Lake-Lac de Gras
area: implications for Archean thermal evolution and diamond
genesis in the central Slave Province

P.H. Thompson, T.J. Lewis, A.S. Judge, F. Lucazeau

1994 survey of the Lake Winnipeg environment: a multi-agency
co-operative project

B.J. Todd, C.F.M. Lewis, L.H. Thorleifson, E. Nielsen,
L. Lockhart

MINERALS/MINÉRAUX

Large, semi-conformable alteration zones within the Onaping
Formation, Whitewater Group, Sudbury Structure, Ontario

D.E. Ames, H.L. Gibson, D.H. Watkinson, I.R. Jonasson

"Prairie-type" brine-associated Au-Ag-Cu mineralization in the
Western Canada Sedimentary Basin

H.J. Abercrombie, R. Feng

Acid-sulphate, advanced argillic, alteration linkage to buried
Cu-Au porphyry systems on north Vancouver Island: the
mineralogical reality

S.B. Ballantyne, A. Panteleyev, D.C. Harris

Mineralogical results from insoluble residues obtained from cold
HF digestion of precious metal-bearing strata, Fort MacKay,
Alberta

S.B. Ballantyne, D.C. Harris, S.F. Sabag

Spatial analysis of geochemical speciation data
Q. Cheng, G.F. Bonham-Carter, G.E.M. Hall, A. Bacj

Ivry and Degrosbois Fe-Ti deposits, Morin Anorthosite, Quebec
O. Diakit , T. Birkett

Glacial dispersion and till geochemistry associated with the
massive sulphide deposits of the Bathurst mining area, New
Brunswick
A. Doiron, M.A. Parkhil

Regional patterns of kimberlite indicator minerals in till, Lac
de Gras area, Northwest Territories
L.A. Dredge, D.E. Kerr, B.C. Ward, I. Kjarsgaard

Submarine alkaline volcanism and active hydrothermal venting in
the New Ireland Forearc Basin, Papua New Guinea
EDISON 1 Scientific party/ quipe scientifique, EDISON 1

GIS-based resource evaluation of Bathurst and Melville islands
B.G. Eddy, G.F. Bonham-Carter, C. Jefferson

The Ansil Cu-Zn deposit: evidence for a long-lived hydrothermal
system
A.G. Galley, D.H. Watkinson, H.L. Gibson, I.R. Jonasson,
G. Riverin

EXTECH II: a new multidisciplinary and integrated project on the
development of exploration models and technology in the Bathurst
mining camp, New Brunswick
W.D. Goodfellow

Till sedimentology and drift composition in the Annabel
Lake-Amisk Lake area, Saskatchewan: implications for drift
prospecting
P. Henderson

Tectonic setting of kimberlites
R.S. Hildebrand, B.A. Kjarsgaard

Borehole geophysical signatures of base metal and gold deposits
in Ontario
P.G. Killeen, K.A. Pflug, C.J. Mwenifumbo, B.E. Elliott

Hydrothermal alteration associated with massive sulphide deposits
of the Bathurst mining camp, New Brunswick

D.R. Lentz

Hydrogeochemistry and hydrology of groundwaters associated with the Halfmile Lake deposit, Bathurst mining camp, New Brunswick
M. Leybourne, W.D. Goodfellow, D.R. Boyle

The use of garnet distribution in surficial materials in reconstructing the glacial history of southeast Gaspésie, Quebec
Y.T. Maurice

Glacial dispersal patterns associated with the C14, B30, A4, and Diamond Lake kimberlite pipes, Kirkland Lake, Ontario
M.B. McClenaghan, I.M. Kjarsgaard

Mineralogical and geochemical studies of hydrothermal sediments associated with base metal mineralization in the Bathurst mining camp, northern New Brunswick
J.M. Peter, W.D. Goodfellow

Mineralogy, composition, and textural relations of seafloor samples from the New Ireland Forearc Basin, Papua New Guinea
J.B. Percival

Spectral gamma-gamma borehole logging technology transferred to IFG Corporation via GSC's Industrial Partners Program
L.D. Schock, P.G. Killeen, B.E. Elliott, D. Blohm

Gravity and magnetic methods applied to mineral exploration in the Bathurst mining camp, New Brunswick
M. D. Thomas, R. Adair, G. Ascough, Y.E. Bloom

Prairie kimberlite study: progress in drift provenance, mineral classification, and geochemical studies
L.H. Thorleifson, R.G. Garrett

Modelling of platinum-group element concentrations in rift-related basaltic magmas
M.C. Williamson, R. Courtney, C. Keen, S. Dehler, C. Harvey

ENERGY/ÉNERGIE

Mapping subsurface geological parameters of Canada's east coast offshore basins

Hydrocarbon charge mapping of east coast basins: new directions from old (and new) data
M.A. Williamson

ENVIRONMENT/ENVIRONNEMENT

Evidence of the 1929 tsunami in southern Newfoundland: the most tragic natural disaster of this type in Canada

T. Anderson, A. Ruffman, M. Tuttle

Sensitive clay failures, Ottawa Valley

J.A. Aylsworth, D.E. Lawrence, J. Traynor

Toxic metals in tree rings as temporal biomarkers of atmospheric pollution: the example of Quebec City

C. Bégin, M.R. La Flèche

Winter geomorphological processes in the Sainte-Anne River, Sainte-Anne-de-la-Pérade, and their impact on the breeding habitat of tommycod

N. Bergeron, A. Roy, D. Chaumont

Hydrogeological and hydrogeochemical studies of base metal mining complex, Westmin Myra Falls Operation, British Columbia

D.R. Boyle, A.J. Desbarats, C.J. Mwenifumbo, G.C. Phipps,

M. Stapinsky, J. Hamilton, I.D. Clark, M.J.L. Robin,

D.C. Gregoire

Quaternary architecture of the Oak Ridges Moraine NATMAP area (projet CARTNAT)

T. Brennand, D. Sharpe, H. Russell, P. Barnett, W. Arnott

Earthquake hazard investigations in the Fraser River Delta, British Columbia: preliminary results from a multidisciplinary deep drilling program

S.R. Dallimore, K. Edwardson, J.A. Hunter, J.J. Clague,

J.L. Luternauer, J.B. Harris, J. Mwenifumbo

Hydrogeology of the Oak Ridges Moraine: partners in geoscience

L. Dyke, D. Sharpe, S. Pullan

Climate change in the Mackenzie Valley: a major cause of permafrost instability and an impediment to development

P.A. Egginton, H. Jetté

Evaluating the fragility of arctic ecosystems: stability and change throughout recent geological time

M. Garneau, J. Bourgeois, K. Gajewski

Investigations into trace-element bioavailability in selected Prairie soils

R.G. Garrett, L.H. Thorleifson

Heavy metal distribution in humus and surficial sediments in the vicinity of a smelter at Flin Flon, Manitoba

P. Henderson, I. McMartin, E. Nielsen, G. Hall

Applications of ground probing radar (GPR) to environmental problems

A. Judge, F. Bonn, T. Brennand, M.M. Burgess, T.W. Fridel, I.M. Kettles, B.J. Moorman, C. Pelletier, J.A. Pilon, S.D. Robinson, H. Russell, T. Shaw, A. Tarussov

Holocene development of peat bogs at Kenosheo Lake and Detour Lake, northern Ontario

I.M. Kettles, H. Jetté, M. Garneau

Geosciences and global change of the Palliser Triangle, southern Prairies

D.S. Lemmen, R.E. Vance, S.A. Wolfe

Glacial Lake Agassiz beaches and reconstruction of major glacial lake levels in the NATMAP Shield Margin area, northern Manitoba and Saskatchewan

I. McMartin

Mercury in till and its glacial dispersal, near Pinchi Fault, north-central British Columbia

A. Plouffe

Technique developments in the Oak Ridges Moraine hydrogeology project: 1) diatoms to determine water level fluctuations, and 2) temperature logs to determine groundwater flow

C. Prévost, S. Hipwell, H. Jetté, V. Allen, A.E. Taylor

Quaternary and environmental geology in the Oak Ridges Moraine NATMAP area: digital compilation

H. Russell, T. Brennand, D. Sharpe, C. Logan

Ice-flow history derived from detailed mapping of striations in Abitibi-Témiscamingue

J.J. Veillette, M.B. McClenaghan

INFORMATION/INFORMATION

Map production from digital field data: 1994 map publications from current bedrock geology projects

K.A. Baker, B. Brodaric, G. Labelle, V. Foster

GSC Fieldlog v3.0: a new prototype version of CGD's field mapping software
B. Brodaric

Development of GIS analysis technology and its application to the NATMAP Slave project
C. Bowie, B.A. Kjarsgaard

New technologies and new directions at the Canadian Geoscience Information Centre
J. Caron, B. Chen, P. Kamel, A.G. Kopf-Johnson

The use of technology for accessing and disseminating geoscience data
P.B. Charlesworth, J.E. Glynn

Preparation of thematic maps from Generalized Geology of the World
L. Chorlton, T. West et al.

Data integration in the Coastal Zone: a new application of GIS technology
K.A. Edwardson, A.G. Sherin

Geological map production using a GIS
Geoscience Information and Communications Division/Division de l'information géoscientifique et des communications

Landsat TM as a mapping and cartographic aid in the Arctic tundra, High Lake, Northwest Territories
D.F. Graham, G. Labelle, J. Glynn

Correlation by GIS methods of airborne radiometrics and surficial materials, southwest Newfoundland
Terre-Neuve
D. Grant, A. Moore, A. Rencz, D. Graham

Ontario NODA Geoscience Database Project: preliminary analyses and results
J.R. Harris, L. Wilkinson, J. Broome

Computer-based technologies for geological/economic analysis of coalfields and other layered deposits
D. Hughes

GIS map library: a window on Cordilleran geology

J.M. Journeay, S.P. Williams

Service centres on the information superhighway: global access to the Geological Survey of Canada

A.G. Kopf-Johnson, M. Mitchell

An automatic system to handle earthquake data requests over the internet

J.A. Lyons, W. McNeil, C.C. Wong

The BORDAT system for storing and organizing borehole log information in the Prairie NATMAP project

L. Murray, R.N. Betcher

DIMOnDS: an interactive digital map production system (computer demonstration)

J. Rupert

Aeromagnetic Survey Exchange: who holds what coverage across Canada?

J. Tod, G. Boyce, F. Dostaler, J. Janveau, R. Kane, L. Lawley, W. Miles

Integrated image products for the southern flank of the Kisseynew domain

D. Viljoen, D. Ross

Spreading the news: Earth sciences for the general public

C. Vodden, L.A. Dredge

A hybrid-GIS model for producing climate change-permafrost impact maps at the regional scale

F. Wright, M. Smith, A.E. Taylor

GEOLOGICAL SURVEY OF CANADA FORUM 1995

"New Directions for Geosciences"

ABSTRACTS

TALKS

New directions in effective geological mapping

A.C. Colvine¹

Canada is an enormous country with a vast range of requirements for geoscientific information. Because of the country's size, even combined federal and provincial geological mapping efforts cannot provide complete modern map coverage at all scales and standards necessary for their diverse usage. Mapping programs must therefore be strategically rather than systematically directed. The principle of the NATMAP Program, for example, combines criteria for a mapping strategy to maximize the effectiveness of scarce resources. A general strategy emphasizes (1) improving the knowledge base in areas of proven high mineral potential, and (2) providing a basis for rational exploration in underexplored areas. Within this context, emphasis must be placed on a comprehensive scientific approach and interagency collaboration from planning to implementation. Application of modern technologies is essential in the effective and efficient delivery and use of mapping information and products.

¹ Continental Geoscience Division, GSC, Ottawa

Greenstone-granite terranes of the northern Goudalie Domain, northeastern Superior Province, Quebec

J.A. Percival¹, T. Skulski¹, S. Lin¹ and K.D. Card¹

The Goudalie Domain, a northwest-trending greenstone-granite terrain and associated negative aeromagnetic anomaly, was mapped at reconnaissance scale in an area extending 200 km north of the Vizien Belt. The Kogaluc-Tasiat Belt, 110 km long, and <1 km wide, of dextrally sheared amphibolite facies mafic metavolcanic rocks, biotite schist, and iron formation, is bordered to the east and west by 15-20 km wide zones containing similar lithological assemblages in the granulite facies that occur as screens in pyroxene-bearing granodiorite and granite. The eastern zone of high-grade supracrustals extends north into the Payne Lake Belt of paragneiss, mafic gneiss, and iron formation, with concordant sheets of granitoid rock, locally cut by Archean dykes. To the east, the Qalluviartuuq Belt of dextrally sheared amphibolite facies mafic metavolcanic schist, biotite schist, and local basal(?) conglomerate locally lies unconformably on tonalitic basement. Favourable environments for VMS and shear-zone-hosted gold mineralization may be present.

¹ Continental Geoscience Division, GSC, Ottawa

1.5-1.0 Ga tectonic evolution of the Grenville Orogen in the St. Maurice region: arc-magmatism, continental collision, anorogenic (?) plutonism and extension

L. Nadeau¹, O. van Breemen², D. Corrigan³, P. Brouillette¹

Four imbricated lithotectonic domains make up the Grenville Orogen in the Portneuf-Saint Maurice region. Structurally up-section, these are: 1) the Mékinac Domain, dominated by granulite facies transposed and granoblastic intermediate and granitic orthogneisses (≈ 1.4 Ga); 2) the eastern extension of the Morin Terrane, comprising amphibolite-granulite facies Grenville Supergroup paragneisses (1.3-1.2 Ga); 3) the Portneuf-Saint-Maurice Domain, underlain by amphibolite facies rocks of the Montauban Group and La Bostonnais Complex, which represent the remnants of a magmatic arc complex (≈ 1.4 Ga); and (4) the Laurentides Parc Domain where granulite facies gneisses are invaded by post peak metamorphic, late syntectonic granites (≈ 1.06 Ga).

Following Grenvillian (1.16-1.10 Ga) northwest-directed tectonic imbrication and crustal thickening, the onset of tectonic denudation is marked by the intrusion of small noritic bodies (1.08 Ga). Subsequent development at mid-crustal level of a regionally extensive network of oblique-slip sinistral extensional shear zones provided channelways and controlled the emplacement of voluminous late syn-tectonic granitic masses (1.06 Ga).

¹ Quebec Geoscience Centre, GSC, Sainte-Foy

² Continental Geoscience Division, GSC, Ottawa

³ Ottawa-Carleton Geoscience Centre, Ottawa

New insights into the Appalachian Orogen from geology and geochronology along the Cape Ray Fault Zone, southwest Newfoundland¹

B. Dubé², K. Lauzière², G.R. Dunning³, J.C. Roddick⁴

The Cape Ray Fault Zone (CRFZ) is a major fault zone in southwestern Newfoundland located at or close to the boundary between composite Laurentia and composite Avalonia, and represents an important structural feature in the understanding of the Appalachian Orogen. The CRFZ recorded reverse-sinistral thrusting of deeper crustal rocks, followed by reverse-dextral motion and retrogression to greenschist facies of the amphibolite rocks thrust onto supracrustal rocks of the Windsor Point Group. This complex structural history occurred over a short period of time between Late Silurian and Early Devonian. Strain partitioning generated by the combined effect of pluton-related and tectonic-related strain fields brought about orogen-parallel transcurrent shearing during the later stages of the collision. Younger deformation includes sinistral transcurrent shearing and an extensional event, postdating late tectonic Devonian granites.

¹ Contribution to Canada-Newfoundland Cooperation Agreement on Mineral Development (1990-1994), a subsidiary agreement under the Canada-Newfoundland Economic and Regional Development Agreement

² Quebec Geoscience Centre, GSC, Sainte-Foy

³ Department of Earth Sciences, Memorial University, St. John's

⁴ Continental Geoscience Division, GSC, Ottawa

Prairie NATMAP: geological, and hydrogeological mapping

R.J. Fulton¹, G. Matile²

The Prairie NATMAP project is taking a fresh look at surficial material(s) mapping in the Canadian Prairie Provinces. Two areas are involved: Virden (62F) and southeastern Manitoba (52E W half & 62H E half). This mapping provides surficial materials data for environmental, hydrogeological, mineral exploration, and land use planning purposes.

Field work has been completed in southeastern Manitoba and three quarters of the Virden area. Open file maps have been prepared for one quarter of the southeastern Manitoba area and for three eighths of the Virden area. Field notes from previous mapping and aggregate resource studies, and borehole logs have been entered into dBase formatted databases.

Items of scientific interest that have been touched on this past year are: a mammoth tusk, outburst flood gravels, bedrock control on geomorphology, a climatically sensitive lake

basin, the relationship between solonchic soils and older till, and Holocene environmental change from a glacial Lake Agassiz lagoon.

¹ Terrain Sciences Division, GSC, Ottawa

² Geological Services, Manitoba Energy and Mines, Winnipeg

Mapping below the Phanerozoic cover: implications for tectonic evolution and economic potential of the Flin Flon Belt, eastern Trans-Hudson orogen¹

A.D. Leclair², S.B. Lucas², R.A. Stern², H.J. Broome², D. Viljoen²

Mapping of Phanerozoic-covered Precambrian basement south of the Flin Flon Belt involved the interpretation of high-resolution potential field data coupled with relogging of drill core from hundreds of basement intersections. The basement is revealed as a mosaic of distinct lithotectonic domains predominantly bounded by major structures. Some domains correlate well with juvenile arc and back-arc assemblages of the exposed Shield, whereas others are restricted to the buried basement. The result is a new tectonic framework for the Flin Flon Belt, which doubles the north-south strike length of many tectonic domains, with the important exception of the Cu-Zn-rich Flin Flon arc assemblage. An upper-amphibolite-grade orthogneiss complex that may represent the mid-crustal root to the Flin Flon arc is restricted to the basement. The mosaic of tectonic domains represents the cumulative product of magmatism, deformation, and tectonic assembly in the interval 1.9-1.7 Ga.

¹ Contribution to Canada-Manitoba and Canada-Saskatchewan Partnership Agreements on Mineral Development (1990-1995), subsidiary agreements under the Canada-Manitoba and Canada-Saskatchewan Economic and Regional Development Agreements.

² Continental Geoscience Division, GSC, Ottawa

Anatomy of the Flin Flon Greenstone Belt: diverse crustal assemblages and their accretionary history¹

S.B. Lucas², R.A. Stern²

The Flin Flon Greenstone Belt is a collage of distinct tectonostratigraphic assemblages that was assembled at a relatively early stage in the tectonic evolution of the Trans-Hudson Orogen. Four crustal assemblage types have been documented in the Flin Flon area: (1) 1.90-1.88 Ga juvenile arc, (2) 1.90 Ga back-arc, (3) oceanic plateau, and (4) 1.92-1.91 Ga arc built on an Archean basement fragment. Early (ca. 1.90 Ga) tholeiitic arc sequences were rifted, creating intra-arc basins in which oceanic basalts, turbidites, and calc-alkaline and shoshonitic volcanoclastics accumulated at 1.89-1.88 Ga. Accretion of the assemblages at 1.88-1.87 Ga was succeeded by construction of 1.876-1.838 Ga arc(s) on the accretionary complex. The post-accretion interval is marked by extensive arc plutonism, continental sedimentation, and subaerial volcanism coeval with, and spatially controlled by, intra-arc

deformation along strike-slip faults.

- ¹ Contribution to Canada-Manitoba and Canada-Saskatchewan Partnership Agreements on Mineral Development (1990-1995), subsidiary agreements under the Canada-Manitoba and Canada-Saskatchewan Economic and Regional Development Agreements
- ² Continental Geoscience Division, GSC, Ottawa

Advances in understanding of the geological history and mineral potential of the Archean Slave Province: synthesis of Slave NATMAP results

J.E. King¹, M.E. Villeneuve¹

Integrated bedrock studies within the Slave Province NATMAP corridor demonstrate that the province is composed of notably diverse crustal components dominated by crust that formed at ca. 3.1, 2.7, and 2.6 Ga. Constituent supracrustal rocks form distinctive and complex stratigraphic/structural belts involving major intrabelt unconformities and/or tectonic stacking. The map pattern of most greenstone belts is dominated by fold interference structures and modified by Late Archean to Early Proterozoic faults (transcurrent to reverse). Intrusive components include large gneiss complexes, many of which are synvolcanic, and a suite of 2.62-2.58 Ga plutons. Correlations of assemblages within and between supracrustal belts, integrated with metallogeny studies, form a powerful basis for identification of areas most favourable for ore discovery. In addition, understanding of Slave crustal structure and its assembly may help to understand kimberlite emplacement.

- ¹ Continental Geoscience Division, GSC, Ottawa

EXTECH-II: a new multidisciplinary, integrated and collaborative project on the development and testing of exploration methods and technology in the Bathurst mining camp, New Brunswick

W.D. Goodfellow¹

EXTECH-II is a five-year EXploration and TECHnology project that was initiated in 1994 in the Bathurst mining camp. The principal objective of the EXTECH-II project is to address problems of declining base metal reserves by developing integrated and multidisciplinary approaches to exploration. It will be necessary to better understand the geological setting of sulphide deposits and processes of sulphide formation and degradation, and to develop, test, and apply geological, geophysical, and geochemical methods of detecting buried deposits. EXTECH-II, initiated by the GSC, represents a collaborative project involving earth scientists from the GSC, the New Brunswick Geological Survey, industry, and universities. The project is structured into five major areas: 1) stratigraphic and volcanological setting of deposits; 2) geology, geochemistry, and genesis of sulphide deposits; 3) surficial geology and geochemistry; 4) ground and airborne geophysics; and 5) geoscience data integration and output using a Geographical Information System (GIS).

¹ Mineral Resources Division, GSC, Ottawa

The origin of the Palaeoproterozoic Onaping Formation and Errington and Vermilion Zn-Cu-Pb massive sulphide deposits, Sudbury, Ontario

H.L. Gibson¹, S.F. Gibbins², J.A. Stoness¹, M.J. Gray³, J.J. Paakki⁴, D.E. Ames⁴, I.R. Jonasson⁴

The Errington and Vermilion Zn-Cu-Pb deposits formed through subseafloor replacement of a proximal hydrothermal vent-facies carbonate sinter of the Vermilion Formation. Proximal, discordant alteration zones within the footwall Onaping Formation are characterized by irregular zones of Fe- and Mg-carbonate surrounding a core of silification and chlorite alteration. Contrary to previous interpretations, the Onaping Formation is not a succession of ash-flow tuffs, nor is it a fallback breccia. It was emplaced by continuous introduction, both passively and explosively, of a melt of uniform 'andesitic' composition at surface in a subaqueous setting. Four semiconformable alteration types, namely silicification, feldspar alteration, chloritization, and carbonate alteration, occur within the Onaping Formation. These zones of semiconformable alteration have also been recognized in the footwall successions of other volcanic-associated massive sulphide deposits such as those at Noranda, Mattagami, and Sturgeon Lake and in the Proterozoic Bergslagen and Skellefte districts of Sweden.

¹ Laurentian University, Sudbury

² Falconbridge Limited, Timmins

³ Lac Minerals Limited, Vancouver

⁴ Mineral Resources Division, GSC, Ottawa

Discovery of old northwestward glacial flow in the James Bay Basin: implications for mineral exploration and ice sheet modelling

J.J. Veillette¹

At several hundred sites over a large area of west-central Quebec and northeastern Ontario roughly centered on James Bay, bedrock-inscribed indicators of ice flowing in a general northwestward direction were measured on the lee sides of outcrops heavily striated by westward and southwestward flowing ice. The consistent position and orientation of these 'old' northwestward striations at the base of the ice flow sequence suggests a strong association with the inception and expansion of the Laurentide Ice Sheet northeastward into central Quebec from an initial growth zone southeast of James Bay. This new model is in agreement with glacial transport data both east and west of James Bay and has direct implications for the application of exploration methods in glaciated terrain. Stratigraphic evidence and a similar former direction of ice movement in the Winisk area of northern Ontario support an Early Wisconsin origin for this event.

¹ Terrain Sciences Division, GSC, Ottawa

“Prairie-type” brine-associated Au-Ag-Cu mineralization in the Western Canada Sedimentary Basin

H.J. Abercrombie¹, R. Feng¹

The discovery of disseminated Au-Ag-Cu mineralization in the Western Canada Sedimentary Basin (WCSB) and underlying Precambrian Shield has provided new mineral exploration opportunities in a traditional energy basin. Au-Ag-Cu mineralization occurs as < 1 μm to $\sim 20 \mu\text{m}$ particles of native and alloyed metals, and metal-chloride, -oxide, and -carbonate phases associated with a polymetallic element suite. A model for "Prairie-type" mineralization invokes leaching and transport of metals by residual evaporite brines from the Middle Devonian Prairie evaporite and other salt-evaporites of the WCSB. Prairie-type mineralization has been found in Proterozoic and Phanerozoic rocks in northeastern Alberta, and in other parts of the WCSB. Recognition of "Prairie-type" mineralization is complicated by micron particle sizes, the lack of macroscopic evidence for mineralization, complex and novel mineralogy, and the lack of reproducibility amongst conventional methods of geoanalysis. Optimal methods for detection include laser ablation ICP-MS and backscattered electron SEM-EDX imaging.

¹ Institute of Sedimentary and Petroleum Geology, GSC, Calgary

GSC's program in geoscience information

A.E. Bourgeois¹

The technology explosion has had a profound effect on the way the Survey delivers information to its various client groups. Not only are new types of products and services possible but they can be delivered in a more cost effective manner and in a much shorter time frame. This flexibility results in much closer cooperation between the individual scientist and product delivery specialists. Increasingly we are seeing teams of specialists working together from the very start of projects. These teams are crossing the boundary lines of organizational structures. Indeed, the lines are blurring to the extent that the organization itself must be reexamined to ensure that traditional structures are not hindering the flows of information

¹ Geoscience Information and Communications Division, GSC, Ottawa

Geological map production using a GIS

G. Labelle¹, V. Dohar¹

The Geoscience Information and Communications Division has been producing geological map production routines in cooperation with science divisions for the past four years. GIS ARC/INFO is used to produce on-demand NATMAP products, A-Series maps, and colour Open Files on 400 dpi electrostatic plotters, and to produce pre-press film for offset printing. We will present a brief history of its development and objectives, a sampling of maps produced and in production, and an overview of the 'front end' GUI (graphical user interface) and Arc Macro Language (AML) used by Cartography (and many of its clients) to import and massage the various CAD and GIS data sets submitted for producing final publication maps. Actual detailed production routines and maps can also be viewed at other poster presentation.

¹ Geoscience Information and Communications Division, GSC, Ottawa

New ways of delivering geoscience data

J.E. Glynn¹, P.B. Charlesworth¹

The Information Highway has received a lot of publicity lately, with its potential for delivering a wide variety of data to businesses, universities, kiosks, and private homes. Traditional methods of delivering geoscience information are no longer adequate to satisfy either our existing clients, or those in our expanding client base.

How can technology be used to enhance our delivery of current products and to develop new products that respond to client needs? In addition to integrated digital geological databases on CD-ROM and remotely accessed geographic databases, one can consider such things as image catalogues of current and historical maps, geographically referenced catalogues of photographs, and folios of digital field notes. These and other potential uses of new technology will be discussed, along with issues such as product design, the development of graphical user interfaces, and current technological barriers to more widespread use.

¹ Geoscience Information and Communications Division, GSC, Ottawa

The GSC's environmental geoscience program: moving towards the future

J.-S. Vincent¹

Building on its surveys, minerals, and energy programs, the Geological Survey of Canada's land based environmental program responds to the needs of governments, industry, and society at large to understand, find solutions, and formulate policies on emerging or long standing environmental issues. The program documents, monitors, and predicts the impact of the physical environment on Canadians and their infrastructures and deals with the impact of development on the environment. Present and planned activities deal with geological hazards such as earthquakes and landslides, permafrost, groundwater, global environmental change, environmental geochemistry, and waste disposal. They are conducted through

integrated multidisciplinary projects such as the Fraser Delta, Palliser Triangle, Oak Ridges Moraine, Lake Winnipeg, and Grande Baleine endeavours. Activities contribute to sustainable economic development, environmental and infrastructure protection, land-use management, environmental assessment of mega projects and other projects, the health and safety of Canadians, and the development of new technology.

¹ Terrain Sciences Division, GSC, Ottawa

Snow and ice chemistry reveals spatial and temporal patterns of pollution in the circumpolar High Arctic

R.M. Koerner¹, J.C. Bourgeois¹

The annual snowpack on perennial sea ice in the Arctic Ocean or on ice caps in the circum-polar area contains aerosols scavenged from the atmosphere. These aerosols represent the natural and industrial pollutant component of the atmosphere for the period from August to April/May. Cores from ice caps extend the record from any one location back in time. Analyses of these samples can therefore give both the spatial and temporal distribution of 'pollution' over the circum-polar region back to pre-industrial times. Results from annual snowpack samples show that pollutants are generally transported from Eurasia into Canada. Ice core analyses indicate that pollution showed a sudden increase in the 1950s followed by a levelling off in the 1970s.

¹ Terrain Sciences Division, GSC, Ottawa

"Definitely not pollution": Canadian geologic settings for native element assemblages of endogenic and exogenic origins

S.B. Ballantyne¹, D.C. Harris¹, A. Panteleyev², S.F. Sabag³

Most native metals found in the surficial environment are often erroneously prejudged to be of man-made or cosmic origin. Mineralogical and geochemical data are presented from three Canadian examples illustrating natural native element accumulation processes: native Cu, Au, Ag, Bi, Zn and, Cu-Au, Au-Pd alloys from supergene and exotic zones of the South Kemess porphyry deposit; native sulphur, Au, Cu, Ag, Bi, Fe, and complex alloys from advanced magmatic volatile acid leached argillic alteration zones of acid sulphate epithermal deposits in North Vancouver Island; alluvial gold and PGMs from Alberta, apparently derived from mantle diapiiric sources, and spheres, shards, and grains of Au, Ag, Pt, Cu, Fe, Pb, Zn, Sn, and alloys recovered by cold hydrofluoric acid digestion from northeastern Alberta Basin strata. Some rare Au-PGE alloys could have sedimentary sources similar to those found in silicified dolostone of Shaba, Zaire.

¹ Mineral Resources Division, GSC, Ottawa

² British Columbia Geological Survey Branch, Victoria

³ Tintina Mines Limited, Toronto

Project Hudsonie - A regional study in environmental geodynamics and geochemistry in the Grande-Baleine region, northern Québec

M. Parent¹, C. Bégin¹, Y. Michaud¹, S.J. Paradis¹, M.R. Laflèche², M.-H. Ruz³, É. Boisvert¹

The environmental impact assessment of large-scale development projects requires access to a regional geoscience database as well as sound knowledge of modern geological processes. With these objectives in mind, the GSC is carrying out a multidisciplinary pilot project in the Grande-Baleine region. Geochemical surveys were conducted along with surficial geology surveys. Observed variations of mercury and other heavy metal concentrations in surficial sediments and soils are primarily controlled by pedogenic processes. Analysis of till-derived soil profiles has further shown that biogeochemical recycling over the last thousand years is at least as important a process as modern anthropogenic contamination. Environmental geodynamic surveys, including tree-ring and paleoecological analyses as well as geophysical surveys (GPR), were carried out to assess and map regional and temporal variations of permafrost distribution, terrain stability, and coastal dynamics. This work shows that the discontinuous permafrost-forest tundra zone is particularly sensitive to environmental disturbances. It also suggests that permafrost dynamics, slope processes, and coastal retreat are controlled by site-specific factors or short-term weather conditions as much as by long-term climatic trends.

¹ Quebec Geoscience Centre, GSC, Sainte-Foy

² Quebec Geoscience Centre, INRS-Géoresources, Sainte-Foy

³ Centre d'études nordiques, Laval University

Geoscience and global change in the Palliser Triangle, southern Prairies

D.S. Lemmen¹, R.E. Vance¹, S.A. Wolfe¹

The Palliser Triangle is an important agricultural area that is periodically beset with drought. Sustainable economic activity may be threatened because general circulation models predict that this semi-arid region will become warmer and drier as atmospheric greenhouse gas concentrations increase. Geoscientific information collected through research coordinated by the Geological Survey of Canada provides a long-term context to assess such predictions. In addition, scenarios of landscape modifications and hydrological responses to climatic change outlined by this research will better prepare land use managers for future global change.

A detailed record of Holocene hydrological and climatic variability will be developed from paleolimnological studies. Such variability directly influences geomorphic process rates. Geomorphic processes are being evaluated through stratigraphic and monitoring studies of the

most dynamic landscape elements. This information will be used with GIS analysis of landscape sensitivity to map areas affected under a variety of global change scenarios.

¹ Terrain Sciences Division, GSC, Calgary

1994 survey of the Lake Winnipeg environment: a multi-agency cooperative project

B.J. Todd¹, C.F.M. Lewis², L.H. Thorleifson¹, E. Nielsen³, W.L. Lockhart⁴

An enhanced understanding of the Lake Winnipeg environment is urgently required. Covering an area 25% larger than Lake Ontario, this shallow lake supports economic activities related to recreation, fisheries, and hydroelectric energy production. Shoreline erosion and toxin pathways in the lake are major concerns. No systematic survey has been carried out since a biological, limnological, and bottom sediment sampling program completed by the Freshwater Institute in 1969.

The 1994 survey was made possible with logistical support from the Canadian Coast Guard, endorsement and funding from Manitoba Hydro, the Province of Manitoba, and the GSC Industrial Partners Program, and funding from GSC and the Freshwater Institute. Several other scientists at government laboratories and universities are participating in analyses.

Multichannel seismic, shallow seismic, magnetometer, side scan sonar, and radar surveys were followed by piston coring, box coring, as well as bottom sediment, limnological, and biological sampling.

¹ Terrain Sciences Division, GSC, Ottawa

² Atlantic Geoscience Centre, GSC, Dartmouth

³ Manitoba Energy and Mines, Winnipeg

⁴ Freshwater Institute, Fisheries and Oceans Canada, Winnipeg

Great Lakes: Applying Marine Geoscience to Environmental Problems

S.M. Blasco¹

Continued commercial, residential, and recreational development of the Great Lakes margin is resulting in accelerated concern over a growing number of environmental issues, including coastal erosion, lake level fluctuations, harbour clean-up, neotectonic activity, lakebed foundation stability, pollution pathways, aggregate mining, and climate change. Resolution of environmental problems requires an in-depth understanding of the geological framework and recent history of the Great Lakes basin; integrated geological, geophysical, and geotechnical investigations, and the application of new technologies. Survey and bottom sampling technologies include integrated differential global positioning (DGPS), digital seismic and sidescan profilers, SWATH mapping, video grabs, and in-situ pore fluid

extraction probes. Digital processing of acquired survey data is essential for the production of lakebed mosaics and high resolution seismic sections. Manned submersibles and remotely operated vehicles play a valuable role in detailed site investigations and highly accurate sampling. Amphibious vehicle technology is now being applied to surveys in hazardous shallow coastal waters.

¹ Atlantic Geoscience Centre, GSC, Dartmouth

Working with clients and partners: a renewed focus for GSC

D.G. Harry¹, D.S. Reade¹, R.F.J. Scoates¹

GSC has a long tradition of partnership with industry, universities, and government agencies. Today, promoting the international competitiveness of Canadian industry and ensuring that our public research contributes to the creation of wealth and jobs are priority objectives for the Survey. Through new client-oriented initiatives, such as the GSC Industrial Partners Program, we are responding directly to the needs of our stakeholders. In many cases, our international reputation and scientific network can be used to create commercial advantages for Canadian companies. Where appropriate, we also support industry by making our unique expertise and facilities available through collaborative research or on a cost-recovery basis.

¹ Coordination and Planning Division, GSC, Ottawa

Marine Geosciences: Present Highlights and Future Directions in Canada's Ocean Territories

D.B. Prior¹

The GSC's marine geoscience program combines basic and applied research, contributing baseline knowledge concepts and technology relevant to contemporary territorial, economic, resource, and environmental issues. The program covers a continuum of geological scales, including tectonic and structural evolution of Canada's margins, development of sedimentary basins and their thermal, subsidence, and sedimentary history, and analysis of Quaternary coastal and marine sedimentary environments and processes. Mapping of Canada's coastal and offshore areas is a fundamental activity, ranging from coastal aerial video reconnaissance, nearshore and continental shelf high resolution surveys, and regional geological and geophysical surveys of continental margins, slopes, and basins. Data are used to develop concepts and models for application to offshore hydrocarbon resource assessment, hazard evaluations, and environmental impact studies. The program is increasingly characterized by partnerships and joint ventures with the private sector, and multi-agency, multidisciplinary collaborative projects.

¹ Atlantic Geoscience Centre, GSC, Dartmouth

Canada and article 76 of the law of the sea: hydrographic and geological considerations

R. Macnab¹

Article 76 of the 1982 United Nations Convention on the Law of the Sea permits coastal nations with wide continental margins to extend their resource jurisdiction and environmental authority into oceanic areas beyond 200 nautical miles. With wide continental margins on the Atlantic and Arctic coasts, Canada could exercise enhanced powers in new marine zones that are potentially as large as the three Prairie Provinces combined.

To extend its jurisdiction beyond 200 nautical miles, a wide-margin state must assemble data describing depth of water and thickness of sediment in the areas affected, and interpret this information in accordance with Article 76. In the Canadian situation, present data holdings partially support the case for an extension beyond 200 nautical miles in the Atlantic and Arctic oceans. A strategic program for acquiring and analyzing new data would strengthen this claim and likely enhance it to cover most if not all of the claimable areas in both oceans.

¹ Atlantic Geoscience Centre, GSC, Dartmouth

Beyond an attractive map: new directions for magnetic data

W.R. Roest¹, M. Pilkington¹, P. Keating¹

Aeromagnetic maps are used extensively to assist geological mapping in areas with limited or no outcrop. With digital magnetic data, we can go beyond this qualitative interpretation and apply quantitative methods to improve our understanding of the Canadian landmass and offshore areas. Together with industry partners and academia, the Applications Section continues to develop techniques for processing and interpretation of aeromagnetic and gravity data. These techniques lead to better digital data products for geological interpretation, for example by resolution enhancement in areas of rugged terrain, and to quantitative analysis of physical properties of the Canadian landmass that can be related to ground-truth measurements. For example, forward and inverse modelling are used to determine the configuration of magnetic sources. Pattern recognition is used to identify and select possible kimberlite-related magnetic anomalies, with the potential for significant savings in diamond exploration.

¹ Geophysics Division, GSC, Ottawa

Computer-based technologies for geological/economic analysis of coalfields and other layered deposits

J.D. Hughes¹

Canada's \$360 billion coal resources provide 15 per cent of the country's electricity. Doubling this percentage as anticipated in 25 years will require comprehensive geoscience information in order to manage it in a sustainable and environmentally responsible manner.

GSC's National Coal Inventory database incorporates primary geological, coal quality, and surface land use information from coalfields across Canada. Three-dimensional models determine geological and economic characteristics of coal resources. This 'expert' system recognizes the ordered, multiple surface nature of coal deposits in the development of realistic geological models from which to define the geological and economic attributes of an area.

The system is applicable to the assessment of other stratified economic deposits. It has been utilized in assessing potable water resources in Manitoba, in analyzing coalbed methane and conventional hydrocarbon reservoirs in Alberta and Saskatchewan, and in assessing diamonds in southern Saskatchewan.

¹ Institute of Sedimentary and Petroleum Geology, GSC, Calgary

Offshore energy: Where? When? Why?

K.D. McAlpine¹

Canadian and foreign energy authorities and policy specialists are sending conflicting messages concerning the world's energy future. One scenario anticipates that stable, flat prices and security of supply will be the norm into the first half of the 21st century; another scenario predicts that global economic growth and *force majeure* political events will cause serious energy shortages. Although Canada's present petroleum production stems almost entirely from the mature Western Canada Sedimentary Basin, it is generally acknowledged that its longer term petroleum energy future and security lies in the frontiers, especially the east coast offshore. It is estimated that perhaps 70 per cent of Canada's remaining reserves of conventional crude oil and 40 per cent of its gas are in frontier basins. While offshore exploration activity is in a lull, the GSC's research and mapping of its vast database holdings are providing continuity of knowledge and expertise, and new insights that will contribute to sustainable development of Canada's energy resources.

¹ Atlantic Geoscience Centre, GSC, Dartmouth

GSC's Program in Energy - exploration innovation and resource assessment

G.D. Mossop¹

The GSC's national program in energy marshals and disseminates geoscientific information in support of the sustainable development of Canada's fossil fuel resources - conventional and heavy crude oil, bitumen, natural gas and natural gas liquids, coal and

coalbed methane. Wealth generated annually by these energy industries in Canada exceeds \$27 billion.

The program has two key elements: 1) research on the geological habitat of known and prospective fossil fuel deposits, fostering industry success in exploration and efficiency in production; and 2) scientifically sound and impartial assessments of the quantity of hydrocarbon resources still to be discovered in Canada and of the quality of coal resources, as a foundation for government policy making and as a guide to industry in its medium- to long-term strategic exploration planning.

The geoscientific work itself constitutes an integrated regional analysis of whole basins - the Western Canada Sedimentary Basin (which currently accounts for 85 per cent of Canada's energy output) and the numerous frontier basins (which promise 70 per cent of Canada's future energy potential).

¹ Institute of Sedimentary and Petroleum Geology, GSC, Calgary

POSTER PRESENTATIONS

1. **Petrogenesis of the Moyie Sills, southeastern B.C.: implications for the early tectonic setting of the Middle Proterozoic Purcell Basin**

H.E. Anderson¹, W.D. Goodfellow¹

The 1467 Ma Moyie Sills occur in a Middle Proterozoic extensional basin formed in an uncertain tectonic setting. The sills were intruded into unlithified turbidites of the lower to middle Aldridge Formation (and the Sullivan SEDEX orebody), near the basal Purcell Supergroup, so their age approximates the time of sediment deposition and ore formation.

The sills are tholeiitic gabbros and diorites contaminated by continental crust. Nd isotopic variations ($\epsilon_{Nd}(1467)$ from 2.4 to -2.0) cannot be explained solely by contamination by the Aldridge Formation ($\epsilon_{Nd}(1467) \sim -0.6$). These isotopic signatures require the occurrence of older (Archean) basement flooring the Purcell basin. Assuming that lithospheric (mechanical boundary layer) thickness is the main control on REE chemistry, the thickness of the lithosphere during generation of the magmas is estimated to be 35-40 km. It is thus apparent that the Purcell basin was developing on highly extended ($\beta \sim 3$) continental crust during Aldridge time.

¹ Mineral Resources Division, GSC, Ottawa

2. **Cambria Icefields geology: update on Industry/GSC 1:50,000 mapping in northwestern British Columbia¹**

C.J. Greig², D. Green³, P.H. Daubeny³, V.J McNicoll⁴, R.G. Anderson², K. Bull⁵

The Red Mountain Au deposit is hosted by Upper Triassic (UTr) cherty argillite, UTr or lower chert, and Lower Jurassic (LJr) Hazelton Group tuffaceous rocks which are intruded by ca. 202 Ma, seriate biotite-hornblende-feldspar-phyric sills and dykes. A complexly faulted, north-northwest trending regional antiform encompasses the deposit and is cospatial with a facies change between UTr-LJr strata and Lower and Middle(?) Jurassic clastic rocks to the west. The eastern section shows structurally higher, less deformed rocks compared to rocks significantly shortened along east-northeast vergent thrust faults and overturned folds to the west. The Early Jurassic mineralizing event was coeval with the porphyry intrusion into only partly lithified host rocks and predated the regional Jura-Cretaceous and Tertiary(?) deformation. Although all aspects of the deposit's genesis are incompletely known, the significance of stratigraphic and magmatic controls suggests potential for similar deposits in the area.

- ¹ GSC - Lac Minerals IPP Project
- ² Cordilleran Division, GSC, Vancouver
- ³ Lac Minerals Ltd., Stewart
- ⁴ Continental Geoscience Division, GSC, Ottawa
- ⁵ Dihedral Exploration, Fairbanks, Alaska

3. **Mercury in till and its glacial dispersal, near Pinchi Fault, north-central British Columbia**

A. Plouffe¹

Pinchi Fault is a major structural break that extends over 450 km and separates Cache Creek Terrane to the west from Quesnellia Terrane to the east in central British Columbia. Mineralized occurrences of mercury (Hg) in bedrock along the fault, with cinnabar (HgS) as the main ore mineral, have been known for several decades. A regional till sampling program conducted in north central British Columbia, and covering a long segment of the fault, has served to define a mercury dispersal train with a maximum distance of glacial transport of 12 to 18 km eastward. Mercury in samples collected on and down-ice from the fault is concentrated in clay and sand size fractions in the till. Cinnabar grains, with some euhedral crystals, are abundant in the sand fraction, even in the oxidized B-horizon. These data corroborate studies of cinnabar stability in soils.

- ¹ Terrain Sciences Division, GSC, Ottawa

4. **Hydrogeological and hydrogeochemical studies of a base metal mining complex, Westmin Myra Falls Operation, British Columbia**

D.R. Boyle¹, A.J. Desbarats¹, C.J. Mwenifumbo¹, G.C. Phipps², M. Stapinsky²,

J. Hamilton³, I.D. Clark², M.J.L. Robin², D.C. Grégoire¹

The Myra Falls mining operation of Westmin Resources Limited, located in Strathcona Provincial Park, Vancouver Island, comprises 15 separate ore zones and many occurrences of volcanogenic massive sulphides (Cu-Zn-Pb). The mining operation covers 15 km² and includes approximately 90 km of drifts and over 1500 underground and surface diamond-drill holes. A three-year multidisciplinary research project, under the Industrial Partners Program, on groundwater hydrogeochemistry and hydrogeology of the area is presently under way. The three main objectives of the research are: to characterize geochemical, geophysical and hydrological features of groundwater regime(s) associated with the massive sulphide deposits and their surrounding volcanogenic-sedimentary environments; to develop groundwater geochemical/geophysical methods for discovering new ore bodies in the camp; and to create high quality geochemical and hydrological databases on the groundwater regime and associated surface waters that can be used in environmental assessments and remediation programs. Preliminary results will be discussed.

¹ Mineral Resources Division, GSC, Ottawa

² University of Ottawa, Ottawa

³ Consultant, Nanaimo

5. Acid-sulphate, advanced argillic, alteration linkage to buried Cu-Au porphyry systems on north Vancouver Island: the mineralogical reality

S.B. Ballantyne¹, A. Panteleyev², D.C. Harris¹

Recent investigations of advanced argillic alteration zones found in the Pemberton Hills of North Vancouver Island have led to the strong implication that these observed shallow acid-sulphate epithermal features are connected to epizonal porphyry deposit intrusions. Strongly silicified, vuggy, acid-leached rocks (magmatic-hydrothermal acidic vapours) do not provide anomalously high lithochemical ore element results. Samples expected to contain hydrothermal rutile (2% TiO₂) were decomposed using cold concentrated hydrofluoric acid. The resultant mineral separation contained native sulphur, Cu, Au, Ag, Zn, Bi, complex alloys, molybdenite, barite, enargite-luzonite, pyrite, and abundant hydrothermal rutile. SEM and EMP investigations have proven the necessary direct linkage to ore potential now buried at depth below the stacked acid sulphate alteration zones.

¹ Mineral Resources Division, GSC, Ottawa

² British Columbia Geological Survey Branch, Victoria

6. Mapping of altered rocks Using LANDSAT TM, lithochemical and airborne gamma ray data - Bruce Jack Lake, British Columbia

J.R. Harris¹, A. Rencz², B. Ballantyne²

This paper investigates the use of LANDSAT TM data used in concert with lithochemical and airborne gamma ray spectrometer data for mapping altered rocks. The study area is located in the Sulphurets region in the Cordillera of northwestern British Columbia, where regional scale expressions of Cu-Au porphyry systems are expressed at the surface.

The area is suitable for a study using remotely sensed data as approximately 20 per cent of the mountainous area is exposed bedrock, large portions of which have undergone intense hydrothermal alteration characterized by silicification and pyrite-sericite.

LANDSAT data were useful in this particular environment for mapping limonitic and hydrothermally altered rocks. The exact nature of the alteration as predicted from spectral theory was confirmed by analyzing ancillary data as well as observations made in the field. In addition, a number of new areas of potentially altered rock were identified for exploration follow-up.

¹ Continental Geoscience Division, GSC, Ottawa

² Mineral Resources Division, GSC, Ottawa

7. High resolution aeromagnetic survey of the Interior Plateau, British Columbia, 1993-94¹

D.J. Teskey², P. Stone², R. Dumont², F. Kiss², K. Anderson², R.A. Gibb²

A high resolution aeromagnetic survey at an altitude of 305 m (draped) and 800 m line spacing was flown over the British Columbia Interior Plateau by Geonex Aerodat Ltd. under contract to the GSC during 1993/94. The area has high potential for epithermal precious metal and gold/copper porphyry deposits but has remained relatively unexplored because of extensive glacial drift cover and a blanket of Miocene and younger lava flows. Interpretation being carried out under the Interior Plateau Program by participants from the British Columbia Geological Survey, and the GSC's Cordilleran Division and Aeromagnetic Surveys Section is expected to reveal previously unknown faults and geological contacts and to provide three-dimensional information to aid geological mapping and stimulate mineral exploration. The survey was partially funded by the British Columbia-Canada Mineral Development Agreement.

¹ Contribution to Canada-British Columbia Agreement on Mineral Development (1991-1995), a subsidiary agreement under the Canada-British Columbia Economic and Regional Development Agreement

² Geophysics Division, GSC, Ottawa

8. Earthquake hazard investigations in the Fraser River Delta, British Columbia: preliminary results from a multidisciplinary deep drilling program

S.R. Dallimore¹, K.A. Edwardson², J.A. Hunter¹, J.J. Clague¹, J.L. Luternauer³,
I.D. Clark⁴, M.E. Evans⁵, J.B. Harris¹, M. Johns⁶, T. Lewis⁶, M. Leybourne⁴,
B. MacDonald⁶, L. Maurice¹, J. Meldrum⁷, P. Monahan⁸, P. Mustard³,
J. Mwenifumbo⁹, R.T. Patterson⁴, E.T. Reinhardt⁴, Y. Wang⁵

The Fraser River delta is situated in the most seismically active area of Canada and as such is susceptible to large magnitude, potentially damaging earthquakes. Assessment of the impact of earthquake shaking on engineering structures requires detailed knowledge of geotechnical properties of shallow sediments within which the structures are founded, in addition to data on the configuration of the bedrock interface and the properties of overlying sediments. In the spring of 1994, scientists from four divisions of the Geological Survey of Canada, and university associates, completed two 300 m deep geotechnical coreholes in the city of Richmond. The purpose of the work was to characterize geological/geophysical/geotechnical properties at two sites with contrasting geological settings. Multiparameter borehole logs have been compiled for each site to allow an interpretation of regional geology and soil response to seismic shaking. Preliminary dynamic soil response modeling based on these data reveals considerable variation between sites.

- 1 Terrain Sciences Division, GSC, Ottawa
- 2 Atlantic Geoscience Centre, GSC, Dartmouth
- 3 Cordilleran Division, GSC, Vancouver
- 4 Ottawa-Carleton Geoscience Centre, Ottawa
- 5 University of Alberta, Edmonton
- 6 Pacific Geoscience Centre, GSC, Sidney
- 7 Queen's University, Kingston
- 8 University of Victoria, Victoria
- 9 Mineral Resources Division, GSC, Ottawa

9. GIS map library a window on cordilleran geology¹

J.M. Journeay², S.P. Williams²

The Geological Survey of Canada (GSC) has been collecting, compiling and interpreting information on the geological framework and evolution of the Canadian Cordillera for more than 150 years. Geographic Information Systems (GIS), a new frontier for the GSC, provide a powerful set of tools for managing and analyzing this evolving database of geoscience information.

The Cordilleran GIS Map Library project was initiated in March 1993 by a small development team from the Cordilleran Division and the Geoscience Information and Communications Division (GICD) of the GSC.

The map library contains a fully integrated database of geological and geographic map data and associated attribute information derived from the Tectonic Assemblage Map (GSC

Map 1712A).

- ¹ Contribution to Canada-British Columbia Agreement on Mineral Development (1991-1995), a subsidiary agreement under the Canada-British Columbia Economic and Regional Development Agreement
- ² Cordilleran Division, GSC, Vancouver

10. The use of technology for accessing and disseminating geoscience data

R.K. Burns¹, P.B. Charlesworth¹, D.J. Ellwood¹, J.E. Glynn¹, P. Huppé¹, D. Vinette¹

New methods of delivering and accessing geoscience data, and new product prototypes will be demonstrated and/or illustrated.

- ¹ Geoscience Information and Communications Division, GSC, Ottawa

11. Preparation of thematic maps from: generalized geology of the world

L. Chorlton¹, T. West¹ and collaborators

The Geological Survey of Canada has recognized the need for a highly generalized geological context map depicting Precambrian terranes, significant as hosts for Canadian ore deposits, for visualizing economic resources, with their characteristics and controls, in their global paleotectonic settings. The newly released CD-ROM "Generalized Geology of the World and Linked Databases" is designed to meet these needs. This map is available in formats that can be imported into a variety of GIS packages.

The Generalized Geology Map of the World illustrates basic elements of global rock type/age distribution. It is meant to be used as a customizable backdrop for other data, such as the Sediment-Hosted Stratiform Copper Deposits. This poster shows how the maps were produced and demonstrates the CD-ROM product.

- ¹ Geoscience Information and Communications Division, GSC, Ottawa

12. Map production from digital field data: 1994 map publications from current bedrock geology projects

K.A. Baker¹, B. Brodaric¹, G. Labelle², V. Foster²

Field data collected digitally can be transformed into an Open File product as a full colour geology map in less than one year. The Continental Geoscience Division (CGD) in cooperation with the Cartography Unit, Geoscience Information and Communications Division (GICD), released several maps by December 1994 from data collected using digital

field systems during the field season. This poster presents a collection of maps highlighting this achievement. The maps are derived from a variety of sources representing the full scope of CGD's activities. Such efficient map production is possible due to implementation of computer-based field mapping systems in the field, map preparation in the office using FIELDLOG, AutoCAD, MiniCAD, and GIS (Geographic Information Systems), and the subsequent transfer of digital data to GICD for cartographic enhancement using GIS.

¹ Continental Geoscience Division, GSC, Ottawa

² Geoscience Information and Communication Division, GSC, Ottawa

13. GSC Fieldlog v3.0: A new prototype version of CGD's field mapping software

B. Brodaric¹

GSC Fieldlog software is extensively used by field mappers at the GSC and elsewhere for recording observations in the field, preparing maps in the field and office, and interfacing field data with GIS and cartographic systems. Some features included in the new v3.0 are: multiple platform functionality, revised database structure using customizable glossaries of geological terms, direct export to ArcInfo and SPANS, enhanced user interface using 'window' dialogues, enhanced data entry mechanisms, and query processes. The prototype will initially operate in the AutoCAD environment, but is also expected to operate independently and with other systems in the future.

¹ Continental Geoscience Division, GSC, Ottawa

14. Geological map production using a GIS

G. Labelle¹ et al.

The Geoscience Information and Communications Division (GICD), Cartography Section, together with the Computer Technology Section will demonstrate the use of ARC/INFO 6.1.1 to produce on-demand NATMAP products, A-Series maps, and colour Open Files on 400 dpi electrostatic plotters, as well as cooperative (GICD and science divisions) production routines (AML) put into place to produce these maps quickly. The poster includes a sampling of maps published and in production as well as actual production routines running on a Sparc2 work station with ARC/INFO, and techniques used to produce large format pre-press film on Scitex from ARC/INFO PostScript files should the map be scheduled for plating and printing through traditional offset printing.

¹ Geoscience Information and Communications Division, GSC, Ottawa

15. DIMonDS

J. Rupert¹

The **Digital Interactive Maps on Demand System (DIMonDS)** is a group of software programs to create and enhance geographical information. Developed specifically for geophysical datasets, DIMonDS can display any geographically based dataset that can be converted into a gridded format. Once gridded, data may be enhanced using a variety of techniques. Data can then be combined with linework and polygons and displayed with a cartographic base, scale bar, colour bar, logos, user-supplied text and titles, using either predefined map formats or a customized layout. A variety of output devices are available, from PostScript printers to large format electrostatic plotters. This demonstration will show just how quickly a quality end-product can be produced from scratch using DIMonDS.

¹ Geophysics Division, GSC, Ottawa

16. Aeromagnetic survey exchange: Who holds what coverage across Canada?

J. Tod¹, G. Boyce¹, F. Dostaler¹, J. Janveau¹, R. Kane¹, L. Lawley¹, W. Miles¹

The Geophysical Data Centre is compiling a database of information on aeromagnetic surveys flown in Canada to facilitate the exchange of information on private sector surveys.

The database contains details of location, survey parameters, and contacts for data or further details about the survey. Access to the database is free of charge. This tracking of private sector surveys will help ensure that these data, and the millions of dollars spent acquiring them, will not be lost as exploration shifts from one region of the country to another.

¹ Geophysics Division, GSC, Ottawa

17. An automatic system to handle earthquake data requests over the Internet

J.A. Lyons¹, W. McNeil¹, C.C. Wong¹

In a novel approach to disseminating earthquake information to clients world-wide, the Canadian National Seismology Data Centre has developed an Automatic Data Request Manager (AutoDRM). AutoDRM scans for incoming data requests in the form of electronic mail messages, extracts the data requested, and sends it back to the requester via return E-mail (for ASCII data less than 100 KB in volume) or, for larger volumes or binary data, makes the data available for retrieval via anonymous FTP and issues a brief E-mail notice, all without human intervention.

Using AutoDRM, digital waveforms from our most remote, unmanned Arctic sites can be supplied to researchers studying earthquake locations, source parameters, etc. anywhere on Internet within minutes of the occurrence of a significant event. Similarly, bulletins

(catalogs) listing earthquake locations, epicentre solutions, and associated phase measurements generated by the GSC and other international agencies may be extracted from the National Earthquake Database.

¹ Geophysics Division, GSC, Ottawa

18. Computer-based technologies for geological/economic analysis of coalfields and other layered deposits

J.D. Hughes¹

Canada's \$360 billion coal resources provide 15 per cent of the country's electricity. Doubling this percentage as anticipated in 25 years will require comprehensive geoscience information in order to manage it in a sustainable and environmentally responsible manner.

GSC's National Coal Inventory database incorporates primary geological, coal quality, and surface land use information from coalfields across Canada. Three-dimensional models determine geological and economic characteristics of coal resources. This 'expert' system recognizes the ordered, multiple surface nature of coal deposits in the development of realistic geological models from which to define the geological and economic attributes of an area.

The system is applicable to the assessment of other stratified economic deposits. It has been utilized in assessing potable water resources in Manitoba, in analyzing coalbed methane and conventional hydrocarbon reservoirs in Alberta and Saskatchewan, and in assessing diamonds in southern Saskatchewan.

¹ Institute of Sedimentary and Petroleum Geology, GSC, Calgary

19. Spreading the news: Earth science for the public

C. Vodden¹, L.A. Dredge²

Since the 1920s the Geological Survey of Canada has been a respected training ground for the Canadian geoscience community, offering students summer employment as field assistants to Survey scientists.

Today's outreach activities are much broader in scope: younger students (pre-Grade 8), native communities, visitors to Canada's national parks are just some of the new audiences for the Survey's educational activities and efforts to increase public awareness about geosciences. Timely information about local geological hazards and associated issues of public safety are another new area of outreach.

Activities vary from office to office across the country and are designed to fit the needs

of various regions. Outreach materials in support of activities are produced corporately to take advantage of economies of scale. Use of plain language and popularization of scientific ideas is a key component of all published materials.

¹ Geoscience Information and Communications Division, GSC, Ottawa

² Terrain Sciences Division, GSC, Ottawa

20. New technologies and new directions at the Canadian Geoscience Information Centre

J. Caron¹, B. Chen¹, P. Kamel¹, A.G. Kopf-Johnson¹

In a geoscience environment undergoing constant change and moving in new directions, the Canadian Geoscience Information Centre (CGIC) continues to meet the geoscience community's needs by offering its clients a wide range of new services and technologies.

Technology-driven information products and services featured at CGIC include the automated library system, database management system, geographic information systems, imaging system, and use of CD-ROMs.

The GSC Network, Internet and CAN/OLE (on-line enquiry service for GEOSCAN) provide the geoscience community with worldwide access to CGIC products and services.

Other new innovations at CGIC include the Logan Legacy Fund, the Volunteers Program, the Technical Enquiries Team, and the Knowledge Index.

CGIC collaborative efforts with the Geoscience Information and Communications Division as well as with all other divisions of the Geological Survey of Canada will enable CGIC to create an environment where challenges of the future will be met.

¹ Geoscience Information and Communications Division, GSC, Ottawa

21. Spectral gamma-gamma borehole logging technology transferred to IFG Corporation via GSC's industrial partners program

L.D. Schock¹, P.G. Killeen¹, B.E. Elliott¹, D. Blohm²

The spectral gamma-gamma (SGG) logging method is a combination of two technologies: 1) natural gamma ray spectral logging, and 2) gamma-gamma or 'density' logging. SGG logging records the energy spectrum of backscattered gamma rays from a low activity source in the probe. This provides information on rock density and concentration of heavy metals. A GSC-developed SGG logging system, calibrated in the Yava Pb deposit, was able to measure in-situ Pb concentrations at a logging speed of 6 m/min. The correlation coefficient between core and in situ assays was 0.88.

GSC publications describing the SGG method, and its potential to be calibrated for iron, nickel, tin, copper, zinc, and other elements, led to collaboration between the GSC and IFG Corporation of Brampton to commercialize the technology under the Industrial Partners Program. The first commercial SGG system underwent successful field testing in the summer of 1994.

¹ Mineral Resources Division, GSC, Ottawa

² IFG Corporation, Brampton

22. GSC developments aid airborne gravity system

J. Halpenny¹, G. Zhang¹

Airborne gravity systems require continuous navigation with accuracy at the centimetre level. As part of its program to aid the Canadian surveying industry, GSC has been developing appropriate kinematic GPS techniques, which are now being used in a joint project (IPP) with Sander Geophysics Ltd. and the Institute for Aerospace Research to create a practical airborne gravity surveying system. GSC also operates its own dynamic gravity meter, which is being used for initial tests of the airborne system. It will be replaced by a new gravity sensor currently being developed by Sander.

¹ Geophysics Division, GSC, Ottawa

23. Petrophysics of tight rocks for mineral and hydrocarbon exploration, and for environmental and structural studies

T.J. Katsube¹, M.A. Williamson², D. Issler³, M. Salisbury², B.A. Kjarsgaard¹

Petrophysics (porosity, permeability, pore structure) for porous reservoir rocks (sandstones and carbonates) is a well established field in petroleum reservoir engineering. Recently, the importance of petrophysics for tight shales has been recognized. Shale seals are actually leaky seals for hydrocarbon reservoirs, and modern exploration requires that the leakage path in a sedimentary basin be known. Techniques for measuring extremely low permeabilities were originally developed for assessing barrier quality of rocks to host permanent storage of high-level radioactive waste.

Tight rock petrophysics is now finding applications in mineral exploration and structural studies. It has helped understand why deep continental conductors lose their electrical conductivity when uplifted. It is helping to explain why some sulphide-rich rocks are poor electrical conductors. It explains some physical processes involved in an intruding body, which may help improve geophysical techniques to detect kimberlites.

¹ Mineral Resources Division, GSC, Ottawa

² Atlantic Geoscience Centre, GSC, Dartmouth

³ Institute for Sedimentary and Petroleum Geology, GSC, Calgary

24. **Modelling of platinum-group element concentrations in rift-related basaltic magmas**

M.-C. Williamson¹, R.C. Courtney¹, C.E. Keen¹, S.A. Dehler¹, C.W. Harvey²

We use a model of lithospheric stretching and decompression melting to predict the volume and trace element concentrations of basaltic magmas generated during rifting. A comparison between the predicted and observed concentrations of rare earth elements (REE) and platinum group elements (PGE) in basaltic rocks from rift zones allows us to examine the geochemically coherent behaviour of these elements during mantle melting. We first illustrate the sensitivity of the model results to changes in some of the physical and chemical input parameters, such as the value of partition coefficients of REE and PGE in silicate and sulphide phases; the composition of the mantle source; the thermal state of the asthenosphere during rifting; and the amount of deformation in the crust and upper mantle. We then outline some possible applications of the modelling approach to the genesis of platiniferous deposits associated with continental rifting.

¹ Atlantic Geoscience Centre, Bedford Institute of Oceanography, Dartmouth

² Department of Earth Sciences, Dalhousie University, Halifax

25. **Spatial analysis of geochemical speciation data¹**

Q. Cheng², G.F. Bonham-Carter², G.E.M. Hall², A. Bajc³

Recent work on the distribution of trace metals in different chemical phases, based on sequential extraction schemes, led to this study of soil, till, and humus samples from the Sudbury Basin. Spatial distributions of metals in a soluble organic phase, a Fe-Mn oxyhydroxide phase and a 'total' analysis from an aqua regia digestion have been compared. Geochemical data consist of three sets of trace element (soluble organic, oxyhydroxide and "total) analyses on about 450 samples, augmented by a digitized geological map and a mineral deposit dataset. GIS and the statistical software system S-Plus have been employed to study spatial patterns of chemical phases, their element associations, and correlations with geological units and mineral deposits. Multifractal methods have been applied to study the nature of the geochemical patterns. A special challenge is to distinguish mineralization associated spatial patterns of element distributions in the study area from the patterns related to regional geological processes.

¹ Contribution to Canada-Ontario Subsidiary Agreement on Northern Ontario Development (1991-1995), under the Canada-Ontario Economic and Regional Development Agreement

² Mineral Resources Division, GSC, Ottawa

³ Ontario Geological Survey

26. Applications of ground probing radar (GPR) to environmental problems

A. Judge, F. Bonn, T. Brennand, M.M. Burgess, T.W. Fridel, I.M. Kettles, B.J. Moorman, C. Pelletier, J.A. Pilon, S.D. Robinson, H. Russell, T. Shaw, A. Tarussov

A. Soil survey from light research aircraft using ground probing radar

A. Tarussov¹, A. Judge², F. Bonn¹

A digital ground probing radar (GPR) was tested as a remote sensing tool for airborne soil profiling. After calibration on a crane, field data were acquired using an ultralight aircraft over agricultural terrain in the St. Lawrence Valley at frequencies of 100 and 200 MHz. A depth penetration of 1-2 m was achieved with the 100 MHz antennas. Digital processing of airborne profiles provided quantitative determination of the dielectric constant of soils and of geological cross-sections. Soil water content in the top 10-15 cm was measured from altitudes of between 8 and 70 m. Low frequency radars appear useful for terrestrial surveys due to the substantial penetration depth and robustness to vegetation and surface roughness effects. The low and slow flight characteristics of the ultralight aircraft used in the experiment provide high ground resolution and precise target identification, making this system suitable for many types of surveys.

¹ Centre d'applications et de recherches en télédétection (CARTEL), Université de Sherbrooke, Sherbrooke

² Terrain Sciences Division, GSC, Ottawa

B. Applications of ground probing radar (GPR) to environmental problems: Oak Ridges Moraine and environs NATMAP

T.A. Brennand¹, H.A.J. Russell², C. Pelletier¹, T. Shaw³, J. Pilon¹

Ground probing radar has been used as part of a hydrogeological investigation of the Oak Ridges Moraine and environs. After topographic correction of the data, we were able to accurately determine the location and topography of the water table at some sites. In addition, we obtained substantial subsurface structural information which improves our understanding of sediment architecture and genesis. Some transects were acquired near aggregate quarries, which allowed direct correlation between radar records and sedimentary exposure. The results presented here highlight the level of geological details detected by the GPR surveys. Even though further studies will be conducted in 1995, we are already able to demonstrate that GPR is an excellent geophysical technique for geological and hydrogeological studies in appropriately resistive surficial sediments.

¹ Terrain Sciences Division, GSC, Ottawa

² Department of Geology, University of Ottawa, Ottawa

³ Department of Geology, Queen's University, Kingston

C. A ground probing radar study of peat landforms in the discontinuous permafrost zone near Fort Simpson, Northwest Territories

I.M. Kettles¹, S.D. Robinson²

Ground probing radar (GPR), supported by coring, was used as a profiling tool at three sites to examine interrelationships between permafrost and peat in various landforms and underlying sediment, and to assess peatland stability. In frozen terrain, GPR responses were generally of higher frequency (narrower pulse) with less lateral continuity (more chaotic in nature) and with deeper penetration than returns from unfrozen peat. Mapping of internal peat stratigraphy, peat-sediment interface, and lateral variability was most successful in unfrozen fens. The degree of peat decomposition within fens can also be estimated from the nature of radar returns. With one exception, interfaces between frozen peat plateau and unfrozen fen are interpreted as near-vertical. At a collapse-scar fen/peat plateau interface, thawing at the base of peat at the plateau edge was inferred. GPR proved a useful tool for mapping peatland morphology in the discontinuous permafrost zone.

¹ Terrain Sciences Division, GSC, Ottawa

² Department of Geography, McGill University, Montreal

D. Ground probing radar investigations of insulated permafrost slopes along the Norman Wells pipeline

S.D. Robinson¹, B.J. Moorman², A.S. Judge³, M.M. Burgess³, T.W. Fridel⁴

The Norman Wells oil pipeline traverses the discontinuous permafrost zone of northwestern Canada. Since pipeline construction in the early 1980s, the prevention and mitigation of adverse environmental impacts resulting from the disturbance to permafrost terrain have been of prime concern. The geotechnical design of thaw-sensitive slopes thus involved the use of an insulating layer of wood chips. Traditional methods of slope performance evaluation do not provide the detailed data necessary to assess changes in wood chip slope stability. Through the Industrial Partners Program, the GSC and Interprovincial Pipe Line are evaluating the capability of ground probing radar (GPR) to provide more intensive and frequent monitoring of complex subsurface conditions. Lithological, thermal, and structural features have been mapped with GPR to depths of 6 m with a resolution of 0.3 m. The surveys have delineated zones of greatest thaw surrounding the pipe and towards the base of the slopes.

¹ Department of Geography, McGill University, Montreal

² Ottawa-Carleton Geoscience Centre, Carleton University, Ottawa

³ Terrain Sciences Division, GSC, Ottawa

⁴ Interprovincial Pipe Line Inc., Edmonton

27. Forearc Basin, Papua New Guinea

EDISON I Scientific Party

In March 1994, a joint German-Canadian cruise on *F/S Sonne* undertook detailed seafloor mapping (1:50 000) around the alkaline volcanic Tabar-Feni Island arc (Papua New-Guinea). Maps of each group (Feni, Tanga, Lihir, Tabar) were made. South of Lihir, 7 young submarine cones were discovered along extensional faults. One (1490m depth) has a hydrothermally active crater with large areas of diffuse venting, accommodating barnacles, clams and other vent fauna, on crusts of pyritic, indurated hyaloclastic mud. Another, larger cone (1070m) of massive vesicular lava contains clay/silica/sulphide veins averaging 6.4% Fe, 6.0% S, 1.8% Pb, 1.0% Zn, 0.4% Cu, 864 ppm As, 443 ppm Sb, 496 ppm Cd, 390 ppm Ag and 20 ppm Au. Ankaramitic and alkali-olivine basalts, are volatile-rich. Several cones are cratered and formed explosively; one consists of ash and bombs (mica lamprophyre) containing xenoliths of anorthositic gabbro, dunite and lherzolite. Our discovery of hydrothermal activity on recent cones is the first report of seafloor venting associated with fore-arc alkaline volcanism.

The Edison 1 Scientific Party was headed by Dr. Peter Herzig (Institute für Mineralogy und Lagerstättenlehre, Aachen) and Dr. Mark Hannington (Mineral Resources Division, Ottawa)

Scientific Party: Antonio Arribas, Klaus Becker, Patrick Browne, Ray Binns, Hans-Herman Gennerich, Martin Hartmann, Bernd Heeseman, Jens Hefter, Ian Jonasson, Roge Kila, Stefan Ladage, Sabine Lange, Thomas Liebe, Brent McInnes, Jayson Meyers, Jeanne Percival, Sven Petersen, Thomas Pichler, Andreas Rosenberger, Giovanni Ruggieri, Thorsten Schott, Ulrich Schwarz, Richard Seiffert, Peter Stoffers, Heinrich Villinger, Kyaw Winn

28. Mineralogy, composition and textural relations of seafloor samples from the New Ireland Forearc Basin, Papua New Guinea

J.B. Percival¹

During the March-April 1994 research cruise of the *F/S Sonne* in the Tabar-to-Feni island chain, Papua New Guinea, 170 lava, pyroclastic and sediment samples were qualitatively analyzed for whole rock and clay-size mineralogy by X-ray diffraction. Rock specimens from dredge and TV-grab stations are usually dominated by the primary minerals feldspar, pyroxene, magnetite, with minor to trace amounts of quartz, zeolites, amphibole and olivine. The carbonates calcite and aragonite, and in some cases kutnohorite (Ca(Mn,Mg,Fe)(CO₃)₂), are abundant in sediment samples. Clay minerals occur in minor to trace amounts and include chlorite and/or kaolinite, Mg-smectite, and local halloysite. Sulphides including pyrite, marcasite and traces of chalcocite, galena and sphalerite as well as gold occur in altered and mineralized lavas. Pb-salts and alunite were also observed. Amorphous material, predominantly Fe and Mn oxyhydroxides, occur in surface coatings on many samples.

¹ Mineral Resources Division, GSC, Ottawa

29. Influence of the buried Chicxulub crater on regional ground water flow, Yucatán, Mexico

A.R. Hildebrand¹, M. Pilkington¹, C. Ortiz-Aleman², R.E. Chavez², M. Connors³

The buried Chicxulub crater is the most important geological control on groundwater flow in the northwestern Yucatán Peninsula, México. An as yet unknown mechanism causes the northward flowing freshwater to be largely diverted around the crater's margin. This diversion is manifested by the development of cenotes (sinkholes) along the crater's perimeter. The main ring of cenotes coincides with the strongest horizontal gradient of the crater's Bouguer gravity anomaly. This gradient feature probably reflects normal faults in the zone of slumping of the crater. The zone of cenotes is bounded by the maxima of the horizontal gradient high with the kilometre-scale 'wiggles' of both coinciding along an arc of ~100 km in length. Detailed gravity profiles reveal that horizontal gradients exceed 2.5 mGal/km at the margin of the main cenote ring, suggesting that gravity surveys may be used to map the Chicxulub-controlled groundwater flow where cenotes are not developed.

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³ Department of Physics, University of Alberta, Edmonton

30. Testing the integrity of subregions of Laurentia in the Proterozoic with paleomagnetism and high-precision dating

K.L. Buchan¹, J.K. Park¹, S.S. Harlan², J.K. Mortensen³, R.F. Emslie¹,
J.C. Roddick¹, K.D. Card¹ and J.P. Hodych⁴

In the past, large uncertainties in ages assigned to Precambrian paleomagnetic poles limited their use in the investigation of the relative movement of Precambrian terranes. However, a new collaborative approach to paleomagnetic and geochronological studies has reduced uncertainties in dating Proterozoic paleopoles from >100 my to <5 my. It takes advantage of recent advances in U-Pb geochronology of mafic rocks, and utilizes rigorous paleomagnetic field tests to establish whether paleopoles are primary and, therefore, closely tied to the U-Pb age of the rock. Thus, it is now possible to directly compare paleopoles of the same age from different regions of Laurentia, to test whether these areas have moved relative to one another. Case studies that test the integrity of subregions of Laurentia in the Paleo-, Meso-, and Neoproterozoic are described.

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² United States Geological Survey, Denver, Colorado

³ University of British Columbia, Vancouver

⁴ Memorial University of Newfoundland, St. John's

31. GIS for mineral resource assessment: an example from the Parry Islands, High Arctic, Canada

B.G. Eddy¹, G.F. Bonham-Carter², C.W. Jefferson²

The application of fuzzy logic in a GIS framework is valuable for mineral resource assessment (MRA) in areas where data are thin or sparse. This is often the case when working in large regions at scales of 1:500 000 or smaller. This study uses a geological map, backed by a digital geological data model, derived from published legends and reports. The data model incorporates fuzzy membership functions which reflect the favourability of geological features with respect to deposit model criteria. This allows a variety of 'evidence maps' to be generated from the geological map, according to the criteria of particular deposit models and their proponents. A fuzzy-logic-based 'inference net', as implemented in the GIS modelling language, is used to combine spatial evidence from the geological map to determine resource potential. A prototype mineral resource map of the Parry Islands reveals the mineral potential with respect to MVT Pb-Zn, sedimentary-Cu, and sediment-hosted sulphide deposit models.

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² Mineral Resources Division, GSC, Ottawa

32. Geology and U-Pb geochronology in the vicinity of Ege Bay, Baffin Island, Northwest Territories¹

R.J. Scammell², K.M. Bethune²

Bedrock mapping and multidisciplinary laboratory investigations have provided insights into the evolution of rocks located between the Archean Committee Fold Belt and the Proterozoic Foxe Fold Belt. Two polydeformed greenschist to upper-amphibolite facies greenstone belts contain 3-50 m thick, laterally continuous (>15 km) volcanic- and turbidite-hosted banded iron formations (BIF). Geochemical analyses indicate potential for BIF-hosted gold deposits. Archean(?) structures and low-pressure high-temperature metamorphism have been affected by Proterozoic tectonism, most intense along the Isortoq Fault, a southeast-dipping structure marking a northwest-transition to granulite facies. Preliminary U-Pb dating of zircons and monazites indicates: (i) bounding orthogneisses (basement?) were emplaced at ~2.77 Ga, (ii) ~2.72 Ga plutonic and volcanic activity within the greenstone belts, (iii) the basal conglomerate within a thick turbidite succession contains granite clasts ~2.84 Ga old; (iv) granulite facies metamorphism and intrusion of syn- to post-kinematic granites occurred at ~1.82 Ga along the Isortoq Fault.

¹ Contribution to Canada-Northwest Territories Mineral Initiatives (1991-1996), an initiative under the Canada-Northwest Territories Economic Development Cooperation Agreement

² Continental Geoscience Division, GSC, Ottawa

33. Quaternary geology of the Inman River area, Northwest Territories

D.A. St-Onge¹, I. McMartin²

This poster presents the Quaternary geology map of the Inman River area. Part of the Late Wisconsinan ice limit is found along the eastern slope of the upland west of Bluenose Lake. Thus, the map provides data essential to understanding ice dynamics along part of the margin of the Late Wisconsinan Laurentide Ice Sheet. This information has ramifications far beyond the immediate study area and contributes to understanding the Quaternary geology of the Canadian landmass.

Land use is an increasing concern of Arctic inhabitants. This study contributes information required for sound land management. Knowledge of the distribution, nature, and origin of glacial and other associated sediments is essential for land-use planning in the proposed Bluenose Lake national park and for other types of development such as a proposed gas pipeline corridor in the area.

¹ Polar Continental Shelf Project, GSC, Ottawa

² Terrain Sciences Division, GSC, Ottawa

34. Landsat TM: a cartographic aid to geological mapping in the Arctic

D.F. Graham¹, J.R. Henderson², G. Labelle³

A land/water raster bitmap was vectorized to generate a water body vector file, and plotted at 1:100 000 - the scale chosen to publish recently acquired geological data in the area of NTS 76L and M (High Lake Greenstone Belt). Excellent correlation can be seen with digitized versions of drainage data from Surveys and Mapping Branch's 1:50 000 and 1:250 000 topographic bases. This demonstrates that TM data can provide drainage data for use in the portrayal of geophysical and geological data. TM data can be useful for production of geological maps by the GSC without copyright restrictions.

The multispectral imaging capabilities of the TM sensor proved useful for highlighting exposed bedrock, vegetated glaciated terrain, and vegetated lowland areas. Extensive lichen cover on bedrock limited the usefulness of the sensor for discriminating bedrock lithologies in the geologically complex Archean terrane.

¹ Mineral Resources Division, GSC, Ottawa

² Continental Geoscience Division, GSC, Ottawa

³ Geoscience Information and Communication Division, GSC, Ottawa

35. Climate change in the Mackenzie Valley: a major cause of permafrost instability and an impediment to development

P.A. Egginton¹, H. Jetté¹

Recently completed high resolution studies on glacial ice cores indicate that 'natural' cycles and changes to global climate may occur rapidly over periods of just a few years. Rapid climatic shifts (whether anthropogenic or natural) can have significant economic consequence. The last major sustained climatic warming occurred about 700 to 1000 years BP - the so called 'medieval warm period'. There is little doubt that such climatic shifts will occur in the future. For this reason the occurrence of the medieval warm period and its consequence is of some interest.

Permafrost areas such as the Mackenzie Valley are sensitive to climatic change. Many geological hazards, such as landslides, are climatically induced. The authors present preliminary paleoenvironmental evidence for a medieval warm period in Mackenzie Valley and consider the implications of such natural change on permafrost stability.

¹Terrain Sciences Division, GSC, Ottawa

36. Evaluating the fragility of Arctic ecosystems: stability and changes throughout recent geological time

M. Garneau¹, J. Bourgeois¹, K. Gajewski²

Pollen and macrofossil analyses of lakes sediments, peat sections, and ice cores provide information about Late Quaternary environmental changes. Each of these three sediment types records different environmental changes with particular spatial and temporal scales of resolution. During the Late Quaternary in the Arctic, subtle changes in ecosystems were recorded; however, limitations of each analytical type had to be considered. Problems such as low pollen concentrations, long distance transport, stratigraphic inversions, and contamination by fossils from older deposits are magnified at these high latitudes. However, recent work has shown that past environments can be reconstructed from arctic sediments, provided problems are taken into account before interpretation.

¹ Terrain Sciences Division, GSC, Ottawa

² University of Ottawa, Ottawa

37. Airborne gamma-ray spectrometer-magnetic-VLF survey of polymetallic mineralization in Mazenod lake area, southern Great Bear magmatic zone, Northwest Territories

B.W. Charbonneau¹, S.S. Gandhi¹, R.J. Hetu¹, P.B. Holman¹, N. Prasad¹

Results of an airborne survey in Mazenod Lake area, Northwest Territories, covering 1500 km² at 500 m line spacing are available as 12 geophysical maps (radiometric, magnetic, and VLF-EM) and profiles, with an accompanying geology and mineral occurrence map.

These data are also available in digital form with a viewing program (SurView).

Several types of mineral occurrences are found within the survey area: i) vein U; ii) vein and disseminated Bi-Cu-Co-Au-As; iii) magnetite-rich veins and breccia fillings, Kiruna/Olympic Dam-type Cu \pm U \pm Au (principal example being the Sue-Dianne deposit); and iv) stratiform Fe oxide. These occurrences are generally marked by high U, U/Th ratio, and magnetic anomalies. Some are also associated with increased K. The survey results reveal several magnetic and radiometric anomalies in addition to those that relate to known mineral occurrences, thus enhancing the exploration potential of the area.

¹ Mineral Resources Division, GSC, Ottawa

38. Nd isotopic evidence for sources of granites, northern Slave Structural Province, Northwest Territories, Canada

A. Davis¹, E. Krogstad¹

Initial ratios of $^{143}\text{Nd}/^{144}\text{Nd}$ (ϵ_{Nd}) for several late granites from an east-west transect across the Anialik, High Lake, and Hood River volcanic belts show that the ϵ_{Nd} of the magmatic sources of all these rocks were similar. All late granite samples have ϵ_{Nd} (2600 Ma) in the range of +1 to -2. This suggests that the source(s) of the granites were nearly homogeneous and somewhat evolved from a model depleted mantle. Such an average source may have been composed of rocks separated from a depleted mantle by 200-300 Ma before 2600 Ma. By contrast, two samples of Kanguyyak gneisses have low ϵ_{Nd} (2600 Ma) values (-7 to -8) consistent with an old crustal history ($T_{\text{DM}} = 3200$ Ma) for these rocks. These data imply that the contribution of Kanguyyak-type material to sources for the sampled ca. 2600 Ma granites was not significant.

¹ Department of Geology, University of Maryland, College Park

39. Transect through the Indin Lake greenstone belt: journey to the mid-crust of the Slave Craton

S. J. Pehrsson¹, J. Grant², J.B. Henderson¹, H. Helmstaedt², J.E. King¹

The Indin Lake greenstone belt of the western Slave Province is comprised of a greywacke-mudstone turbidite sequence intercalated with distinct volcanic assemblages. Contact relationships within the belt are consistent with tectonic stacking of a mafic volcanic assemblage within the turbidite sequence, which conformably to unconformably overlies an intermediate- to felsic-dominated volcanic assemblage. A U-Pb zircon age of 2685 \pm 5 Ma constrains the maximum age of sedimentation and the age of primary felsic volcanoclastic deposits within the sedimentary sequence. An uppermost-amphibolite to granulite facies gneiss domain to the east is juxtaposed with the belt by a Late Archean to Early Proterozoic fault. Identification of volcanic and sedimentary supracrustal components within the gneisses

coupled with a synvolcanic crystallization age of 2680 ± 5 Ma for gneissic tonalite in the domain suggest that these high-grade rocks represent the exhumed mid-crust of the greenstone belt .

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² Queen's University, Kingston

40. Thematic structural studies in the Slave Structural Province: preliminary results and implications for the Yellowknife domain

W. Bleeker¹, C. Beaumont-Smith²

The Yellowknife Domain and its greenstone belts form the focus of the present study. Building on earlier work by Henderson (1985), Lambert (1988), and others, the geology and in particular the structural geometry of the eastern part of the domain have been investigated. Preliminary results indicate that the structure of the area is dominated by two phases of regional folding that produce mushroom-type interference patterns. The Sleepy Dragon Complex is such a regional-scale interference structure. Its geometry and timing of formation contradict the hypothesis that it represents a core complex. They also cast doubt on previous kinematic studies. D2 was a response to dextral transpression during which both the Defeat Suite and Prosperous Suite granitoids were emplaced. Regional low-pressure metamorphism is largely late-D2 and associated with granitoid emplacement. Following F2 folding, D2 dextral transpression became localized in discrete dextral shear zones that record retrograde metamorphism.

¹ Continental Geoscience Division, GSC, Yellowknife

² University of New Brunswick, Fredericton

41. Overview of the geology and mineral occurrences of High Lake Greenstone Belt, Slave structural province, Northwest Territories

J.R. Henderson¹, M.N. Henderson², J.A. Kerswill²
M. Villeneuve¹, C.A. Petch³, J.F. Dehls⁴, M.D. O'Keefe³

High Lake Greenstone Belt has been mapped along a strike length of 100 km from Hood River north to Coronation Gulf. A basement terrane to the supracrustal rocks has not been recognized. The oldest volcanic rocks (2.71 Ga) are felsic and predominate in the western part of the belt. They are succeeded by basaltic, andesitic, and dacitic flows and tuffs (ca. 2.67 Ga) observed in the eastern part of the belt. The youngest volcanic rocks, mapped in the center of the belt, consist of dacitic flows (2613 Ma) and tuffs with associated graphitic-sulphidic slates and siltstones. The belt is surrounded and intruded by ca. 2.6 Ga plutons and batholiths.

Synvolcanic massive sulphides occur in intermediate to felsic volcanic rocks, within

zones of hydrothermal alteration indicated by porphyroblastic knots of quartz-sericite-chlorite or cordierite ('dalmatianite'). Epigenetic gold occurs with arsenopyrite-pyrrhotite-quartz in dilatant zones in mafic volcanic rocks.

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- ² Mineral Resources Division, GSC, Ottawa
- ³ Department of Geological Sciences, Queen's University, Kingston
- ⁴ Department of Geology, University of Toronto, Toronto

42. Development of GIS analysis technology and their application to the NATMAP Slave Province Project

C. Bowie¹, B.A. Kjarsgaard¹, J. Broome¹

To date, the GIS component of the NATMAP Slave Province Project has focused primarily on development and compilation of a digital geoscientific database for the region. The digital nature of this database has facilitated timely release of preliminary bedrock geology and surficial maps in hard copy and digital formats (CD-ROM). Datasets collected and archived by project participants include bedrock and surficial maps/field observations, bedrock and till geochemistry, and geochronology. Data from sources outside the project include geophysics, remotely sensed imagery, geochemistry, and topographic bases.

Release of these data in digital format permits an integrated approach to geoscientific mapping and exploration using GIS or CAD software. This poster examines GIS analysis and integration techniques applied to the Slave NATMAP in the context of achieving a better understanding of the distribution of kimberlite pipes in the Lac de Gras region. Statistical and visual analysis techniques will be presented.

- ¹ Continental Geoscience Division, GSC, Ottawa

43. Geology of the Winter Lake supracrustal belt¹

R.B. Hrabi², M.E. Villeneuve³, W.J. Davis³, H. Helmstaedt², J.E. King³

The Winter Lake supracrustal belt represents a unique assemblage of rock units recording the evolution in this part of the Slave Province over 700 million years. Basement-aged felsic metavolcanic rocks, themselves formed at distinctly different times (ca. 3.3 Ga and 3.1 Ga), occur at the structural base of the belt. Komatiitic basalts, unique in the Slave Province, form part of a mafic metavolcanic sequence overlying the older rocks. Trace element geochemistry and Nd isotopic data suggest that the komatiitic basalts contain a component of older crustal material while at least some of the mafic rocks appear to be uncontaminated. Above the mafic sequence, felsic metavolcanic rocks are younger than 2625 Ma. Polymictic conglomerates and sandstones also clearly postdate the mafic metavolcanic rocks. Field evidence suggests that these unconformably overlie the mafic metavolcanic and

turbiditic metasedimentary rocks.

¹ Contribution to Canada-Northwest Territories Mineral Initiative (1991-1996), an initiative under the Canada-Northwest Territories Economic Development Cooperation Agreement

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

³ Continental Geoscience Division, GSC, Ottawa

44. Tectonic setting of kimberlites

R.S. Hildebrand¹, B. Kjardsgaard¹

Kimberlites occur where continental crust is older than 1.5 Ga, and they may contain economic diamond deposits where that crust is Archean. Their tectonic setting, however, remains unknown and their triggering mechanism unresolved. We propose that kimberlites are concentrated in foredeeps and related flexural bulges and are products of continental collision. Within North America, one swath of Cretaceous-Eocene kimberlites extends from the Northwest Territories to Colorado and occurs within the Cordilleran foredeep or its flexural bulge. Another older swath, extending from eastern Canada to the southern United States, is spatially related to the Appalachian foredeep/bulge: kimberlites in the high Arctic relate to the Innuitian Orogen. In each case kimberlitic magmas were emplaced during, or shortly after, foredeep development. Similar relations occur in the South African, Senegal-Guinea, and Liberia-Ivory Coast occurrences. If this observation is correct, then kimberlites are lower plate phenomena likely triggered by downflexed subArchean tectosphere.

¹ Continental Geoscience Division, GSC, Ottawa

45. An overview of the occurrence and distribution of kimberlites in Canada^{1,2,3}

B.A. Kjarsgaard^{4,5}

Exploration for diamond-bearing kimberlites in Canada continues throughout the country in 1994. Known kimberlites are of quite variable diamond grade. Barren/low grade (<1c/100t) kimberlites include the Somerset Island field (Northwest Territories) and Cross pipe (British Columbia). Low grade (1 - 15c/100t) kimberlites include pipes in the Fort à la Corne field (Saskatchewan) and Kirkland Lake field (Ontario/Quebec). High but variable grade (<25 to >300c/100t) pipes are currently being bulk sampled in the Lac de Gras field (NWT); some kimberlites in this field contain stones with average values of US \$100/carat. Diamond sampling and assessment continues in the Attawapiskat field and James Bay area (Ontario), Candle Lake field (Saskatchewan), and other new discoveries in the Slave Province, Northwest Territories (Ranch Lake, Cross Lake, Aylmer Lake, Drybones Bay). Numerous occurrences of 'supposed' kimberlites are reviewed and properly classified within a modern petrological framework.

- ¹ Contribution to Canada-Northwest Territories Mineral Initiatives (1991-1996), an initiative under the Canada-Northwest Territories Economic Development Cooperation Agreement
- ² Contribution to Canada-Saskatchewan Partnership Agreement on Mineral Development (1990-1995), a subsidiary agreement under the Canada-Saskatchewan Economic and Regional Development Agreement
- ³ Contribution to Canada-Alberta Agreement on Mineral Development (1992-1995), a subsidiary agreement under the Canada-Alberta Economic and Regional Development Agreement
- ⁴ Continental Geoscience Division, GSC, Ottawa
- ⁵ Mineral Resources Division, GSC, Ottawa

46. Revised geology, north Lac de Gras area, Northwest Territories: implications for diamond and gold exploration¹

B.A. Kjarsgaard^{2,3}, R.N. Spark⁴, Z.J. Jakop⁵

Geologic mapping at 1:50 000 in the northeast quadrant of 76D has resulted in improved discrimination of rock units and an enhanced understanding of the tectono-magmatism of the area. The oldest bedrock in the area consists of Yellowknife Supergroup greywackes; both Itchen and Contwoyto formations are present. East/west tectonic juxtaposition of low-grade phyllites and upper-amphibolite grade schists occurs in two zones. Metasediments are intruded by Concession Suite equivalent diorite-tonalite-granodiorite plutons (syn D₂). Late D₂ two-mica granites and post D₂ porphyritic biotite granites complete the Archean intrusive events. Five Proterozoic dyke swarms (MacKay, Contwoyto, Lac de Gras, '305', Mackenzie) crosscut these rocks. The youngest magmatism in the area involved Eocene kimberlite emplacement. Information acquired by mapping provides a framework for understanding local controls on kimberlite emplacement. Furthermore, the discovery of previously unrecognized Contwoyto-type silicate BIF in the map area has important implications for gold exploration.

- ¹ Contribution to Canada-Northwest Territories Mineral Initiatives (1991-1996), an initiative under the Canada-Northwest Territories Economic Development Cooperation Agreement
- ² Continental Geoscience Division, GSC, Ottawa
- ³ Mineral Resources Division, GSC, Ottawa
- ⁴ Department of Geology, University of New Brunswick, Fredericton
- ⁵ Department of Earth Sciences, Carleton University, Ottawa

47. Regional patterns of kimberlite indicator minerals in till, Lac de Gras area, Northwest Territories

L.A.Dredge¹, D.E. Kerr¹, B.C. Ward¹, I. Kjarsgaard²

Heavy mineral concentrates from the Lac de Gras area (NTS 86A, 76D, and 76C) were examined for kimberlite indicator minerals as part of the Slave NATMAP project. The 0.25-0.5 and 0.5-1.0 mm size fractions were picked and classified. Suspect grains were analyzed by electron microprobe. Concentrations of indicator minerals ranged from 0 to >1000 per sample. The majority of indicator minerals were found in the .25-0.5 mm size fraction. The relative proportion of indicator minerals is ~75% pyropes, ~25% chrome diopsides, ~1% Mg-ilmenites, ~1% chromites, and <<1% eclogitic garnets. Samples with the highest concentration of indicator minerals were found adjacent to and down-ice from the 'Corridor of Hope', where the highest concentration of kimberlites has been reported.

Kelyphite reaction surfaces on pyrope grains do not confirm the proximity of kimberlite.

¹ Terrain Sciences Division, GSC, Ottawa

² Private consultant, Ottawa

48. Geology and mineral potential of the Winter Lake - Lac de Gras area, central Slave Province, Northwest Territories

P.H. Thompson¹, J.A. Kerswill², E. Froese¹

Thin discontinuous volcanic belts separate an extensive granitoid complex from a large metasedimentary domain. Discordant metamorphosed dykes, discordant isograds, and the change from curvilinear fold interference patterns to blocky subrhombic structures indicate that the granitoid complex is older than the supracrustal rocks (Yellowknife Supergroup). Younger granitoids intrude both domains.

The honeycomb-like distribution of supracrustal rocks within and around large blocks of granitoid complex, reflecting extensional structures related to basin formation, strongly influenced later regional compressional structures.

Regional low pressure metamorphism and syntectonic magmatism are attributed to high geothermal gradients that developed within thinning continental lithosphere (supracrustal basin formation) and persisted during moderate crustal overthickening.

Metamorphosed hydrothermal alteration zones identified near base metal occurrences in the Courageous Lake volcanic belt (Grizzly, Ptarmigan, Deb) were also recognized in less explored and in newly discovered supracrustal sequences. Sulphide-rich banded iron formation within the Winter Lake supracrustal belt provides additional economic interest.

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² Mineral Resources Division, GSC, Ottawa

49. Thermal properties of rock units in the Winter Lake - Lac de Gras area -

implications for archean thermal evolution and diamond genesis in the central Slave Province

P.H. Thompson¹, T.J. Lewis², A.S. Judge³, F. Lucazeau⁴

Radiogenic heat production varies with rock type from 0.10-0.80 $\mu\text{W}/\text{m}^3$ in amphibolite and tonalitic gneiss to 8.0-15.77 $\mu\text{W}/\text{m}^3$ in late granites. Metasedimentary rocks and other granitoid units fall between these extremes. Thermal conductivity ranges from 2.30 to 4.90 W/mK. Conductivity parallel to planar foliation or layering is up to 1.6 times higher than that perpendicular to these features.

One-dimensional finite difference models using values similar to new data and thin (<100 km) lithosphere can reproduce observed low pressure regional metamorphism and abundant granitoid magmatism by shortening and moderate overthickening of volcano-sedimentary basins formed within thinning continental lithosphere. Geothermal gradients seem to preclude formation of diamonds beneath the Slave Province 2.6 Ga ago.

Comparison of observed and calculated geothermal gradients indicates that the crust today cannot contain significant volumes of rocks with heat production at the high end of the measured range. Modelling suggests this must also be true of the past.

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² Pacific Geoscience Centre, GSC, Sidney

³ Terrain Sciences Division, GSC, Ottawa

⁴ Centre géologique et géophysique CNRS, Montpellier, France

50. Prairie kimberlite study: progress in drift provenance, mineral classification, and geochemical studies^{1,2}

L.H. Thorleifson³, R.G. Garrett⁴

A till and soil sampling survey of the Prairie region was carried out in 1992 by the GSC, with support from Manitoba Energy and Mines and participation by the Alberta and Saskatchewan Research Councils. Project funding was by federal-provincial mineral development agreements. Objectives were to map regional trends in the frequency and chemistry of indicator minerals, to demonstrate indicator mineral methods recently developed in the private sector, to map regional glacial geology, with emphasis on distance and direction of glacial transport, and to map regional soil geochemistry in support of mineral exploration, environmental management, and agriculture. Since the 1993 release of preliminary results, eclogitic garnets were reanalyzed by electron microprobe at reduced detection limits, peridotitic garnets and Cr-spinels were reanalyzed by proton microprobe, and additional soil and till geochemical analyses were completed. Pebble lithology and bulk mineralogy of heavy mineral concentrates are used to map regional ice flow trends.

- ¹ Contribution to Canada-Alberta Agreement on Mineral Development (1992-1995), a subsidiary agreement under the Canada-Alberta Economic and Regional Development Agreement
- ² Contribution to Canada-Saskatchewan Partnership Agreement on Mineral Development (1990-1995), a subsidiary agreement under the Canada-Saskatchewan Economic and Regional Development Agreement
- ³ Terrain Sciences Division, GSC, Ottawa
- ⁴ Mineral Resources Division, GSC, Ottawa

51. New occurrences of lamproitic rocks in the Churchill Province: olivine-rich dykes and phreatomagmatic centres

T.D. Peterson¹, D.D. Hogarth²

New discoveries of ultrapotassic rocks in the Northwest Territories are significant for diamond exploration and regional tectonics. A volcanic centre of the Kuungmi Formation (<1.72 Ga) in the Thelon Basin (63°05'N, 102°55'W) resulted from explosive interaction of magma with water-saturated sandstone. Vesicular tuffs, sandy tuffs with >50% quartz, and accretionary lapilli, features common to diamondiferous lamproite centres, are present. Lamproite dykes have been found in south Baffin Island (62°53' N, 65°21'W). They contain olivine (Fo₈₇₋₈₉), leucite, diopside, tetraferriphlogopite, shcherbakovite, perovskite, and djerfisherite (+ others). Four specimens average TiO₂ 3.3%, Al₂O₃ 10%, K₂O 8.3%, and Na₂O 1.3%. Present-day ⁸⁷Sr/⁸⁶Sr=0.711542, ¹⁴⁴Nd/¹⁴³Nd= 0.511541; assuming T=40 Ma, ε_{Nd}=-21. These discoveries substantially extend the age span and areal distribution of lamproitic rocks in the region, although coexistence of diatremic facies and olivine lamproites at one centre has not yet been observed.

- ¹ Continental Geoscience Division, GSC, Ottawa
- ² Department of Geology, University of Ottawa, Ottawa

52. Glacial dispersal patterns associated with the C14, B30, A4 and Diamond Lake kimberlite pipes, Kirkland Lake, Ontario

M.B. McClenaghan¹, I.M. Kjarsgaard²

Humus, soil, till, and vegetation samples were collected over and down-ice from four kimberlite pipes to document their geochemical and glacial dispersal patterns and to evaluate the usefulness of these different media for kimberlite exploration. Preliminary results indicate that kimberlite indicator mineral concentration decreases dramatically within 500 m down-ice from a pipe and reaches background values of a few grains per sample within 2 km. A method for discriminating between regional and kimberlitic Cr-diopside has been developed using several hundred microprobe analyses of grains from the kimberlite pipes and 600 regional till and sand samples. Till overlying the kimberlites contains elevated values of Cr, Ni, Ba, Sr, Ta, Nb, and some REE. Tree twigs and bark over kimberlites are enriched in Sr,

Cr, Rb, Zn. These geochemical patterns indicate that till and vegetation geochemistry are useful tools for kimberlite exploration.

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² Private consultant, Ottawa

53. 1:50 000 combined bedrock surficial geology mapping of the northern Minto Inlier Ni-Cu-PGE prospect, Victoria Island, Northwest Territories¹

R.H. Rainbird², D.A. Hodgson³

Northeastern Minto Inlier is underlain by gently folded platformal sedimentary strata of the Neoproterozoic Shaler Supergroup, which are intruded by up to 100 m thick highly differentiated mafic sills of the 723 Ma Franklin events. Bedrock mapping on the northwest margin of the inlier has defined a zone of northeast-striking block faults, considered to be an integral component of a model for localization of Ni-Cu-PGE in the Franklin sills. The deformation is latest Neoproterozoic as it does not affect lower Paleozoic carbonates and shales, which unconformably overlie the Shaler Supergroup to the north. Bedrock is discontinuously overlain by carbonate-rich till deposited by a generally northward-flowing glacier. Ice-margin retreat, outwash deposition and marine incursion (to 140 m) occurred between 11 and 10 ka. A 10 ka readvance of lowland and marine-based ice overlapped eastern and northern fringes of Minto Inlier.

¹ Contribution to the Canada-Northwest Territories Mineral Initiatives (1991-1996), an initiative under the Canada-Northwest Territories Economic Development Cooperation Agreement

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³ Terrain Sciences Division, GSC, Ottawa

54. A hybrid-GIS model for producing climate change-permafrost impact maps at the regional scale

F. Wright¹, M.W. Smith², A. Taylor¹

Potential environmental consequences of an expected global warming provide an impetus for the development of models to predict the distribution of permafrost in northern regions. A simple model proposed by previous workers utilises available mapped climatic, topographic, vegetation, and forestry data as model inputs. While capable of predicting the occurrence of permafrost, this model does not include a mechanism for predicting the depth of frozen ground. A GIS-compatible hybrid model has been developed which relates output from the earlier model to that of a one-dimensional, finite-element heat conduction model and provides an estimate of permafrost thickness for various terrain conditions. The hybrid model was applied to a climate change-permafrost impact mapping project over a 16 000 km² area of the Mackenzie Valley near Fort Simpson, Northwest Territories.

- ¹ Terrain Sciences Division, GSC, Ottawa
² Department of Geography, Carleton University, Ottawa

55. **Mineralogical results from insoluble residues obtained from cold HF digestion of precious metal-bearing strata, Fort MacKay, Alberta**

S.B. Ballantyne¹, D.C. Harris¹, S.F. Sabag²

Samples of Devonian carbonate stratigraphy reported by Tintina Mines Limited to contain anomalous gold and silver concentrations were decomposed by prolonged digestion in cold hydrofluoric acid. Detailed mineralogical characterization of the resultant mineral separates of two bitumen-rich muddy limestone sections and one sulphide-rich limestone breccia were completed using SEM backscattered electron images with EDS analysis and electron microprobe analyses. Native elements Au, Ag, Cu, Pt, Pb, Zn, Ni, Fe, Cd, Sn, alloys Cu-Zn, Fe-Ni, Fe-Ni-Cr, and pyrite, rare sphalerite, chlorine and iodine-metal complexes, and carbon-bitumen-sulphide-metal associations have been identified and their form and distribution documented. This diverse mineral and native element assemblage may suggest genetic processes including bacterial reduction, oxyhalogen brine transport to reductive sites, and explosive mantle diapiric emplacement (native metals in lamproites, Aldan; gold in Mir pipe, Soviet Union).

- ¹ Mineral Resources Division, GSC, Ottawa
² Tintina Mines Limited, Toronto

56. **"Prairie-type" brine-associated Au-Ag-Cu mineralization in the Western Canada Sedimentary Basin**

H.J. Abercrombie¹, R. Feng¹

The discovery of disseminated Au-Ag-Cu mineralization in the Western Canada Sedimentary Basin (WCSB) and underlying Precambrian Shield has provided new mineral exploration opportunities in a traditional energy basin. Au-Ag-Cu mineralization occurs as $<1 \mu\text{m}$ to $\sim 20 \mu\text{m}$ particles of native and alloyed metals, and metal-chloride, -oxide, and -carbonate phases associated with a polymetallic element suite. A model for "Prairie-type" mineralization invokes leaching and transport of metals by residual evaporite brines from the Middle Devonian Prairie evaporite and other salt-evaporites of the WCSB. Prairie-type mineralization has been found in Proterozoic and Phanerozoic rocks in northeastern Alberta, and in other parts of the WCSB. Recognition of "Prairie-type" mineralization is complicated by micron particle sizes, the lack of macroscopic evidence for mineralization, complex and novel mineralogy, and the lack of reproducibility amongst conventional methods of geoanalysis. Optimal methods for detection include laser ablation ICP-MS and backscattered electron SEM-EDX imaging.

¹Institute of Sedimentary and Petroleum Geology, GSC, Calgary

57. Recent results from electromagnetic studies in the Western Canada Basin

R.D. Kurtz¹, D.E. Boerner¹, J.A. Craven¹, F.W. Jones²

The Precambrian basement beneath the Western Canada Basin in Alberta is known only from limited drill intersections with recovered core, and by tracing magnetic and gravity signatures from the exposed Shield.

Recent LITHOPROBE seismic investigations have corroborated the basic model of compression related to southeastern subduction under the Hearne Craton. Long-period electromagnetic studies provide a new view of the basement consisting of highly conductive structures in the upper crust, spatially correlative with anticlines and inferred domain boundaries. The Red Deer High is a magnetic anomaly associated with exceptionally conductive structures in the upper part of the crystalline basement and is thought to be associated with a Proterozoic foredeep sequence.

¹ Continental Geoscience Division, GSC, Ottawa

² University of Alberta, Edmonton

58. Probing the lower crust: U-Pb geochronology and isotopic studies of lower crustal xenoliths entrained in alkaline intrusions, southern Alberta

W.J. Davis¹

Lower crustal xenoliths entrained in alkaline magmatic rocks provide a unique opportunity to study the age and history of the lower continental crust of the Canadian Shield. These data are essential to evaluate hypotheses concerning the formation and evolution of Precambrian cratons and the relationship of lower crustal metamorphism to mineralization in the upper crust. U-Pb analyses of zircon and other accessory minerals can yield protolith and metamorphic ages, and constrain the cooling history of the xenoliths. As an example, U-Pb dating of xenoliths from the Archean Medicine Hat Block of southern Alberta and northern Montana indicates that the lower crust underwent granulite-grade metamorphism at ~1.8-1.7 Ga, which is much younger than the Archean age of the upper crust. Metamorphism may be related to Paleoproterozoic assembly of Laurentia. Nd model ages of ~1.8-1.7 Ga for the host metapelites may suggest a linkage between mantle metasomatism and lower crustal metamorphism.

¹ Continental Geoscience Division, GSC, Ottawa

59. LITHOPROBE seismic reflection profiling in Alberta

D.W. Eaton¹, B. Milkereit¹, G.M. Ross²

LITHOPROBE has completed two major seismic reflection programs in Alberta. The objectives of the surveys are to test models for the tectonic assembly of Precambrian basement rocks beneath the Western Canada Sedimentary Basin and to determine the influence of basement rocks on the basin's evolution. A major result of the first survey across central Alberta was the discovery of a previously unrecognized northwest-vergent thick-skinned orogenic belt. Available geochronological constraints suggest that this deformation was coeval with the adjacent Trans-Hudson Orogen in Saskatchewan. New insights about the influence of basement rocks on the Phanerozoic cover have also been developed; in particular, a major west-east Paleozoic facies change is shown to be abrupt. It overlies the Rimbey magmatic arc in the basement, and underlies the Devonian Rimbey-Meadowbrook reef chain, suggesting the possibility of deep-seated controls on reef growth. New data were acquired in 1994 and are currently being analyzed.

¹ Continental Geoscience Division, GSC, Ottawa

² Institute of Sedimentary and Petroleum Geology, GSC, Calgary

60. Surficial geology of the Virden area, Prairie NATMAP

C. Sun¹, R.J. Fulton², A. Blais²

Mapping of the Virden (62F) area of southwestern Manitoba and southeastern Saskatchewan provides a fresh look at surficial geology mapping in the Canadian Prairie Provinces and furnishes surficial materials data for environmental, hydrogeological, mineral exploration, and land use planning purposes.

Field work is three quarters complete and open file maps have been prepared for three eighths of the area. Field notes from previous mapping and aggregate resource studies, and borehole logs have been entered into dBASE formatted databases.

The legend devised for this area uses 18 materials/landform units. The inclusion of specific features such as potholes and minor moraine ridges provide further subdivision of the units.

Items of scientific interest that have been touched on this past year are: a mammoth tusk, outburst flood gravels, bedrock control on geomorphology, a climatically sensitive lake basin, a boulder pavement at the base of the surface till, and the relationship between solonchic soils and older till.

¹ Department of Geological Sciences, University of Manitoba, Winnipeg

² Terrain Sciences Division, GSC, Ottawa

61. Surficial geology of the southeastern part of Prairie NATMAP area¹

G. Matile², L.H. Thorleifson³

Surficial geological mapping, drift sampling, and Quaternary stratigraphic studies are being conducted in southeastern Manitoba as contributions to the National Geoscience Mapping Program (NATMAP) and the Canada-Manitoba Partnership Agreement on Mineral Development (MDA). The area spans the prairie/shield contact and the provincial boundary. Partially complete compilation of colour 1:100 000 surficial geology maps includes synthesis of mapping carried out by the former Aggregate Resources Section of the Mines Branch. Emphasis is on engineering, environmental, and groundwater geology in the portion of the area underlain by Phanerozoic rocks. Subsurface data from water wells and previous geological drilling are being compiled. The area underlain by Precambrian rocks is a Mineral Development Agreement project area, where emphasis is on indicator mineral tracing and geochemistry in a drift-covered area with potential for base metals and other commodities.

¹ Contribution to Canada-Manitoba Partnership Agreement on Mineral Development (1990-1995), a subsidiary agreement under the Canada-Manitoba Economic and Regional Development Agreement.

² Manitoba Energy and Mines, Winnipeg

³ Terrain Sciences Division, GSC, Ottawa

62. The bordat system for storing and organizing borehole log information in the Prairie NATMAP project

L. Murray¹, R.N. Betcher²

One of the most important goals of the Prairie NATMAP Project is to provide subsurface data that can be used for aquifer delineation. A borehole database, referred to as BORDAT, was developed as the source of this stratigraphic information.

BORDAT is a relational database created for Prairie NATMAP work in southeastern and southwestern Manitoba and southeastern Saskatchewan from borehole data provided by Manitoba Water Resources Branch, Saskatchewan Water Corporation, and Geological Survey of Canada. The database consists of four tables containing header, stratigraphic, well construction, and additional comments information.

Much of the data was available in ASCII format and extraction required extensive manipulation. As a finalizing touch to the database package, a user interface was constructed to facilitate entry of future data. The main strength of the database is that it provides data in a form that can be used to create regional stratigraphic cross-sections and maps.

¹ Naldrett Paleoenvironmental Geosciences, Winnipeg

² Water Resources Branch, Manitoba Department of Natural Resources, Winnipeg

63. Till sedimentology and drift composition in the Annabel Lake-Amisk Lake area, Saskatchewan: implications for drift prospecting¹

P. Henderson²

Striations indicate that the study area was glaciated predominantly by south-southwestward ice flow, although older, rare striae have been observed indicating westward, southwestward, and southeastward flow. Tills deposited by these events are generally compact and form discontinuous deposits with compositional and textural characteristics related to bedrock. During ice retreat, the area was inundated by proglacial Lake Agassiz resulting in the deposition of thick extensive glaciolacustrine sediments. In the north and east, younger tills have been recognized overlying these glaciolacustrine deposits and have been linked to deposition during a southwesterly glacial readvance into the lake basin. In section, the upper diamictons, interpreted as flow tills, show considerable sedimentological, compositional, and textural variation. The provenance of these tills is related more to re sedimentation processes than bedrock composition. Tracing indicators of mineralization in till in the area therefore depends upon an understanding of facies and facies relationships.

¹ Contribution to Canada-Saskatchewan Partnership Agreement on Mineral Development (1990-1995), a subsidiary agreement under the Canada-Saskatchewan Economic and Regional Development Agreement

² Terrain Sciences Division, GSC, Ottawa

64. **Investigations into trace-element bioavailability in selected Prairie soils¹**

R.G. Garrett², L.H. Thorleifson³

Surface soil geochemical data acquired during the 1992 MDA-supported ultra-low density till and soil survey provides evidence of systematic variation across 735 000 km² of Prairie farmland. Surface soil geochemistry reflects the composition of parent material, dominantly glacial sediments, while the influence of Shield and Phanerozoic source rock geochemistry on soils through glacial sediment composition is apparent.

Crops obtain their nutrients dominantly from soil. However, simultaneously non-nutrient toxic elements (e.g., Cd) become incorporated in the plants. In cooperation with the Grains Commission, a review of 1992 data indicated that the relationship between total soil chemistry and elemental uptake is poor. Soils and crops were sampled in five study areas in Manitoba and Saskatchewan in 1994 to better understand the role of source bedrock geochemistry and trace-element speciation in controlling Cd uptake in durum wheat.

¹ Contribution to Canada-Saskatchewan and Canada-Alberta Partnership Agreement on Mineral Development (1990-1995), a subsidiary agreement under the Canada-Saskatchewan and Canada-Alberta Economic and Regional Development Agreement

² Mineral Resources Division, GSC, Ottawa

³ Terrain Sciences Division, GSC, Ottawa

65. Geoscience and global change in the Palliser Triangle, southern Prairies

D.S. Lemmen¹, R.E. Vance¹, S.A. Wolfe¹

The Palliser Triangle is an important agricultural area that is periodically beset with drought. Sustainable economic activity may be threatened because general circulation models predict that this semi-arid region will become warmer and drier as atmospheric greenhouse gas concentrations increase. Geoscientific information collected through research coordinated by the Geological Survey of Canada provides a long-term context to assess such predictions. In addition, scenarios of landscape modifications and hydrological responses to climatic change outlined by this research will better prepare land use managers for future global change.

A detailed record of Holocene hydrological and climatic variability will be developed from paleolimnological studies. Such variability directly influences geomorphic process rates. Geomorphic processes are being evaluated through stratigraphic and monitoring studies of the most dynamic landscape elements. This information will be used with GIS analysis of landscape sensitivity to map areas affected under a variety of global change scenarios.

¹Terrain Sciences Division, GSC, Calgary

66. Glacial Lake Agassiz beaches and reconstruction of major glacial lake levels in the NATMAP shield margin area, northern Manitoba and Saskatchewan

I. McMartin¹

Numerous Lake Agassiz raised beaches have been identified since recent surficial mapping at 1:100 000 was initiated in the study area. They occur mostly on the Paleozoic cover as isolated or series of ridges, and include moderately well sorted sand and gravel, or rock shingles. Differential isostatic uplift has caused the beach ridges to tilt up toward the north-northeast, and apparent tilts measured on continuous ridges vary from 0.17 m/km to 0.49 m/km. The highest beaches are found at an elevation of 337 m on the crest of The Pas moraine and are correlated to the Gladstone level of Lake Agassiz. The lowest beaches are found in the eastern part of the study area, at elevation 233 m (southeast) to 270 m (northeast), and are thought to include the Ponton level. On the Shield, abundant shorelines surrounding Precambrian outcrops suggests the presence of archipelagos at different lake levels. A reconstruction of major lake levels is presented.

¹ Terrain Sciences Division, GSC, Ottawa

67. Integrated image products for the southern flank of the Kiseynew domain

D. Viljoen¹, D. Ross¹

The goal of the NATMAP Shield Margin Project is to provide 1:100 000 bedrock

geology compilation for the Flin Flon-Snow Lake area in Manitoba and Saskatchewan, including buried Precambrian basement in the southern half of the project area. To assist in achieving this goal, project participants have been contributing data to a geoscience database. Data layers include geology maps ranging from 1:20 000 to 1:500 000, high resolution aeromagnetics, satellite imagery, topographic bases, geochronology, quaternary data, and more.

With project data available in digital form, Geographic Information Systems (GIS) can be used to rapidly create integrated image products that aid in visualizing relationships between datasets. Relationships between geology and potential field data in exposed bedrock north of the Shield margin have been extrapolated south of the Shield margin to assist mapping of Precambrian basement where it is buried under a thin veneer of Phanerozoic cover.

¹ Continental Geoscience Division, GSC, Ottawa

68. Gravity and magnetic models for the Churchill-Superior boundary zone, Manitoba

M.D. Thomas¹, E.I. Tanczyk¹

Trans-Hudson Orogen LITHOPROBE seismic reflection profiling across the Churchill-Superior boundary zone revealed east-dipping crustal reflectors, contrary to geologically based expectations predicting west-dipping structures within an eroded collisional fold-thrust belt. A prominent gravity high along the boundary zone has its axis within the Pikwitonei Domain, but its western flank extends into the adjacent Thompson Belt. This is explained by relatively dense Pikwitonei granulites dipping westward beneath the Thompson Belt, or by dense rocks within the latter. Density studies support the former picture. Modelling the gravity high over the Kisseynew Domain indicates that its boundary with the Thompson Belt also dips west. Magnetic modelling within the Thompson Belt favours steep dips for geological units, consistent with those observed for metamorphic foliations. The apparent disparity in structure modelled by seismic and gravity-magnetic methods can be reconciled if east-dipping reflectors image pervasive discontinuities rather than lithological boundaries.

¹ Continental Geoscience Division, GSC, Ottawa

69. Heavy metal distribution in humus and surficial sediment in the vicinity of a smelter at Flin Flon, Manitoba

P.J. Henderson¹, I. McMartin¹, E. Nielsen², G. Hall³

Humus and till samples were collected in northern Manitoba and Saskatchewan. Within the area, the smelter complex at Flin Flon is a known source of airborne pollutants,

specifically Zn, Pb, Fe, Cu, Cd, As, and Hg. Results of geochemical analysis indicate that concentrations of metal pollutants in humus are many orders of magnitude higher than in underlying till near the smelter. Humus values decrease toward background levels at distances greater than 35 km from the smelter. Distribution patterns in till appear unaffected by anomalously high concentrations in humus and can be related to local bedrock composition and glacial transport. Preliminary results from sequential leaching on samples collected along two transects extending from the smelter stack are presented. They suggest that elevated values of heavy metals in humus near the smelter are bound to particulate matter, while those farther away are linked to organic phases.

¹ Terrain Sciences Division, GSC, Ottawa

² Geological Services, Manitoba Energy and Mines, Winnipeg

³ Mineral Resources Division, GSC, Ottawa

70. **Tectonostratigraphy and tectonic history of the Paleoproterozoic Flin Flon Belt¹**

R.A. Stern², S.B. Lucas² and E.C. Syme³

The Flin Flon Belt represents a major terrane within the mosaic of juvenile crustal elements comprising the internal zone of the Paleoproterozoic Trans-Hudson Orogen in Manitoba and Saskatchewan. However, the belt itself represents a complex collage of 1.92-1.88 Ga tectonostratigraphic assemblages (predominantly juvenile arc and back-arc) welded together by 1.88-1.83 arc plutons related to post-accretion 'autochthonous' arcs. The plutons form a juvenile calc-alkaline suite and are associated with an interval involving addition of new mantle melts and reworking of juvenile crust. Exhumation of the accretionary complex and post-accretion plutons is recorded in 1.845 Ga and 1.835 Ga alluvial/fluviol sequences deposited, along with coeval volcanic rocks, in transtensional basins. Accretion-related thrust structures were reutilized as strike-slip faults accommodating intra-arc deformation (1.88-1.83 Ga) as well as collisional (1.83-1.80 Ga) and post-collisional (1.80-1.70 Ga) transpression.

¹ Contribution to Canada-Manitoba and Canada-Saskatchewan Partnership Agreements on Mineral Development (1990-1995), subsidiary agreements under the Canada-Manitoba and Canada-Saskatchewan Economic and Regional Development Agreements

² Continental Geoscience Division, GSC, Ottawa

³ Manitoba Geological Services Branch, Manitoba Energy and Mines, Winnipeg

71. **A new regional tectonic framework for the Flin Flon-Hanson Lake belt and its sub-Phanerozoic extension, eastern Trans-Hudson Orogen¹**

A.D. Leclair², D. Viljoen², S.B. Lucas², R.A. Stern², H.J. Broome²

The discovery of major lithotectonic domains in the Phanerozoic-covered Precambrian basement and their linkages with tectonostratigraphic assemblages in the exposed Shield provides a new framework for understanding the tectonic history of the Flin Flon-Hanson Lake Belt. The buried Athapapuskow and Amisk Lake domains correlate with the 1.90-1.88 Ga volcano-plutonic assemblages of the Flin Flon accretionary collage. The Clearwater Domain forms an integral part of the ca. 1.89 Ga Snow Lake arc segment and is flanked by the Kiseynew Gneiss Belt to the east. The Namew Gneiss Complex contains 1.88-1.85 Ga calc-alkaline metaplutonic rocks interpreted as the mid-crustal core to an arc represented by volcanic and plutonic rocks in the exposed Flin Flon collage. The Cormorant Batholith (ca. 1.83 Ga) stitches the contact between this complex and the Clearwater Domain. The crustal domains have strike lengths of >100 km and are predominantly bounded by major shear zones.

¹ Contribution to Canada-Manitoba and Canada-Saskatchewan Partnership Agreements on Mineral Development (1990-1995), subsidiary agreements under the Canada-Manitoba and Canada-Saskatchewan Economic and Regional Development Agreements.

² Continental Geoscience Division, GSC, Ottawa

72. **1994 survey of the Lake Winnipeg environment: a multi-agency cooperative project**

B.J. Todd¹, C.F.M. Lewis², L.H. Thorleifson¹, E. Nielsen³, W.L. Lockhart⁴

An enhanced understanding of the Lake Winnipeg environment is urgently required. Covering an area 25% larger than Lake Ontario, this shallow lake supports economic activities related to recreation, fisheries, and hydroelectric energy production. Shoreline erosion and the pathways of toxins in the lake currently are major concerns. No systematic survey has been carried out since a biological, limnological, and bottom sediment sampling program was completed by the Freshwater Institute in 1969.

The 1994 survey was made possible by the logistical support of the Canadian Coast Guard, endorsement and funding from Manitoba Hydro, the Province of Manitoba, and the GSC Industrial Partners Program, and by funding from GSC and the Freshwater Institute. Several other scientists at government labs and universities are participating in analyses.

Multichannel seismic, shallow seismic, magnetometer, side scan sonar, and radar surveys were followed by piston coring, box coring, as well as bottom sediment, limnological, and biological sampling.

¹ Terrain Sciences Division, GSC, Ottawa

² Atlantic Geoscience Centre, GSC, Dartmouth

³ Manitoba Energy and Mines, Winnipeg

⁴ Freshwater Institute, Fisheries and Oceans Canada, Winnipeg

73. Neotectonics of the Great Lakes: stratigraphic and structural features of lakebed sediments and bedrock

C.F.M. Lewis¹, R.L. Thomas², S.M. Blasco¹, B.J. Todd¹, G.D.M. Cameron³

A variety of unusual geomorphic features have been observed in surficial sediments and exposed bedrock of the Ontario, Simcoe, and Georgian Bay lake basins. Such features include plumose structures, linear and conical sediment depressions, high amplitude backscatter anomalies, bedrock ridges and sediment/bedrock offsets, scarps and lineaments, etc. A collaborative project has been initiated to investigate the origin, history, and neotectonic implications of these features. Relatively continuous sedimentation in the central lake basins may preserve a record of recent disturbance or deformation associated with these features. Understanding the stratigraphic and structural context of these features in terms of the regional geological framework is essential for assessing the magnitude and distribution of neotectonic activity during the Holocene. Depending on the extent and severity of neotectonic activity, results may impact future environmental and engineering assessments related to ensuring sustainable development in the Great Lakes region.

¹ Atlantic Geoscience Centre, GSC, Dartmouth

² University of Waterloo, Waterloo

³ Cameron Consulting

74. Metamorphic map of the Canadian Shield: summary of recent progress

R.G. Berman¹, K.E. Venance¹, P. Arscott¹

Work on a revised metamorphic map of the Canadian Shield is progressing in conjunction with efforts of the Ontario Geological Survey and Quebec Geoscience Centre. Use of FIELDLOG software has facilitated the development of a digital point source database of paragenetic and thermobarometric data. AutoCAD and ArcInfo are used for digital cartography and production of publication quality maps at different map scales.

The map legend, based on quantitative petrogenetic grids, highlights pressure differences in amphibolite and granulite grade rocks. Recent refinements in thermodynamic properties of olivine, orthopyroxene, garnet, cordierite, ilmenite, biotite, and amphibole allow for more accurate thermobarometric estimates for a variety of bulk compositions, as well as P-T path constraints from computed grids for specific rock compositions.

The displayed metamorphic map illustrates progress in incorporating new P-T results, reinterpretation of archived mineral parageneses, and results of recent field work.

¹ Continental Geoscience Division, GSC, Ottawa

75. Holocene development of peat bogs at Kenosheo Lake and Detour Lake, northern

Ontario

I.M. Kettles¹, H. Jetté¹, M. Garneau²

As part of the Industrial Partners Program, the Geological Survey of Canada and Ontario Hydro initiated a project to study peat bogs as repositories of naturally occurring and atmospherically derived metals. Work at GSC focused on determining the long term development of two bogs and involved establishing geochemical profiles through the entire peat sequence and determining, through fossil analysis and use of Quaternary dating methods, the paleoenvironmental history. Wood from basal peat (1.1 m) at a site near Detour Lake was dated at 7280 ± 70 years BP (Beta-70113 [AMS]), while wood from 30-33 cm was dated at 180 ± 50 years BP (GSC-5764 [conventional]). At the Kenosheo Lake site, wood from basal peat (2.5 m) was dated at 4000 ± 80 years BP (IsoTrace - TO-4318 [AMS]) and wood from 70 cm, at 1720 ± 70 years BP (GSC-5672 [conventional]). Macrofossils, pollen, and trace element content varied with depth in cores from both sites.

¹ Terrain Sciences Division, GSC, Ottawa

² Quebec Geoscience Centre, GSC, Sainte-Foy

76. Ontario NODA Geoscience Database Project: Preliminary Analysis and Results¹

J.R. Harris², L. Wilkinson², J. Broome², K. Heather²

A geoscience database consisting of 25 layers of data including topographic, hydrographic, geological, geochemical, mineral, and geophysical data has been compiled using a GIS over the Swayze Greenstone Belt in Ontario.

This poster demonstrates how a GIS has been used in concert with statistical and chemical classification programs to analyze and classify geochemical data with respect to mapped lithology. A number of geochemical maps which show rock type as well as alteration patterns are presented and compared to lithological observations made in the field. A number of mineral potential maps based on three models (Ni sulphide, VMS, and gold) are also presented and the GIS methodology used to construct these maps are discussed.

¹ NODA funded cooperative venture between the Geological Survey of Canada, Ontario Geological Survey, and Falconbridge and Noranda

² Continental Geoscience Division, GSC, Ottawa

77. Large semi-conformable alteration zones within the Onaping Formation, Whitewater Group, Sudbury Structure, Ontario¹

D.E. Ames², H.L. Gibson³, D.H. Watkinson⁴, I.R. Jonasson²

The Proterozoic Onaping Formation is a 1.4 km thick sequence of subaqueously

deposited, andesitic, vitric, fragmental rocks and feeder dikes. It is the footwall to the Vermillion and Errington Zn-Cu-Pb replacement deposits and hosts numerous Cu, Zn, Pb, stringer-, stratiform- and replacement- type occurrences. Semiconformable alteration zones in the Onaping Formation are, from base to top: silicification, feldspar, chlorite, carbon, and carbonate. These form zones at least 60 km long, which is an order of magnitude larger than semiconformable alteration zones in the Noranda, Sturgeon Lake, Snow Lake, and Bergslagen VMS camps.

Field mapping concentrated on defining megascopic characteristics, timing, and distribution of alteration types and determining stratigraphic, syn-depositional, and postdepositional structural controls. The relationship of alteration assemblages to mineral deposits, Sudbury Intrusive Complex, and/or tectonic features will be assessed.

- ¹ Contribution to Canada-Ontario Subsidiary Agreement on Northern Ontario Development (1991-1995), under the Canada-Ontario Economic and Regional Development Agreement
- ² Mineral Resources Division, GSC, Ottawa
- ³ Laurentian University, Sudbury
- ⁴ Carleton University, Ottawa

78. Seismic image of an early proterozoic rift basin

B. Milkereit¹, J. Wu¹

In 1991, Falconbridge Ltd. acquired three proprietary high frequency vibroseis reflection profiles across the Huronian Supergroup across the Temagami Lake magnetic anomaly, one of the largest positive magnetic anomalies of the Canadian Shield. High quality seismic images were obtained through a combination of spectral balancing, refraction static corrections, and cross-dip corrections. Interpretation of seismic data is constrained by deep borehole data. The upper metasedimentary formations are seismically transparent, the lower sedimentary and volcanic formations show prominent layered reflections. Reflections within the basement exhibit an unconformable relationship with overlying formations and structures. Steep-dipping reflections within the basement complex are interpreted as faults or shear zones. The data reveal one of the oldest preserved rift basins on earth and support a revised tectonic model for the Southern Province, including rifting along pre-existing zones of weakness in the Archean crust, subsequent development of a passive margin stage with deposition of three sedimentary formations, and deformation during the Penokean Orogeny.

- ¹ Continental Geoscience Division, GSC, Ottawa

79. Probing the three-dimensional nature of the Sudbury structure

B. Milkereit¹, J. Wu¹, Jun. Cowan²

The 1990/91 LITHOPROBE seismic program showed that the Sudbury Structure is markedly asymmetric at depth, suggesting a crustal model in which shortening and imbrication has occurred. LITHOPROBE, through financial support from Inco Exploration and Technical Services Inc. (IETS) and Falconbridge Ltd., acquired two new high frequency vibroseis seismic reflection profiles across the South Range of the Sudbury Igneous Complex. The main objective of the seismic survey was to establish the three-dimensional nature of lithological contacts and deformation zones imaged previously. In addition, IETS conducted a proprietary high resolution seismic reflection survey in the South Range. The new data set provides important information on lithological contacts and deformation zones at depth. In light of the shape of the regional gravity anomaly and the apparently closed surface geology of the Sudbury Structure, the 'simple' crustal model of telescoping and imbrication of lithological units and associated shortening as derived from seismic data can be tested and modified.

¹ Continental Geoscience Division, GSC, Ottawa

² Department of Geology, University of Toronto, Toronto

80. Borehole geophysical signatures of base-metal and gold deposits in Ontario

P.G. Killeen¹, K.A. Pflug¹, C.J. Mwenifumbo¹, B.E. Elliott¹

In-situ measurements of physical rock properties were carried out in more than 15 boreholes associated with Ontario base metal and gold deposits. Measurements were made with GSC portable and truck-mounted logging systems. Parameters measured include induced polarization, electrical resistivity, self potential, magnetic susceptibility, natural gamma ray spectrometry, spectral gamma-gamma, temperature and T-gradient, and acoustic velocity. Selected holes were logged with 3-component magnetometer and VLF systems.

In 1992 and 1993, logs were recorded at the McConnell nickel deposit (INCO Ltd.), Kidd Creek mine and its satellite, the Chance occurrence (Falconbridge Ltd.). In summer 1994, several holes were logged in the Kirkland Lake Gold Mining Camp representing both established mines and new occurrences near the Kirkland Lake-Larder Lake break and the Destor-Porcupine fault (Lac Minerals Ltd., American Barrick Resources Corporation, and Sudbury Contact Mines).

Geophysical logs from selected holes illustrate the physical properties of some of these deposits, their host rocks, and associated alterations.

¹ Mineral Resources Division, GSC, Ottawa

81. Sensitive clay failures, Ottawa Valley

J.M. Aylsworth¹, D.E. Lawrence¹, J.A. Traynor¹

Historically, landslides and slope stability problems in sensitive marine (Leda) clays have been responsible for loss of life, personal injury, and property damage. Periodic large slope failures have been documented since before the turn of the century.

Terrain Sciences Division has recently initiated a project to investigate how and why landslide types and failure mechanisms vary throughout the Champlain Sea Basin. Research will focus on the spatial and stratigraphic distribution of sediments, hydrological conditions, and critical geological controls.

An initial undertaking will be the compilation of a landslide database, to facilitate synthesis of existing information and analysis and interpretation of geological controls, critical conditions, and associated failure mechanisms throughout the basin.

An overview of the proposed project activities is summarized and case histories of several local landslides are presented.

¹ Terrain Sciences Division, GSC, Ottawa

**82. Technique developments in the Oak Ridges Moraine hydrogeology project:
1) Diatoms to determine water level fluctuations and 2) temperature logs to determine groundwater flow**

C. Prévost¹, S. Hipwell¹, H. Jetté¹, V. Allen¹, A. Taylor¹

Techniques commonly used in geological activities are applied to our new Oak Ridges Moraine hydrogeology program to document i) occurrence and volume of groundwater recharge and ii) sustainability of this resource through time.

1. Diatoms (algae) are used to interpret environmental conditions through stratigraphic investigations. Analysis of a core collected from a shallow pond adjacent to a kettle lake has shown a clear link between diatoms and water depth. Shifts in the assemblages provided evidence of 5 distinct water-level zones covering the last 300 years. Pollen analyses provided a chronology and documented anthropogenic changes.
2. Groundwater temperatures have been analyzed extensively in the literature. In our study, some 30 water observation wells and geological test holes have been logged and analyzed to detect groundwater flow. Anomalous features in some wells have been interpreted as arising from water flow along faults, and in others from vertical flow at rates less than 0.5 m/year.

¹ Terrain Sciences Division, GSC, Ottawa

83. Quaternary and environmental geology in the Oak Ridges Moraine NATMAP area: digital compilation

H.A.J. Russell¹, T.A. Brennand², D.R. Sharpe², C. Logan²

The Oak Ridges Moraine is a strategic resource in the Greater Toronto Area and environs due to its aesthetic value, natural heritage, and function as a source of aggregates and a major recharge area and aquifer system. A digital compilation of the regional surface and subsurface geology is urgently needed by provincial and municipal agencies to facilitate future groundwater, waste disposal, and resource planning. ORM NATMAP collaborators have collected new and archival records and designed a standardized relational database in Microsoft Access, to rationalize the various sources and types of information and degrees of detail. We are continually searching for new data sources and updating this database. Here we show our present data distribution by source and depth. Comparative plots highlight a sparsity of geological information at depth. We showcase examples of possible products and queries from this database and welcome client requests.

¹ Department of Geology, University of Ottawa, Ottawa

² Terrain Sciences Division, GSC, Ottawa

84. **Hydrogeology of the Oak Ridges Moraine: partners in geoscience**

L.D. Dyke¹, D.R. Sharpe¹, S.E. Pullan¹

The Oak Ridges Moraine is a major aquifer complex and one of the most heavily used groundwater sources in Canada. Expanding the utilization of this resource and directing landuse planning is problematic because the extent of aquifers and distribution of recharge areas is poorly understood. In 1993, the Geological Survey of Canada began a three-year hydrogeology study of the moraine. The primary objective is to understand the moraine's interior structure to identify stratigraphic units that control groundwater flow. Investigations have concentrated on three drainage basins (Humber, Holland, Bowmanville), which represent the range of hydraulic gradients on the moraine.

Connection of upper with lower aquifers may be important to groundwater flow. Thus, high resolution seismic reflection profiling has proved instrumental in mapping the moraine structure. Ground-penetrating radar maps the water table in glaciofluvial sediments and electromagnetic induction is used to estimate the texture and infiltration capacity of the sediments between the surface and the water table.

¹ Terrain Sciences Division, GSC, Ottawa

85. **Quaternary architecture of the Oak Ridges Moraine NATMAP area**

T.A. Brennand¹, D.R. Sharpe¹, H.A.J. Russell², P.J. Barnett³, W. Arnott²

The Oak Ridges Moraine (ORM) is the most prominent glacial landform in Ontario, and a strategic resource in the Greater Toronto Area and environs due to its aesthetic value,

natural heritage, and function as a source of aggregates and a major recharge area and aquifer. However, regional subsurface geology is poorly understood, although it is urgently needed to facilitate future groundwater, waste disposal, and resource planning. In response, ORM NATMAP collaborators have designed a digital relational database to store and query archival and new borehole and surficial data. Lake and river bluff geological transects will be combined with GSC and OGS research drillholes, existing stratigraphic logs, and shallow seismic reflection profiles to create detailed geological cross-sections through the ORM NATMAP area and facilitate database evaluation. Investigation of commercial gravel pits and geophysical imaging by georadar provide a glimpse of the sedimentary architecture of the ORM.

¹ Terrain Sciences Division, GSC, Ottawa

² Department of Geology, University of Ottawa, Ottawa

³ Ontario Geological Survey, Sudbury

86. Magmatic and structural evolution of Archean granite-greenstone belts in the Goudalie Domain, northeast Superior Province

T. Skulski¹, S. Lin¹, J.A. Percival¹, K.D. Card¹, P. Winsky²

The southern Goudalie Domain separates the Lake Minto and Utsalik domains. Differences in the Nd isotopic composition between Lake Minto and Utsalik 2725 Ma plutons suggest that the two represent protocratons separated by a 2786 Ma ocean basin preserved as slivers in the Vizien Belt. Complex deformation in the Vizien Belt resulted in fault juxtaposition of oceanic crustal fragments on continental sequences. In the north, the Kogaluc Belt consists of a ~2744 Ma calc-alkaline volcano-sedimentary pile intruded by 2733 Ma granodiorite, and characterized by an early dip-slip shear fabric and later dextral strike-slip mylonite. High-grade Kogaluc equivalents may include migmatitic mafic and paragneisses east and west of the belt that are intruded by charnockite and later granite. Near Payne Lake, the Kogaluc gneisses and plutons are cut by Archean mafic dykes that may be feeders to a younger volcano-sedimentary pile that rests unconformably on tonalite near Lake Qalluviartuuq.

¹ Continental Geoscience Division, GSC, Ottawa

² Department of Earth Sciences, Boston University, Boston

87. Tectonic-metallogenic and mineral deposit maps of superior Structural Province

K.D. Card¹, R.A. Frith¹, K.H. Poulsen¹

Two tectonic-metallogenic maps of Superior Province were compiled at 1:2 500 000 to accompany a contribution to the Decade of North American Geology (DNAG). Source

maps included published and unpublished maps compiled to 1:1 000 000 Digital Chart of the World. Twenty maps were prepared, raster scanned, and processed using Arc-Info software over a two month period. The Mineral Deposit Map was prepared from Tectonic-Metallogenic Map, and individual deposits were keyed by type, size, and location from dBase files.

Geological units were grouped by age and tectonic type, which included volcanic depositional environment and plutonic intrusive-orogenic sequence in order to relate economic mineral deposits with units. Supracrustal rocks were keyed to late or early successor basins to differentiate among accretionary complexes, calc-alkaline and tholeiitic flows, and submarine tholeiitic-komatiitic plain sequences. Where regional metamorphism is high, bulk composition, gneissosity and 'unknown' affinity designations were used.

¹ Continental Geoscience Division, GSC, Ottawa

88. Magnetic signature of the Lac à l'Eau Claire craters, Quebec: modification of regional trends

R.G. Scott¹, M. Pilkington², E.I. Tanczyk³

The Lac à l'Eau Claire impact craters (287 Ma) are characterized by impact-induced thermochemical remagnetization (TCRM), resulting in magnetic anomaly lows over both craters. Thermal and AF demagnetization of samples from drill core reveal an easily removable viscous magnetic component (VRM), and a shallow dipping stable component (TCRM), consistent with cooling during the Kiaman reversed polarity interval (255-320 Ma). Koenigsberger ratios are < 1 , indicating that magnetic susceptibility is the dominant factor responsible for observed magnetic signatures. Anisotropy of magnetic susceptibility (AMS) fabrics exhibits low inclinations of the maximum axis of susceptibility (K_1), consistent with vertical compression during impact. The low angle for K_1 , in contrast to the high inclination of the earth's field at this latitude, appears to contribute to the reduction in the amplitude of the magnetic anomaly. Post-impact hematization of upper felsic melt rocks also contributes to the reduced magnetic field over the craters.

¹ Department of Earth Sciences, University of Ottawa, Ottawa

² Geophysics Division, GSC, Ottawa

³ Continental Geoscience Division, GSC, Ottawa

89. Large-scale fluid infiltration and re-equilibration of Archean basement granulites during Paleoproterozoic continental underthrusting, Ungava Orogen, Quebec

M.R. St-Onge¹, O. Ijewliw¹

The metamorphic history of underthrust Archean crust in the Ungava Orogen documents the importance of geohydrological controls on mineral re-equilibration. In the underthrust

basement, two-pyroxene orthogneisses record moderate pressures (≤ 5 kbar), high temperatures ($\sim 825^\circ\text{C}$), and low $a_{\text{H}_2\text{O}}$ (0.1-0.2) at ~ 2.7 Ga. Map distribution of retrograde mineral zones in the basement indicate a causal relationship between Paleoproterozoic metamorphism in the overlying Cape Smith Belt (CSB) and hydration of basement granulites. Grt-Hbl coronas record re-equilibration between 7.7-9.8 kbar, 640-700°C, and $a_{\text{H}_2\text{O}}=0.8-0.9$, consistent with conditions documented in CSB pelites. Major element concentrations document a zone of metasomatic change beneath CSB consistent with fluid flow down a T-gradient. The source of fluids is interpreted to be the dehydrating CSB implying that the thermal structure in the basement was characterized by dipping and/or possibly inverted isotherms.

¹ Continental Geoscience Division, GSC, Ottawa

90. Airborne geophysical surveys in the Chapais-Chibougamau area

G.J. Palacky¹, F. Kiss², D.L. Lefebvre³, D.J. Dion³

The Special Assistance Program for the Mining Sector of the Chapais-Chibougamau Region funded an airborne geophysical program whose aim was to stimulate exploration activities in the area. In the first phase, 9200 line km were flown in February-March 1993 in the lac Verneuil area; in the final phase, 13 700 km were surveyed in February-May 1994 in the lac des Vents area. Geophysical methods used were multifrequency, multicoil helicopter electromagnetics (HEM), total-field magnetics, and VLF-EM. Line spacing in this detailed survey was 100 m. Results were released to the public as geophysical maps, stacked profiles (in microfiche), and digital data. The poster presentation includes examples of colour maps of apparent conductivity and total-field magnetics. The apparent conductivity map compiled from 8187 Hz horizontal coplanar HEM data outlined many elongated conductive trends (most likely caused by graphitic schists) and several isolated anomalies, which may be due to massive sulphides.

¹ Mineral Resources Division, GSC, Ottawa

² Geophysics Division, GSC, Ottawa

³ Ministère des Ressources naturelles, Québec

91. Structural synthesis (1:250 000) of the La Tuque (31P) and Shawinigan (31I) areas, Grenville Province, Quebec

L. Nadeau¹, P. Brouillette¹

Our understanding of the tectonic evolution of the Grenville Orogen is based on integrated detailed structural, metamorphic, and geochronological studies of key regions. It is striking that no structural map (at 1:250 000 or smaller scales) is available for the bulk of the Grenville when a wide variety of geological, geophysical, and satellite imagery data are available.

We present a structural synthesis for a large and poorly known sector of the Grenville Province of Quebec. The maps result from the combined analysis of all available geological data and the aeromagnetic fabric as depicted by potential field and calculated vertical gradient data. Analysis allows us to single out geological bodies and areas with prominent structural continuity and to highlight the distinctive regional structural pattern of the Mékinac-Taureau, Portneuf-Saint-Maurice, and Morin domains. The emerging picture provides a framework for both regional tectonic and detailed structural studies.

¹ Quebec Geoscience Centre, GSC, Sainte-Foy

92. Crustal structure in the eastern Grenville Province near the Manicouagan Reservoir, Quebec

David W. Eaton¹ and the Manicouagan Corridor Working Group

Lithoprobe seismic reflection profiling near the Manicouagan Reservoir, Quebec, has shed new light on the three-dimensional crustal structure in this part of the Grenville Orogen. The profile extends 250 km north from the Manic 5 dam, and crosses the boundary between the Parautochthonous and Allochthonous belts. Mafic eclogites exposed in the Manicouagan Shear Belt produce a distinctive band of high-amplitude reflections that are abruptly cut off by the Hart Jaune Fault, consistent with a model of late extension for this region. Significant crustal thickening beneath the Parautochthonous Belt is indicated by a change in Moho reflection time from 13 s to 16 s. This is accompanied by a dramatic change in the seismic expression of the Moho, from the base of a narrow band of reflections beneath the Parautochthonous Belt to the base of a zone of lower-crustal reflectivity beneath the Allochthonous Belt. Further evidence suggests the possibility of a 'double Moho' beneath the Allochthon.

¹ Continental Geoscience Division, GSC, Ottawa

93. Toxic metals in tree-rings as temporal biomarkers of atmospheric pollution: the Québec City example

C. Bégin¹, M. Richer-La Flèche¹

This paper presents first results of a research project initiated at QGC in order to develop and promote dendrogeochemical analysis as a new technique of environmental biomonitoring. Toxic metal concentrations and standard radial growth parameters were measured in a series of white spruce (*Picea glauca* (Moench) Voss) specimens from suburban Québec City. These data allow us to reconstruct and characterize the evolution of atmospheric contamination during the last century. Dendrogeochemical profiles clearly bring out the major events that marked the urbanization of the Québec City region, such as the construction of highways, major industrial plants, or industrial parks. Results were then

compared to historical records to verify the annual resolution of tree-ring geochemical signatures. Dendrogeochemical analysis thus appears to be a powerful tool for studying the effect of inorganic contaminants on plant productivity in urban areas.

¹ Quebec Geoscience Centre, GSC, Sainte-Foy

94. 1:1 000 000 geological compilation of the eastern central Superior Province, Quebec

A. Ciesielski¹, R.A. Frith¹

A geological compilation of the James Bay region and the Bienville subprovince, Quebec, was carried out using the latest studies and authors' field observations. To the south, the James Bay geological region is separated from the Abitibi volcanic subprovince by the Opatica granodioritic gneiss belt. The centre of the area is occupied by the Opinaca metasedimentary subprovince, surrounded by the La Grande-Eastmain and Frotet-Evans volcanic, sedimentary and plutonic belts. Contacts between sedimentary, and volcanic domains are either faulted or normal, locally showing volcanic rocks overlying detrital sequences. The La Grande/Bienville, Bienville/Ashuanipi, and Bienville/Minto subprovince boundaries are arbitrary, mostly based on aeromagnetic contrasts characteristic of adjacent tonalitic, granitic, or charnockitic orthogneisses.

¹ Continental Geoscience Division, GSC, Ottawa

95. Winter geomorphological processes in the Sainte-Anne River, Sainte-Anne-de-la-Pérade, and their impact on the breeding habitat of tommycod

N.E. Bergeron¹, A. Roy², D. Chaumont¹

This poster describes the relationship between geomorphology, flow dynamics, and the migration pattern of tommycod at the mouth of the Sainte-Anne River. Results show that channel capacity tends to decrease downstream at low tide, probably because of particular sand silting conditions near the mouth of the river. This reduced capacity leads to accelerated flow in the area around the river mouth. High flow velocities at ebb tide could limit the number of tommycod entering the river and reaching their spawning grounds. This would explain the tendency of tommycod to migrate upstream during periods of current reversal associated with rising tides. Our data show that large numbers of tommycod take advantage of these periods to enter the river and reach their spawning grounds.

¹ Quebec Geoscience Centre, GSC, Sainte-Foy

² University of Montreal, Montreal

96. Ivry and Degrosbois Fe-Ti deposits, Morin Anorthosite, Quebec

O. Diakit¹, T. Birkett²

The Ivry and Degrosbois Fe-Ti deposits are parts of a larger mineralized system associated with jotunite intrusive into the Morin anorthosite. The Ivry facies is characterized by massive ilmenite ores with common sulphides and biotite; associated alteration includes scapolite after plagioclase. Degrosbois facies rocks have abundant magnetite and fluorapatite. Jotunites of this system are gabbro-norites with later subsolidus ferroan pargasite.

According to textural and chemical data, the Degrosbois facies rocks could have originated as an immiscible-liquid rich in Fe, Ti, and P (nelsonite). The Ivry facies may represent yet another immiscible liquid separated after partial crystallization of the Degrosbois facies magma. Imperfect liquid-crystal separation explains much of the chemical variation in the rocks.

Anorthosite-associated Fe-Ti deposits are invariably associated with jotunite and commonly include both Ivry-type and Degrosbois-type facies. Ivry facies rocks have higher Ti and Ti/Fe but much lower P than Degrosbois-facies ores.

¹ Quebec Geoscience Centre, INRS-Géoresources, Sainte-Foy

² Quebec Geoscience Centre, GSC, Sainte-Foy

97. **Quaternary geology from Lac Batiscan to Portneuf, Quebec: practical applications**

A.M. Bolduc¹

A regional surficial geology mapping project is being undertaken in the Portneuf area of Quebec. The area covers two types of terrain, the Laurentians with a thin and discontinuous Quaternary cover to the north, and the area covered by the Champlain Sea to the south, where Quaternary units are more diverse and of various thicknesses. In the north, local needs primarily involve locating suitable aggregates for construction and maintenance of logging and recreational roads. In the south, needs include planning urban and industrial development, siting of waste disposal sites, etc., and knowledge of groundwater resources, including protection of recharge areas. Because of the complex spatial arrangement of Quaternary units, surface mapping is required as well as are excellent knowledge of the units at depth, to understand constraints imposed by sediment types.

¹ Quebec Geoscience Centre, GSC, Sainte-Foy

98. **Ice-flow history derived from detailed mapping of striations in Abitibi-Témiscamingue**

J.J. Veillette¹, M.B. McClenaghan¹

Recent measurement of striations in the Abitibi and Timiskaming regions has revealed a complex ice flow history. This area is underlain by the world's largest granite-'greenstone' belt, Canada's primary source of precious and base metal deposits, which is largely covered by glacial deposits. Because of this constraint, drift sampling is one of the principal exploration methods used. To be effective, this method requires an understanding of the ice flow sequence, which includes an initial southeast flow mainly known from dispersal data, followed by flows to the northwest, the west-southwest, and the southwest, and ending with synchronous and convergent flows to the southwest and southeast. This erosional sequence may be correlated to depositional stratigraphy known from glacial deposits and transport data. Mapping of cross-striated bedrock surfaces and accompanying analysis of drift transport provide a flow model far superior to models derived solely from the orientation of deglaciation landforms and striations.

¹ Terrain Sciences Division, GSC, Ottawa

99. **The use of garnet distribution in surficial materials in reconstructing the glacial history of southeast Gaspé peninsula, Quebec.**

Y.T. Maurice¹

The distribution patterns of four garnet types in surficial materials in southeastern Gaspé are interpreted in terms of glacial history of the area, bedrock lithostratigraphy, and mineral occurrences. Type 1 anhedral Ca-garnet fragments were brought into the region by the same ice flow that caused massive southward dispersal of McGerrigle granite debris. Type 2 Ca-garnet crystals seem to be related to skarns within the boundaries of the study area. Type 3 coloured pyralspite garnet crystals are related to a tectonic breccia within the Maquereau-Mictaw contact zone. Type 4 high temperature Grenville-type anhedral garnets were not brought into the region by Laurentide ice as one might suspect, but seem rather to be related to specific horizons within the Silurian Lower Chaleurs Group. Their distribution supports the view that late Wisconsinian ice penetrated some 5 to 6 km inland from Chaleur Bay near Saint-Godefroi.

¹ Mineral Resources Division, GSC, Ottawa

100. **Terrain dynamics and Quaternary geology on the east coast of Hudson Bay**

Y. Michaud¹, C. Bégin¹, M.-H. Ruz², M. Parent¹, S.J. Paradis¹, É. Boisvert¹

Quaternary terrains in the Petite rivière de la Baleine and Manitounuk Sound areas are widely affected by modern geomorphic processes such as mass movements, coastal erosion, and permafrost aggradation-degradation. Recent work aimed at establishing the spatio-temporal evolution of these phenomena show that (1) many areas are affected by the combined action of these processes, which may also act independently elsewhere, and (2) these processes are often triggered suddenly by brief climatic events or by limited

environmental perturbations. The early 1990s are a good example of how spring climatic conditions can generate detachment failures and coastal retreat without inhibiting permafrost aggradation elsewhere in the area. Natural events such as heavy rainfall and snowfall, cold and heat waves, or forest fires can also trigger renewed geomorphic responses.

¹ Quebec Geoscience Centre, GSC, Sainte-Foy

² Centre d'études nordiques, Laval University

101. St. Lawrence River gravity survey aids Charlevoix study

R.V. Cooper¹, M. Lamontagne¹, J. Halpenny¹

A GSC gravity survey of the lower St. Lawrence River has successfully demonstrated a new, lower cost marine survey technique. Using a 34 foot launch, over 1000 km of profiles were measured in the river between Quebec City and Rimouski in a 10-day period in August 1994. New GSC software used with GPS navigation and an improved gravity meter controller made it feasible to use a launch rather than a large survey ship. This greatly reduced costs and allowed measurements in shallow areas inaccessible to larger vessels. The results have been added to the National Gravity Data Base and provide a clearer understanding of the Charlevoix impact structure and the accompanying earthquake zone, especially in underwater areas where most earthquakes occur. The 5000 points of gravity data will be interpreted together with remote sensing data and more than 1500 earthquake epicentres recorded since 1977.

¹ Geophysics Division, GSC, Ottawa

102. Mineralogical and geochemical studies of hydrothermal sediments associated with base metal mineralization in the Bathurst Mining Camp, Northern New Brunswick

J.M. Peter¹, W.D. Goodfellow¹

Many massive sulphide deposits in the Bathurst Mining Camp are associated with iron formation (IF). Previous work in the Brunswick Belt has shown that bulk geochemistry and mineralogy of IF varies with proximity to known deposits. High concentrations of certain elements and element ratios occur nearest known deposits and also indicate several new exploration targets. S and C isotope compositions of sulphides and carbonates in IF also vary about the one deposit we have studied, with the heaviest values nearest and within mineralization. We are conducting similar studies along the Heath Steele Belt, which hosts the Heath Steele mine and several other deposits. This belt is in the same stratigraphic position as the Brunswick Belt, and the IF is mineralogically similar. Variations in elemental abundances and isotopic compositions of IF are effective vectors towards massive sulphide mineralization and have applications in the exploration for concealed deposits in the camp and elsewhere.

¹ Mineral Resources Division, GSC, Ottawa

103. **EXTECH-II: a new multidisciplinary, integrated and collaborative project on the development and testing of exploration methods and technology in the Bathurst Mining Camp, New Brunswick**

W.D. Goodfellow¹

EXTECH-II is a five-year EXploration and TECHnology project that was initiated in 1994 in the Bathurst Mining Camp. The principal objective of the EXTECH-II project is to address problems of declining basemetal reserves by developing integrated and multidisciplinary approaches to exploration. It will be necessary to better understand the geological setting of sulphide deposits, processes of sulphide formation and degradation, and to develop, test and apply geological, geophysical and geochemical methods of detecting buried deposits. EXTECH-II, initiated by the GSC, represents a collaborative project that involves earth scientists from the GSC, the New Brunswick Geological Survey, industry and universities. The project is structured into five major areas: 1) stratigraphic and volcanologic setting of deposits; 2) geology, geochemistry and genesis of sulphide deposits; 3) surficial geology and geochemistry; 4) ground and airborne geophysics; and 5) geoscience data integration and output using a Geographical Information System (GIS).

¹ EXTECH-II Coordinator, GSC, Ottawa

104. **The Ansil Cu-Zn deposit: evidence for, a long-lived hydrothermal system**

A.G. Galley¹, D.H. Watkinson², H.L. Gibson³, I.R. Jonasson¹, G. Riverin²

The Ansil volcanic-associated massive sulphide deposit is hosted by an extensive zone of discordant alteration that extends for over 2000 m of strike length and crosscuts over 1000 m of stratigraphy. The alteration zone begins at the upper contact of the Flavrian intrusive complex and extends over 1000 m upsection through three volcanic formations to the base of the Lower Amulet Formation. The alteration zone developed within a fault system that was active during the first stages of subsidence that resulted in the formation of the Noranda Cauldron.

Evidence suggests that the hydrothermal system breached the seafloor on three occasions, with the Ansil deposit beginning to form during the second event. The deposit continued to form during the emplacement of 500 m of overlying andesite flows through the partial replacement of felsic and andesitic volcanoclastic facies. Subseafloor evolution is most likely a common mechanism in the development of massive sulphide deposits in long-lived hydrothermal systems.

¹ Mineral Resources Division, GSC, Ottawa

- ² Carleton University, Ottawa
³ Laurentian University, Sudbury

105. Hydrogeochemistry and hydrology of groundwaters associated with the Halfmile Lake deposit, Bathurst Mining Camp, New Brunswick

M.I. Leybourne¹, W.D. Goodfellow², D.R. Boyle²

A hydrogeochemical and hydrological study of the Half Mile Lake Zn-Pb deposit area has been initiated as part of the new EXTECH initiative in the Bathurst Mining Camp. The two main objectives of the research are: a) to characterize the geochemical and hydrological features of surface and groundwater regimes associated with massive sulphide zones and their surrounding volcanogenic-sedimentary environments, and b) to develop groundwater geochemical methods for discovering new ore bodies in the camp. A number of borehole water sampling and geophysical logging techniques are being used in addition to detailed geochemical sampling of surface waters (streams, springs, seeps) and their associated sediments. Preliminary geochemical data will be discussed.

- ¹ Department of Geology, University of Ottawa, Ottawa
² Mineral Resources Division, GSC, Ottawa

106. Hydrothermal alteration associated with massive sulphide deposits of the Bathurst Mining Camp, New Brunswick

D.R. Lentz¹, W.D. Goodfellow²

Hydrothermal alteration associated with proximal/autochthonous massive sulphide deposits is manifested by distal sericitic and proximal Fe-Mg chloritic assemblages enveloping sulphide-rich stockworks. In many instances, stockwork-related alteration has been sheared and/or transposed resulting in an asymmetric distribution with respect to the deposit. Hanging wall alteration is more cryptic than footwall alteration and is characterized by variable amounts of Fe-Mg chlorite, sericite, and carbonate. In most cases, alteration is characterized by Fe-enrichment, although some deposits hosted stratigraphically higher in the Tetagouche Group have talc rather than Fe-Mg chlorite in the alteration envelopes. This may reflect compositional differences in their respective footwall lithotypes and, together with reaction temperatures and fluid/rock ratios, control aMg/aFe in the ore-forming fluid during seawater infiltration/exchange processes. Within the low Na halo, the most favourable alteration indices are increasing $(Fe+Mg)/K$, Al/K , and $(Fe+Mg)/Al$ ratios.

- ¹ New Brunswick Geological Surveys Branch, Bathurst
² Mineral Resources Division, GSC, Ottawa

107. Glacial dispersion and till geochemistry associated with the massive sulphide

deposits of the Bathurst mining area, New Brunswick

A. Doiron¹, M.A. Parkhill²

Part of the EXTECH-II project involves studying glacial dispersion around massive sulphide deposits of the Bathurst camp. Dispersion patterns that are defined will serve as a regional model. The study focused on the dispersion of glacial pebbles and of trace elements in till matrices ($< 63 \mu\text{m}$). Results allow interpretation of data gathered during other EXTECH-II studies such as stable lead isotopes in tills, soil and stream sediment geochemistry, groundwater and surface water hydrogeochemistry, biogeochemistry, and radiometric surveys. In the summer of 1994, surface tills were sampled around the Half Mile Lake and Restigouche deposits. A project carried out jointly with Noranda Exploration at Half Mile Lake led to the definition of geochemical variations in vertical profiles up to 3.5 m long.

¹Quebec Geoscience Centre, GSC, Sainte-Foy

²New Brunswick Department of Natural Resources and Energy, Bathurst

108. Gravity and magnetic methods applied to mineral exploration in the Bathurst Mining Camp, New Brunswick

M.D. Thomas¹, R.N. Adair², G. Ascough², Y.E. Bloom³

Sulphide deposits are significantly more dense than host rocks and generate small gravity 'highs' that provide targets for exploration. Gravity surveys can also be used to assess gossans and geochemical and electrical conductivity anomalies. The Brunswick No. 6 deposit (12 million tonnes), located at surface, produced a 4.5 mGal amplitude 'high', but other deposits have yielded much smaller anomalies because of their size, shape, depth, and/or distribution of component zones. Ambiguity in interpretation arises because such anomalies may be related to mafic igneous rocks. Magnetic responses of sulphide deposits are variable and direct discovery by magnetic survey requires a significant presence of pyrrhotite. Indirect exploration may be feasible, however, because some deposits are associated with iron formations and alteration zones, which may have their own magnetic fingerprints. Studies of densities and magnetic properties of ores and host rocks are being conducted to evaluate the potential for further gravity and magnetic exploration in the camp.

¹ Continental Geoscience Division, GSC, Ottawa

² Noranda Exploration Company, Limited, Bathurst

³ University of Western Ontario, London

109. A Cape Breton to Newfoundland fibre optic cable route survey

H. Josenhans¹

A consortium of government and industry has recently obtained continuous swath bathymetry and sidescan sonar imagery along a proposed fibre optic cable corridor across the Cabot Strait between Nova Scotia and Newfoundland. The Atlantic Provinces Optical Cable Systems (APOCS) consortium requested and funded this study to determine seafloor/environmental conditions within the cable route corridor and to identify potential geological hazards and define the most suitable cable route. Continuous swath data were collected at speeds up to 16 kts and digitally processed to produce depth contours at 1 m interval, shallowgrams of topography, and backscatter data which reveal the textural character of the seafloor. Data can be viewed interactively in three dimensions through use of digital techniques. Images reveal submerged river channels cut into bedrock, areas of active seafloor erosion, mobile sand ribbons, current eroded pockmarks at 500 m depth, and large paleo-iceberg scour marks.

¹ Atlantic Geoscience Centre, GSC, Dartmouth

110. High resolution seismic reflection image of parasitic folding in Meguma metasediments: Nova Scotia¹

K.C. Coflin², M.H. Salisbury², P.S. Giles²

High resolution multi-channel reflection seismic data are used to image a known gold-bearing structure in Meguma metasediments west of Halifax, Nova Scotia. The purpose of this Nova Scotia MDA project is to determine if this technique could be used effectively and efficiently in these geological conditions. This area was chosen because the structure is relatively well understood as a parasitic fold on one limb of a plunging anticline. A 5 km profile was acquired and processed using conventional high resolution seismic technology. The image collected demonstrates that it is possible to consider this technique in augmenting conventional exploration methods.

¹ Contribution to Canada-Nova Scotia Cooperation Agreement on Mineral Development (1992-1995), a subsidiary agreement under the Canada-Nova Scotia Economic and Regional Development Agreement

² Atlantic Geoscience Centre, GSC, Dartmouth

111. A vital tool for effective marine geological studies: swath bathymetry from Halifax Harbour

G.B.J. Fader¹, R.C. Courtney¹, R.O. Miller¹

The recent collection of multibeam bathymetry by the Canadian Hydrographic Service and the processing of the data by the Atlantic Geoscience Centre has produced new, detailed images of seabed relief with astounding clarity and precision. These images provide marine geologists with an increased level of insight into sediment distributions and seabed features

and processes, which were unattainable using conventional survey systems. However, interpretation of the origin of topographic elements must still be based on traditional geological data sets comprising sidescan sonograms, seismic profiles, samples, cores, and photographs. Multibeam bathymetry is a powerful new tool in the array of marine geological sensors. It is a unifying base for the interpretation of seabed geology and represents one of the most significant new developments in ocean mapping. An example is provided from inner Halifax Harbour.

¹ Atlantic Geoscience Centre, GSC, Dartmouth

112. New 1:250 000 map of Cape Breton Island and tectonic revision, Magdalen Basin NATMAP Project

G. Lynch¹, P.S. Giles², T. Houlahan¹

The Magdalen Basin NATMAP program coordinates the efforts of a large number of geoscientists from various institutions who are working on different aspects of the Carboniferous Magdalen Basin and its basement. The objectives are to produce an integrated digital database and the first 1:250 000 geological maps of the mainland along the southeast margin of the Gulf of St. Lawrence. A new map of Cape Breton Island provides a unique view of the regional extent of major structures relating to the formation of the basin and the Appalachian Orogen. A complete cycle of orogenic buildup, extensional collapse, and successor basin formation is recorded. The regional scale map illustrates elements of Silurian imbricate thrusting and high-grade metamorphism, early Devonian nappe emplacement, and late Devonian-Carboniferous extensional denudation and detachment faulting that have affected various stages of Carboniferous basin development.

¹ Quebec Geoscience Centre, GSC, Sainte-Foy

² Atlantic Geoscience Centre, GSC, Dartmouth

113. Evidence of the 1929 tsunami in southern Newfoundland - the most tragic natural disaster of this type in Canada

T.W. Anderson¹, A. Ruffman², M. Tuttle³

On November 18, 1929, the 'Grand Banks' earthquake (magnitude 7.2) occurred 18 ± 2 km below the seabed of about 2000 m depth, 350 km south of Newfoundland. Offshore it triggered an underwater slump that flowed as a turbidity current 1100 km out onto the abyssal plain, severing twelve transAtlantic telegraph cables in its path. The tsunami generated by the slump caused 28 deaths and extensive property and shore damage in up to 40 communities in southern Burin Peninsula, and a death in Nova Scotia.

A joint venture is underway by the authors to investigate geological evidence for the tsunami onshore Burin Peninsula. Field studies in 1993 and 1994 were concentrated at the

heads of bays where probable tsunami-laid sand and pebble layers occur as distinct bands 10-15 cm below the surface of the uppermost peat. Peat monoliths were collected for dating and paleoenvironmental, lithological, and geochemical analyses to define the age and environments of deposition. Preliminary results from Taylor's Bay are presented.

¹ Terrain Sciences Division, GSC, Ottawa

² Geomarine Associates Ltd., Halifax

³ Department of Geology, University of Maryland, College Park

114. Correlation by GIS methods of airborne radiometrics and surficial materials, southwest Newfoundland

D.R. Grant¹, A. Moore¹, A. Rencz², D. Graham²

Geographic information systems (GIS) can be used to compare quantitatively maps of surface material and airborne gamma-ray spectrometry (U, Th, K). In southwestern Newfoundland, an area with radial ice flow and variable till thickness and transport distance, the spectrometric signal of certain granitic bedrock areas in the Long Range Mountains is enhanced compared to sedimentary rock of the coastal lowlands, and can be used to map glacial dispersal more than 30 km from the sources. Drumlins and other streamlined till forms of granitic provenance are clearly evident as enhanced areas on spectrometric maps. The spectrometric signal is stronger over fens than lakes, likely reflecting outcrops, boulders, and shallow, more mineralized water. The signal is apparently lower over coarse alluvium compared to parent till, suggesting some differentiation with texture. Tests demonstrate the usefulness of GIS analysis and Quaternary geology to interpret spectrometric and other geochemical maps.

¹ Terrain Sciences Division, GSC, Ottawa

² Mineral Resources Division, GSC, Ottawa

115. Data integration in the coastal zone: a new application of GIS technology

K.A. Edwardson¹, A.G. Sherin¹

An information database is being developed using a commercial GIS, to store coastal morphological and geological interpretations of aerial video surveys and field mapping carried out by the Atlantic Geoscience Centre. Data for linear and point coastal features are stored using the GIS's dynamic segmentation capability. This capability reduces graphical data redundancy by storing a single graphical representation of the coastline, which is subdivided when a query is made. Enhanced analysis of coastal morphology and processes is possible when coastal feature data are integrated with other digital data including satellite imagery, acoustic imagery of the seafloor, photographs, topographic data, hydrographic data, and terrestrial and marine geological interpretations. An operational prototype of the system has been developed in collaboration with the Government of Newfoundland and Labrador.

¹ Atlantic Geoscience Centre, Bedford Institute of Oceanography, GSC, Dartmouth

116. Ocean Drilling Program proposal – Northwest Atlantic Margin Project: high resolution record of sediment fluxes to the northwest Atlantic Ocean Basin

C.T. Schafer¹, S. Thibaudeau¹, E. Collins², B. Maclean¹

Can geological evidence from continental shelf Quaternary deposits confirm recent deep-ocean sedimentary evidence of nearly synchronous increases in discharges of icebergs from portions of the Laurentide Ice Sheet?

The Laurentide Ice Sheet (LIS) influenced the oceanic budget and the atmospheric balance. New data from high resolution continental shelf deposits are required to link the fine-scale features of the northwest Atlantic Ocean basin deposits and glacially-modulated continental margin sediment fluxes.

Discharge from the Hudson Strait area is laden with detrital carbonate, whereas sediments from the St. Lawrence drainage system characteristically carry reddish, quartz-rich sediments. The NW Atlantic Margin Project (NWAMP) proposes to: a) investigate ice-transported proximal and associated distal sediments on the outer continental margin as a record of ice sheet behaviour, and b) assess the effect of ice sheet behaviour on climate change along the Northwest Atlantic Ocean during Miocene through Holocene.

¹ Atlantic Geoscience Centre, GSC, Dartmouth

² Dalhousie University, Halifax

117. Mapping subsurface geological parameters of Canada's east coast Offshore basins

P. Moir¹, M. Williamson¹

The Atlantic Geoscience Centre uses several diverse computer software programs and databases to map, visualize, evaluate, and interpret numerous subsurface geoscientific parameters for the east coast offshore. No reliance is placed on any single turnkey system; emphasis is placed on the ability to move data freely between computer software programs and computer platforms using standard interchanges and data models. In this way scientific synthesis, modelling, and interpretations can be performed using the software/platform most suited to the task. This poster demonstrates the importance of relational databases, geographic information systems, scientific visualization software, 2D and 3D seismic interpretation, and basin modelling software in our subsurface 'mapping' procedures.

¹ Atlantic Geoscience Centre, GSC, Dartmouth

118. Hydrocarbon charge mapping of east coast basins: new directions from old data

M. Williamson¹

Oil and gas is distributed offshore Nova Scotia and Newfoundland in response to the interplay of numerous geological, chemical, and physical processes. Reconstruction of the dynamics of this interplay allows for a more comprehensive assessment of geological opportunities and risks associated with sustainable development of the resource.

The Atlantic Geoscience Centre, in partnership with exploration and production companies, and Dalhousie University Department of Earth Sciences, are engaged in a long-term interdisciplinary effort to reconstruct these dynamics. The emphasis is on a detailed investigation of the numerous subsurface geological parameters required to quantify the nature and interplay of processes that have occurred. The fuzzy inference and neural network techniques shown in this poster serve to demonstrate some of our efforts to maximize information/signal extraction from typically noisy and incomplete frontier data sets.

¹ Atlantic Geoscience Centre, GSC, Dartmouth

119. Possible targets for Ni-Cu-Co mineralization in anorogenic mafic plutonic rocks of Labrador

B. Ryan¹, R.F. Emslie²

Diamond Fields Resources' discovery of significant major Ni-Cu-Co mineralization near Nain has created a staking rush in northern Labrador. The base metal discovery occurs within an east trending basic dyke, and includes 33 m of massive sulphide. We consider the dyke to be related, perhaps as a feeder, to the nearby Reid Brook troctolitic layered intrusion, one of several such intrusions in the Mesoproterozoic anorogenic Nain Plutonic Suite (NPS). These other olivine-bearing layered intrusions have been staked, and represent viable hosts for similar sulphide mineralization. There are mesoscopic, petrological, and geochemical differences among all the troctolitic intrusions. A sample from the Reid Brook intrusion has yielded the least crustally-contaminated Nd isotopic ratio of any of the NPS rocks yet analyzed. We present some field and geochemical data on each of the troctolitic layered intrusions in the suite, and highlight lesser known parts of the Suite that may contain similar rocks. The discovery of nickel and copper sulphides in mafic rocks of the Nain area opens up the possibility that other anorogenic plutons in Labrador, such as Harp Lake (already known to contain many small Ni-Cu showings), may also host economic quantities of base metals.

¹ Geological Survey Branch, Newfoundland Department of Natural Resources, St. John's

² Continental Geoscience Division, GSC, Ottawa

120. A multidisciplinary study of the central Meguma area, Nova Scotia

R.J. Ryan¹, R.C. Boehner¹

The Central Meguma Coordinated Project area is the focus of a multidisciplinary examination of the mineral and energy resource potential of central Nova Scotia. This geologically diverse area includes Cambro-Ordovician metasedimentary rocks of the Meguma Group, Devonian granitoids, Carboniferous and Triassic sedimentary rocks, poorly consolidated Cretaceous sediments, and complex Quaternary glacial deposits. Many related component studies by Nova Scotia Department of Natural Resources, Geological Survey of Canada, and universities constitute this comprehensive program. These projects include: (1) geological mapping, (2) detailed stratigraphy, sedimentology, and petrochemistry, (3) magnetic, seismic, and gravity studies, (4) diamond-drilling of Carboniferous, Cretaceous and Meguma strata, (5) remote sensing, (6) geochemistry, including multimedia studies and regional biogeochemistry, (7) mineral deposits studies and mineral inventory, including base metals in the Carboniferous, vein and disseminated gold in the Meguma, and appraisal of industrial minerals, and (8) environmental geology, including acid drainage from sulphide-rich slates and hazards of old mining districts.

¹ Nova Scotia Department of Natural Resources, Halifax

121. Geology of the Big Bald Mountain area, Bathurst Camp, northern New Brunswick

L.R. Fyffe¹, R.A. Wilson¹

The Big Bald Mountain area is underlain by sedimentary and volcanic rocks of the Miramichi and Tetagouche groups, and by syn- to post-tectonic granitoid rocks. The Miramichi Group consists mainly of quartzose turbidites of the Chain of Rocks and Knights Brook formations. The Tetagouche Group comprises a basal unit of sedimentary rock (Patrick Brook Formation), overlain by felsic volcanic rocks (Nepisiguit Falls, Flat Landing Brook, and Clearwater Stream formations and Stony Brook Complex) and interbedded mafic volcanic and sedimentary rocks (Boucher Brook Formation). The project area is transected by the Pringle Brook Fault, a broad zone of dextral shearing that juxtaposes two domains of contrasting felsic volcanic lithology and petrochemistry. The Nepisiguit Falls and Flat Landing Brook formations occur only north of the fault. South of the fault, the Clearwater Stream Formation and Stony Brook Complex occupy the stratigraphic positions of the Nepisiguit Falls and Flat Landing Brook formations, respectively.

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

122. Geology of the Hartts Lake - Murray Brook area, Bathurst Camp, northern New Brunswick

S. Gower¹, S.R. McCutcheon¹

The northwest-trending Forty Four Mile Brook Thrust has been recognized as a major tectonic contact that subdivides the Hartts Lake-Murray Brook area into eastern and western structural domains. East of the thrust, steeply dipping felsic volcanic rocks of the Flat Landing Brook Formation and mafic volcanic and sedimentary rocks of the Boucher Brook Formation are folded into tight, north-trending, doubly plunging F2 folds. A thin unit (Brunswick horizon) has been outlined near the top of the Nepisiguit Falls Formation in the northeastern part of the survey area. West of the thrust, the general trend of the rock units is east-west and the main foliations are shallow dipping (flat belt). The presence of the Popple Depot granite and the shallow dip of the Nepisiguit Falls-Flat Landing Brook contact make the western side of the field area particularly attractive for exploration.

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

123. The Swayze Greenstone Belt Program: a multidisciplinary approach to geoscientific studies in the western Abitibi Subprovince

J.A. Ayer¹, M.A. Bernier¹, S.L. Fumerton¹, C.A. Kaszycki¹

The NODA-sponsored program to assist mineral exploration in the Swayze greenstone belt has benefited from a wide range of multidisciplinary projects from both the Ontario Geological Survey and the Geological Survey of Canada. All projects utilized computer-based methods. Surficial mapping covering five NTS sheets provides a database of Quaternary geology, stratigraphy, ice flow history, and drift geochemistry outlining a number of new areas with anomalous metal values. Detailed and regional bedrock mapping focused on the northern part of the greenstone belt updates the Archean geological/tectonic framework, provides modern genetic constraints on deposit types and locations, and identifies areas with lithogeochemical patterns, alteration, or structures favourable for mineralization. A computerized database of mineral prospects throughout the greenstone belt and surrounding areas enables queries on deposit attributes, places prospects in a modern genetic framework, and identifies new deposit types and exploration targets.

¹ Ontario Geological Survey, Sudbury

124. Geological compilation of the western part of the Paleoproterozoic Flin Flon Belt, Manitoba

E.C. Syme¹, P.G. Lenton¹, L. Chackowsky¹

As part of the NATMAP Shield Margin Project, Manitoba Energy and Mines has embarked on a program of geological compilation for the Flin Flon belt and Kisseynew South Flank.

The compilation includes vintage maps published between 1945 and 1970, new mapping conducted since 1976, and thematic studies conducted in support of the NATMAP project. The aim of the compilation is to produce a seamless geological overview (at 1:100 000 scale) that incorporates recent advances in our understanding of the belt. To that end, the western part of the Flin Flon belt, including parts of NTS sheets 63K/10, 11, 12, 13, and 15, was compiled at 1:50 000 scale and digitized using GIS software. The compilation reveals a complex tectonostratigraphic architecture in the Amisk Collage, including juvenile arc, ocean floor, ocean plateau, evolved arc, and successor basin assemblages. Tectonic boundaries between assemblages possibly originated as accretionary structures but were subsequently reutilized as intraplate faults.

¹ Geological Services Branch, Manitoba Energy and Mines, Winnipeg

125. The Pelican Slide: product of collision between an archean microcontinent and a Paleoproterozoic protocontinent, Reindeer Zone, Trans-Hudson Orogen¹

K.E. Ashton², J. F. Lewry³, R. Macdonald²

The Pelican Slide is a 5-10 km wide recrystallized mylonite zone along which the Paleoproterozoic Flin Flon volcanic belt has been thrust southwestward over a granulite facies footwall complex that includes the Archean Sahli Granite. The Sturgeon-Weir Shear Zone, which has been used as a domainal boundary between the Flin Flon volcanic belt and the Hanson Lake Block, is a moderately east-dipping splay off the Pelican Slide which extends southward to higher crustal levels.

The sinistral > reverse, north-dipping Annabel Lake Shear Zone also formed during this regional, southwest-verging event, as relatively hot, ductile rocks of the Kisseynew and northwestern Flin Flon domains slid past cold, competent rocks of the low grade, southern Flin Flon volcanic belt.

The southwest-vergent deformational event is thought to have resulted from underplating of the Flin Flon volcanic belt by an Archean microcontinent seismically profiled by LITHOPROBE and exposed at the Sahli Granite.

¹ Contribution to Canada-Saskatchewan Partnership Agreement on Mineral Development (1990-1995), a subsidiary agreement under the Canada-Saskatchewan Economic and Regional Development Agreement

² Saskatchewan Geological Survey, Regina

³ University of Regina, Regina

126. Lithotectonic assemblages of the Amisk Lake area: western Flin Flon-Snow Lake greenstone belt

B.A. Reilly¹, W.L. Slimmon¹, K.E. Ashton¹, D.J. Thomas¹,

C.T. Harper¹, B.R. Watters², L.M. Heaman³

The Amisk Lake area of Saskatchewan, centred approximately 25 km west of Flin Flon, is underlain by several distinct lithotectonic assemblages which comprise part of the Flin Flon-Snow Lake greenstone belt, an accretionary collage of the Paleoproterozoic Trans-Hudson Orogen. Features which may be shared by rock units of each assemblage include lithofacies, structure, metamorphism, geochemistry, geophysics, and geochronology. Tholeiitic, back-arc/oceanic plateau, subaqueous basaltic flows of the Sandy Bay Assemblage are in fault contact between tholeiitic, island arc, subaqueous basaltic flows of the Birch Lake Assemblage and tholeiitic, island arc, subaerial and subaqueous basaltic flows and volcanoclastic rocks of the Crater Island and Muskeg Bay assemblages. Calc-alkaline, island arc, subaerial felsic to intermediate volcanoclastic rocks of the West Amisk Assemblage conformably overlie the Crater Island and Muskeg Bay assemblages and are overlain by volcanogenic turbidites of the Welsh Lake Assemblage. The Flin Flon-Snow Lake greenstone belt is one of the most productive base metal mineral regions in Canada. Recognition of distinct lithotectonic assemblages is a useful first-order exploration guide, as volcanogenic massive sulphide mineralization is hosted by tholeiitic island arc assemblages.

¹ Saskatchewan Geological Survey, Regina

² Department of Geology, University of Regina, Regina

³ Department of Geology, University of Alberta, Edmonton

127. Reconnaissance till mineral and geochemical survey, northern Alberta: preliminary report, year 3¹

M.M. Fenton², J.G. Pawlowicz²

Fieldwork focused on northeastern Alberta (north of 55° and east of 116°), using helicopters provided by Tintina Mines Ltd., Lac Minerals Ltd., Focal Resources Ltd., and Birch Mountain Resources Ltd. Samples include till and bedrock or glaciofluvial sediment. Multiple till sections were sampled east of the Athabasca River and north of the Clearwater River.

Field textural data indicate that the surface till is very sandy (>80% sand) east of the Athabasca River and north of the Clearwater River, and less sandy (20-40% sand) to the west and south. Less sandy till was found at depth below the very sandy till. Unusual float includes: (1) carbonate slabs containing pebbles and cobbles of coarse igneous rock (Tp. 96, Rg. 7W4) and (2) conglomerate cobbles with a fine grained, slightly calcareous, reddish brown groundmass and clasts of granitic and dark, fine grained rock (Tp. 88, Rg. 8W4).

¹ Contribution to Canada-Alberta Agreement on Mineral Development (1992-1995), a subsidiary agreement under the Canada-Alberta Economic and Regional Development Agreement

² Alberta Geological Survey, Edmonton

128. **The diamond potential of Alberta: a regional synthesis of the structural and stratigraphic setting and other preliminary indications of diamond potential¹**

M.B. Dufresne², R.A. Olson², D.R. Schmitt³, B. McKinstry⁴, D.R. Eccles⁵,
M.M. Fenton⁵, J.G. Pawlowicz⁵, W.A.D. Edwards⁵, R.J.H. Richardson⁵

Alberta is favourable for diamondiferous deposits because: (1) it is underlain by large areas of Precambrian crust that acted as "cool roots", (2) major faults and other tectonic structures may have acted as conduits for the intrusion of diamondiferous diatremes, (3) diamondiferous kimberlite or lamproite intrusions exist in several provinces, territories, and states adjacent to or near Alberta, (4) evidence exists for at least four and possibly five ages of volcanic activity in Alberta and some of these are age equivalent to diamondiferous diatreme emplacement elsewhere in North America or in the world, (5) several anomalously thick bentonites exist in places, some of which may represent a local igneous source rather than being wind-blown ejecta from distant sources, (6) numerous diamond indicator mineral anomalies exist at several places, and (7) a large number of geological, geophysical, and geochemical anomalies are found in Alberta, at least some of which may be related to the emplacement of potentially diamondiferous diatremes.

In short, Alberta has at least moderate to high potential to contain diamondiferous diatremes, vent-related deposits, or secondary deposits in sedimentary settings. Despite this potential, the province is as yet largely unexplored for such deposits.

¹ Contribution to Canada-Alberta Agreement on Mineral Development (1992-1995), a subsidiary agreement under the Canada-Alberta Economic and Regional Development Agreement

² APEX Geoscience Ltd., Edmonton

³ University of Alberta, Edmonton

⁴ Elad Enterprises Incorporated, Calgary

⁵ Alberta Geological Survey, Edmonton

129. **N.W.T. MINFILE - A computerized mineral occurrence catabase**

V.Z. Sterenberg¹, H.E. Cooper², C.J. Doucette², C.E. Ellis³

The N.W.T. MINFILE Computerized Mineral Showings Database is being developed through the collaborative efforts of the Canada - Northwest Territories Mineral Initiatives Office, the Northwest Territories Geological Mapping Division of Indian and Northern Affairs Canada, and the Systems and Communications Division of the Government of the Northwest Territories.

N.W.T. MINFILE runs in FOXPRO 2.5, utilizing VISUAL BASIC 3.0 to allow operation in DOS or WINDOWS environments. Database design is modelled after B.C. MINFILE, with screens devoted to Identification/Location, Mineralization, Host Rock, Geological Setting, Reserves, Production, and References. "Canned" queries and reports

incorporating these data are generated. Database development and data capture of mineral occurrences from the Slave, Cordillera, Hearne, and Arctic Platform provinces are ongoing. Conversion of other digital databases to N.W.T. MINFILE format has begun. Based on progress to date, a beta version of the database, containing approximately 1000 occurrences, may be available by mid-1995.

- ¹ Canada - Northwest Territories Mineral Initiatives Office, Energy, Mines, and Petroleum Resources, Government of the Northwest Territories, Yellowknife
- ² Systems and Communications Division, Government of Northwest Territories, Yellowknife
- ³ Northwest Territories, Geological Mapping Division, Indian and Northern Affairs Canada, Yellowknife

130. Neoproterozoic basement-cover relationships, U-Pb geochronology, and a reinterpretation of the southwestern Avalon zone, Newfoundland Appalachians

S.J. O'Brien¹, C.F. O'Driscoll¹, R.D. Tucker²

Recent data from the Connaigre Peninsula reveal a protracted, episodic history for the Avalon Zone in the Neoproterozoic, establishing that zone's composite tectonostratigraphic nature. 673 ± 3 Ma bimodal intrusions (Furbys Cove Intrusive Suite) were emplaced into 682 ± 3 Ma, VMS-hosting, arc rocks (Tickle Point Formation) before deposition of a 626 ± 3 Ma volcano-sedimentary cover (Connaigre Bay Group). The latter rests unconformably upon the 685-670 Ma rocks, unaffected by ductile shearing in the basement. 621 ± 3 Ma calc-alkaline granodiorites crosscut cover and basement rocks, including mylonites. All were remobilized before emplacement of 567 ± 3 Ma diorites across the basement-cover contact. 568 ± 5 Ma to 552 ± 3 Ma rift-related volcanic and associated flysch-to-molasse facies rocks (Long Harbour Group) form a second, younger Neoproterozoic (fault-bounded) cover. Its thick siliciclastic successions correlate with Ediacaran-bearing and younger Neoproterozoic strata of the Avalon Peninsula. Its 552 ± 3 Ma age is a maximum for the base of the overlying fossiliferous Cambrian Succession.

- ¹ Geological Survey Branch, Newfoundland Department of Natural Resources, St. John's
- ² Department of Earth and Planetary Sciences, Washington University, St. Louis

131. British Columbia Geological Survey Branch 1994-95 Highlights

P. Matysek¹

In 1994, the British Columbia government committed to a five year \$100 million program intended to revitalize exploration, maintain international competitiveness, and create new, value added opportunities. Specific British Columbia Geological Survey Branch program highlights include:

- The awarding of \$4 million in grants to over 130 companies and prospectors to provide exploration risk capital;
- Continuation of multidisciplinary geoscience programs in regions where existing mines are forecast to close and in areas with significant identified mineral potential;
- Further development of state-of-the-art 1:250 000 scale provincial mineral potential maps;
- Successful promotion and marketing of provincial industrial mineral resources in Western Canada, the Pacific Rim, and Europe;
- Initiation of a pilot program to produce a detailed earthquake hazard map of part of the Fraser Valley, as well as a multi-year project to develop an inventory of provincial sand and gravel resources; and
- Development of a joint British Columbia Geological Survey Branch/Geological Survey of Canada strategic plan to address selected geoscience needs for British Columbia.

¹ British Columbia Geological Survey Branch (BCGSB), British Columbia Ministry of Energy, Mines, and Petroleum Resources

132. Service centres on the information superhighway: global access to the Geological Survey of Canada

A.G. Kopf-Johnson¹, M. Mitchell¹

From its beginnings as ARPAnet and the eventual takeover by academia and business, Internet has become a massive system of over 36 000 linked systems serving upwards of 20 million individuals. It is an ever-expanding source of information and organizations must now carefully plan how to present their programs and information resources to the global market. The Geological Survey of Canada recognizes the need for a coordinated approach and, in cooperation with NRCan, is building a gopher server to improve public access to databases, catalogs, directories of expertise, and general information on geosciences in Canada. Knowledge networking will play an important role in making GSC research and programs available on Internet, and we will continue to expand and enhance our services as other tools such as Mosaic are implemented.

¹ Geoscience Information and Communications Division, GSC, Ottawa