ATLANTIC GEOSCIENCE SOCIETY

ABSTRACTS

1987 SYMPOSIUM
FREDERICTON, NEW BRUNSWICK

MARITIME SEDIMENTS AND ATLANTIC GEOLOGY

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23, 95-111 (1987)

0711-1150/87/020095-17$3.55/0

The 1987 Symposium of the Atlantic Geoscience Society was held at the Howard Johnson Motor Lodge, Fredericton, New Brunswick on February 6-7, 1987 and was dedicated to the late Dr. Ernest W. Hale formerly of the Department of Geology, University of New Brunswick. Two workshops were convened on Friday, 6th February:- Metamorphism and Ultrabasic-basic Complexes by John Spray, and Maturation Studies and Petroleum Geology by Graham Williams. Saturday, 7th February was organized into four sessions:- (i) Metallotectonic maps and gold, (ii) Granitoid-related mineral deposits, (iii) Base metal and other economic deposits, and (iv) Non-economical regional studies. A total of 21 papers were given at these sessions, all of which were informative and generally well-presented. Additionally, 11 poster sessions were on display, the quality of which were excellent.

On behalf of the Atlantic Geoscience Society may we thank John Spray for organizing and running such a successful and enjoyable Symposium and Don Bachinski, Arnie McAllister, John Spray and Les Fyffe for acting as chairmen of individual sessions. Last, but not least, we extend our thanks to the many graduate and undergraduate students at the University of New Brunswick for their help in registration and ensuring that the meeting ran smoothly, and Rose Northrup for technical assistance.

In the following pages we publish the abstracts of talks and poster sessions given at the meeting.

GEOLOGY AND DEVELOPMENT OF THE PUGWASH SALT DEPOSIT, PUGWASH, NOVA SCOTIA

D.C. Carter
Nova Scotia Department of Mines and Energy
Halifax, Nova Scotia, B3J 2X1

The Canadian Salt Company mine at Pugwash affords an opportunity to examine the internal structure, sedimentology and stratigraphy of a complex diapiric evaporite deposit. This deposit appears to be typical of diapiric anticlines developed within the Cumberland Sub-basin and may be representative of discrete diapirs throughout the Maritimes Basin.

The evaporite sequence exposed in the Pugwash Mine consists of massive, nodular and stylolitic anhydrite and clear, white, reddish-brown to black halite with minor occurrences of carnallite and sylvite. The anhydrite and halite occur both as thick beds and thinly interbedded intervals transitional to each other. The halite and, to a lesser extent, the anhydrite have deformed plastically. The halite shows extensive flowage characteristics including mylonite development. The anhydrite units have been ruptured and rafted passively by halite flowage with resulting attenuation and elimination of parts of the sequence. This boudinage development, at scales ranging from centimeters to tens of meters, has left a complex series of steeply dipping anhydrite units interstratified with and isolated in a halite matrix. The resultant structure is typical of emigration or thinning of the salt deposit and indicates that the Pugwash salt deposit: (1) represents a piercement diapir and; (2) that the present deposit is in fact a remnant of the original.

HYDROTHERMAL ALTERATION AND ASSOCIATED MINERALIZATION WITHIN A POLYPHASE INTRUSIVE COMPLEX FROM THE SOUTH MOUNTAIN BATHOLITH

M.C. Corey
Nova Scotia Department of Mines and Energy
Halifax, Nova Scotia, B3J 2X1

The Big Indian Lake polyphase intrusion (BIPI) is a 18-20 km^2 hyperaluminous complex located within a granodiorite phase of the South Mountain Batholith (SMB). The BIPI complex is comprised of four mineralogically similar, but texturally variable, phases which display intimate spatial relationships and sharp irregular contacts. Field observations indicate that the textural variations observed may be due to multiple injections of a siliceous melt through a granodiorite carapace. The most abundant phase is a texturally variable two-mica monzogranite, which is intruded by small (< 500 m^2) bodies of quartz-feldspar porphyry and leucocratic microgranite. Early, post-magmatic fluid-rock interaction extensively modified the mineralogy of these phases resulting in a hyperaluminous mineral assemblage (garnet, cordierite, muscovite). Although observed in all phases, the metasomatic overprint is most intense and pervasive within the microgranite phase.

A later shear-related hydrothermal alteration period overprinted the earlier metasomatic assemblage modifying the mineralogy to produce a zone of high alumina alteration. This zone is characterized by andalusite, cordierite, spinel, apatite, pyrite and the first reported occurrence of sillimanite within the SMB. A third, and final, lower temperature alteration event characterized by intense hematization utilized the same structure and overprinted previous alteration assemblages.

Field and petrographic evidence suggest that the intense hydrothermal metasomatic effects observed are due to an evolving fluid phase which was associated with intrusion of the last phase (microgranite) of the BIPI complex. Repeated fluid-rock interaction resulted in extensive compositional and mineralogical modifications producing a more stable hyperaluminous mineral assemblage. The alteration types within the BIPI complex are very similar to those commonly observed in porphyry Cu-Mo deposits (e.g., Climax, Henderson).

Quartz-chlorite-tourmaline greisen veins and significant vein-type W-Cu-Mo and shear-related U-Cu mineralization are associated with the hydrothermal alteration. The recognition of such widespread and pervasive hydrothermal activity, in particular the high alumina alteration, has important petrogenetic and mineral exploration implications.

THE DEEP COVE PLUTON AND ASSOCIATED POLYMETALLIC MINERALIZATION, GABARUS BAY, CAPE BRETON ISLAND, NOVA SCOTIA

Frank A.R. Dennis
Acadia University, Wolfville, Nova Scotia, B0P 1X0

The Deep Cove Pluton and country rocks of the Fourchu Group at Gabarus Bay, Cape Breton Island are being studied in detail as part of a M.Sc. research program. The study is based on both field mapping and logging of core from a total of 22 holes drilled by Amax Minerals Exploration in the pluton and in the adjacent country rock to delineate alteration zones containing polymetallic Cu-Zn-Bi-Ag.

The Upper Precambrian Fourchu Group consists of a complex sequence of mainly pyroclastic rocks of predominantly intermediate composition. The Deep Cove Pluton is a small, roughly pear-shaped, monzogranitic body of Devonian age. The monzogranite is seriate porphyritic, with 1 mm- to 1 cm-sized phenocrysts of plagioclase (oligoclase/andesine) and minor quartz and biotite in a fine grained groundmass of quartz, sanidine and minor plagioclase. Associated with the pluton are co-magmatic dykes ranging in composition from tonalite to syenogranite.

Mineralization at Deep Cove is of two types. One is a simple quartz-molybdenite association, with molybdenite occurring as coarse "books" up to 2 cm in size predominantly near the walls of quartz veins which are up to 7 cm wide. These veins occur both within the pluton and in the country rocks up to 1.5 km east of the pluton, but are absent to the west of the pluton.

The main type of mineralization consists of polymetallic sulphide veins, containing Fe, Cu, Zn and Mo sulphides, generally associated with lensoid to tabular greisen bodies up to 30 m thick within the monzogranite. These greisen zones display gradational to sharp contacts with the relatively unaltered monzogranite and are marked by complete obliteration of original textures. They are dominated mineralogically by quartz and white mica, but in places contain up to 40% sulphides over 10-20 cm zones. Sulphides may occur both as disseminations within the greisen, and more commonly, in mm- to cm-sized veins, typically with calcite. The greisen zones also contain significant Ag and Bi. Electron microprobe analyses confirm the presence of both tetrahedrite and a Bi-Ag-Sb-Cu sulfosalt.

THE FOURNIER GROUP MAFIC COMPLEX, NORTHERN NEW BRUNSWICK

Patricia Flagler
Department of Geology, University of New Brunswick
Fredericton, New Brunswick, E3B 5A3

The Fournier Group mafic complex is a predominantly basic igneous suite with ultrabasic and intermediate rock associations. It occurs along the southwest margin of the Baie des Chaleurs, north of Bathurst. The complex possesses a surface exposure of approximately 30 km^2. Previous workers have subdivided the complex into three divisions: 1) the Deveraux Formation consisting of gabbro, peridotite, diabase dykes and trondhjemite, 2) the "Melange Formation" consisting of pillow lavas and slumped sediments and, 3) the Pointe Verte Formation of pillow lavas and greywackes overlying what some consider to be a regional unconformity. The basic assemblages show evidence of static low grade hydrothermal metamorphism and, locally, dynamic amphibolite facies metamorphism in ductile shear zones. Ultrabasic assemblages have been serpentinized.

The complex is unconformably overlain and surrounded by Silurian conglomerates and arkosic sandstones of the Armstrong Brook Formation. Graptolites and conodonts sampled from the Pointe Verte Formation yield a Llandeilian to early Caradocian age, which gives a minimum age for the mafic complex. The sequence has been affected by both the Taconic and Acadian orogenies. Regionally, the complex lies within the Dunnage Zone which is interpreted as a series of island arcs built upon oceanic crust.

The complex has been referred to as an ophiolite by previous workers. It contains ultramafics, gabbros, sheeted diabase dykes, pillow basalts and associated sediments. No true mantle tectonite unit has been identified within the complex. Therefore it is at best a dismembered ophiolite corresponding to a slice of ocean crust.

PETROCHEMISTRY OF AMPHIBOLITES FROM THE MIRAMICHI HIGHLANDS, NEW BRUNSWICK

L.R. Fyffe
Department of Natural Resources and Energy
P.O. Box 6000, Fredericton, New Brunswick, E3B 5H1

Amphibolites occur interlayered with psammite, cordierite-silimanite- bearing schists and granitic augen gneiss in the Trousers Lake area of central New Brunswick. This highly deformed amphibolite suite has previously been considered to form part of a Precambrian basement complex or to have been derived from calcareous sedimentary rocks of Cambro-Ordovician age. A similar suite of rocks to the south in the Sisson Brook area has been mapped as high-grade metamorphic equivalents of Ordovician volcanic rocks of the Tetagouche Group. Chemical analyses were performed on samples from these two suites of amphibolites with the view to resolving some of the conflicting interpretations.

Amphibolites from both suites exhibit a trend with negative slope typical of igneous rocks when plotted on a Cr versus TiO_2 variation diagram. Two samples from Sisson Brook, which were recognized in the field to have a probable sedimentary protolith, based on their lower amphibole content, fall on the sedimentary trend in this diagram and on a Zr/TiO_2 versus Ni plot.

The Trousers Lake and Sisson Brook suites exhibit an iron-enrichment trend on an AFM diagram and are tholeiitic rather than alkalic as indicated by their Nb to Y ratios. On the other hand, previously analyzed subgreenschist - grade mafic volcanic rocks of the Tetagouche Group characteristically possess both tholeiitic and alkalic affinities.

It can be concluded that most of the amphibolites in the Miramichi Highlands were derived from an igneous protolith. Their similar chemistries suggest a common genesis for the Trousers Lake and Sisson Brook suites. They may represent a tholeiitic sequence that developed within the Ordovician Tetagouche volcanic complex earlier than the associated tholeiitic and alkalic lavas found to the east. Alternatively they may represent an entirely older basement sequence. Zircon dating presently being carried out by the Geological Survey of Canada should distinguish between the above models.

STRATIGRAPHIC FRAMEWORK OF THE SYDNEY BASIN AND THE HISTORY OF THE NORTH AMERICAN / GONDWANA COLLISION

Martin R. Gibling
Department of Geology, Dalhousie University
Halifax, Nova Scotia, B3H 3J5

The Sydney Basin occupied a strategic location on the margin of the North American craton in the Late Paleozoic, athwart the St. Lawrence Promontory of the Appalachian Orogen and closely adjacent to the Meguma Terrane, originally part of the Gondwana continent. The rhomb-shaped basin was bounded by strike-slip faults, many of which splayed from the Minas Geofracture along which the Meguma Terrane was emplaced. The collisional history of the two continents may thus be reflected in the basin's stratigraphic succession.

The basinal fill, about 4 km thick, spans 75 Ma from the Tournaisian to the Permian and consists of two fining-upward megasequences, separated by a hiatus. The lower megasequence (Horton, Windsor and Canso groups) contains fanglomerates derived from a series of small basement blocks bounded by active strike-slip faults. The upper megasequence (Morien Group and overlying redbeds) consists of coal-bearing alluvial strata, deposited from a long-lived, NE-flowing drainage system. Local faults were inactive but activity continued on the Minas Geofracture and its splays. The intervening hiatus, about 22 Ma in duration involved uplift, erosion, karst-weathering and minor deformation.

The fill records two major tectonic pulses, which can also be traced across much of the Atlantic region and which are interpreted as distinct phases in the emplacement of the Meguma Terrane. Both pulses resulted in strike-slip activity and subsidence (possibly thermal) which decreased in intensity with time. The hiatus correlates with unconformities and stratigraphic gaps in other basins in the region, with tectonic activity on the Minas Geofracture in southern New Brunswick, and with a thermal phase in the Meguma Terrane. Uplift of the Meguma probably provided the sediment source for the alluvial fill. The increase in abundance of redbeds in Stephanian to Permian time, also observed across the region, may be attributed in part to an increasingly "continental" climate as the two landmasses amalgamated.

The basin's position over the St. Lawrence Promontory, where a NW-trending dislocation appears to underlie the Laurentian Channel, suggests that a long-lived fracture system cutting the North American craton (a transform fault?) also may have governed the location of the basin.

POLYMETALLIC VEIN-TYPE URANIUM DEPOSITS, LONG LAKE AREA VICTORIA COUNTY, NORTH-CENTRAL NEW BRUNSWICK

Hassan Hassan
Department of Geology, University of New Brunswick
Fredericton, N.B., E3B 5A3

Polymetallic U (± Cu, Pb, Zn, Mo, W, Sn and Ag) deposits of the Long Lake area occur in intensely altered and highly brecciated northwesterly-trending, fracture-filling quartz (chaledony and/or jasperoid) veins crosscutting highly evolved, post-Acadian granites of the North Pole Pluton. The centre of the mineralization occurs in an area of the granite that is associated with coincident high airborne radiometric eU, eTh and K anomalies and a strong negative (<-48 mgls) Bouguer gravity anomaly.

The high-level, post-tectonic, peraluminous North Pole Pluton was emplaced discordantly during Early Devonian time in a seismically active area of the metallotectonic Miramichi Anticlinorium domain. Petrologically the North Pole Pluton consists of three, probably comagmatic, phases; biotite granite (older phase), biotite-muscovite granite and quartz- feldspar porphyry granite (younger phase). Available petrochemical data for the North Pole Pluton suggest that it is 'S-type' and has geological, geochemical and geophysical characteristics which are similar to those S-type granites that host economic U-Sn-W-Mo deposits elsewhere, such as the Hercynian granites of Massif Central in France, the Hercynian granites of southwest England and the Millet Brook granite of Nova Scotia.

A magmatic-hydrothermal conceptual model is proposed to describe the polymetallic uranium vein-deposits in the North Pole Pluton.

STRUCTURAL CONTROL OF GOLD-BEARING QUARTZ VEIN EMPLACEMENT DURING PLUTONISM IN THE MEGUMA GROUP, NOVA SCOTIA

Charlotte Hy
Department of Geology, University of New Brunswick
Fredericton, New Brunswick, E3B 5A3

The eastern part of the Meguma Group (Nova Scotia) is known for its numerous occurrences of gold-bearing quartz veins, mined for more than one hundred years. Mines are all situated in the hinges of large anticlines of Acadian age. Gold occurrences also seem to be spatially linked to the post-Acadian granitoid of Middle-to Late-Devonian age.

Collected samples from mines of eastern Nova Scotia (Caribou, Fifteen Mile Stream, Goldenville, Harrigan Cove, Lake Catcha, Mooseland, Tangier) indicate a systematic shear deformation of the rocks, emphasized by a strong stretching lineation affecting the metamorphic porphyroblasts.

During field work close to the Musquodoboit Batholith, steeply dipping shear zones affecting the sediments were discovered. The sense of movement shows that the pluton moved up relative to the sediments.

At Mooseland Mine, rocks were also affected by the shear movement and, it is possible to refine the relative timing between granite emplacement, veining and deformation. In this area the contact metamorphism has produced biotite porphyroblasts which in certain places overprint the shearing and in other places are deformed by the shearing. This shows that shearing was syn-metamorphic. Spatially related to the veins, porphyroblasts of arsenopyrite developed in equilibrium with the biotite porphyroblasts showing that part of the veining, at least, was syn- metamorphic as well. Some veins are sheared, some are not, demonstrating that veining and shearing, both syn-metamorphic, were probably contemporareous at least in Mooseland.

The pluton emplacement induced the development of biotite, andalusite and cordierite in chlorite-muscovite-bearing slates. These transformations have been quantified in order to estimate the amounts of silica and fluids available to form quartz veins.

A simple model is proposed to account for the quartz veins, the metamorphic transformations and their association with shear zones. The pluton rising in chlorite-muscovite-rich slates, provoked the release of abundant fluids and quartz. These fluids moved upwards using the shear zone planes induced by the rising pluton. The fluids were then trapped in anticlinal hinges. Whether the gold contained in the veins came from the slates or from the pluton remains unanswered at present.

METAMORPHISM AT THE BASE OF THE WHITE HILLS PERIDOTITE, ST. ANTHONY COMPLEX, NEWFOUNDLAND: A SHEAR ZONE IN THE MANTLE?

R.A. Jamieson
Department of Geology, Dalhousie University
Halifax, N.S., B3H 3J5
and
T.J. Calon
Department of Earth Sciences
Memorial University, St. John's, Newfoundland, A1B 3X5

The White Hills Peridotite, an allochthonous slice of oceanic upper mantle, shows a pattern of deformation and metamorphism near its basal contact related to upward displacement of the peridotite from the mantle to the crust. Retrograde metamorphism of ultramafic rocks accompanied successive stages of deformation in a polystage ductile shear zone. Microstructures and mineral assemblages of the earliest phase of deformation appear to be related to upper mantle flow in the spinel lherzolite stability field (P > 10 kb; T 900-1200 ^{o}C). In the vicinity of the peridotite margins, early D_1 structures are overprinted by high temperature mylonite zones in which evidence for the transition from spinel lherzolite to plagioclase lherzolite conditions is preserved (P 7-10 kb; T 800-1000 ^{o}C). This pressure decrease reflects upward displacement during shearing under granulite facies conditions. These D_2 mylonites are overprinted by narrow D_3 shear zones showing lower temperature microstructures and mineral assemblages. A P-T-t path for the White Hills Peridotite can be defined from the mineral assemblages and overprinting microstructural relationships. The inferred P-T conditions for the peridotite mylonite zones overlap with those estimated from underlying metamorphic rocks, implying that the shear zones developed during juxtaposition of the White Hills Peridotite with the rest of the St. Anthony Complex.

METALLOTECTONIC MAPS: THE ECONOMIC POTENTIAL OF TERRANE ANALYSIS

J. Duncan Keppie
Nova Scotia Department of Mines and Energy
P.O. Box 1087
Halifax, Nova Scotia, B3J 2X1

Metallogenic and metallotectonic maps attempt to relate mineral deposits to tectonic setting, initially within the framework of geosynclinal theory, but now replaced by plate tectonic theory. These maps are interpretive in contrast to the more factual mineral occurrence and metal province maps. In the same way, a tectonic map illustrates the evolution of the outer part of the Earth through time and is interpretive, whereas geological and structural maps are more factual. A Tectonic Element is defined as a specific, tectonic environment characterized by a distinct tectono-stratigraphic or tectono-plutonic rock unit. A metallotect is defined as a genetically related group of metals which is cogenetic with a Tectonic Element. Tectonic Elements and Metallotects may be grouped into several Tectonic Stages, e.g.:

STAGE	METALLOTECT		TECTONIC ELEMENT
Stable	stratabound Fe-Mn	in	epicontinental basin
	conglomerate U-Au	in	intracontinental basin
Collision	Sn-W-U-F-Mo-Au	in	collision plutons
	pegmatitic Nb-Ta	in	collision plutons

STAGE	METALLOTECT		TECTONIC ELEMENT
	Au-Zn-Mn veins	in	collision structures
	sandstone U-Cu-V	in	foreland, hinterland and
	stratabound Pb-Zn-Cu	in	intramontane basins
	U-Fe-Th-REE-Sr-Ba	in	alkalic volcanic rift
Subduction	alluvial Au-Sn	in	retroarc compressive basin
	Au-Hg-F-Sb volcanics	in	retroarc extensional basin
	P black shale	in	backarc basin
	Cu-Fe-Zn basalts	in	backarc basin
	Cr ultramafics	in	backarc upper mantle
	Besshi-type Cu-Zn	in	backarc basin seamount
	Hg-Au-Te andesites	in	volcanic arc
	Sb-W-Hg basalts	in	volcanic arc
	Fe-apatite rhyolites	in	volcanic arc
	Kuroko-type Zn-Pb-Cu	in	volcanic arc rift
	Cu-Au-Mo porphyry	in	magmatic arc
	placer Au	in	forearc basin
	Hg-Sb-W flysch	in	forearc basin
	Au veins	in	trench complex
Spreading	Mn-Ni-Co nodules	in	oceanic crust layer 1
	Cu-Fe-Zn basalts	in	ocean crust layer 2
	Cu-Ti gabbro	in	ocean crust layer 3
	Ni-Cr-Pt ultramafics	in	upper mantle
	Cyprus-type Cu-Fe-Zn	in	ocean transform
	placer Ti-Zr	in	continental shelf
	Pb-Zn carbonates	in	continental shelf
	banded iron formation	in	continental shelf
Rift	Cu-U-REE carbonatite	in	within-plate pluton
	alkaline U-Sn-Nb	in	within-plate pluton
	sandstone U	in	rift valley
	Sullivan Ag-Pb-Zn	in	rift valley

GEOLOGY OF THE TURGEON VOLCANOGENIC CU-ZN DEPOSIT, NORTHERN NEW BRUNSWICK

Karen Kettles
Department of Geology, University of New Brunswick
Fredericton, New Brunswick, E3B 5A3

The Turgeon volcanogenic copper-zinc deposit is a small massive sulphide deposit hosted by basaltic rocks in the Elmtree Inlier of northern New Brunswick. The basalts occur in the Pointe Verte Formation, of the Ordovician Fournier Group. This formation lies stratigraphically above what is considered to be an "ophiolite" complex. The Pointe Verte Formation consists of interbedded pillow basalts and greywackes that outcrop in the northwestern part of the Inlier. The location of the deposit and its relationship with the ophiolite suggest it is similar to the classic Cyprus-type sulphide deposits found above or near spreading centers.

The Turgeon deposit is owned by Heron Mines Ltd. It consists of two main sulphide occurrences, the Powerline showing and the Beaver Pond showing. In these two areas the ore forms disseminations, veinlets, and fault-bounded lenses, pods, and pipes. The stringer mineralization is hosted by chloritized basalts and represents the stockwork zone. The massive sulphide bodies are affected by later faults which may coincide in part with earlier synvolcanic faults on the seafloor. Banding in the ores parallels the local strike of the units. The main sulphide minerals are pyrite, chalcopyrite, sphalerite, and minor magnetite and pyrrhotite. Associated alteration of host rocks near the mineralized areas is mainly silicification and chloritization.

The rock units in the mine-area consist of basalts, gabbros, interbedded sediments and conglomerate, mafic and felsic dykes, and a later breccia. The sediments overlie and interfinger with the basalts as does, albeit discontinuously, the conglomerate. The gabbroic bodies have similar chemical signatures to the basalts and are considered to be feeders to overlying basalts. The basalts hosting the mineralization are pillowed to massive, amygdaloidal, and locally variolitic. The sequence displays a shallowing-upwards nature, as documented by changes in amygdule content and interpillow matrix. The geochemical nature of the basalts and gabbros suggest they are mainly tholeiitic, and have ocean crust affinities. Thus the deposit's origin can be related to the formation of oceanic crust in a spreading environment.

EAST KEMPTVILLE TIN DEPOSIT, NOVA SCOTIA: LITHOPHILE-ELEMENT MINERALIZATION ASSOCIATED WITH A TOPAZ GRANITE

Daniel J. Kontak
Nova Scotia Department of Mines and Energy
Halifax, Nova Scotia, B3J 2X1

The East Kemptville Sn(-Cu-Zn) deposit (56 million tonnes/ 0.165% Sn), located in Yarmouth Co., N. S., is North America's first primary producer of tin. Greisen-style mineralization (qtz.-topaz-cassiterite) is developed within a leucocratic monzogranite intrusion at the SW termination of the 370 Ma old, peraluminous South Mountain Batholith (SMB). The northern part of the deposit has recently been mapped (1:200 scale), revealing for the first time the nature of the host granitoid and mineralization in outcrop.

The mapped area (600 m x 250 m) is underlain (≈ 40%) by relatively pristine, leucocratic, muscovite-bearing monzogranite (Q=42%, P=33%, A=25%); the remaining surface exposure (≈ 60%) is comprised of variably altered and mineralized granite. The freshest granite samples have a fine- to medium grained, hypidiomorphic granular texture and consist of quartz, oligoclase, orthoclase microperthite, muscovite, topaz and apatite - all are considered to represent magmatic phases. Major element chemistry (N=13 wt. %) is very uniform: SiO_2 (≈74.5), Al_2O_3 (14.5-15), K_2O (3.5-4.0), Na_2O (3.5-3.9), CaO (0.4-0.7) $Fe_2O_{3(T)}$ (1.1-1.4), P_2O_5 (0.45-0.6), TiO_2 (<0.08), and MgO (0.03-0.07). Trace element (ppm) chemistry is also uniform: U (16-34), Th (5-6), Rb (900-1150), Sr (35-80), Ga (32-42), Ba (<10), Nb (26-37) and Y (25-50). Despite the relatively fresh appearance of the leucogranite, the contents of Sn (80-450 ppm), F (0.45-1.3 wt.%), Li (170-700 ppm) and W (11-44 ppm) are anomalously high, contrasting with lower values for B (<10 ppm). Much of the trace element chemistry differs from that found in evolved rocks of the SMB and, instead, is more comparable to that found in topaz rhyolites/granites and ongonites.

Mineralization occurs in the form of NE-trending greisen zones (10 cm to 10 m wide) or quartz veins as part of three paragenetically distinct stages: (i) qtz.-topaz-cassiterite±sulphide (Fe-Cu-Zn) greisens; (ii) qtz.-sulphide (Fe-Cu-Zn)±cassiterite veins; and (iii) qtz.-phosphate±sulphide (Fe-Zn±Cu) veins. Late-stage clay alteration occurs as coatings on earlier mineralized quartz veins and in altered granite.

$\delta^{34}S$ (N = 16) for all stages of mineralization is very uniform (pyrite = 5.1 ‰; sphalerite = 5.3 ‰; galena = 3.6 ‰; chalcopyrite = 5.3 ‰) and indicates a dominantly magmatic source for sulphur during all stages of mineralization. Similarly, a magmatic origin for oxygen is also indicated during the entire episode of mineralization.

Post-dating both the intrusive and mineralizing events was a shear-related deformation. The granite bears a heterogenously developed spaced cleavage, C-S fabrics and proto- to ultramylonitic textures. These fabrics all trend NE-SW, essentially parallelling the trend of mineralized structures.

It is suggested that the East Kemptville granite represents a discrete, specialized, F-rich intrusive (i.e., topaz granite) generated within a shear-related regime post-dating emplacement of the SMB. The same structure localized the intrusion and the ambient stress was responsible for the preferred orientation of mineralized veins. Later reactivation of this structure resulted in the subparallel orientation of veins and deformational fabrics.

THE LUKES ARM - SOP'S ARM - BOONES POINT COMPLEX: AN EARLY TRANSPRESSION ZONE IN NOTRE DAME BAY, NEWFOUNDLAND

Bruno Lafrance
Department of Geology, University of New Brunswick
Fredericton, New Brunswick, E3B 5A3

A large movement zone, the Lukes Arm - Sop's Arm - Boones Point Complex, extending from Sop's Arm to New World Island in Notre Dame Bay, has been interpreted as a belt of subaqueous debris flows deposited from an overriding south-directed nappe. However, detailed structural study in the Bay of Exploits has revealed that the Lukes Arm - Sop's Arm - Boones Point Complex is a tectonic melange related to transcurrent movement.

The deformational history of the Bay of Exploits area (eastern Notre Dame Bay) can be divided into three distinct stages. During the first stage of deformation, thrusting in Early Silurian time was followed by climactic F_2 folding as a result of continental collision. A regional axial-planar S_2 cleavage is associated with F_2 folds. In the second stage, continued shortening caused the formation of a major transpression zone (the Lukes Arm - Sop's Arm - Boones Point Complex) extending from New World Island to Sop's Arm. Transpression obliterated the D_1 structures but generated four generations of folds that were later overprinted by mylonites in zones of intense shear. The time of intitiation of transpression in the zone is constrained by overprinting criteria to a period between Late Llandovery to Early Devonian. The sense of movement in this zone was dextral followed by sinistral movement. The third stage of regional deformation consisted of brittle faults with associated angular folding.

RESULTS OF RECENT MAPPING OF THE SOUTH MOUNTAIN BATHOLITH AND THE IMPLICATIONS FOR MINERAL POTENTIAL

M.A. MacDonald, M.C. Corey, L.J. Ham and R.J. Horne
Nova Scotia Department of Mines and Energy
Halifax, Nova Scotia, B3J 2X1

Geological mapping of the eastern half of the South Mountain Batholith (SMB) has delineated approximately twenty discrete intrusive phases consisting of granodiorite, transitional granite (monzogranite and granodiorite), biotite monzogranite, biotite-muscovite monzogranite (i/ megacrystic, ii/ equigranular) and complex intrusives (highly variable texture and mineralogy). Contacts between units are both intrusive and gradational.

Approximately fifty smaller, fine-to medium-grained muscovite-biotite monzogranitic and leucogranitic bodies (<1->5 km^2) occur within the above granitic rocks. Contacts with host rocks are predominantly intrusive; however, some gradational contacts were observed.

Three plutonic centres of two-mica monzogranite have been outlined within the biotite granodiorites and transitional granite units. Two of these intrusions, the Halifax and New Ross plutons (≈ 30 km in diam.), are zoned with a biotite-muscovite border phase surrounding a more mafic core of biotite (+/- muscovite) monzogranite. Conversely, the Lake George- Springfield monzogranites (1-7 x 50 km and 5 x 20 km respectively), comprising the third plutonic centre, are long and narrow, unzoned, dyke-like bodies which are separated by an intensely sheared wedge of transitional granite.

To date approximately 30 significant new mineral showings (sulphides, W, Sn, U) have been discovered and are classifed into three general types as follows: (1) polymetallic (As, Cu, Zn, W, Sn, Mo, U) mineralization associated with quartz-greisen veins which are frequently related to granite/ metasediment contacts. Host rocks range from granodioritic to leucogranitic. (2) polymetallic (F, Cu, Zn, Mo, W, U) mineralization occurring both as disseminations and fracture fillings in monzogranites and leucogranites. (3) U (+/- Cu) mineralization in intensely altered and sheared(?) rock of granodioritic to leucogranitic composition.

The modes of occurrence of all known mineral showings have been used to create a comprehensive model for mineralization in the SMB.

Distinct zones of the SMB tend to have characteristic mineralization (i.e., W-Cu; As-Cu; F; U-Cu; etc.), with some of these areas corresponding to the metallogenic domains outlined by Chatterjee (1983). For example, the geochemical signatures and mineralogy of the monzogranitic rocks of the Halifax Pluton (HP), appear to more closely resemble the Musquodoboit Batholith (MB) than the central portions of the SMB. These parameters include: concentrations of P_2O_5 and normative corundum (0.24%, 3.23% (HP); 0.25%, 2.78% (MB, MacDonald and Clarke, 1985); 0.12%, 2.16% (central SMB, MacKenzie and Clarke, 1975); and the modal percentages of cordierite (several large areas >10 km^2 with 2-5% in HP and MB, cordierite-rich areas very restricted in central SMB). The presence of quartz-wolframite vein systems in the Halifax Pluton suggests potential for tungsten mineralization - another similarity to the Musquodoboit Batholith.

Potential for gold mineralization in the Halifax Pluton is indicated by elevated gold values in lake sediments from the western part of the peninsula. Gold anomalies are most abundant over the Halifax peninsula monzogranite suggesting possible bedrock control.

PETROGENETIC STUDIES OF THE BURNTHILL GRANITE AND RELATED Sn-W MINERAL DEPOSITS, CENTRAL NEW BRUNSWICK

H.E. MacLellan
Department of Natural Resources and Energy
P.O. Box 6000, Fredericton, New Brunswick, E3B 5H1
and
R.P. Taylor
Department of Geology, Carleton University
Ottawa, Ontario, K1S 5B6

The Burnthill Granite is the largest in a cluster of five post-tectonic Middle Devonian plutons located within the Miramichi Highlands of central New Brunswick. Recent work has confirmed that the Burnthill Granite is a multiphase, high silica granitic pluton emplaced at shallow crustal levels. The two main phases are a coarse-grained subporphyritic granite in the north and a medium-grained equigranular granite forming two lobes in the south. The northern contacts of the equigranular granite with the subporphyritic granite are gradational, but the southern contacts are sharp. A fine-grained facies of the equigranular granite similarly has both gradational and sharp contacts with the medium-grained equigranular granite. These contact features between three phases with very similar chemistries suggest that all have crystallized from a single, zoned magma chamber that has undergone a complex cooling history involving localized remobilization of the magma.

Alkali feldspars from the coarse-grained subporphyritic granite contain abundant perthitic lamellae and no development of microcline twinning. As grain size decreases, from north to south, the proportion of perthitic lamellae in the alkali feldspars decreases, and microcline twinning is more frequently developed. These are strong indicators that the temperatures of crystallization decreased from north to south.

The close association between the equigranular granites and mineral occurrences leads to the conclusion that collection of fluids in the south resulted in late crystallization of the magma in that area. Field relations are consistent with the interpretation that the mineral deposits were formed from fluorine-rich magmatic fluids. The fluids were originally concentrated near the roof zone of the magma chamber, which has been subsequently tilted toward the south. Brittle fracture of the cooling granite allowed escape of the fluids along fractures, leading to the development of several mineralized occurrences. The character of each deposit is controlled by the following interdependent factors: 1) the type of fracturing (i.e., joints, faults, stockworks); 2) the thermal regime at the time of fracturing; 3) the location of the hydrothermal system with respect to the granite contact; and 4) the availability and composition of the fluids.

MAJOR STRUCTURAL CONTROLS ON THE B-ZONE ORE BODY, HEATH STEELE MINES, NEWCASTLE, NEW BRUNSWICK

C. Moreton
Department of Geology, University of New Brunswick
Fredericton, New Brunswick, E3B 5A3

On the basis of tonnage and economic importance, Heath Steele Mines is the second largest base metal massive sulphide deposit in the Bathurst mining camp of northern New Brunswick. The exact structural and stratigraphic relationships between the five main sulphide lenses (B, E and ACD zones) are not known (to date) principally because of a lack of adequate exposure, an absence of useful marker horizons and intense polyphase deformation. In an attempt to open up more ground for exploration, a study has been initiated to establish the geological setting of the zones to aid correlation of the stratigraphy and structure across the mine property as a whole.

Detailed mapping around the B-zone has established that the mine stratigraphy, including the sulphide lenses, is much simpler than previously recognized. Metasedimentary rocks (turbidites?) predominate in the stratigraphic footwall whereas metavolcanic rocks ("porphyries") occupy the hangingwall. Any metavolcanic rocks in the structural footwall reflect repetition of hanging wall rocks due to F_1/F_2 folding. In general the sequence youngs north and is metamorphosed to greenschist grade.

Using this stratigraphy and regional airborne EM patterns it can be shown that the B-zone orebody lies on the north limb of a tight, WNW(?) plunging F_2 antiform. A systematic shallowing in F_2 fold plunges, both from top to bottom (in a topographic sense) and east to west, is attributed to a variation in orientation of the pre-D_2 surface. It is suggested that the inferred geometry of the pre-D_2 surface, as well as the distribution of the mine stratigraphy, is consistent with a recumbent F_1 fold. An axial surface foliation (S_1) related to the recumbent fold is documented in the hinges of F_2 folds only since, on morphology at least, it cannot be distinguished from S_2 - both are transposition foliations enhanced by metamorphic differentiation. The main foliation at the mine is thus referred to as a composite foliation (S_1/S_2).

Although younger deformations are documented at Heath Steele Mines they do not appear to have a significant effect on ore distribution. Even so, their relative ages are a matter of debate since unequivocal overprinting relationships have not been observed. It is suspected that microscopic data will be necessary to resolve this problem.

CANADIAN GOLD - ASPECTS OF GEOLOGY AND PRODUCTION

David J. Mossman
Mount Allison University
Sackville, New Brunswick, E0A 3C0

Canada maintains third place position world wide as production continues to rise. Production in 1986 will for the first time exceed 100 tonnes. Over 60 mines are active and several others are about to start up. Production averages about 50,000 Troy ounces/year. Lode deposits with grade averaging about 10g/tonne account for about 75 percent of present production. The balance, except for about 4 percent from placers, is a by-product of base metal mining. All known types of gold occurrences exist in Canada, but only a few selected types are economic. By far the most productive are lode deposits of Archean greenstone belts in the Slave and Superior provinces. Contrasting genetic schemes for these center on primary exhalative processes versus deep subcrustal extraction with strong structural control.

ORDOVICIAN PATCH REEFS IN THE ST.-HONORE AREA OF QUEBEC

Ron Pickerill
Department of Geology, University of New Brunswick
Fredericton, New Brunswick, E3B 5A3
and
Tom Harland
Poroperm-Geochem Limited, Saultney, Chester, CH4 8RD, England

Small patch reefs occur near the top of the exposed sequence of Middle Ordovician Trenton limestones in the Chicoutimi area of Quebec. Despite their small size, the reefs comprise diverse assemblages of organisms, including representatives of all major groups presently recorded from other Middle Ordovician reefs. Reef growth started and continued in a fully marine, open shelf environment and, other than a slight overall deepening, perhaps with increased water turbidity in the latest stages of development, environmental factors such as energy levels were essentially constant.

However, substrates on which the reefs developed were variable, ranging from loose skeletal lenses to firm or hardened bioturbated wackestones. Earliest stages of reef growth reflect this variability. Loose or less firm substrates were colonised by clusters and thickets of ramose and encrusting trepostome bryozoans with abundant pelmatozoan debris, which together stabilised the substrate and provided the basis for further reef development. Examples of large isolate receptaculitid colonies surrounded by abundant solitary corals and gastropods demonstrate their potential to provide the basis for reef development, and the numerous fragmentary colonies present within bryozoan thickets and associated early reef sediments show they were probably present in the initial stages of most reefs. The resultant firmer, slightly elevated substrates provided excellent sites for attachment and growth of stromatoporoids and colonial corals, which then dominated the later stages of reef growth. On firmer and hardened areas of the substrate, stromatoporoids and corals colonised the surface directly and the earlier stages of reef initiation are absent. The compositions and developmental stages of these late Trenton reefs closely match those seen in broadly contemporaneous reefs elsewhere and are essentially the same as those of many much larger Silurian and Devonian reefs throughout the world.

TILL GEOCHEMISTRY AND EXPLORATION FOR GOLD IN NORTHERN NEW BRUNSWICK

A.G. Pronk
Department of Natural Resources and Energy
Mineral Resources Division
Fredericton, New Brunswick, E3B 5H1

Within two years after the discovery of Lacana's "Elmtree gold," at least a half dozen other showings have been found throughout northern New Brunswick. Several of these are located in the Upsalquitch Forks area and appear to be related to the Rocky Brook-Millstream fault zone. No showings associated with this fault are known in the Tetagouche Lakes area (21 O/9), situated between the Elmtree-Au find and the Upsalquitch Forks map sheet (21 O/10), but Northumberland Mines has drilled gossan developed over the Murray Brook sulphide deposit and proven minable reserves of gold.

A regolith-mapping and till geochemistry survey was carried out in the Tetagouche Lakes area during the summer of 1985 and in the Upsalquitch Forks area in 1986. Initially a forestry-related study, it has proven to be successful in outlining target areas for further gold exploration. B- and C-horizon basal till samples were taken on a 2 km grid and analyzed for Cu, Pb, Zn, Ag, Mn, Fe, Ni, Co, Cd, Mo, As, Sb, and Au.

One of the problems in geochemical exploration for gold is the reproducibility of analytical results. Traditionally in soil surveys, the -80 mesh fraction and heavy mineral concentrates have been used, but in the last few years, more emphasis is being put on analyzing the -250 mesh fraction (clay plus silt). Further attention was given to the clay fraction analysis used by the GSC in regional surveys and comparison was made with the -250 mesh fraction. The latter is less costly and seems more advantageous in New Brunswick with its locally derived tills and heterogeneous bedrock. Satisfactory site to site correlations can be made and regional patterns outlined.

A more detailed survey using the -250 mesh fraction or humus samples would be a cost-effective means for following up detected anomalies.

A MODEL FOR THE EVOLUTION OF HOT (>200°C) OVERPRESSURED BRINES UNDER AN EVAPORITE SEAL: THE FUNDY/MAGDALEN CARBONIFEROUS BASIN OF ATLANTIC CANADA AND ITS ASSOCIATED Pb-Zn-Ba DEPOSITS

Casey E. Ravenhurst, Peter H. Reynolds and Marcos Zentilli
Department of Geology, Dalhousie University
Halifax, Nova Scotia, B3H 3J5

Mineralizing fluids for stratabound lead-zinc-barite deposits such as Gays River, located on the platform of the Magdalen Basin, were hot (150-250°) saline brines that were very similar isotopically and chemically to oil-field and basinal brines. Sulfur, probably derived from the voluminous Mississippian evaporites ($\delta 34S = 14 \pm 1$ ‰), was likely carried as sulfate (in a fluid with neutral pH) to the depositional site where complete (non-biogenic?) reduction (at $\simeq$ 200°C) occurred.

The brines probably originated from under the Windsor Group evaporites in the southern part of the deep Magdalen Basin. Horton Group clastic rocks and the Pembroke breccia were likely aquifers for the brines. A Rb-Sr isochron indicates a homogenizing event at 300±6 Ma in the Horton strata directly below the Pembroke breccia; an event that coincides with a pulse of regional tectonism recorded in the stratigraphic succession.

Mathematical modeling of excess pore fluid pressure buildup under the evaporite seal was carried out using the TWODEPEP finite element program. Results indicate that during periods of rapid sediment or tectonic loading, fluid pressures could have approached the lithostatic load. At least one sudden massive hydrofracturing, fluid expulsion event occurred by 299 Ma and possibly as early as late Windsor time (336 Ma).

NEWLY-RECOGNIZED TSUNAMI IN ATLANTIC CANADA

Alan Ruffman
Geomarine Associates Limited, 5112 Prince Street
Halifax, Nova Scotia, B3J 2L4

Prior to 1985, only two tsunami were known in the scientific literature to have impinged on Atlantic Canada. One was reported in 1864 in St. Shott's, Newfoundland, and the large November 18, 1929 event caused significant loss of life and damage in southern Newfoundland. The June 27, 1864 tsunami has now been pinpointed in time. The November 18, 1929 tsunami from the Laurentian Slope (formerly the "Grand Banks") Earthquake is now known to have had significant impact from St. Shott's and Branch on the Avalon Peninsula of Newfoundland to the Burin Peninsula where 27 persons lost their lives, to St. Pierre et Miquelon, to Cape Breton Island where one death occurred, to County Harbour on the mainland and to at least the Head of St. Margaret's Bay where run up was seen.

The 1929 tsunami may have had a significant effect on parts of the ocean floor on the shelf, hence on the benthic and groundfish fishery.

The Lisbon Earthquake on November 1, 1755 caused a tsunami in Bonavista, Newfoundland probably recorded in the folksong, "When the Great Sea Hove In." This event has now been confirmed from three other sources. A second apparently teleseismic tsunami has been identified from historic seismic studies as occurring on September 24, 1848 and affecting St. John's, Bonavista, Catalina and Elliston in Newfoundland, as well as Fishing Harbour in South Labrador.

A September 11, 1908 event affected the Gulf of St. Lawrence and northern Cape Breton. Northern Cape Breton was affected by a May 1914 event. These two events and the 1864 event raise questions as to the 100,000 year presumed return period of the Laurentian Slope event.

An April 18, 1843 tsunami has been identified in the Yarmouth area and a probable tsunami has been identified in Liverpool on January 19, 1813. A small seismic event has been identified in northern Baffin Bay on Ubekendt Island, Greenland. This event may have had a glacial origin. A further ten high-tide events have been identified which appear to have a non- seismic origin. One "ghost" event has been eliminated from the tsunami record.

THE EASTWARD EXTENSION OF THE GREAT DYKE OF NOVA SCOTIA TO THE MOUTH OF HALIFAX HARBOUR

Alan Ruffman, Andrew Heyes and John Clarke
Geomarine Associates Limited, 5112 Prince Street
Halifax, Nova Scotia, B3J 2L4

The Great Dyke of Nova Scotia, as designated in Ted Lawrence's 1966 M.Sc. thesis, was suggested by early GSC and Dalhousie workers to pass eastward from its last known outcrop on West Ironbound Island in Mahone Bay to the area offshore of Inner Sambro Island just off the south coast of the Bald Rock Peninsula south of Halifax. A recent discovery of a small dyke of diabase on the southwestern end of the Bald Rock peninsula lends credence to Lawrence's suggestion.

Geomarine Associates has now assessed new magnetic data available offshore and has confirmed the dyke intrudes eastward across the granite batholith at least to the centre of the approaches of Halifax Harbour; the contact between the granite and the Meguma is also detailed. The results of an offshore airborne EM experiment to measure bathymetry off Sambro and Ketch Harbour are assessed and the results of a ten year old survey off the Sandy Cove seaweed station are also integrated. The bathymetry data from thirty year old hydrographic surveys are also used to define geological contacts.

ALTERATION ASSOCIATED WITH MEGUMA GOLD DEPOSITS IN SOUTHEASTERN NOVA SCOTIA, CANADA

P.K. Smith and D.J. Kontak
Nova Scotia Department of Mines and Energy
Halifax, Nova Scotia, B3J 2X1

Vein-type gold mineralization in the Lower Paleozoic turbidites of the Meguma Group have historically been regarded as structurally controlled "saddle reef" deposits lacking alteration effects. Recent examination of thirty gold deposits in the Goldenville Formation east of Halifax suggest that these historical preclusions are incorrect and misleading. Instead, large scale (km^2) alteration haloes are associated with most deposits. These haloes preferentially occur in structural dilatent zones on the steep-dipping overturned fold limbs of anticlines where favorable lithologies act as suitable trap-rocks.

Alteration types include silicification, carbonitization and sericitization with less extensive prophylitic zones surrounding the auriferous horizons. Silicification is generally the most prominent and is easily recognized in sandstone lithologies where it extends up to 5 km along strike and 1 km across strike. All degrees of intensity are observed, from minor bleaching to massive replacement which produces rocks resembling quartzites. The end product of the most intense case of alteration may be represented by replacement-type quartz veins. Disseminated carbonate alteration is pervasive at many districts and is easily recognized in both sand and shale lithologies at low metamorphic grades. Phyllic alteration is most commonly

observed in siltstone lithologies (rarely in sandstone) as almost complete replacement by white mica. Rare prophylitic alteration is manifested by epidote in the quartz veins at some of the gold districts.

A working model is suggested in which a deep-seated heat source channelled hydrothermal fluids along structural weaknesses producing veins, anomalous metamorphism, alteration and mineralization. Its significance to exploration dictates that, for the first time in the history of Meguma gold deposits, the potential exists for locating new and buried auriferous horizons similar to that exercised in other major gold camps throughout the world. The dimensions of the alteration zones and analogies to other deposit-types with similar size alteration zones (e.g., Carlin-type gold deposits; porphyry Cu-Mo deposits) indicate great potential for the Meguma-type gold deposits.

A REVIEW OF METAMORPHIC PROCESSES AFFECTING ALPINE-TYPE PERIDOTITES

John G. Spray
Department of Geology, University of New Brunswick
Fredericton, New Brunswick, E3B 5A3

Alpine-type peridotites are ultramafic-mafic complexes and are conventionally divided into two subtypes: lherzolitic and ophiolitic. The ophiolitic subtype shows similarities with modern ocean crust and upper mantle. Metamorphic effects in ophiolites can be attributed to (1) authochthonous 'oceanic' processes (hydrothermal alteration at spreading centres and in fracture zones and the basalt to eclogite transformation in subduction zones) and (2) allochthonous displacement/emplacement processes associated with obduction. Displacement thrusting creates prograde shear zones at ophiolite bases whilst continental emplacement is essentially retrogressive on both ophiolite bases and internal igneous and earlier metamorphic events.

Whilst ophiolites are tectonically emplaced from oceanic sites of generation, lherzolitic bodies predominantly occur in orogens as slices of subcontinental mantle which have been emplaced into the crust via deep fault zones. They typically possess high grade thermal or dynamothermal auroeles but, unlike ophiolites, lack a mafic crustal unit and comprise four-phase lherzolites rather than harzburgites. The lherzolites show evidence of partial re-equilibration to lower P-T assemblages during their ascent and crustal emplacement. Like ophiolites, once in the continental realm, lherzolite bodies are subject to hydration effects and any orogenic overprinting that may ensue.

METAMORPHIC PROCESSES IN THE UPPER MANTLE EXEMPLIFIED BY ALPINE-TYPE PERIDOTITES

John G. Spray
Department of Geology, University of New Brunswick
Fredericton, New Brunswick, E3B 5A3

Investigating the Earth's mantle is, in the strict sense, only possible by indirect means. The two main sources of information on the mantle come from xenoliths, carried in either alkali basalts or kimberlites, and alpine-type peridotites. Xenoliths tend to be of restricted size (usually <30 cm diameter) and usually suffer static annealing during accent under high temperature and zero deviatoric stress conditons. Because of this, partial recrystallization emplacement effects have to be "seen through" in order to assess true mantle textures. On the other hand, alpine-type peridotites suffer decreasing temperature under increasing deviatoric stress during their emplacement, making them less susceptible to annealing. Furthermore, alpine-type peridotites provide a larger mantle sample, typically occurring in masses of hundreds of km^3 This permits in situ evaluation of the structure, petrology and chemistry of the upper mantle.

The lherzolite subtype occurs as mantle slabs in the garnet, spinel or plagioclase lherzolite stability fields, representing mantle samples from <100 km depth. Spinel lherzolite is the most common. They are typified by the lherzolite massifs of the western Mediterranean. The ophiolite subtype occurs with plagioclase lherzolite or harzburgite mantle units, representing mantle samples from <20 km depth. Both subtypes commonly show the development of tectonite fabrics which have formed due to solid state high temperature creep. The development of gneissose and migmatitic fabrics is commonplace, particularly in the lherzolite subtype.

In addition to the solid state deformation of peridotite, a number of mafic segregation processes occur within the upper mantle. This results in the formation of veins, dykes and layers which may cross-cut peridotite tectonite fabrics. Their origin is problematic but they probably represent (1) trapped partial melts; (2) melt residue; (3) recycled ocean crust (via subduction zones); (4) metamorphic differentiates or (5) mantle metasomatites. They are important phenomena as they have a bearing on the generation of primary, primitive and parental magmas to the ocean crust.

FRACTURE CONTROLLED Pb-Zn MINERALIZATION NEAR EASTVILLE, COLCHESTER COUNTY, NOVA SCOTIA

Tim Stokes and Marcos Zentilli
Department of Geology, Dalhousie University
Halifax, Nova Scotia, B3H 3J5

The Eastville sulphide mineralization, which has a strike length of over 10 kms, is stratigraphically located along the Goldenville-Halifax transition zone of the Cambro-Ordovician Meguma Group. It occurs on the north limb of a ENE-trending syncline and is cut by later northerly striking faults, (as interpreted from offsets along the transition zone).

From a recent study of drill core, a definite correlation exists between the number of sphalerite-galena-calcite fractures and higher combined Pb-Zn grades (0.5-8%). These mineralized fracture systems include veins/veinlets, stockworks, and breccias that cross-cut bedding (090, 45S), the axial cleavage (065,50-85SE), and earlier quartz veins (355, 80E). This suggests that the lower grade (<0.5%) disseminated sphalerite and galena, conformable with bedding, have been remobilized and concentrated along the later fracture systems. A preliminary study of 13 oriented mineralized vein/veinlets indicate that there are two possible fracture directions, 065/85SE and 355/75E. These are similar to the axial cleavage and early quartz vein directions. It is unclear, due to the small data base, whether this indicates later movement along pre-existing anisotropic fractures or is coincidental. The orientation and size of the breccia zones are unknown, as is their mechanism of formation. The later northerly trending faults provide the most suitable mechanism for producing the fracture systems, but as yet their displacement and sense of shearing is unclear. The Liscomb Pluton emplacement and the recently interpreted deep-seated lineament could also provide an additional mechanism.

Due to the lack of alteration and the type of mineral assemblage present, it is speculated that the late fracturing systems are closely associated with a limited influx of low temperature fluids. This would link a structural deformation event to a specific chemical environment, an approach that could be used in the examination of other base metal anomalies and more importantly, gold mineralization along the Halifax- Goldenville transition zone.

REGIONAL GEOLOGICAL SETTING OF MINERALIZATION WITHIN THE JUMPING BROOK METAMORPHIC SUITE, WESTERN CAPE BRETON HIGHLANDS

P. Tallman and R.A. Jamieson
Department of Geology, Dalhousie University
Halifax, Nova Scotia, B3H 3J5

Geological mapping of the Jumping Brook Metamorphic Suite (JBMS) at 1:10000 and 1:25000, and detailed field studies of associated mineral deposits, have established a regional stratigraphic and structural framework for mineralization. Low- to medium-grade metavolcanic and metasedimentary rocks between the Cheticamp River and Forest Glen Brook have been divided into three informally named lithodemic units. At the base of the sequence, the Faribault Brook metavolcanics consist of schistose metabasites with a sub-alkaline, tholeiitic basaltic composition. This unit is widest in the south and narrows northward, pinching out in the vicinity of Faribault Brook. Structurally overlying the Faribault Brook metavolcanics is the Barren Brook schist, a sequence of sericitic metasedimentary and tuffaceous rocks, characterised by blue "quartz eyes." This unit, which is separated from the Faribault Brook metavolcanics by a boulder conglomerate, also pinches out in the vicinity of Faribault Brook. The Dauphinee Brook schist, which consists of interlayered pelites, semipelites, and psammites, overlies both of these units; it is widespread north of the Cheticamp River but pinches out south of Faribault Brook. Anastomosing ductile shear zones mark the contact between metabasites and metasediments in the Faribault Brook area where very fine-grained, possibly mylonitic, felsic schists separate interleaved metavolcanics, metatuffs, and metasediments.

The JBMS may represent a sequence of island arc mafic volcanics and associated felsic tuffs, thickening to the south, interfingering with and overlain by a sedimentary sequence thickening to the north. Mineralization is spatially associated with the lithological and structural transition from mafic and felsic volcanics to sedimentary rocks. Microstructural evidence that significant mineralization preceeded regional metamorphism and deformation is consistent with previous interpretations that the mineral deposits are hydrothermal and are stratigraphically related to this transition zone. Regional deformation and metamorphism, and ductile shearing in the transition zone, have remobilized some sulphides and masked the original character of the deposits. The age of volcanism, and thus mineralization, is probably Late Ordovician - Silurian.

* Contribution to the Canada-Nova Scotia Mineral Development Agreement, 1984-89. Project carried by Geological Survey of Canada, Mineral Resources Division, Project 700059, Contract # 27 ST23233-5-0403.

LATE HADRYNIAN METAVOLCANIC ROCKS OF SOUTHEASTERN CAPE BRETON ISLAND: A FAVOURABLE ENVIRONMENT FOR PRECIOUS AND BASE METAL MINERALIZATION

Michael J. Thicke, Sandra M. Barr and Alan J. Sexton
Department of Geology, Acadia University
Wolfville, Nova Scotia, BOP 1X0

Late Hadrynian metavolcanic rocks of the Fourchu Group occur in five belts in southeastern Cape Breton Island. These include the Coxheath Hills, Sporting Mountain, East Bay Hills, Stirling and Coastal belts. All of the belts consist of mafic, intermediate and felsic pyroclastic rocks and lava flows with variable amounts of intercalated sedimentary rocks and all are intruded by Late Hadrynian to Early Cambrian or Devonian granitoid plutons. Significant differences occur among the five belts, including (1) a greater abundance of intermediate to mafic metavolcanic rocks and a lesser abundance of felsic metavolcanic rocks in the East Bay Hills belt compared to the Coxheath Hills and Sporting Mountain belts, (2) more widespread subaqueous depositional conditions, more bimodal nature of lava flows and a greater volume of epiclastic rocks, carbonate and chert in the Stirling belt in comparison with the other belts. Regional metamorphism in the Fourchu Group ranges from subgreenschist to greenschist facies and deformation has produced narrow zones of chloritic schist mainly trending northeasterly but also northerly.

Major and trace element geochemistry indicates that the metavolcanic rocks are subalkaline and generally calcalkaline, although the coastal belt tends to be tholeiitic. The tectonic setting indicated by the geochemistry is a magmatic arc environment. Only background values of Au (<10-20 ppb) have been identified in unmineralized metavolcanic rocks of the Coxheath Hills, Sporting Mountain and East Bay Hills belts. Au geochemical data are unavailable for the Stirling and Coastal belts.

The Late Hadrynian metavolcanic rocks of southeastern Cape Breton Island are favourable hosts for shear zone/vein-hosted precious and base metal mineralization because of (1) the presence of past-producing ore deposits in the Coxheath Hills (shear zone/vein-hosted Cu-Mo-Au mineralization) and in the Stirling belt (massive sulphide mineralization at the Mindamar Mine), (2) the presence of suitable lithologies, such as andesites, that contain structures (faults, shear zones) of both regional and local extent, and (3) the long duration of Late Hadrynian to Early Cambrian, as well as Devonian, igneous activity.

THE TETAGOUCHE GROUP: RECORD OF A CAMBRIAN-EARLY ORDOVICIAN PASSIVE MARGIN AND MIDDLE ORDOVICIAN BACK-ARC BASIN

C.R. van Staal
Geological Survey of Canada
Ottawa, Ontario, K1A 0E8

The central part of the New Brunswick Appalachians is underlain by Cambro-Ordovician volcanic-sedimentary rocks of the Tetagouche Group and correlatives. Cambrian marine quartzose sediments and Tremadocian- Arenigian black shales extend from Bathurst to the Cookson Inlier in southern New Brunswick. The quartzose sediments are interpreted as a clastic wedge deposited on a westward dipping continental slope and rise of the Iapetus Ocean. They are overlain by Early Ordovician black shales and quartzose sediments which appear to onlap on to the Avalon Platform.

Initiation of S-type igneous activity in Late Arenig times is marked by a locally preserved disconformity, produced by the "Penobscot disturbance." Rocks below and above the disconformity record an identical structural history, and pebbles in the conglomerate overlying the black shales do not contain a predepositional cleavage. This disconformity is explained by thermal bulging related to earliest rifting associated with eruption of extensive S-type silicic volcanism. Mafic igneous activity followed silicic volcanism in late Middle Ordovician time. Basalts, which are abundant in the northern part of the Miramichi Zone and along its western margin, have compositions typical of ocean floor and oceanic island. Although they can be correlated with the Pointe Verte Formation of the ophiolitic Fournier Group, these MORB and WPB basalts erupted locally on sialic crust.

Structural and metamorphic data suggest that the main body of the basalts was thrust southeastwards over the quartzose sediments that underlies most of the Miramichi Zone. These relationships suggest that the Tetagouche volcanics formed in a back-arc basin that evolved into a marginal sea floored by oceanic crust. Southeast obduction of the ophiolitic Fournier Group and associated accretionary wedge suggest northwest-directed subduction during closure of the marginal sea in Late Ordovician and/or Early Silurian times.

MANGANESE-RICH STRATA OF THE GOLDENVILLE - HALIFAX TRANSITION IN THE MAHONE BAY AREA, SOUTH SHORE, NOVA SCOTIA

John W.F. Waldron
Department of Geology, Saint Mary's University
Halifax, Nova Scotia, B3H 3C3

The Cambro-Ordovician Meguma Group is well exposed in the Mahone Bay and Lunenburg areas on the Nova Scotia South Shore. The Group has traditionally been divided into two formations: the lower, Goldenville Formation, consists mainly of metamorphosed turbiditic sandstones with subordinate slates; whereas the upper, Halifax Formation, consists predominantly of slate with lesser amounts of sandstone. Both formations are metamorphosed at chlorite grade.

Recently, several distinct members have been recognized in the Goldenville-Halifax transition in the Mahone Bay area. The lowest member identified, the New Harbour Member of the Goldenville Formation, consists of extremely thickly bedded (up to 20 m) sandstones with very minor slate. It is overlain by the Tancook Member (and the laterally equivalent West Dublin and Risser's Beach members), consisting of subequal proportions of slate and generally thinner turbiditic sandstone beds. Burrows, especially spreiten resembling *Teichichnus*, become increasingly abundant up-section. About 60 m below the top of the unit, a bed of brown-weathering sandy limestone contains numerous shell and echinoderm fragments.

The overlying Mosher's Island Member consists of grey-green slate and argillite containing disseminated spessartines and concretions of manganoan carbonate. With the exception of some sandstone beds near the base of the unit, in which spreite burrows are spectacularly developed, the sandstones are not bioturbated; they show well developed parallel laminations and current-ripple cross-laminations. The concretions probably developed early in diagenesis, perhaps as a result of Mn^{++} accumulation in increasingly oxygen-deficient seawater. The Mosher's Island Member passes up into black pyrite-rich carbonaceous slates and thinly bedded siltstones of the Cunard Member of the Halifax Formation; both slates and siltstones in the Cunard Member contain abundant pyrite.

SILURIAN HELIOLITID, HALYSITID, AND SYRINGOPORID TABULATE CORALS FROM THE CHALEUR BAY REGION: PRELIMINARY RESULTS

Graham A. Young
Department of Geology, University of New Brunswick
Fredericton, New Brunswick, E3B 5A3

The Silurian clastic and carbonate rocks of the Chaleur Bay region possess a range of faunas which include most of the important lower Paleozoic invertebrate groups. A large collection of heliolitid, halysitid, and syringoporid tabulate corals from eighteen sections of the Anse Cascon, Anse a Pierre Loiselle, La Vieille, and Gascons formations of the southern Gaspe Peninsula, and the Armstrong Brook, Petit Rocher, Limestone Point, and La Vieille formations of northern New Brunswick, includes twenty-seven species distributed among ten genera. All species were defined using both quantitative and qualitative data.

The high diversity of this collection is related, in part, to the occurrence of Tabulata in a broad range of lithologies representing intertidal to open shelf environments (including several shelf bioherms). The range of environments should allow some understanding of factors controlling distribution, and preliminary analysis of halysitid distribution suggests strong facies-control on the occurrence of the most abundant species.

The widely-held belief that North American and European Silurian Tabulata show little provinciality is incorrect, and is related to past misidentification of North American specimens. The Chaleur Bay faunas are very different from European faunas, and quite distinct from those of Anticosti Island and northern Newfoundland as well. Each of the three major groups studied has species endemic to the Chaleur Bay region.

The stratigraphy of the Chaleur Bay region is still open to considerable interpretation. Conodonts are rare or absent in many sections, brachiopods have not been thoroughly studied, and much correlation between sections has been based on lithology. It is expected that analysis of tabulate distribution patterns will help to clarify this picture.

GEOLOGY OF THE CHETWYND GOLD DEPOSIT, NEWFOUNDLAND[1]

Alan Yule
Department of Geology, Dalhousie University
Halifax, Nova Scotia, B3H 3J5

The host rocks of the Chetwynd gold deposit can be separated into two distinct lithological packages: a southern sequence dominated by Cambrian quartz grits and mafic and felsic volcanic rocks, which includes various gabbroic and grandodiroitic sills, and a northern sequence of Lower-Middle Ordovician (542 Ma) felsic volcanic rocks and various conglomeratic units, which includes a number of Early Silurian (420 Ma) granitic Hawk's Nest Pond Porphyry sills. The 499 Ma Roti Bay Granite intrudes the base of the southern sequence, and the Late Devonian (372 Ma) Chetwynd Granite

truncates all units to the northeast.

The Chetwynd area has experienced at least three phases of deformation. D1 has affected all rocks, except the Chetwynd Granite, resulting in the formation of a strong NE-SW striking, steeply south-dipping structural grain. Many of the lithologies have been isoclinally folded and transposed, and mylonite has formed in numerous discrete NE-SW striking shear zones. D2 is a much weaker, N-S striking, steeply dipping crenulation cleavage, and D3 has produced numerous brittle, vertical faults parallel to the NE-SW shear foliation. Abundant NE-SW cross- fractures, with apparently no significant displacement, are also present in all units.

The mineralized/altered zone is approximately 250 m wide and is asymmetrically zoned in terms of alteration and metals, from a high- aluminum, quartz-sericite-andalusite southern margin, to a silicified, Cu-Au-Fe mineralized medial zone, to an intensely silicified, pyritized northern margin. Pyrite, and lesser chalcopyrite and bornite, are commonly observed forming a braided pattern parallel to the NE-SW shear foliation. The ore zone has been intensely deformed, and intruded by at least two generations of mafic dykes. The earliest phase of these dykes has been hydrothermally altered (and mineralized?).

Field relations suggest that the northern and southern sequences of rocks are in fault contact along a large mylonite zone north of the mineralized/altered zone. Therefore, the Chetwynd gold deposit is hosted by the upper portion of the older (Cambrian) southern sequence of metasediments and metavolcanics, and mineralization is probably unrelated to the felsic magmatism of the north.

1 - Research supported through B.P.-Selco Resources Canada and NSERC Grant A9036 to Marcos Zentilli.