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Atlantic Universities Geological Conference 2004

October 28–30, 2004

A B S T R A C T S

CONFERENCE HOSTED BY:

THE FLETCHER GEOLOGY CLUB

ACADIA UNIVERSITY

WOLFVILLE, NOVA SCOTIA

Again this year, abstracts from the annual Atlantic Universities Geological Conference (AUGC) are published in Atlantic Geology. This publication provides a permanent record of the abstracts, and also focuses attention on the excellent quality of the oral presentations and posters and the interesting and varied geoscience that they cover.

THE EDITORS

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The Callie lode gold deposit, Northern Territory, Australia: high grade, sheeted, auriferous quartz veins in an anticlinal structural environment

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The Callie lode gold deposit, located in the Tanami desert at Dead Bullock Soak, Northern Territory, Australia, is hosted by fine-grained, carbonaceous, clastic metasedimentary rocks of Paleoproterozoic age that have been folded into a complex anticline. Mineralization consists of coarse native gold within 1 to 2 cm thick sheeted quartz ± chlorite veins that can be related to folding of the sedimentary sequence. Sericite and chlorite may represent associated hydrothermal alteration products, but do not generally exhibit any spatial relationship with mineralization or veining. Au-bearing veins occur within bleached (de-carbonized) zones within the productive pelitic host stratigraphy (Lower Blake Beds, Callie Laminated Beds, Magpie Schist). Production and reserves in the deposit consist of 6.5 M tonnes grading 6.7 grams per tonne, and are mined from underground workings developed from the bottom of the initial open pit.

Gold mineralization exhibits a very large nugget effect that creates significant reserve estimation challenges. Visible gold commonly occurs at the intersections of veins with the basal, coarse-grained portions of distal turbidite beds, suggesting an important precipitation control. Historic explanations for gold precipitation have involved redox reactions between oxidizing, auriferous fluids and carbonaceous sediments to precipitate gold. This model does not explain the relationship between gold shoots within the veins and the basal portions of turbidite beds. Detailed investigation of the higher grade portions of these veins reveals that an alternative precipitation mechanism is required. The strong relationship between the higher grade portions of veins and turbidite beds suggests a metasomatically driven precipitation control involving chemical reactions between the auriferous fluids and the minerals within the coarser turbidite bases.

The similarities and differences between the Callie deposit and saddle reef gold deposits in Nova Scotia and Victoria, Australia provide important insights into critical factors that control the genesis of these deposits.

Cosmogenic nuclide dating of glaciomarine deltas in Southern Maine

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As the ice margin of the Laurentide Ice Sheet (LIS) retreated from the eastern continental shelf of Maine beginning approximately 17000 years ago, there was widespread marine transgression and deposition of glaciomarine sediment. Evidence of the contemporaneous transgression with retreat is preserved in ice-proximal and esker-fed deltas (along with other glaciomarine features) which were deposited along the edge of the retreating ice margin. The topset-foreset contacts within these deltas provide excellent paleo-sea-level indicators. Precise age determinations for the topset-foreset contacts provide valuable information regarding the rate and style of deglaciation.

Terrestrial cosmogenic nuclide exposure (TCN) dating provides a means to precisely date surface exposure durations. Using TCN dating, deltaic sediments from the topset-foreset contacts can be dated to provide a more precise age of the ice margin at its time of retreat from the region. The present study aims to test the validity of using TCN exposure dating on glaciomarine deltas where a radiocarbon based chronology exists for comparison. In order to date the topset-foreset contacts, three of the best studied glaciomarine deltas in Southern Maine will be exposure dated using cosmogenic ^{10}Be. Eleven sand samples were collected in vertical profiles (1 to 3m) under stones fences along gravel pit boundaries where soil profiles below the tree rooting depth show minimum disturbance in the delta sediments. The results will be compared to the existing radiocarbon dates to determine whether TCN dating can be applied to other deltas and contribute to the glacial chronology of the LIS.

The sedimentology of Minto-Salmon Harbour mine site and its high sulphur coals

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The Minto coal field at the Salmon Harbour mine site is located in central New Brunswick. The coal field lies in the upper part of the Minto Formation of the Pictou Group, the uppermost unit within the Maritimes Basin in this area. Bio-stratigraphy gives an age of Middle Carboniferous, Westphalian C. The stratigraphic succession at the mine site is divided into 7 units. The first unit is the coal seam which is of high volatile A bituminous grade that contains between 5 to 9 % sulphur. The sulphur levels increase to a high of 9% as the coal becomes thinner towards the sub-basin margins. This unit is interpreted as a shallow poorly drained bog swamp environment. Unit two, the shale that forms the roof rocks and contains an abundance of organic material used in age dating, and is interpreted as suspension sedimentation that is infilling the bog swamp. Units three and five are mudstones/siltstones with soil horizons and minor interbeded fine sands. These are interpreted as sheet floods and over-bank deposits. Unit four is a sandstone-conglomerate with trough cross beds, rip-up clasts and climbing ripples and is interpreted as a river channel. Unit 6 is smaller channels that pinch out and are not always present in the section. Unit 7 is the present day overburden.

Sulphur and carbon analyses (using LECO method) show,

at the base of unit two shales, 3.1 wt% sulphur and 1.32 wt% carbon values, and lower values up-section. The same is true for the other units where higher levels of sulphur and carbon were observed at the base of each unit and decreased up-section. In units 2 and 3 petrographic analysis identifies quartz as a blocky cement and kaolinite as a pore-filling vermiform clay phase. The quartz also forms "dog tooth" crystals alongside calcium carbonate cement (5–12%) with a minor kaolinite phase. The quartz and kaolinite reflect an acid pore water environment, and the later calcium carbonate phase that fills the remaining pore space may reflect a later more alkaline pore water environment.

The Minto area is modelled as a shallow depositional subbasin of an ancient river valley that was poorly drained. The river valley fill is dominated by normal grading fluvial facies, with trough cross bedding overlain by climbing ripples that indicates palaeoflow towards the northeast. The development of soil horizons containing peds with preserved organic material is indicative of long periods of subaerial exposure in better-drained areas of the floodplain. The peat bog developed in the poorly drained areas. The source of the sulphur in the coal is debatable. Although sulfate from seawater would provide an abundant source of sulphur for the coals, no sedimentological evidence for marine influence is noted. Instead it is proposed that sulphate-rich freshwaters were derived from solution erosion of the adjacent Windsor Group evaporites.

Characterizing the atmospheric distribution of heavy metals from the Come By Chance oil refinery using *Alectoria sarmentosa*

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This study is concerned with the dispersion of heavy metals from the Come By Chance Oil Refinery on the Avalon Peninsula of Newfoundland. Biomonitoring utilizes properties of or a part of an organism to obtain information on a certain quantity in the biosphere. Using the lichen species *Alectoria Sarmentosa*, samples from the area are analysed for heavy metal concentrations and lead isotopic ratios.

Metals enriched in oil refining processes, show a clear dispersion pattern from the refinery to the North West following prevailing wind direction. Maximum concentrations of nickel (6.66 ppm) and vanadium (23.11 ppm) occur within 3 kilometres from the refinery. Using nickel to vanadium ratios in lichens and from the refinery emission data, it is shown that nickel and vanadium are fractioned during transport, with vanadium being preferentially deposited in the area of maximum plume fallout. The correlation of lead with vanadium and nickel is low and the lead isotopic evidence is not correlated with these metals. For lichen samples, ^{206}Pb / ^{207}Pb values range from 1.14 to 1.19 and ^{208}Pb / ^{206}Pb values range from 2.06 to 2.11. The lead signal is a mixture between past leaded gasoline values and natural soil lead. However, a lead contribution from the refinery can not be ruled out as the emissions were not measured directly.

Upper Cretaceous-Cenozoic salt movement in the Abenaki Subbasin, offshore Nova Scotia

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Salt diapirism is an important process related to the petroleum system of the Scotian Margin. Three large salt diapirs occur in the western part of the Abenaki subbasin. According to previous work published by others, diapirs appear to have been active in two phases. The first phase occurred during the Middle Jurassic as clastic sediments of the Mohican and Mic Mac formations built out into the Scotian Basin. A second phase of renewed movement occurred during the Cenozoic. The latter movement formed a roughly circular withdrawal syncline that was subsequently infilled by younger Cenozoic sediments. This second event was approximately coeval with deposition of Upper Cretaceous and Paleogene prograding sediments in the Abenaki Subbasin. Prograding clinoform units of the Banquereau Formation are seen to downlap on chalks of the Wyandot Formation in the area around the diapirs. Prior to subsidence, topsets of the clinoform units would have been approximately horizontal with respect to sea level, but they now form a broad synclinal shape. The deposition of these sediments may have been sufficient to cause loading and eventual movement of the underlying salt. If such sediment loading did cause salt withdrawal, the age of horizons within, above or below the clinoform units could precisely constrain the timing of salt movement. However, salt withdrawal might have occured well after deposition of clinoform units, and so be unrelated to sediment loading. This latter possibility raises the question of what other process could have reactivated these salt structures so late in the basin's history. This talk discusses plans for addressing these questions over the next year.

Volcanism of the Silurian Eastport Formation, Maine, USA

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The Coastal Volcanic belt (CVB) extends from Massachusetts to New Brunswick and comprises bimodal volcanic rocks associated with continental extension. The Silurian Eastport Formation is located in the northern part of the CVB in Maine and New Brunswick. The volcanology of a portion of the Eastport Formation in Maine was mapped in detail to

determine the paleo-volcanic setting and help constrain the development of the northern Appalachian orogen.

The mapped area includes sedimentary rocks, mafic lithic tuffs, felsic vitric tuffs, mafic flows, and fine-grained mafic intrusions. The sedimentary rocks are dominantly siltstone and fine-grained sandstone with minor conglomerate. Sedimentary structures indicate a shoaling upward sequence from lower shore face to intertidal environments. The mafic lithic tuffs are variable in composition but generally characterized by a high percentage (up to 90%) of lithic clasts, and <10% of magmatic fragments. The low abundance and scoriacecous nature of the magmatic fragments is consistent with phreatomagmatic eruptions. Bedding structures indicate variable depositional processes including surge, airfall and lahars. The felsic vitric tuffs contain a high percentage (up to 90%) of juvenile fragments and <10% accidental lithic clasts. The high abundance of bubble-wall glass shards and pumice fragments indicate a volatile-rich magmatic eruption. The alignment of elongate pumice clasts and lack of other bedding structures is characteristic of pyroclastic flows. The mafic flows are fine-grained with structures interpreted to be vesicular flow tops, massive interiors, flow bottom breccias, and in-situ brecciation. These rocks are interpreted to be Hawaiian-type flows that interacted with water. The mafic intrusions show variable contact relationships and represent multiple intrusive events, including evidence for non-explosive interaction with wet unconsolidated sediment. The flows and intrusions are sub-alkalic basalt to basaltic andesite with extensional tectonic affinities.

This part of the Eastport area is characterized by variable styles of volcanism, but typically indicating the interaction with water in an intertidal environment, consistent with other parts of the Eastport Formation, and the Silurian Cranberry Island series of the CVB. These results suggest a significant shallow marine extensional basin within the northern Appalachians during the Silurian, with variable eruptive styles of bimodal volcanism, similar to the Rio Grande or Basin and Range.

The Romeo II Sill, Cape Smith foldbelt, Quebec: studying the potential for Cu-Ni-PGE's

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The Cape Smith Foldbelt, which formed approximately 1.86 billion years ago, consists of three main geologic groups; the Povungnituk Group, the Chukotat Group and the Watts Group. Over the past 40 years a there has been a lot of interest in the foldbelt because of its potential for Cu-Ni-PGE's. With 6 deposits discovered on the main trend already, the area has experienced a recent exploration boom.

The Romeo II Sill is located entirely within the Povungnituk Group volcanics, south of the main trend just below the Cross Lake Deposit. Twenty-six samples were analyzed for major element oxides, trace elements and rare earth elements: 8 of these samples were cut into thin sections which have been analyzed optically. Microprobe work on individual relic mineral crystals will come in the near future. Although most of the textures are well preserved, petrographic analysis reveals that the sill has been highly altered with up to 90% serpentine, chlorite, talc and other alteration minerals present. Despite this alteration the whole rock geochemical data preserve an igneous imprint which could be useful in determining whether there is potential for synmagmatic sulfides (specifically Cu-Ni-PGE's). For example, there is a positive correlation between Ni, Cr, Co and Mg. REE data display slight to moderate LREE enrichment, with little evidence for crustal contamination. By using geochemical methods, both whole rock and individual mineral compositions are being comparatively studied to potentially locate a characteristic compositional 'Raglan' suite which could be then used to assess the potential of the Romeo II Sill and other sills in the area for sulfides.

Petrology and tectonic setting of the Seal Island Pluton, offshore southwestern Nova Scotia

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The Seal Island Pluton outcrops on Seal Island as well as nearby Mud, Round, and Noddy islands, located 30 km west of Cape Sable Island off southwestern Nova Scotia. A limited amount of study of the Seal Island Pluton has been done previously, but its age and relationship to the mainly Devonian granitoid intrusions of mainland Nova Scotia are uncertain. It has been reported to consist of coarse-grained biotite granodiorite and monzogranite, gradational to muscovite-biotite monzogranite and syenogranite, and to be similar in texture and mineralogy to the South Mountain Batholith. Based on the presence of hornfels and metasandstone xenoliths in the monzogranite and syenogranite, the pluton intruded the Meguma Group.

This study aims to examine through petrographic and geochemical analysis the origin, tectonic setting, and emplacement of the Seal Island Pluton and interpret its relationship to other granitoid intrusions of southwestern Nova Scotia. The pluton was mapped and sampled during two days in the summer of 2004 on all the islands on which it outcrops. Preliminary results suggest that it consists mainly of biotite monzogranite. Weak foliation resulting from preferred orientation of biotite ± muscovite was observed in most outcrops, generally trending approximately north-south. Steep shear zones (<50 cm wide) occur throughout the pluton but are more abundant along the western side of Seal Island. These zones trend north to north-northeast and have subhorizontal mineral lineations, locally well developed c-s fabrics, and asymmetric porphyoclasts which exhibit dextral sense of shear. The shearing may be

related to the offshore extension of the major Chebogue Point Shear Zone southeast of Yarmouth.

A distinctive characteristic of the pluton is the presence of tourmaline layers and patches, in places composing up to almost 2% of the rock. Pegmatite dykes and pods occur throughout the pluton, and rare mafic dykes (<1.5 m wide) occur on Seal and Mud islands. The two dykes on Seal Island are highly deformed as they occur in north-trending shear zones. The dykes are likely syn-to late intrusive within the granite based on observed commingling textures. Magnetic susceptibility was measured in the field at all outcrops, and susceptibility values are low in granite and pegmatite, ranging from 0.00 to 0.35, but mainly between 007 to 0.15 $x10^{-3}$ SI units. Mafic dykes have somewhat higher values (0.53-0.75).

Samples from the Seal Island Pluton are being analysed for major and trace elements, and petrographic studies are in progress. Mineral analyses will be done by electron microprobe.

Preliminary work suggests that the pluton differs in appearance from the Wedgeport, Shelburne, and Barrington Passage plutons, and is unlikely to directly link to any of these nearby "peripheral plutons" of the South Mountain Batholith.

Structural controls on Meguma gold: a study on the Cochrane Hill deposit

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Gold deposits are common in the Halifax and Goldenville formations of the Cambrian-Ordovician Meguma Group in mainland Nova Scotia. Regional studies suggest that gold mineralization occurred during the mid-to-late Acadian orogeny. Cochrane Hill Deposit in north-eastern Nova Scotia is of interest because of its known reserves, and its potential for continuation along strike and at depth. The deposit is located along the overturned southern limb 200m south of the hinge of the Cochrane Hill Anticline adjacent to a steeply dipping shear zone. Tight isoclinal folds within the metasediments show evidence of five phases of deformation. The metasedimentary rocks are invaded by quartz veins whose style of deformation varies depending on relative timing of emplacement. Conical folds have been used as a predictor for gold deposits. Detailed measurements on individual quartz veins were carried out in order to determine the nature of the folds; whether they are continuous throughout the claim area, and their geometry (cylindrical or conical). Variations in fold axes orientations for folds with similar axial planes are consistent with regional evidence for dextral shear during progressive fold development and vein emplacement.

Stratigraphy and structure of the Dunnage-Coaker corridor, central Newfoundland

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This study focuses on the relationships between the Dunnage Mélange and the Coaker Porphyry, within the Dunnage-Coaker Corridor. Previous workers who have studied the area presented different scenarios for the origin of the mélange, especially the development of its chaotic nature. The focal point of this study has been to resolve stratigraphic and structural relationships between the Dunnage Mélange and the Coaker Porphyry, as well as to delineate stratigraphic variations within the mélange.

Stratigraphically, the sedimentary units within the mélange exhibit alternating successions between shale units and coarse conglomeratic shale units. These units were intruded by the Coaker Porphyry as high-level intrusive to extrusive, tabular, and sill-like bodies. Mafic volcanic blocks occur as semi-continuous horizons suggesting the presence of original extrusive flow units within the basin.

The structural geometry of the Dunnage-Coaker Corridor is related to the effects of a series of fold events. F_1 folding was generally tight and asymmetric, and created associated S_1 cleavage. These folds were refolded by F_2 open to tight asymmetric folds. Related to the F_2 fold structures is S_2 cleavage, which is the most easily recognizable feature throughout the area. This stage of folding was followed by a third stage (F_3) that caused kink and chevron monoclinal and polyclinal fold systems. The "chaotic" nature of the Dunnage Mélange can be attributed to fold interference patterns related to the first (F_1) and second (F_2) generations of folding.

Late Cenozoic seismic stratigraphy of the Mohican Channel area, Scotian Slope

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The Mohican Channel of the continental slope, offshore Nova Scotia is an ideal study area for Late Cenozoic seismic stratigraphy. The Geological Survey of Canada (Atlantic) has collected high-resolution, two-dimensional seismic surveys across the Scotian Slope. These surveys have been used to identify seismic reflectors and to construct a general framework of seismic stratigraphy in the study area.

The Scotian Slope is a glacially influenced continental margin. Further seismic interpretation of the surveys will investigate the effects of Cenozoic glaciation on sedimentation styles. Specific features to look for will be erosional surfaces, ice scouring and evidence of glacial debris.

The frequency and magnitude of mass transport complexes

on the slope is another element of this study. Glaciation as a possible trigger for these events has been suggested and will be explored further.

Within the study area, an experimental seismic system known as the digital deep-towed hydrophone (DDH) was tested. The DDH consists of a seismic source towed at the sea surface and a receiver towed at depth near the seafloor. This unconventional geometry provides less attenuation of the signal through the water column and reduces the effect of lateral echoing from features such as canyon walls. The role of this novel technique in seismic interpretation and its improvement on conventional surface seismics will be studied more within the project.