Mineral Resources Branch

Mining Matters for Nova Scotia 2003

Opportunities for Economic Development

Report ME 2003-2

Ed. D. R. MacDonald

Nova Scotia
Natural Resources

Honourable Richard Hurlburt
Minister

D. J. Graham
Deputy Minister

Halifax, Nova Scotia
2003

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Program

Wednesday, November 19, 2003

8:30 am - 7:00 pm - Registration (Commonwealth Foyer)

10:00 am - 9:00 pm - Displays Open (Commonwealth A)

8:30 am - 8:40 am - Welcoming remarks (Dan Graham, Deputy Minister of Natural Resources)
Note: All talks will be presented in Commonwealth Room B

Session 1 - Current Trends in Precious Metal Activities in Nova Scotia (co-hosted by the Mining Society of Nova Scotia)
Session Chairs: Sam Schwartz, President, Mining Society of Nova Scotia; Howard Donohoe, DNR

8:40 am - 9:00 am
Mike MacDonald, DNR: Summary of Nova Scotia's mineral industry and introduction to Meguma gold deposits

9:00 am - 9:20 am
Rick Horne, DNR: Geological controls on Meguma quartz-vein gold deposits

9:20 am - 9:35 am
Will Felderhof, President and CEO, Acadian Gold Corp.: Forest Hills gold project: an update

9:35 am - 9:50 am
Andrew Von Kursell, President, Azure Resources Corp.: Mooseland-Dufferin gold projects: an update

9:50 am - 10:05 am
Paul Smith, DNR: Non-vein gold mineralization in the Meguma Group: Moose River and Brookfield deposits

10:05 am - 10:20 am
Coffee break

10:20 am - 10:35 am
Bob Ryan, DNR: Nova Scotia-Australia-New Zealand gold connection: implications for Meguma gold deposits

10:35 am - 10:55 am
Dan Kontak, George O'Reilly, DNR: Overview of non-Meguma gold settings in Nova Scotia

10:55 am - 11:20 am
Mike Downes, President and CEO of Monster Copper Corp.: A brief overview of iron oxide-copper-gold (IOCG) deposits and IOCG exploration in Nova Scotia by Monster Copper Corp. and Wallbridge Mining Company

11:20 am - 11:40 am
Rick Horne, DNR: Gold mineralization in the Kemptville shear zone: a possible example of TAG mineralization in southern Nova Scotia

11:40 am - 1:30 pm
Lunch break (no event scheduled)

12:00 pm - 12:20 pm
Fall business meeting of the Mining Society of Nova Scotia

Session 2 - Industrial Minerals: a Precious Resource
Session Chair: Mike Cherry, DNR

1:30 pm - 2:10 pm
Brad Wilson: From amethyst to zircon: the ABCs of Canadian coloured gemstones

2:10 pm - 2:30 pm
Phil Finck, DNR: The 'Windsor Sea' and its precious gift of industrial minerals

2:30 pm - 2:50 pm
Garth Prime, DNR: Insights into the past, present and future of Nova Scotia's stone industry

2:50 pm - 3:00 pm
Garth DeMont, DNR: Why all the excitement about carbonates?

3:00 pm - 3:20 pm
Scott Swinden, DNR: Amendments to the *Mineral Resources Act*

3:20 pm - 5:00 pm
Time to view and discuss displays

5:00 pm - 9:00 pm
Beer and Beef Reception, hosted by the Hon. Richard Hurlburt, Minister of Natural Resources, Cost $10

Thursday, November 20

8:30 am - 12:30 pm - Registration

8:30 am - 4:00 pm - Displays open (Commonwealth A)

Session 3 - Current Geoscience Research in Nova Scotia
Session Chair: Mike MacDonald, DNR

8:50 am - 9:00 am
Mike Cherry, DNR: Opening remarks

9:00 am - 9:20 am
Dan Kontak, DNR: Comparison of the Brazil Lake pegmatite with Little Nahanni pegmatites, N.W.T.: one model does not fit all

9:20 am - 9:40 am
M. B. Parsons, NRCan (Atlantic); P. K. Smith, T. A. Goodwin, DNR; G. E. M. Hall, A. L. Sangster and J. B. Percival, NRCan (Ottawa): Distribution and speciation of elements associated with historical mine tailings at selected lode gold deposits in the Meguma Terrane, southern Nova Scotia

9:40 am - 10:00 am
A. MacRae, St. Mary's University; J. Shimeld and R. Fensome, NRCan (Atlantic): Implications of Upper Cretaceous-Cenozoic shelf sedimentary systems for Scotian Slope reservoirs

10:00 am - 10:15 am
Coffee break

10:15 am - 10:35 am
Dave Risk and Amanda Diochon, St. Francis Xavier University (Environmental Earth Sciences Lab) and Dalhousie University: Ground-level studies of ecosystem carbon cycling processes

10:35 am - 11:20 am
Dave Hughes, NRCan (Calgary): Energy supply/demand trends and forecasts: implications for a sustainable energy future for Canada and the world

11:20 am - 11:40 am
Tom Lamb, Dan Khan and Ernie Hennick, DNR: Mineral rights disposition strategy for the Sydney Coalfield

11:40 am - 1:00 pm
Lunch break (no event scheduled)

1:00 pm - 4:00 pm
Displays open

4:00 pm
Conference closed

Bromine Stratigraphy of Windsor Group Salt in Nova Scotia - A Guide to Evaporite Basin Depositional Conditions, Stratigraphic Correlation, Structural Configuration, Chemical Alteration and Regional Variation

R. C. Boehner

The methodology of utilizing bromine substitution for chloride in progressive saline evaporite deposits, including halite, sylvite and carnallite, has been well developed and applied to potash exploration and interpretation of many marine evaporite sequences. Distribution coefficients for bromine in chloride salts deposited from sea water are less than one. Therefore, residual brines depositing progressive evaporite sequences are systematically and predictably enriched in bromine if the rate of evaporation equals or exceeds the rate of basin influx-reflux.

The Windsor Group comprises five major depositional cycles that approximately coincide with subzones A to E of the lower and upper Windsor. Major Cycle 1 (MC1) is the lowermost (subzone A of the Lower Windsor), thickest and contains the greatest proportion of evaporites, especially salt and locally economic potash. MC1 facies in Nova Scotia, New Brunswick and Newfoundland are very similar lithologically, suggesting interrelated and probably nearly synchronous depositional histories in the Maritimes Basin. Major seaway connections with the Mid-Euramerican Sea (?), possibly through the Nova Scotia Platform and parts of Cape Breton through to Newfoundland, allowed very rapid invasion of a sub-sea-level intermontane basin complex. Physical and dynamic restriction in a highly evaporitic arid environment caused salinity increases from normal to hypersaline. This progression produced the classic marine evaporite suite of marine basal carbonate, anhydrite, halite and potash, with varying siliciclastics in a vertical sequence up to 600 m thick. Although local variations are present in Major Cycle 1, there is generally a regional lateral facies change with less saline facies to the southeast (Nova Scotia Platform) and more saline facies to the northwest (New Brunswick Platform).

Major Cycles 2 and 3 to 5 (middle and upper Windsor Group, respectively) comprise assemblages of numerous individual minor cycles: marine carbonate, anhydrite, salt (rare potash) and red (green) siliciclastics (in ascending order). Salt is typically a minor component and decreases upward in successively younger cycles. In central Cape Breton Island, however, salt is dominant (especially in Major Cycle 2) and the overall stratigraphic thickness doubles or triples.

Bromine profiles representing Br content of NaCl in several widely separated sections of MC1 in New Brunswick and Nova Scotia are similar to the increasing-upward theoretical profile, and actual profiles from marine evaporite analogues worldwide. A distinctive peak in the lower half of the halite phase coincides with major potash deposition. Deviations and irregularities in the overall increasing-upward trend reflect variation in depositional salinity, due in part to repeated freshening influx that produced numerous minor recessive cycles of anhydrite. Locally, Br profiles assist in the correlation of the anhydrite zones as well as confirming or indicating repetition by folding in sequences lacking distinctive marker units. Bromine stratigraphy is useful for indicating the conditions for potash deposition and consequently contributes to assessing the potash exploration potential of an evaporite basin.

Current Research at Joggins: Testimony to a Prospective World Heritage Site

J. H. Calder, S. J. Davies[1], H. J. Falcon-Lang[2], M. R. Gibling[3], B. L. Hebert[4], M. C. Rygel[3] and A. C. Scott[5]

The coastal cliff section of Carboniferous strata at Joggins has long been described as the classic exposure of the Pennsylvanian 'Coal Age'. The high level of scientific investigation presently is in part a response to the prospective nomination of this section and its scientific justification as a natural World Heritage Site. Several papers recently published or currently in press by a working group of international colleagues, referenced below, bear testimony to ongoing discovery and the high level of scientific interest that this classic site continues to hold.

Bibliography

Calder, J. H., Gibling, M. R., Scott, A. C., Davies, S. J. and Hebert, B. L. In press: A fossil lycopsid forest succession in the classic Joggins section of Nova Scotia: paleoecology of a disturbance-prone Pennsylvanian wetland; i*n* S. J. Greb and W. A. DiMichele (eds.), *Wetlands through Time;* Geological Society of America Special Paper.

Davies, S. J. and Gibling, M. R. 2003: Architecture of coastal and alluvial deposits in an extensional basin: the Carboniferous Joggins Formation of eastern Canada; Sedimentology, v. 50, p. 415-439.

Falcon-Lang, H. J. 2003: Response of Late Carboniferous tropical vegetation to transgressive-regressive rhythms at Joggins, Nova Scotia; Journal of the Geological Society of London, v. 160, p. 643-647.

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Falcon-Lang, H. J., Calder, J. H., Davies, S. J., Gibling, M. R. and Rygel, M. C. In press: Palaeobiology meets sequence stratigraphy: all change for the Carboniferous; The Geoscientist.

Hebert, B. L. and Calder, J. H. In press: On the discovery of a unique terrestrial faunal assemblage in the classic Pennsylvanian section at Joggins, Nova Scotia; Canadian Journal of Earth Sciences.

Rygel, M. C., Gibling, M. R. and Calder, J. H. Submitted: Vegetation-induced sedimentary structures from fossil forests in the Pennsylvanian Joggins Formation, Nova Scotia; Sedimentology.

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A Late Triassic Terrestrial Vertebrate Community, as Indicated by Reptile Footprints Preserved in the Upper Wolfville Formation (Fundy Super-group) at North Medford, Nova Scotia[1]

B. Cameron[2] and N. Wood[2]

Vertebrate trace fossils are much more common than body fossils, such as bones and teeth, in the Late Triassic Wolfville and Blomidon formations in the extensive coastal exposures of the eastern and western Annapolis Valley. A one-metre zone near the top of the Wolfville Formation has yielded an abundance of footprints on several bedding surfaces. This unique assemblage was discovered by Donald Baird in 1975 and has only been partially studied and described in two publications since then. One new species of dinosaur footprints, *Atreipus acadianus*, was recognized by Paul Olsen and Donald Baird in 1986.

This footprint assemblage is represented in our collections mostly by isolated footprints on small pieces of sandstone beds eroded free of the outcrop by tides and storms. It clearly indicates, however, that dinosaurs were probably not the numerically and ecologically dominant terrestrial vertebrates of the Late Triassic, although they became so in the succeeding Early Jurassic Period. The late Carnian or early Norian age places this assemblage soon after the time of origin of the dinosaurs. The footprint characteristics of the quadrupedal ichnospecies *Atreipus acadianus* indicate both saurischian and ornithischian features. The typical three-toed, slender pes (about 10 cm long) has a coelurosaur-like shape, but the forefoot prints resemble a hoof-like, four-toed ornithischian manus (about 4 cm long). These are probably the oldest known dinosaur footprints in Canada. The outcrop is being rapidly eroded away by the relentless tides of the Minas Basin, so a detailed study of the ichnofaunule, including the associated small and large invertebrate burrows and trails, is being conducted.

This one ichnospecies is the only dinosaur fossil preserved in the upper Wolfville Formation, but it is associated on the same bedding surfaces with up to four other kinds of footprints made by smaller and larger vertebrates. The dinosaur, therefore, represents only about 20% of the ichnotaxa preserved. The smallest prints (1-1.5 cm long) are those of a probable sphenodontid *Rhynchosauroides* cf. *R.. brunswicki* that left quadrupedal trackways. Somewhat larger prints (about 2-3.5 cm long) may represent two other small reptiles. One is an uncommon digitigrade footprint, and the other is a common plantigrade footprint. The largest footprints belong to a quadrupedal pseudosuchian thecodontid *Brachychirotherium* cf. *B. parvum*. The later is represented with excellently preserved skin impressions that indicate a fine-grained scaly appearance to the wide soles and thick toes of the feet.

Because we have been able to recover some short trackways of *Atreipus acadianus*, *Brachychirotherium* cf. *B. parvum*, and *Rhynchosauroides* cf. *R.. brunswicki,* we are attempting to determine the characteristics of their locomotion, such as speed, using the equations of R. McNeill Alexander. These trackways should also allow us to estimate the size and shape of the trackmakers.

Concurrently, we are studying the sedimentology and stratigraphy of the site to enhance our under-standing of the paleoenvironments and paleoclimate at the time these trace fossils were made. Because trace fossils represent dynamic interactions preserved in the sediments where they were made, it is possible to use them to better understand the habits, dynamic interactions, and paleoecological structure of this community of vertebrate and invertebrate trackmakers.

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Overview of a New Mapping and Resource Evaluation Program for NTS Areas 11E/06 and 11E/07

P. S. Giles and R. D Naylor

The Geological Survey of Canada (GSC) and the Nova Scotia Department of Natural Resources have initiated a two year project to create new 1:50 000 scale digital maps of NTS areas of 11E/06 and 11E/07 and improve the understanding of the hydrocarbon and mineral resources in these map areas. The work forms part of the Targeted Geoscience Initiative (TGI) Program, and a project to evaluate the Hydrocarbon Potential in Paleozoic Basins of the Canadian Appalachians. In addition to GSC and NSDNR staff, this collaborative project will include researchers from various Canadian universities, other government organizations and industry.

The majority of the study area is underlain by Carboniferous strata that are of considerable interest for hydrocarbon and mineral resource potential. Unfortunately, uncertainty about the stratigraphy and structure of the Carboniferous strata has often hindered exploration efforts. Higher quality bedrock and geophysical maps are required to develop more refined stratigraphic and structural models to assist mineral and hydrocarbon exploration.

Recent high-quality (often 1:10 000 scale) bedrock data exist for significant parts of the study area. However, much of the data has not previously been made publically available in map form. Digital compilation and interpretation of these data will be one of our initial priorities. New bedrock data will be collected in areas where high-quality mapping data does not exist. We expect that most new mapping will be undertaken within NTS area 11E/06. Geophysical data (including seismic, vertical gradient and potential field data) exist within the project area. The quality of these data will be evaluated and, where possible, new digital geophysical maps and cross-sections will be created.

Specific mineral deposit and hydrocarbon potential assessments will also form a component of our work. These include study of regional maturation data and Cu-U-Au mineralization near Mount Thom.

The goal of this project is to collect, compile, interpret and publish as much high-quality geological information as possible for the study area. Combining new project data with recent, unpublished high-quality historical data will allow us to produce comprehensive maps and reports that will be of significant interest to mineral and hydrocarbon exploration companies.

Geochemical Metadata Compilation: An Update

T. A. Goodwin and B. E. Fisher

The geochemical metadata compilation project continued throughout the year, albeit at a reduced pace relative to previous years. The project was initiated two years ago to capture metadata from regional geochemical data sets available from the Department of Natural Resources.

Metadata include but are not limited to: (1) survey information such as the year(s) the survey was completed, the survey area, sample density, project funding, field preparation methods, names of the sampling crews etc., (2) sample preparation information including the name of the laboratory, drying temperature, size fraction, etc., (3) analytical methodology information including the name of the laboratory used, dissolution technique, elements analyzed, detection limits, etc., and (4) publication information including citations for open file reports and/or maps, plus where the digital files reside on the department's server.

Once all pertinent survey information has been captured and entered into a digital database, the metadata database will serve as a timeless archive of all survey information, which is critical when comparing or merging various data sets that are not linked temporally or analytically. End users can then determine the applicability of each data set once metadata files are reviewed.

To date, the department has entered metadata for the regional geochemical surveys tabulated below.

MEDIUM	YEAR(S)	SURVEY AREA	REPORT(S)
soil	1986-1988	Meguma Zone	OFR 94-021
till	1986-1988	Meguma Zone	OFR 94-021
till	1977-1986	mainland Nova Scotia	various
till	1984-1989	South Mountain Batholith	OFR 90-004 to 006
rock	1984-1989	South Mountain Batholith	OFR 89-001, OFR 90-007
stream sediment	1982-1983	northern Nova Scotia and Cape Breton	various
stream sediment	1986-1987	northern Nova Scotia	OFR 89-007
stream water	1986-1987	northern Nova Scotia	OFR 89-007
lake sediments	1977-1978	southern mainland Nova Scotia	various
lake sediments	1984	re-analysis of southern mainland N. S.	various
lake sediments	1983	eastern Cape Breton	various
lake water	1983	eastern Cape Breton	various
trees	1991	southwestern Nova Scotia	GSC OF 2556
trees	1991	southeastern Cape Breton	GSC OF 2558

Final editing of each file has not been completed to date. Future work will include the capture of pertinent metadata for the remaining digital geochemical data sets available from the department and the identification of any inconsistences or errors that may reside within the data sets.

The South Mountain Batholith Geochemical Database: An Update

L. J. Ham

The South Mountain Batholith (SMB) of southwestern Nova Scotia was geologically mapped as part of the 1984-1989 Canada-Nova Scotia Mineral Development Agreement. In addition to mapping, 597 geochemical samples, representing the complete range of composition within the batholith, were analyzed for major oxides and 21 trace elements. The data were released as two open file reports (Ham *et al.,* 1989, 1990); these reports included sample location maps, which were manually drafted.

Sample locations were digitized onto base maps in the early 1990s. These sample locations and corresponding analytical results were ultimately posted to the Nova Scotia Department of Natural Resources (NSDNR) web site. Fourteen NTS map areas comprise the SMB, and sample locations were plotted on individual 1:50 000 scale map sheets.

Recent interest in granites and the SMB has seen a corresponding renewed interest in the SMB geochemical database. With the renewed interest, however, came the realization that because of improvements in computer technology, data manipulation and projection differences, positional errors had been introduced for the geochemical sample locations. The majority of these sample locations plot incorrectly (on average ± 500 m) on the digital bases. However, although the locations are mis-plotted, general geochemical patterns and interpretations drawn for the SMB using the analytical data are not affected.

A project was initiated to correct the locations for the entire database. This work was undertaken in collaboration with Dr. Cliff Stanley at Acadia University. Geology students at Acadia University researched the original field maps (1 inch to 1/4 mile scale) and field notes from the SMB project, and re-plotted locations of all samples. These locations, and questionable or missing locations, were subsequently verified by the author and a summer student during the summer of 2003.

The verification of these sample locations with greater accuracy (<100 m) is almost complete, with 13 of the 14 sheets finished. The revised data will be given to the NSDNR GIS staff and posted to the web site in the near future.

References

Ham, L. J., Corey, M. C., Horne, R. J. and MacDonald, M. A. 1990: Lithogeochemistry of the western portion of the South Mountain Batholith, Nova Scotia, NTS Map Sheets 21A/03, 21A/04, 21A/05, 21A/06, 21A/07, 21A/11, 21A/12 and 21A/14; Nova Scotia Department of Mines and Energy, Open File Report 90-007, 42 p.

Ham, L. J., Marsh, S. W., Corey, M. C., Horne, R. J. and MacDonald, M. A. 1989: Lithogeochemistry of the eastern portion of the South Mountain Batholith, Nova Scotia, NTS Map Sheets 11D/05, 11D/12, 11D/13, 21A/09, 21A/10, 21A/15, 21A/16, and parts of 21H/01 and 21H/02; Nova Scotia Department of Mines and Energy, Open File Report 89-001, 65 p.

Energy Supply/Demand Trends and Forecasts: Implications for a Sustainable Energy Future for Canada and the World

J. D. Hughes[1]

An analysis of world and North American energy production and consumption over the past several decades indicates strong growth. Even with the growth of "zero emission" nuclear and large hydro, hydrocarbons (oil, gas and coal) made up more than 85% of world primary energy consumption in 2002, and are forecast to make up more than 85% of a greatly expanded energy demand by 2025. Energy demand in the developing world is forecast by the Energy Information Administration to grow by 94% through 2025, when this region will account for nearly half of the world's energy consumption. The question is, are these forecast growth rates sustainable, given the magnitude and distribution of the world's remaining energy reserves, and what are some of the political and social ramifications of maintaining this rate of consumption? Natural gas in North America is of particular concern, as it is largely a captive market (with the exception of about 1% LNG at present) and demand, particularly for electricity generation, is forecast to grow dramatically over the next two decades. This talk focuses on the "Big Picture" and how Canada fits into it, as well as what must be considered going forward to assure a sustainable energy future.

David Hughes Biography:

David Hughes is a geologist with more than 30 years experience studying the energy resources of Canada for the Geological Survey of Canada and the private sector. He is the Leader of the National Coal Inventory, which is a digital knowledge base on coal used to determine the availability of resources for conventional and non-conventional uses, including coalbed methane production and the sequestration of CO_2. He is also Team Leader for Non-conventional Gas for the Canadian Gas Potential Committee. For the past several years, he has developed a keen interest in the "Big Picture", as it relates to the longer term prognosis for continuity of energy supplies and some of the political and environmental ramifications concerning their use.

[1]Geological Survey of Canada, Calgary, Alberta

Comparison of the Brazil Lake, Nova Scotia, and Little Nahanni, N.W.T., LCT Pegmatite Suites

D. J. Kontak, L. Groat[1] and E. Barnes[1]

Spodumene-rich pegmatites form part of the LCT (enriched in lithium-cesium-tantallum) subgroup. Globally these pegmatites are important sources of Li, Cs, Ta, Nb and Sn, are sought after for valued gem minerals, and are important sources for industrial minerals. Comparison of two LCT pegmatites, the Brazil Lake area of southwest Nova Scotia and the Little Nahanni area (LNPG) of the Northwest Territories, indicates that whereas there are general similarities, there are also dramatic differences between the two and, therefore, one genetic model does not fit all. Importantly, the excellent exposure of the LNPG suite indicates that there is more to the Brazil Lake area than exposure suggests.

The Brazil Lake pegmatites occur as ≤10 m wide and ≤100 m long lenses in deformed metavolcanic and metasedimentary rocks of the Silurian White Rock Formation. U/Pb dating of tantalite indicates pegmatite crystallization at 378 ± 1 Ma, which contrasts with a Re/Os age of 354 ± 3 Ma for molybdenite from a quartz vein adjacent to the pegmatite. The pegmatite lenses are slightly discordant to the Acadian-age, northeast-trending and steeply-dipping fabric in the wall rocks, and bent spodumene crystals and mylonitic fabrics occur in the pegmatites. The pegmatites are dominated by coarse (≤1.5 m), blocky K-feldspar (Or_{75-80}), coarse spodumene (≤2 m) and quartz. Abundant secondary albite occurs as fine-grained, sacchroidal-textured albite or euhedral platy cleavelandite. White mica occurs throughout the pegmatite, most of which is of secondary origin. Accessory minerals include tourmaline, Nb-Ta oxides, garnet, triplite (?), amblygonite-montebrasite, apatite, beryl, and cassiterite. The pegmatite is unusual in that it lacks discrete internal layering, pocket zones, rarely has a discontinuous aplite zone at the contact, but instead has areas dominated by either coarse spodumene or K-feldspar. Abundant secondary albite records a pervasive metasomatic overprint reflecting incursion of a Na-rich fluid during the subsolidus stage of pegmatite evolution. Much of the tantalite, apatite and mica relates to these albitic zones. Metasomatism of the wall rocks is manifest by the presence of tourmaline in both the volcanics and sediments.

The LNPG suite is a Cretaceous (81 Ma) dyke swarm of ca. 11 km by 5 km, hosted by deep water sedimentary rocks of the late Proterozoic, Selwyn Basin Hyland Group that are regionally deformed and metamorphosed. Near the LNPG suite the metasediments contain andalusite, staurolite and cordierite suggestive of a thermal dome. Individual pegmatites exceed 1-2 km and are ≤15 m wide and fall into spodumene- and lepidolite types, with the former more common. The pegmatites are internally organized with a narrow (≤5 cm) wall zone of aplite followed by alternating layers, sometimes crenulate-textured, variably enriched in spodumene or lepidolite, coarse K-feldspar and quartz. Pocket zones are rare and when present are at higher structural levels. Albite occurs as a late-stage subsolidus mineral that records Na metasomatism. Enrichment in Nb, Ta and Sn occur where secondary albite is developed, as in Brazil Lake pegmatites.

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Regional Fold Geometry of the Meguma Group, Halifax Region to Ecum Secum

S. K. Y. Lee[*1], *N. Culshaw*[1] *and R. J. Horne*

Folds are commonly accompanied by thrusts in deformed low- to medium-grade sedimentary belts. The Acadian fold belt affecting the Meguma Terrane (comprising the slaty Halifax and sandy Goldenville formations) in south mainland Nova Scotia lacks thrusts.

To address why folds predominate in the Acadian Fold Belt, an applied geographic information systems-geophysical approach provided the tools to establish and constrain a basic geometry of the folds with the construction of balanced cross-sections.

The construction of balanced cross-sections requires a minimum of two bed (marker) units; however, there is only one mapped marker in the Acadian Fold Belt, the Halifax-Goldenville boundary. Nonetheless, the existence of a consistent pattern of vertical gradient magnetic (VG) anomalies within the sandy Goldenville Formation suggested that construction of two "virtual" markers was a viable option. In detail, the pattern of VG anomalies consisted of several discrete VG anomalies that implied the presence of sulphide-rich slaty beds within the Goldenville. Surprisingly, these discrete VG anomalies correlated with "slate-like" lithologies within the Goldenville illustrated on the cross-sections (but not mentioned in map legends) of E. R. Faribault (1893-1909). Like other sulphide-rich slaty units in the Meguma Terrane (MT), geophysical modeling of Faribault's geological section utilizing the inferred slaty units interlayered with the sandy Goldenville produced high calculated VG anomaly patterns similar to the observed. Two additional "virtual" markers were then established and, together with the Halifax-Goldenville boundary, allowed for the construction of balanced sections.

Across the 90 x 150 km^2 study area, four cross-sections were built with these three marker horizons using the kink method. Application of the kink method assumes parallel folding, therefore constant unit thickness. Local investigations show that flexural-slip (i.e. layer-parallel folding) occurred in the MT (Horne, 2001). Comparisons between balanced cross-sections reveal how folds in the Acadian fold belt evolved. From south to north, folds appear to almost double in amplitude, i.e. towards the Chedabucto-Cobequid fault zone, and a common vergence of folds does not exist. From west to east or vice versa, one can observe how fold hinges bifurcate, and/or migrate (Young, 2000) from chevron- to box-fold geometry during the development of anticlinoria and synclinoria. Current cross-sectional analysis has resulted in the questioning of the existence of a discrete detachment horizon.

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Young, M. D. 2000: "Minor folds in coticule layers and their relationship to regional fold evolution, central Meguma Terrane, Nova Scotia", B.Sc. Honours thesis, Dalhousie University, Halifax, Nova Scotia.

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Distribution of Zinc and Cadmium in Stream Sediments from the West Barney's River Area, Antigonish Highlands, Nova Scotia

C. Moore[1], C. Stanley[1] and T. A. Goodwin

Several stream sediment geochemical surveys have been undertaken by the Geological Survey of Canada, the Nova Scotia Department of Natural Resources, and private mining companies in the Antigonish Highlands since the late-1950s in an attempt to locate potentially economic mineralization. As a result of these surveys, three areas of 3-5 km^2 size have been identified that contain anomalous concentrations of Zn. These are located at Kirkmount, Eigg Mountain, and Georgeville, and occur in areas underlain by large regional-scale faults. At Kirkmount, drilling by the Nova Scotia Department of Natural Resources has revealed the presence of willemite hosted by a major regional-scale structure. As a result, these three geochemical anomalies are thought to be related to undiscovered oxide zinc deposits hosted by these through-going structures.

A fourth Zn geochemical anomaly of much larger spatial extent (roughly 30 km^2; > 500 ppm) has also been identified, and occurs within the West Barney's River drainage basin. Rocks in this area are underlain by a Devonian granite intrusion, and large-scale regional faults are absent. At present, no conclusive geochemical evidence exists to explain why this area contains anomalous Zn and Cd. As a result, the source of this large geochemical anomaly remains unclear.

Consequently, a high density stream sediment survey (300 m spacing) in the West Barney's River drainage basin was conducted in May-June 2003. *Aqua regia* digestion and ICP-OES and ICP-MS geochemical analysis of the -125 µm sediment fraction of approximately 100 samples for trace elements confirms the anomalous character of Zn and Cd in these stream sediments. Unfortunately these data fail to provide evidence of the type of mineralization present in the drainage basin.

Oxide zinc deposits contain a number of naturally occurring minerals, some of which are soluble in surface waters. These include: willemite [Zn_2SiO_4], hemimorphite [$Zn_4Si_2O_7(OH)_2 \cdot H_20$], sauconite [$Zn_6Si_8ZnO_{20}(OH)_4$], zincite [ZnO], zinc hydroxide [Zn(OH)], hydrozincite [$Zn_5(CO_3)_2(OH)_6$], and smithsonite [$ZnCO_3$]. The speciation of Zn in the stream sediments may provide constraints on the mineral hosting Zn at its original source. For example, if Zn was hydromorphically dispersed and subsequently adsorbed on clays, carbonate minerals, organic material, and/or Fe- and Mn-oxy-hydroxides, it is likely that the original Zn minerals were soluble. Alternatively, if the Zn is dispersed clastically downstream as heavy minerals, the Zn was likely originally contained in insoluble minerals.

Work in progress on a 15 sample subset of the original samples from across the study area is directed to determine in what form the anomalous Zn exists in the stream sediments. This involves total multi-element analysis of the non-magnetic heavy mineral -2 mm +125 µm fraction of the sediment samples, and sequential selective extraction analysis of the -125 µm sediment fraction. Based on the metal speciation determined from these results, other geological and mineralogical constraints, and remote sensing and geophysical information, the source mineralogy, geochemical/mineralogical dispersion mechanism, and possibly the location of the source of this anomaly, will hopefully be determined.

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Distribution and Speciation of Elements Associated with Historical Mine Tailings at Selected Lode Gold Deposits of the Meguma Terrane, Southern Nova Scotia

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This multidisciplinary project, part of the Geological Survey of Canada's Metals in the Environment (MITE) Program, was initiated in April 2003 to examine the distribution of metals and metalloids in the environment surrounding historical gold mining operations throughout Nova Scotia. From 1861 to the mid-1940s, gold was produced from 64 mining districts in the province. During this time, most of the gold was recovered using stamp mills and mercury amalgamation, and an estimated 10-25% of that Hg was lost to the tailings. Other potentially toxic elements (e.g. As, Tl) occur naturally in the ore, and may be present at relatively high concentrations in the mine wastes. Recent Environment Canada studies of the Caribou and Goldenville gold districts have shown that elevated concentrations of As, Cd, Hg, Pb, and Tl are present in the tailings, surrounding waters, surface sediments, and biota downstream from these mine sites. Although there is limited published information on the Au content of tailings from many of these deposits, the concentrations of Hg and other elements at most sites have yet to be determined. The primary and secondary (weathering-related) mineralogy of the tailings is not well understood, and the speciation and potential biological impacts of metals and metalloids in the environment surrounding these sites are currently unknown. The main objectives of the present study are to: (1) determine the concentrations, distribution, and speciation of elements near these mine sites; (2) identify and characterize processes that control the release of elements from the tailings; and, (3) quantify the off-site transport of elements from the mine wastes, and the transformation and fate of these elements in the receiving environments.

The first year of this three-year project focused on identifying gold mines that are most likely to contain significant quantities of Hg in the mine wastes (based on production records), and included reconnaissance-level sampling of tailings, soils, till, rocks, sediment, water, and vegetation at ten gold mining districts: Mount Uniacke, East Rawdon, Leipsigate, North Brookfield, Whiteburn, Lake Catcha, Mooseland, Salmon River, Cochrane Hill, and Upper and Lower Seal Harbour. Hyperspectral and polarized radar measurements of the tailings and vegetation at Upper and Lower Seal Harbour were carried out by Geomatics Canada, and samples of water, sediments, and tailings were collected from Lake Catcha and Lower Seal Harbour by the University of Ottawa for microbial measurements and methylmercury analyses. At most sites, the mine tailings display a well-developed vertical stratigraphy, with reddish-brown oxidized tailings overlying grey, unoxidized tailings. X-ray diffraction results show that secondary minerals such as scorodite ($Fe^{+3}AsO_4 \cdot 2H_2O$) are abundant at many sites; these phases may serve as a temporary sink for elements released from the mine wastes. Preliminary water chemistry data indicate that the dissolved (<0.45 µm) concentrations of As are very high at some locations (up to 6200 µg/L), as compared to background values of generally less than 25 µg/L (the Health Canada drinking water limit). Additional chemical and mineralogical results are pending. Based on the results of these initial analyses, between one and three sites will be selected for detailed multidisciplinary studies during the second field season.

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Bedrock Aggregate Potential Near the Halifax-Dartmouth Market

G. Prime

A recent examination of aggregate potential in the Halifax-Dartmouth area by NSDNR concluded that the future of the resource may be in jeopardy. Although local quarries are currently capable of supplying the 3 million tonnes of stone required each year, reserves are declining. At the same time, attempts to permit new quarries which could replenish stone supplies have been unsuccessful. This dilemma can largely be attributed to the recent population growth and urban development, which have encroached on the resource land. Competing land uses, municipal by-laws and environmental regulations have severely restricted where quarries can operate in the region. The problem is compounded by a lack of legislation which might offer some protection to the resource. As a result much of the resource land has been sterilized and the remainder is being threatened with a similar fate. If present trends continue, access to the resource will ultimately disappear.

It is the opinion of the author that the potential loss of the local resource is a concern which should be taken seriously. These basic construction materials are essential to the prosperity of the community. If they can't be produced locally, they must be obtained elsewhere. The simplest and most realistic alternative would appear to be truck hauls from distant locations. However, one major drawback to this option is transportation costs. Haulage charges are the highest component in the delivered price of aggregate. Depending on the location of the aggregate source, this solution could double or triple the landed cost of the stone. This would significantly increase the costs of basic construction, such as homes and publically funded infrastructure. More than 300 tonnes of aggregate are used in the construction of a new home in Canada while each kilometre of paved two-lane highway requires about 26,000 tonnes of stone. Thus the consumer and the tax payer should have an interest in where Metro obtains its stone. Beyond the socio-economic value of reasonably priced aggregate are the environmental benefits associated with local sources. Each additional kilometre that a tonne of stone has to be hauled requires more fossil fuels, generates increased emissions and increases wear on equipment and highways. As a responsible society, we should make every effort possible to keep these costs to a minimum.

If the resource is endangered, is there anything that we can do to extend or protect it? To answer this question, NSDNR has decided to take a second look at the aggregate potential in the region. The goal is to determine if there are any sites near Metro which realistically have a chance of producing high-quality aggregate in the future. The focus is locations which: (1) have geotechnical characteristics suitable for the production of high-quality aggregate, (2) occur near the Metro market, and (3) would minimize social and environmental impacts. An examination of geological data, a land-use constraints map, air photos and the property ownership database has resulted in the identification of an area with promising characteristics for resource development. A field investigation and sampling program were conducted in the autumn of 2002. Based on the field observations and analytical data, there appear to be locations within the study area which may be suitable for quarrying aggregate. In addition to the technical merits of the sites, they were also selected because of their proximity to a 100 series highway. Although this would normally be seen as a major handicap to development because of the highway's controlled access, it may actually be an opportunity to minimize impacts on the community. The author proposes that the construction of a dedicated access by way of an overpass connector may be a solution. The capital costs of the structure would be expensive; however, it may provide an opportunity to produce high quality aggregate near the market for several decades into the future. A report is being prepared and will be available early in the new year.

Towards a Regional Groundwater Resource Characterization of the Annapolis-Cornwallis Valley, Nova Scotia

M. Ross[1], C. Rivard[1], Y. Michaud[1], C. Deblonde[1], T. Webster[2], A. Rivera[1] and A. Blackmore[2]

The Annapolis-Cornwallis Valley Aquifer Study (ACVAS) is a three-year project that will assess the groundwater resource at regional scale. In recent decades, population growth, intensive farming and economic development of the Annapolis-Cornwallis Valley have put high pressure on water resources. One of the consequences is that surface water supplies in the Annapolis-Cornwallis Valley have become insufficient. The perceived solution is to use groundwater. However, the extent of groundwater resources is still poorly known in the Annapolis-Cornwallis Valley and knowledge, regarding aquifer/aquitard geometry and properties, as well as recharge rates and groundwater dynamics at regional scale, is limited. The overall objective of the ACVAS project is thus to characterize and quantify groundwater resources within the granular and fractured aquifers of the Annapolis-Cornwallis Valley, to ensure their protection and to optimize their management and exploitation. So far, a wealth of archival data have been gathered and transformed into a numerical format when necessary; a piezometric survey has been carried out; and real-time monitoring of groundwater levels have been initiated, allowing the development of the project database and the preliminary hydrogeologic characterization phase. The latter also includes the preliminary computer-based construction of a geologic/hydrostratigraphic model. A common framework model is thus emerging which, presented in numerical format, allows the current knowledge of unit distribution and thickness as well as the physical properties of the material. This preliminary effort already supports decision-making and scientific reasoning necessary to optimize field work planning for the next year. Indeed, the capabilities of modern geomodeling systems, such as 3D visualization, truly help identify areas which need further investigation and help improve general understanding of the basin geology and hydrogeologic settings. It is expected that the resulting 3D framework will eventually provide the needed information to the regional groundwater flow model, as well as for other hydrogeologic applications, such as aquifer vulnerability mapping.

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Surficial Geological Map and Arcview® Database for NTS Map Area 11F/11 (Port Hawkesbury)

R. R. Stea

The surficial geology map for the Port Hawkesbury map area is near completion and will be exhibited at Mining Matters for Nova Scotia 2003. The map is based on surface mapping and air photograph interpretation of the area, along with compilation of previous 3D stratigraphic data including water well logs, diamond-drill holes and geotechnical drilling. These data were integrated into the ARCVIEW® Geographic Information System. The GIS database will include 3-dimensional surficial information including high-resolution seismic surveys, new diamond-drilling, and wire line coring in areas of thick unconsolidated deposits. The map and database will be an invaluable tool for:

1. exploration of industrial mineral commodities such as sand, gravel, industrial clays and peat resources,
2. geotechnical and environmental assessments for construction,
3. evaluation of surface and subsurface water resources, and
4. interpretation and evaluation of landscapes and biodiversity.

Early Cretaceous Outliers in Northern Nova Scotia: The Fault Connection

R. R. Stea, G. Pe-Piper[1] and D. J. W.Piper[2]

This project was designed to evaluate the stratigraphy, sedimentology and provenance of the terrestrial Early Cretaceous outliers in Nova Scotia with the goal of assembling a paleogeographic reconstruction of that time period, linking the onshore deposits with the offshore basins. The study is in part funded through the ExxonMobil Sable Project, Petroleum Research Atlantic Canada, and NSERC. Oil and gas reservoirs have been found in the deltaic facies of the Early Cretaceous depositional basins offshore and further exploration and reservoir development will be enhanced by a more complete picture of the paleo-drainage and fluvial systems and their detrital petrology. The Cretaceous outliers host deposits of silica sand (presently mined in both Nova Scotia and New Brunswick) and kaolin and further drilling may uncover new deposits of these valuable industrial minerals. With these goals in mind the research team has designed a project to compile existing sources of data and obtain new data in the “hidden” Cretaceous basins of Nova Scotia.

Two outliers were drilled at Belmont, Colchester County, and Brierly Brook, Antigonish County. Seven holes were drilled at the Brierly Brook area and the known area of outcrop was extended from a single exposure to an open-ended, linear belt of occurrences 3 km long along the northern edge of the Antigonish Basin. Up to 40 metres of interbedded silica sand, organic stony clay, and variegated silty clay were encountered in the narrow (~100 m wide) outcrop belt. Preliminary pollen analysis implies an Early Cretaceous age for the organic clay (R. Fensome, personal communication, 2002). At Belmont, three holes were drilled, in a north-south transect across the outlier, with the northernmost two holes encountering 30 m of Cretaceous sediments. Reconnaissance of bedrock and water wells of the area shows a linear east-west belt of possible occurrences, associated with a deep trough of unconsolidated sediment and an east-west trending fault in Triassic bedrock.

There is increasing evidence that the Early Cretaceous strata are preserved in downfaulted blocks along fault zones that define the margins of highland regions in Nova Scotia. Late-Mesosoic dextral slip on the Cobequid - Chedabucto - SW Grand Banks fault system can account for the observed deformation of the Chaswood Formation, and also explains some of the major themes in the Cretaceous evolution of the Scotian Basin. A further implication of the emerging data is that much of the present Nova Scotia landscape owes its origin to late Mesozoic tectonic activity rather than differential erosion during the Tertiary.

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Geology of the Washabuck Peninsula, Central Cape Breton Island, Nova Scotia

D. R. G. Wasylik[1], C. E. White and S. M. Barr[1]

The Washabuck Peninsula lies in the central part of Cape Breton Island in the area between Iona, Baddeck and Whycocomagh in the Bras d'Or Lake. Recent geological mapping on the peninsula, at a scale of 1:10 000, confirms the presence of pre-Carboniferous basement blocks with lithological similarities to other Neoproterozoic basement blocks in the Bras d'Or Terrane. These basement blocks are overlain by Carboniferous sedimentary rocks of the Horton Group.

The oldest stratified rocks in the basement blocks, herein termed the Maskells Harbour Formation (MHF), occur in two separate areas. In the northeast the formation consists of interbedded quartzofeldspathic metasandstone and metasiltstone with thin minor quartzite and marble; however, the block in the southwest consists dominantly of calcitic to dolomitic marble interbedded with minor quartzite. The MHF in the northeastern block is intruded by unfoliated, medium-grained diorite, quartz diorite and hornblende-biotite granodiorite, herein termed Washabuck pluton. Associated with the pluton are late-stage coarse-grained hornblendite dykes. The MHF in the southwestern block is intruded by unfoliated medium- to coarse-grained hypidiomorphic hornblende-biotite granite and associated aplitic dykes, herein termed the Grassy Cove granite. Similar granite occurs in the northeastern block as large dykes in the MHF and Washabuck pluton. All igneous units contain metasedimentary xenoliths of the MHF and like the MHF are cut by numerous mafic dykes.

Regional metamorphic grade in the MHF is relatively low, and reaches only biotite grade; however, close to the margins of the plutonic units, grade has increased to produce cordierite-biotite assemblages. This increase in grade has imparted a gneissic appearance to the metamorphic rocks by accentuating the bedding but it is clearly related to contact metamorphism. No gneissic or migmatitic rocks were observed. Because of lithological similarity to the Blues Brook and Malagawatch formations, the MHF is considered to be part of the Neoproterozoic George River Metamorphic Suite. The similarity of the Washabuck pluton and Grassy Cove granite to dated igneous units in the Creignish Hills and North Mountain suggest similar Late Neoproterozoic ages for these units. These correlations indicate that the basement blocks on the Washabuck Peninsula are part of the Bras d'Or Terrane.

Overlying the older units are sedimentary rocks assigned to the Horton Group, which like elsewhere in Cape Breton Island can be subdivided into three formations. The oldest unit, Creignish Formation, consists of orange oligomictic conglomerate, arkosic sandstone and siltstone with minor red sandstone and siltstone. Clasts are dominantly granitic. The overlying Strathlorne Formation is characterized by dark grey siltstone, sandstone and thin impure limestone. Although red sandstone and siltstone is typically absent in the Strathlorne Formation it increases in abundance towards the top of the unit, which is conformably overlain by red sandstone, siltstone, polymictic conglomerate and minor grey siltstone of the Ainslie Formation. Throughout the Ainslie Formation are minor interbeds of grey, locally fossiliferous limestone. Along the northwestern margin of the peninsula the Ainslie Formation is disconformably overlain by grey laminated limestone of the Macumber Formation that forms the basal member of the Windsor Group. However, the contact between the Windsor and Horton groups is a fault on the southeastern side of the peninsula. Although faults are common, the distribution of units indicates that the Horton Group is folded into a regional southwest-plunging anticline, with the metamorphic and igneous "basement" rocks in the core.

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GIS Database Construction in Support of a GSC-lead Groundwater Project for the Annapolis-Cornwallis Valley

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The Geological Survey of Canada (Quebec) along with several partners (NSDNR, NSDOE, Acadia U., AGRG/COGS, USGS, NGOs) have begun a hydrogeology project within the Annapolis and Cornwallis Valleys of Nova Scotia. This area is the most productive agricultural region within the province. With droughts in recent years and increased population there is a need for better water resource management. Thus, this area has been targeted as a national strategic aquifer. The Applied Geomatics Research Group at COGS has a role to compile a digital GIS database of all the relevant information to the project. The compilation began in the summer of 2003 and has involved the digitization of paper maps related to the quaternary and bedrock geology along with drillhole stratigraphy and water well information. Additional GIS layers that are important to the project when considering the water budget, surface-groundwater interaction, water quality, and aquifer recharge are landcover and landuse information and a Digital Elevation Model (DEM). Currently the highest resolution DEM available for the region is based on the NSTDB 1:10 000 maps at a 20 m resolution. As part of their research program, the AGRG has also been involved in a project to collect very dense and precise elevation using a new technology known as LIDAR – Light Detection and Ranging, which involves firing a laser from a aircraft to measure the terrain elevation. Part of the valley has already been processed near Bridgetown and the eastern end of the valley was flown in May of 2003, with the remaining western extent planned for the fall of 2003. This new technology allows the ground to be measured below the vegetation canopy, thus providing terrain detail that has not been previously available by using traditional aerial photography techniques to extract elevation. This new data will be used to produce a DEM on the order of 2 m resolution with a height accuracy of 30 cm. The existing 20 m DEM and the high resolution DEM from LIDAR will eventually be used to interpret the surficial landforms for the valley. The area has been affected by at least four ice advances and has a complex glacial history. The revised landforms will be important in order to map out different hydrostratigraphic units within the valley. The landforms can be interpreted from their geomphological characteristics and validated with ground truthing to determine their composition. These data can then be used in combination with drill hole information to build a new 3-D model for the area to be used for groundwater modeling applications by the GSC. This model can then be used to access the aquifer distribution within the area and can be used as a management tool for examining issue such a recharge rates, water budget, and vulnerability to contamination.

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Geology of the Whycocomagh Map Area (NTS 11F/14), Southwestern Cape Breton Island[1]

C. E. White, R. C. Boehner and G. J. DeMont

A significant component of the federal-provincial Targeted Geoscience Initiative (TGI) was the geological compilation map of the Whycocomagh map sheet (11F/14) in southwestern Cape Breton Island. The TGI provided an opportunity to compile and update previous geological mapping and re-assess previous work in the area, as well as to acquire new data that were critical in interpreting and understanding the complex geology in the area. The oldest stratified units in the map area are exposed in the Creignish Hills and on North Mountain. They consist of low-grade metamorphic rocks including slate, quartzite, marble and metavolcanic rocks (Blues Brook and Malagawatch formations, respectively) and have been assigned to the George River Metamorphic Suite. Other stratified units include low-pressure/high-temperature amphibolite-facies gneiss, amphibolite and migmatite (Skye Mountain and Melford metamorphic suites and Lime Hill gneissic complex) which are part of the Bras d'Or Gneiss. The metamorphic rocks have been intruded by ca. 555 Ma varied dioritic to granitic plutons with calc-alkalic, continental-margin arc affinity. These rocks represent the southernmost exposed part of the peri-Gondwanan Bras d'Or terrane.

Unconformably overlying or in faulted contact with the basement blocks is a complex late Paleozoic overstep basin fill comprising sedimentary rocks of the Carboniferous Horton, Windsor, Mabou and Cumberland groups. The Horton Group consists of coarse- and fine-grained siliciclastic rocks which exceed 2000 m in thickness northwest of the Creignish Hills, but thin dramatically to approximately 100 m on the southeastern side of the Creignish Hills. These rocks are locally overstepped by the Windsor Group on North Mountain. Basaltic and rhyolitic flows of the Fisset Brook Formation underlie the Horton Group in the western part of the map area. The Windsor Group is dominated by saline evaporite rocks including salt and minor potash with subordinate carbonate rocks, anhydrite and red beds. It is complexly deformed with isoclinal and recumbent folds in the middle and upper parts above a major decollement. This regional Ainslie detachment occurs near the top of the basal anhydrite and basal carbonate of the lower Windsor Group, which appear to have remained structurally attached to the underlying Horton Group and basement rocks. The medium- to fine-grained siliciclastic strata of the Mabou and Cumberland groups that conformably overlie the Windsor Group and are generally less deformed (e.g. Maple Brook Syncline). However, this contact is also inferred to be a detachment, at least locally separating the siliciclastic strata from underlying saline evaporitic rocks of the mobile Windsor Group.

Two drill holes in the River Denys basin have intercepted basaltic flow rocks on top of Carboniferous strata. A recent $^{40}Ar/^{39}Ar$ whole-rock analysis indicates that the basalt is Mesozoic in age and hence may be genetically related to the Triassic-Jurassic North Mountain Basalt on mainland Nova Scotia and southern New Brunswick.

The pre-Carboniferous rocks are hosts for numerous base- and precious-metal deposits and as sources of carbonate rock, building stone and aggregate. Carboniferous rocks contain major industrial mineral deposits including salt and gypsum, as well as numerous occurrences of base metals, barite, potash, limestone and anhydrite. Carboniferous units are also currently being explored for their hydrocarbon potential.

[1]Project funded by Nova Scotia Department of Natural Resources, the federal-provincial Targeted Geoscience Initiative, and a Natural Sciences and Engineering Research Council grant

Assessment of Potential Granitic Aggregate Sources in the Halifax Regional Municipality Area

C. E. White and G. Prime

Construction aggregate (crushed stone) is an important resource in Nova Scotia. It is used in concrete, asphalt, road base, fill and many other applications. Stone quality is critical to the performance of these construction aggregate products. Quality is related to physical and chemical properties of the aggregate, which are a result of its geological origin, mineralogy and subsequent structural deformation and alteration.

An detailed assessment to evaluate bedrock aggregate potential in and around the Halifax Regional Municipality (HRM) is a follow-up project to the larger Aggregate Program developed by the Resource Evaluation section of the Department of Natural Resources. This assessment was focused on HRM because the current resources in this area are being continuously depleted by the rapidly increasing aggregate demand of the construction industry. Concurrently, the availability of resource land which could replace aggregate reserves is shrinking due to urban growth and associated land use constraints. Recent attempts to permit new quarries have been unsuccessful.

In this project the granitoid lithologies in the South Mountain Batholith are evaluated for two reasons: (1) its proximity to HRM, and (2) the distribution of rock units within the batholith are well mapped and documented. During the 2002 and 2003 field seasons, detailed examinations of natural outcrops along highways and side roads were conducted in the HRM area. Observations included rock identification, representative sampling, determination of overburden type and thickness, and geological features present (e.g. degree of weathering, dykes, flow alignment, fractures, mineralization). Petrographic examinations were carried out on 30 hand specimens and thin sections to determine the quality of the rock by identification of microfractures, grain size, strained quartz, mineral alteration, and mica content, as well as the intensity of iron and manganese oxide staining on fractures. All samples were slabbed and stained for potassium feldspar. Thin sections were point counted to quantitatively determine the rock name and percent deleterious components. The petrographic features will be compared to aggregate test results on the samples to determine if these characteristics can be used to assess aggregate quality.

In order for a particular rock type to be considered as a high-quality aggregate for industrial use, it has to pass rigorous physical and chemical testing and procedures. However, a detailed petrographic assessment prior to these costly tests may quickly eliminate certain sites for aggregate use and promote others. Ultimately a more detailed data base will be produced for the HRM area, not just for units in the South Mountain Batholith but also for lithologies in the Goldenville Formation.

Preliminary Bedrock Geology Map of the Area between Baccaro Point and Sable River, Shelburne County (NTS 20P/06, 11 and 14)

C. E. White and D. R. G. Wasylik[1]

The Southwest Nova Mapping Project was initiated in 1998 to produce a series of 1:50 000 scale geological bedrock maps of the Meguma Terrane from Digby to Shelburne. Mapping (1:10 000 scale) related to this project concluded at the end of the summer of 2003 in map areas 20P/06, 11 and 14. In this map area, the Meguma Group is divided into the Cambrian to Early Ordovician Goldenville and overlying Halifax formations, and the two-part subdivision of the Goldenville Formation recognized in the previous map areas to the west is continued to the east into the present map area. The lower unit is thickly bedded, massive, metasandstone that displays a featureless areomagnetic signature. In contrast, the upper unit consists of interbedded massive to well laminated metasandstone with minor metasiltstone and slate and rare conglomerate which displays a varied and chaotic areomagnetic signature. In the eastern and central part of the map area, both of these units of the Goldenville Formation are spotted with biotite and locally well cleaved but as metamorphic grade increases to the west, porphyroblasts of staurolite and andalusite are developed in the more pelitic beds. Calc-silicate nodules and beds are common throughout the formation. Grazing and burrowing trace fossils were observed in the upper unit but have not been assigned an age. The Halifax Formation is exposed only in areas of higher metamorphic grade in the map area, and is characterized by porphyroblastic staurolite, cordierite and andalusite granofels and schist.

The ca. 373-372 Ma Shelburne and Port Mouton plutons (and associated satellite bodies) intruded rocks of the Meguma Group in the map area. They consist of medium-grained, locally foliated, biotite- and muscovite-bearing monzogranite to tonalite. Xenoliths of metasedimentary rocks are abundant. Along the western margin of the Shelburne Pluton, a small xenolithic body of medium- to coarse-grained diorite (ca. 376 Ma Birchtown Diorite) outcrops within the monzogranite. Pegmatite (containing tourmaline+garnet ± beryl), aplite and biotite-muscovite granite dykes are common.

Units in the Meguma Group in the map area, as elsewhere, were deformed during the Devonian Acadian Orogeny into regional, north- to northeast-trending F_1 folds with a well developed axial planar cleavage. Intersection lineations (L1) plunge gently to the north-northeast and south-southwest. Deformation was accompanied by greenschist facies (biotite-grade) metamorphism. In comparison to the syntectonic ca. 375 Ma Barrington Passage Pluton to the west, the Shelburne Pluton 1) is less foliated, 2) is not surrounded by migmatitic Meguma Group and 3) has produced a wide granofelsic contact metamorphic aureole which lacks a mineral lineation. These differences suggest that the Shelburne Pluton intruded at a shallower level in the crust and was late syn- to post tectonic.

The Early Jurassic Shelburne Dyke is poorly exposed but based on its distinctive aeromagnetic signature, it extends through the map area.

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