

**IN THE MATTER OF AN ARBITRATION UNDER
CHAPTER ELEVEN OF THE NORTH AMERICAN FREE TRADE AGREEMENT
AND THE UNCITRAL RULES OF 1976**

BETWEEN:

**WILLIAM RALPH CLAYTON, WILLIAM RICHARD CLAYTON, DOUGLAS
CLAYTON, DANIEL CLAYTON AND BILCON OF DELAWARE, INC.**

Claimants/Investors

AND:

GOVERNMENT OF CANADA

Respondent

WITNESS STATEMENT OF

DAN FOUGERE

December 12, 2016

I. BACKGROUND

1. I am a chartered accountant with 40 years' experience in the financial services, real estate, energy, mining, and not-for-profit sectors.
2. I qualified as a chartered accountant in 1977 and started practicing with Doane Raymond, now Grant Thornton. From 1981 to 1990, I was Vice-President of Finance at Atlantic Trust. I was then Vice-President of Finance at Homburg Incorporated from 1990 to 1993, and Director of Finance at NS Power Services Ltd., now Emera Inc., from 1994 to 1998.
3. From 1998 to 2011, I was the administrative manager of the Porcupine Mountain tidewater quarry located in Auld's Cove, Nova Scotia, owned by Martin Marietta Materials Canada Limited ("Martin Marietta").
4. Since 2011, I have served as the Director of Finance for the Sisters of Saint Martha, in Antigonish, Nova Scotia.
5. My Curriculum Vitae is attached as Appendix A, and the description of my position at Martin Marietta is attached as Appendix B.

A. *Martin Marietta*

6. At Martin Marietta, I was responsible for financial planning, preparing and implementing budgets, overseeing and controlling costs and implementing efficiency measures for all aspects of the quarry operations. I also made recommendations for profitability improvement and prepared business cases and plans in support of capital investment.
7. In 2000, with the encouragement and support of the Government of Nova Scotia, the Porcupine Mountain Quarry began increasing crushed stone production. The increase was achieved by improving operating efficiency, increasing the workforce, and increasing the plant's operating hours.

8. By 2008, the Porcupine Mountain Quarry had approximately doubled its production to over 3.7 million tons annually, putting the operation among Canada's top aggregate producers.
9. From February 2008 to February 2009, I served as the Acting Plant Manager, and was responsible for all quarry operations. Under my supervision, Porcupine Mountain achieved notable safety and production milestones.¹
10. During my years with Martin Marietta, I worked extensively with both government and industry officials in Nova Scotia, and I shared our production, employment, and generic economic data with many Provincial officials. The increase in production of approximately 2 million tons per year from 2000 to 2008 was done with the support of the Government and without any additional environmental assessment requirements. Government approval to extend the operations permit for the Quarry for another 10 years was also granted in 2011 without any additional environmental assessment requirements.

II. NOVA SCOTIA AGGREGATES INDUSTRY

11. The aggregates industry has been an important sector of the economy of Nova Scotia for decades. Gardner Pinfold, a Halifax-based consulting firm, has regularly produced reports analyzing the economic impact of the mineral industry in Nova Scotia.²
12. These reports show that aggregate production in Nova Scotia has followed a consistent upward trend from 1925 to the present.³ In 2006, over \$76,000,000 of crushed stone was produced in Nova Scotia.⁴

¹ Safety and Production Milestones (*Investors' Schedule of Documents, Tab C1031*).

² Economic Impact of the Mineral Industry in Nova Scotia, dated May 2006 (*Investors' Schedule of Documents, Tab C1032*), Economic Impact of the Mineral Industry in Nova Scotia – 2006, dated May 2008 (*Investors' Schedule of Documents, Tab C1033*), Economic Impact of the Mineral Industry in Nova Scotia – 2012, dated October 2013 (*Investors' Schedule of Documents, Tab C1034*).

³ Economic Impact of the Mineral Industry in Nova Scotia – 2006, dated May 2008 (**Fougere Exhibit 1; Investors' Schedule of Documents, Tab C1033, at p. 33**).

13. The history of the Porcupine Mountain Quarry itself illustrates the historical and continued importance of the aggregates industry in Nova Scotia. In the early 1950's, 10 million tons of rock were quarried from Porcupine Mountain to construct the Canso Causeway, a 1.4-kilometer link between mainland Nova Scotia and Cape Breton Island.
14. Following the completion of the Canso Causeway in 1955, the quarry lay dormant until 1978, when it was bought by Nova Construction of Antigonish to supply road building materials for the provincial highway system. In 1995, Martin Marietta purchased the tidewater quarry, recognizing its potential to supply aggregates to the eastern seaboard of the United States, using low-cost marine transportation.
15. The Porcupine Mountain Quarry has reserves of over 300 million tons of granite, which will last for at least 50 years. The quarry operates 24 hours a day, 7 days a week. Because the port at Auld's Cove is ice-free, aggregates from the Quarry can be shipped 12 months per year to markets in the US, including New York City and the Caribbean.⁵
16. Similarly to Whites Point, the location of the Porcupine Mountain Quarry, next to a deep-water ice-free year-round port, gives it a cost advantage over quarries that need to transport stone by truck or rail, which are significantly more expensive than transporting aggregates by ship.

⁴ Economic Impact of the Mineral Industry in Nova Scotia – 2006, dated May 2008 (**Fougere Exhibit 2; Investors' Schedule of Documents, Tab C1033, at p. 22**).

⁵ Martin Marietta Long Haul Distribution Network (**Fougere Exhibit 3; Investors' Schedule of Documents, Tab C1035**), Martin Marietta Major Shipping Points (**Fougere Exhibit 4; Investors' Schedule of Documents, Tab C1036**).

III. NOVA SCOTIA GOVERNMENT PROMOTION OF THE AGGREGATE INDUSTRY

17. The Nova Scotia Government has consistently promoted investment in Nova Scotia's aggregate industry. In 1996, the Government published *Take Advantage of Mineral Exploration and Development in Nova Scotia*,⁶ which featured an aerial photo of the tidewater quarry at Porcupine Mountain. To attract investors, the brochure promised a "One Window" fast track approach to regulatory approvals and permits, and touted the benefits of Nova Scotia's strategic location for fast and easy transportation to deep-water, ice-free seaports in US markets.
18. In 2006, the Nova Scotia Government published two promotional brochures. *Opportunity for Export Aggregate* highlighted the fact that "Nova Scotia... [has] an excellent record in permitting new quarries and heavy industrial projects", and reiterated its declaration that the "Province of Nova Scotia is open for business".⁷ Once again, a photograph of the Porcupine Mountain tidewater quarry was featured on the front page of the brochure.
19. Also in 2006, the promotional brochure, *Industrial Mineral Potential in Nova Scotia – Opportunities to Develop Deep-water Aggregate Quarries*,⁸ specifically featured the "unlimited amounts of trap rock" available at the "North Mountain", and that "Deep, Ice-Free harbours provide Nova Scotia's mineral products with [a] window on the world". The North Mountain is the location of the Whites Point Quarry.
20. In 2008, the Nova Scotia Government published, as part of its "Mineral Resources Branch Report of Activities 2007", an article entitled "*An Overview of the Industrial Mineral Potential of the North Mountain Basalt*".⁹ The article

⁶ Take Advantage of Mineral Exploration and Development in Nova Scotia (Fougere Exhibit 5; Investors' Schedule of Documents, Tab C1037).

⁷ Opportunity for Export Aggregate (Fougere Exhibit 6; Investors' Schedule of Documents, Tab C1038).

⁸ Industrial Mineral Potential in Nova Scotia – Opportunities to Develop Deep-water Aggregate Quarries (Fougere Exhibit 7; Investors' Schedule of Documents, Tab C1039).

⁹ An Overview of the Industrial Mineral Potential of the North Mountain Basalt (Fougere Exhibit 8; Investors' Schedule of Documents, Tab C1040).

noted that “[t]he depositional origin and composition of the North Mountain Basalt has resulted in properties that give the rocks a high stone resource potential”,¹⁰ and noted:

The North Mountain Basalt is an important component of the bedrock aggregate resource. Commonly called trap rock by the industry, it has been used to produce crushed stone for several decades, as witnessed by the presence of numerous active and abandoned quarries along the mountain length.¹¹

21. The article also discussed Bilcon’s Whites Point Quarry, noting the “national attention” received by the quarry despite the “relatively modest size of the development proposal”:¹²

Although the author is cognisant of the sensitivities of communities to heavy industry such as quarrying in the region, it also has to be recognized that mining is one of the cornerstones of the rural economy. During the fieldwork phase of this report the author listened to quiet support for the Whites Point project by area residents concerned about the state of employment in the region. Beyond the direct benefits to quarry employees there are many support industries that interact with, or benefit from, aggregate operations. This includes trucking, equipment sales and road builders, to name a few. Ensuring the continued viability and long term success of this industry should be a goal shared by the producers, governments and communities.¹³

22. The article concluded that “*industry, communities and individuals have a shared interest in continued quarrying on the North Mountain. These stone resources are vital to the development of the communities, employment and tax revenue in the region*”.¹⁴

¹⁰ An Overview of the Industrial Mineral Potential of the North Mountain Basalt (Fougere Exhibit 8, at p. 85; *Investors’ Schedule of Documents, Tab C1040*).

¹¹ An Overview of the Industrial Mineral Potential of the North Mountain Basalt (Fougere Exhibit 8, at p. 86; *Investors’ Schedule of Documents, Tab C1040*).

¹² An Overview of the Industrial Mineral Potential of the North Mountain Basalt (Fougere Exhibit 8, at p. 101; *Investors’ Schedule of Documents, Tab C1040*).

¹³ An Overview of the Industrial Mineral Potential of the North Mountain Basalt (Fougere Exhibit 8, at p. 101; *Investors’ Schedule of Documents, Tab C1040*).

¹⁴ An Overview of the Industrial Mineral Potential of the North Mountain Basalt (Fougere Exhibit 8, at p. 102; *Investors’ Schedule of Documents, Tab C1040*).

23. In 2008, while I was serving as President of the Nova Scotia Chamber of Commerce, Martin Marietta accepted an invitation to become a member of the “*Nova Scotia Come to Life*” branding initiative of the Nova Scotia Government. During an interview with a representative of the Nova Scotia Government, I provided a profile of the Porcupine Mountain Quarry. The resulting article was featured online as part of the program launch, and recognized that the Porcupine Mountain Quarry’s “*location next to a water distribution route gives it a cost advantage over operations that have to ship granite by truck or rail*”.¹⁵
24. In 2010, I was invited to represent Martin Marietta as a member of a trade mission delegation to Trinidad to promote Nova Scotia exports, including the export of aggregates. The trade mission was organized by Nova Scotia Business Inc. (NSBI), an agency of the Government of Nova Scotia, supported by the Government of Canada. NSBI introduced me to seven large Trinidadian contractors, including Caribbean Minerals Inc., the largest importer of aggregates in Trinidad.¹⁶
25. In 2016, consistent with the decades-long policy of the Nova Scotia Government to promote and attract investment in the development of Nova Scotia quarries for the export of aggregate from Nova Scotia to the US, the Governments of Nova Scotia and Canada approved the development by the Vulcan Materials Company of the Black Point Quarry on the Atlantic shore of Guysborough, Nova Scotia. Vulcan Materials is a US public company and North America’s largest producer of construction aggregates. The Ministerial approvals, to produce 6 to 8 million tons per year of aggregate to be shipped to the US, were granted in approximately 14 months after the EIS was filed.¹⁷

¹⁵ Nova Scotia Come to Life – Martin Marietta Materials (**Fougere Exhibit 9; Investors’ Schedule of Documents, Tab C1041**).

¹⁶ E-mail from Nova Scotia Business Inc. to Dan Fougere re: Trade Mission (**Investors’ Schedule of Documents, Tab C1042**), Trade Mission to Trinidad Evaluation Form (**Investors’ Schedule of Documents, Tab C1043**), Global Materials Incorporated - Aggregates Supplies (**Investors’ Schedule of Documents, Tab C1044**).

¹⁷ Black Point Quarry Project History (**Fougere Exhibit 10; Investors’ Schedule of Documents, Tab C1045**).

IV. WHITES POINT QUARRY OPERATING COSTS

26. I have visited the Whites Point Quarry site, [REDACTED]

[REDACTED]

[REDACTED]

27. I have prepared the attached Pro Forma Statement of Operations for the Whites Point Quarry for the five years ending December 31, 2015.¹⁸ For the purpose of the Pro Forma, I have incorporated information provided to me and described in the attached charts.¹⁹ Based on my experience as a chartered accountant, comptroller, and manager of a major quarry, the Major Assumptions and Conditions in Note 1 of the Pro Forma are reasonable, and the Pro Forma reflects the conventional form of presentation of the revenues, costs, income, and taxes of a significant quarry operation in Nova Scotia. This presentation is typical of the metrics, categories, and methodology used in the aggregate industry for annual budgeting and financial analysis, and in order to measure profitability.

Dated: December 12, 2016



Dan Fougere

¹⁸ Whites Point Quarry Pro Forma Statement of Operations (**Fougere Exhibit 11; Investors' Schedule of Documents, Tab C1046**).

¹⁹ Whites Point Operating Costs, 2011-2015 (**Fougere Exhibit 12; Investors' Schedule of Documents, Tab C1010**), Whites Point Repair and Maintenance Costs, 2011-2015 (**Fougere Exhibit 13; Investors' Schedule of Documents, Tab C1047**), Revenue Matrix Summary, 2011-2015 (**Fougere Exhibit 14; Investors' Schedule of Documents, Tab C1002**).

APPENDIX A
CURRICULUM VITAE
DAN FOUGERE, CPA, CA

Education

1973 **Bachelor of Business Administration, Saint Francis Xavier University**
1977 **Chartered Accountant, Nova Scotia Institute**
2014 **Canon Law, Saint Paul University, Ottawa**

Work Experience

1973 – 1981 **Doane Raymond (Now Grant Thornton), Halifax, NS**
 ○ *Public Practice*

1981– 1990 **Atlantic Trust, Halifax, NS**
 ○ *Vice-President, Finance*

1990 – 1993 **Homburg Incorporated, Halifax, NS**
 ○ *Vice-President, Finance*

1994 – 1998 **NS Power Services Ltd. (now Emera Inc.), Halifax, NS**
 ○ *Director of Finance*

1998 – 2011 **Martin Marietta Materials Canada Limited, Porcupine Mountain, NS**
 ○ *Administrative Manager*

2011 – *Present* **Sisters of Saint Martha, Antigonish, NS**
 ○ *Director of Finance*

Volunteer Activities

1998 – 2007 **Strait Area Minor Hockey, Executive Committee**

2000 – 2004 **Port Hawkesbury Civic Centre, Steering Committee**
 ○ *Funding, design and construction*

2004 - 2006 **Havre Boucher Community Centre, Steering Committee**
 ○ *Funding, design and construction*

2006 – 2008 **Strait Area Chamber of Commerce, President**

2008 – 2009 **Nova Scotia Chamber of Commerce, President**

2008 – 2010 **Atlantic Provinces Chamber of Commerce, Board of Directors**

2010 – 2016 **Strait of Canso Superport Corporation, Board of Directors**

2013 – 2015 **Antigonish Community Health Board, Board Chair**

2015 – *Present* **Nova Scotia Chartered Professional Accountants**
 ○ *Currently serving on Membership Committee*

2015 – *Present* **East Coast Credit Union, Board of Directors**
 ○ *Currently on Executive Committee and Chair, Audit Committee*

2015 – *Present* **Antigonish Chamber of Commerce, Board of Directors**
 ○ *Currently serving as President*

APPENDIX B

MARTIN MARIETTA POSITION

Martin Marietta Materials Canada Administrative Manager

- Financial Reporting:** Administer the Event Accounting software and accounting records in Canadian dollars. Prepare and submit daily, weekly, monthly, quarterly and annual financial and other management reports on time and as required.
- Government Reporting:** Prepare and submit all government returns not later than due date, including but not limited to HST returns, Employer Payroll Remittances, Workers Compensation Returns and Remittances, Employee T-4's and T-4 Summary, Non-Resident W/H Tax return, annual Transactions with Non-Residents return, and annual Corporate Tax Return.
- Financial Planning:** Prepare Annual Operations Plan/Budget on schedule and in accordance with the guidance and financial models received from Division Head Office.
- Operational Analysis:** Provide recommendations for profitability improvement and preparation of viable Business Case/Plan in support of requests for investment capital.
- DSO:** Manage accounts receivable so as to maintain daily sales outstanding in accordance with company guidelines.
- Office Admin:** Implement and maintain administrative procedures and internal controls in accordance with company policy.
- Community Relations:** Represent the interests of Martin Marietta and promote good community relations by carrying out volunteer activities in a responsible and professional manner.

EXHIBIT 1

WITNESS STATEMENT OF DAN FOUGERE

Construction Aggregate Production 1925 - 2006

Has also followed a consistent upward trend

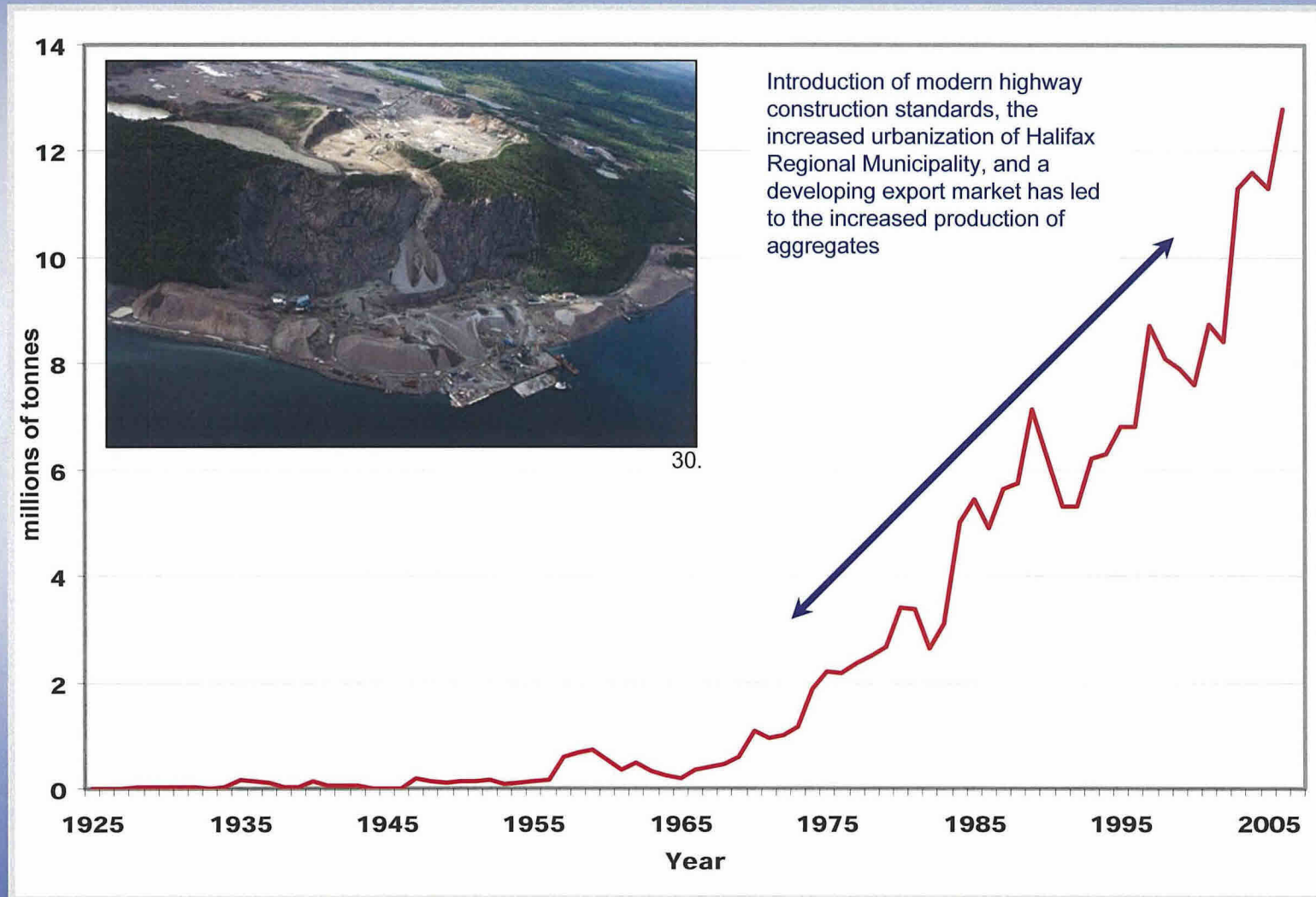


EXHIBIT 2

WITNESS STATEMENT OF DAN FOUGERE

2006 Value of Primary Production by Commodity (\$,000)

Coal	\$20,559	7.0%
Metals	\$680	0.1%
Anhydrite	\$2,038	0.7%
Gypsum	\$108,525	37.2%
Limestone	\$3,626	1.2%
Peat	\$1,535	0.5%
Salt	\$55,631	19.1%
Crushed Stone	\$76,096	26.1%
Sand and Gravel	\$10,800	3.7%
Other (includes: clay, barite, silica sand, dimension stone and limestone for cement)	\$12,256	4.2%
Total Mineral Production	\$291,746	100%

EXHIBIT 3

WITNESS STATEMENT OF DAN FOUGERE

LONG HAUL DISTRIBUTION NETWORK

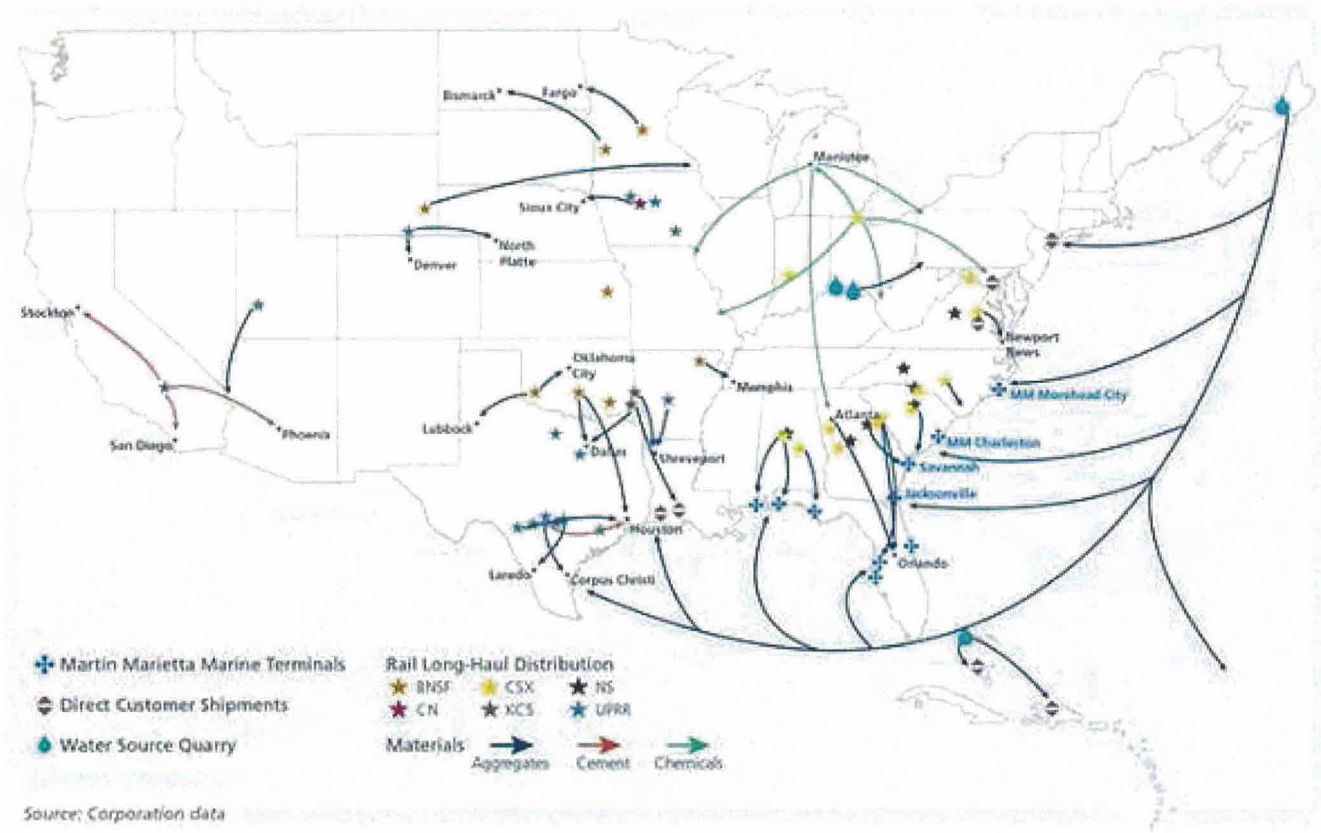


EXHIBIT 4

WITNESS STATEMENT OF DAN FOUGERE



Nova Scotia

● Major Shipping Points

- Lake Charles
- Beaumont
- Mobile
- Panama City
- Tampa
- Port Manatee
- Jacksonville
- Port Canaveral
- Nassau
- Charleston S.C.
- Savannah
- Bermuda
- New York
- Prince Edward Island
- Auld's Cove
- Trinidad

EXHIBIT 5

WITNESS STATEMENT
OF
DAN FOUGERE

Take Advantage of Mineral Exploration and Development in Nova Scotia

Nova Scotia

We're

Worth

Exploring

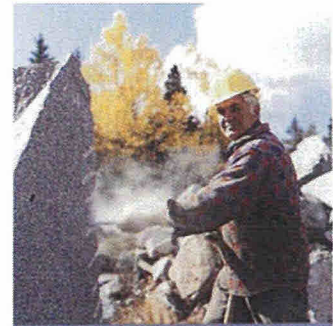
Nova Scotia, Canada, is situated on the Eastern Seaboard of North America. With a long history of mining coal, metallic minerals and industrial minerals, Nova Scotia offers many advantages to the mineral industry. For example, Nova Scotia has:

- some of the lowest costs for exploration in Canada
- an attractive land tenure system, including map-based claim staking
- a 'One Window' approach to permits and regulations

- an excellent transportation infrastructure linked to several deep-water, ice-free seaports strategically located for North American and European markets



Nova Scotia dimension stone in the hands of an artist.



A 200 year legacy of mining has provided Nova Scotia with a highly skilled workforce.

- a skilled workforce with experience in mineral development and exploration
- a dynamic business climate



Nova Scotia aggregate deposits enjoy a tremendous advantage for shipping to destinations around the world.

- comprehensive geological, geochemical and geophysical databases
- a highly competitive regime of mineral royalties and taxes
- an active mineral industry that has proven the economic success of Nova Scotia mineral deposits.

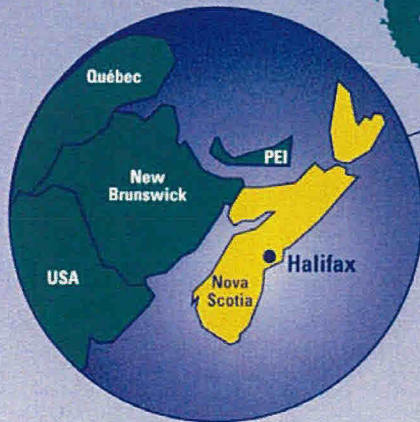


High-grade lead-zinc ore from the Gays River deposit.

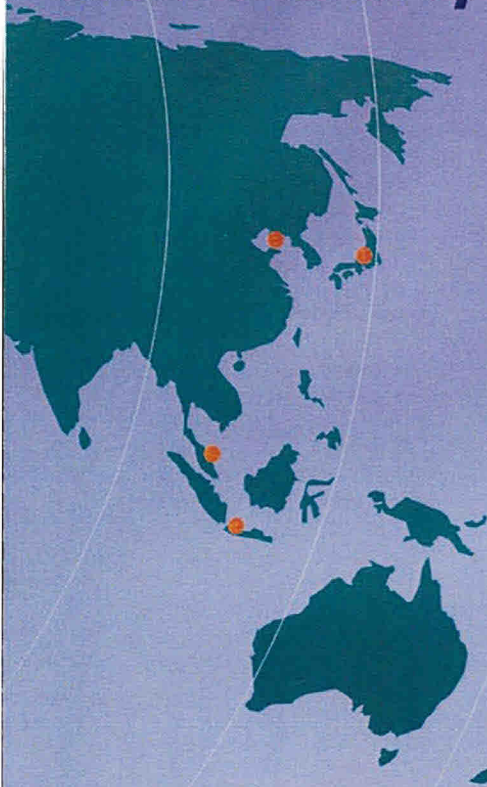
Destinations for Nova Scotia Mineral Products



*Deep, ice-free
harbours ensure
Nova Scotia's
mineral products
economical and
fast transport to
the world.*



Highlights of the Nova Scotia Mineral Industry



Mineral Production

Nova Scotia's mining history has included the production of coal, gold, copper-lead-zinc, tin, iron, antimony, manganese, and a great number of industrial mineral commodities. In terms of current production, Nova Scotia can claim the following:

- Greatest number of mines per unit area, and second greatest value of mineral production per square kilometre of all Canadian provinces (data from Mining Association of Canada).

- Most productive gypsum-mining region in the world, responsible for 80% of Canadian and 7% of world gypsum production (data from Nova Scotia Department of Natural Resources).

- Accounts for 12% of total value of Canadian coal production (data from Mining Association of Canada).

- Major producer and exporter of salt, aggregate, limestone and dolomite.

- Producer of barite, dimension stone and peat.

Exploration and Development

Several gold deposits are currently in the feasibility or pre-production stages of development. In addition to these development projects, active exploration in Nova Scotia has focused on the following targets:

- Cretaceous kaolin and silica sand deposits in central Nova Scotia. Recent drilling has revealed new laterally continuous deposits.

- Industrial mineral commodities including gypsum, limestone and dolomite, surficial and bedrock aggregate, peat, and building stone.

- Sediment-hosted disseminated gold deposits in the Meguma Group of southern Nova Scotia, host to 64 former gold districts. Gold has traditionally been produced from narrow, high-grade veins (averaging 7-15 g/t), but recent exploration has revealed low-grade gold with high tonnage potential.

- Paleoplacer gold deposits in Witwatersrand-type environments with very little history of exploration.

- High-grade auriferous quartz veins hosted by sheared Precambrian gneiss and diorite in the central Cape Breton Highlands.

- Copper-gold (±nickel±cobalt) deposits associated with iron carbonate veins along the trace of the Cobequid-Chedabucto Fault Zone, a regional transform fault system. This environment includes the past-producing Londonderry deposits.

- Copper-nickel-cobalt occurrences associated with mafic to ultramafic bodies in northern Cape Breton Island. Recent airborne vertical gradiometer surveys have revealed large anomalies, some associated with known ultramafic intrusives, Cu-Ni stream sediment anomalies, and Cu-Ni-Co occurrences.

- Volcanogenic massive sulphide deposits in the Stirling belt of eastern Cape Breton Island, host to the past-producing Stirling Cu-Pb-Zn-Ag-Au VMS deposit.

- Stratabound massive sulphide deposits with associated gold (≤0.30 oz./t) near Cheticamp, Cape Breton Island. Deposits are hosted by shallow-dipping sericite schist bounded by chlorite schist.

- Surface coal deposits with open-pit potential in northern mainland Nova Scotia.

- Coalbed methane deposits associated with the coal basins of northern Nova Scotia.

EXHIBIT 6

WITNESS STATEMENT
OF
DAN FOUGERE

The potential is here.



OPPORTUNITY FOR EXPORT AGGREGATE

Are transportation costs and stone quality concerns making life difficult for you as an aggregate supplier, concrete producer or road builder?

Are you concerned about the security of your aggregate supplies for the future? Nova Scotia has a lot to offer:

A Proven Track Record

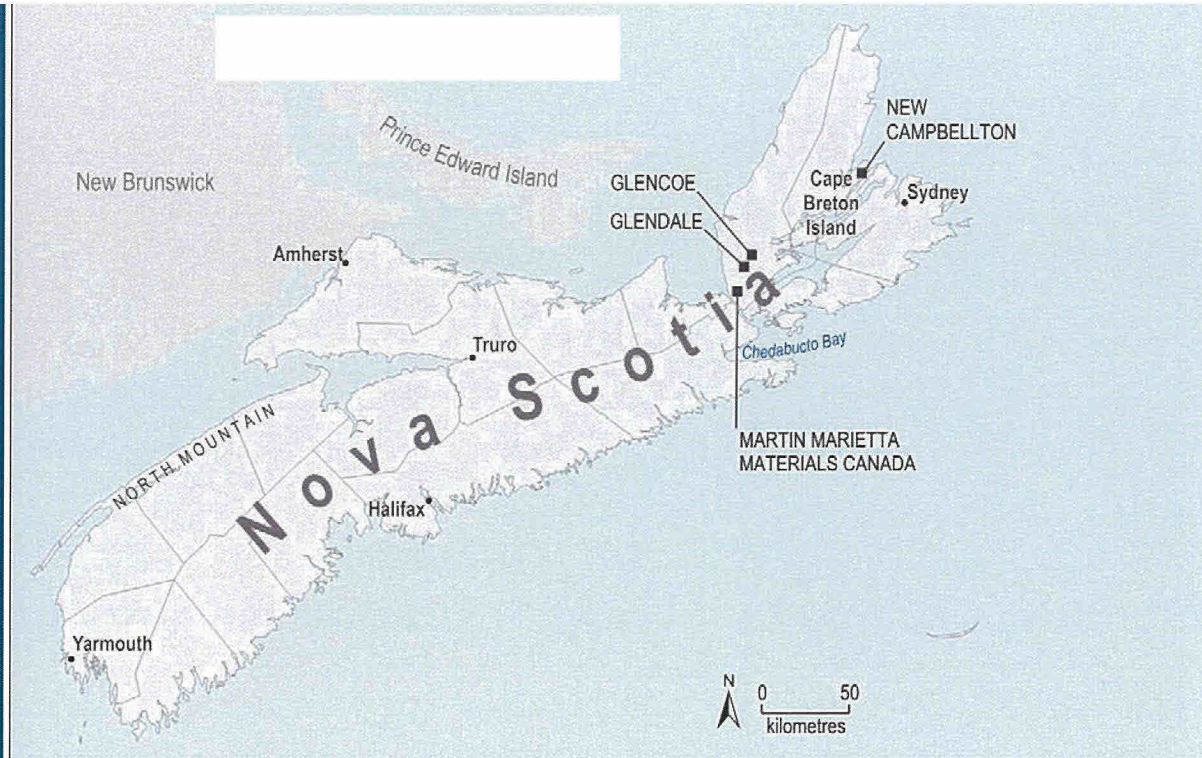
- For more than two decades Nova Scotia has been an industry leader in the marine transport of high quality stone products using bulk carriers and barges.
- Martin Marietta Materials Canada on the Strait of Canso is one of the largest tidewater stone quarries in North America, capable of loading 70 000 tonne Post-Panamax vessels.
- Currently more than 3 million tonnes of aggregate are being exported annually to destinations such as Savannah, Houston, Bermuda and the Ascension Islands.

The Maritime Advantage

- Nova Scotia's location on the Atlantic coast is 80 kilometres from the Northeastern United States with the capability of competitive shipping to the Gulf Coast and the Caribbean.
- 7400 kilometres of rugged coastline include sheltered harbours and water depths amenable to docking and loading large vessels.
- A moderate, coastal climate permits year-round shipping.
- Diverse geological resources along the coast are capable of producing high quality construction aggregate.

The Martin Marietta quarry on the Strait of Canso





Map of Nova Scotia showing the sites discussed in text

Opportunities

- Nova Scotia has undeveloped sites, near suitable tidewater, that are capable of producing high quality granite, limestone and traprock aggregate.
- Potential sites include the south shore of Chedabucto Bay, New Campbellton on the Bras d'Or Lakes and the North Mountain area along the Bay of Fundy.
- Some sites have the potential for stone reserves of several hundred million tonnes.
- An established and knowledgeable stone industry may offer opportunities for partnerships in new stone export ventures.
- There may be the opportunity for the co-production of limestone aggregate and cement grade carbonate at Glencoe and Glendale on Cape Breton Island.

A Welcoming Business Climate and Supportive Government

Nova Scotia and the Strait of Canso area have an excellent record in permitting new quarries and heavy industrial projects. New gypsum, coal, silica and crushed stone quarries have been permitted in Nova Scotia within the last five years. The Sable Offshore Energy Project, including offshore gas wells, sub-sea pipelines, a gas plant and the Maritimes & Northeast gas pipeline to Boston area markets have been approved.

In December, 2005, Anadarco received federal and provincial environmental permits to proceed with the construction of an LNG regasification plant at Bear Head, part of the Strait of Canso Super Port.

The Province of Nova Scotia is open for business and you are invited to contact us for further information.



Natural Resources
Mineral Resources Branch

1701 Hollis Street
Halifax, Nova Scotia
B3J 2T9 Canada

For more information contact:

R. J. (Bob) Ryan
Manager, Resource Evaluation
phone: 902-424-8148
E-mail: rjryan@gov.ns.ca
or visit our website:
<http://www.gov.ns.ca/natr/meb>



EXHIBIT 7

WITNESS STATEMENT OF DAN FOUGERE

CONFIDENTIAL

Industrial Mineral Potential in Nova Scotia

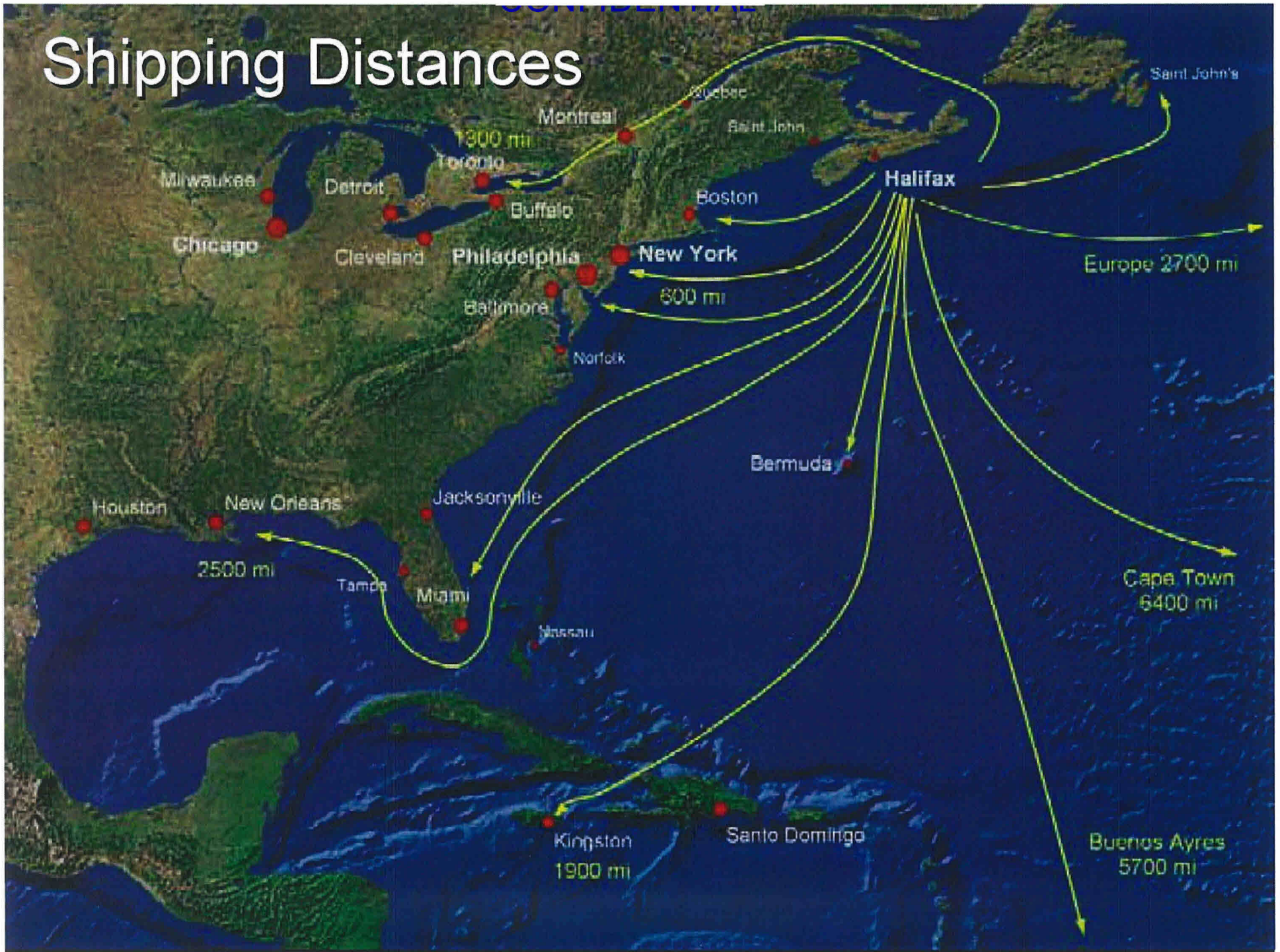
Opportunities to Develop Deep-water Aggregate Quarries

P. Finck

Natural Resources

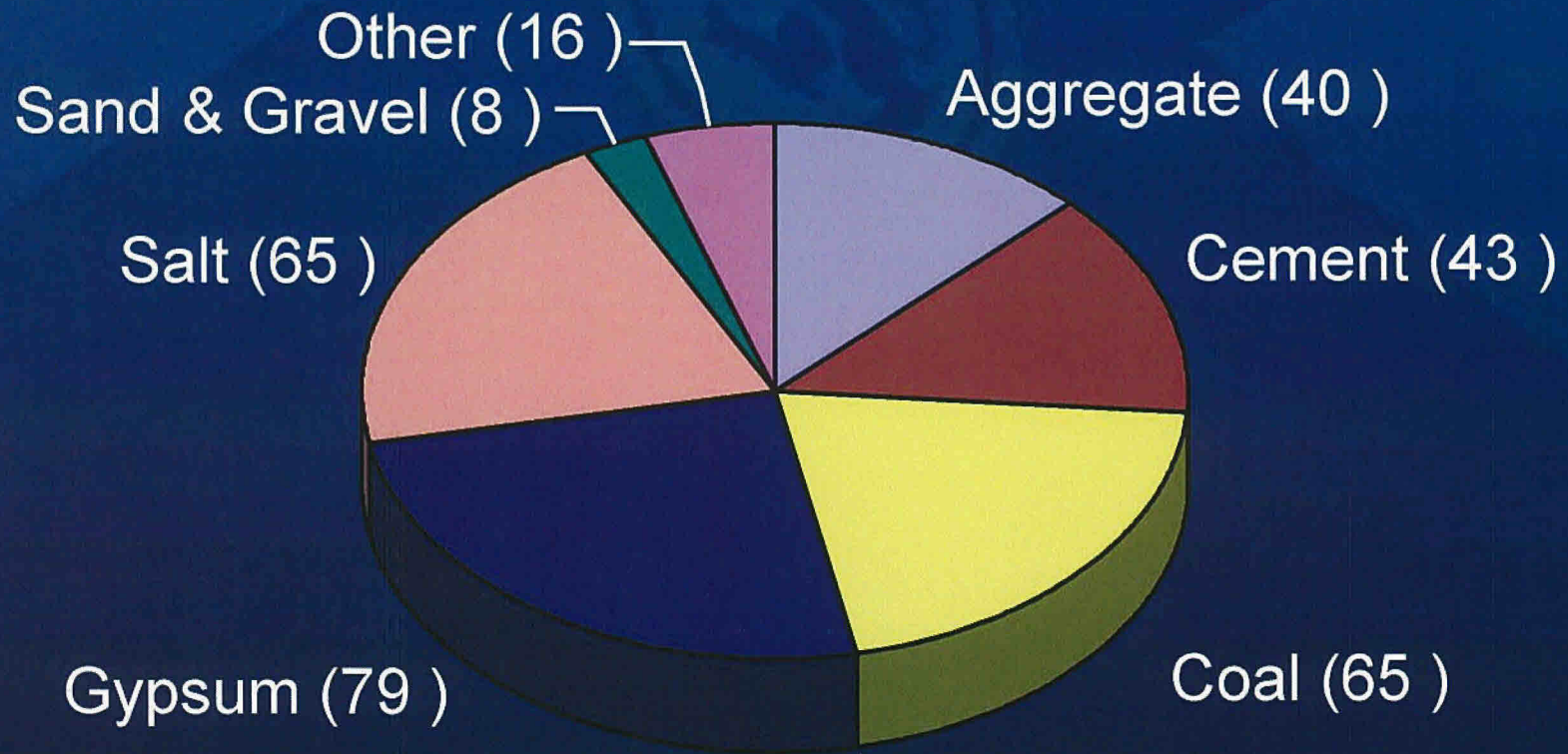


Shipping Distances

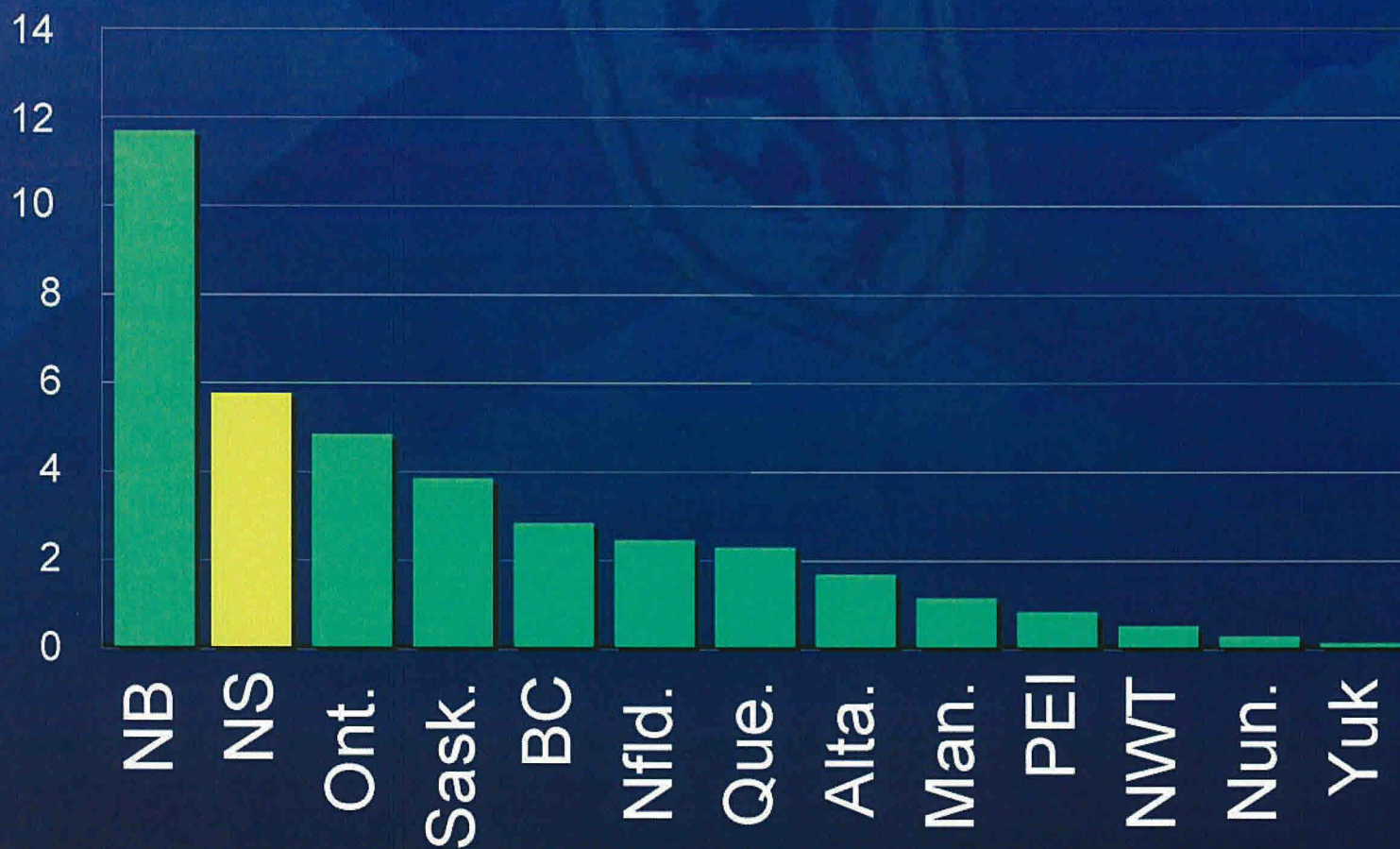


Mineral Production by Commodity, 2001

\$316 Million



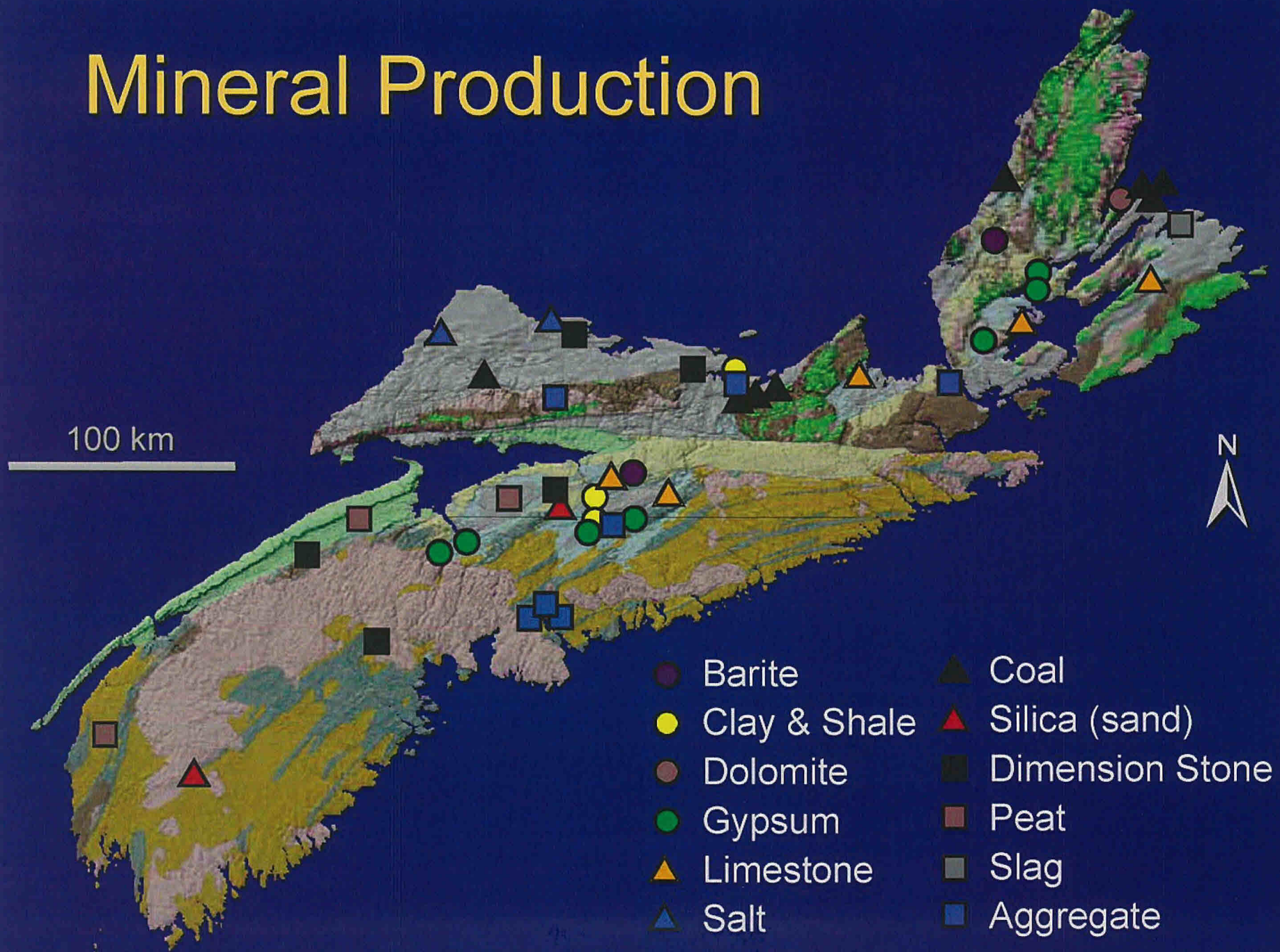
Avg. Value of Mineral Production / km²



Natural Resources



Mineral Production



Nova Scotia Mineral Production

Industrial Minerals	Amount (tonnes)	Value (\$000)
Anhydrite	180,000	
Barite	600	
Gypsum	7,200,000	
Limestone & Dolomite	700,000	
Peat	9,300	
Salt	900,000	
Silica	49,000	
<i>Total</i>		140,000
Structural Materials		
Building - Ornamental Stone	2000	
Clay Products	25,400	
Crushed Stone	7,800,000	
Sand & Gravel	2,750,000	
Cement	331,000	
<i>Total</i>		96,060
Total Mineral Production		236,060

Troy Quarry

- total production
10 M tones
- metasediment
& granite



Conrad Brothers (Dartmouth)

- 7.5 M tonnes (domestic)
- 2.5 M tonnes (export)
- adequate supply



Offshore Markets

- Martin Marietta
- operating near capacity
- exporting to the Gulf, East Coast & Caribbean



Sites of Interest

1. Kelly's Mountain

2. Maritime Stone

3. Rhodena Rock

4. Queensport



5. Eastern Shore

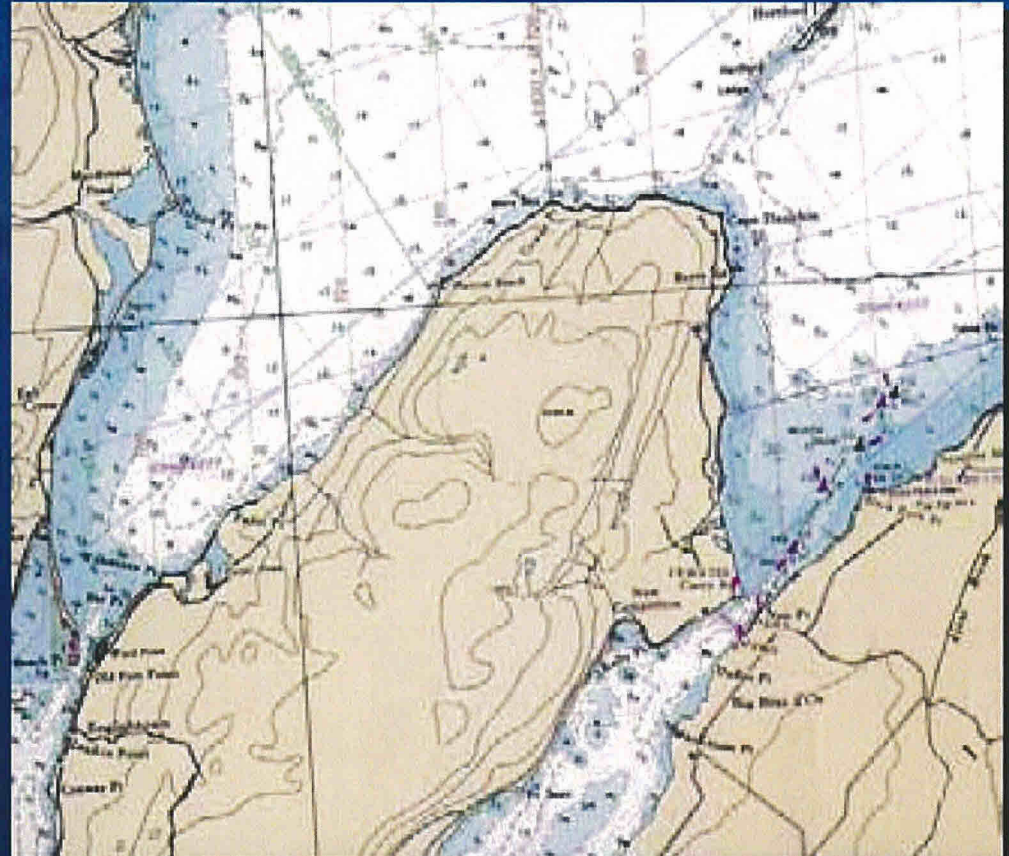
6. Port Mouton Island

7. North Mountain

8. Aspotogan

Kellys Mountain Area

- water depth
 - > 45 feet north side
 - < 30 K south channel
- elevation up to 300 m
- unlimited tonnage



Kellys Mountain Area

- Crown Land Areas (North side)
- Scotia Limestone mining lease (south side)
- red granite, LA abrasion of 22
- unlimited tonnages



Sites of Interest

1. Kelly's Mountain
2. **Maritime Stone**
3. Rhodena Rock
4. Queensport



5. Eastern Shore
6. Port Mouton Island
7. North Mountain
8. Aspotogan

Maritime Rock Quarry

- access to deep water
- ice free mid-March to January
- relatively isolated



Shipping

- 30 K tonne through Canso Causeway
- north around Cape Breton Island



Natural Resources


NOVA SCOTIA

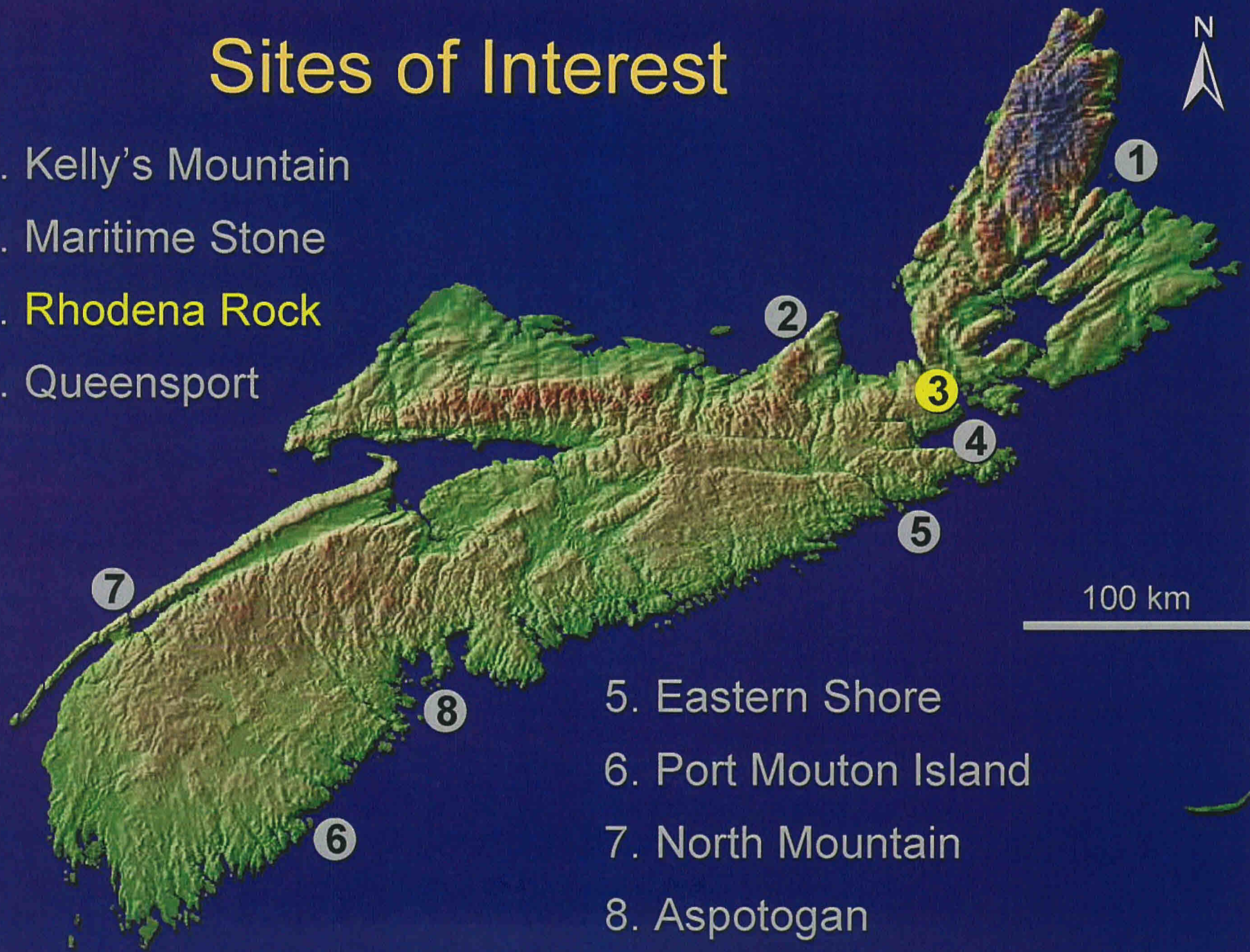
Resource

- mafic granite
- LA abrasion of 17
- existing 4 hectare permit



Sites of Interest

1. Kelly's Mountain
2. Maritime Stone
3. Rhodena Rock
4. Queensport



5. Eastern Shore
6. Port Mouton Island
7. North Mountain
8. Aspotogan

Rhodena Rock



Located beside Martin Marietta's operation at Canso

Rhodena Rock

- mixed volcanics & granites
- deep water access by conveyor
- truck to Mulgrave
- high quality stone
- optioned by Lafarge
- tonnage?



Sites of Interest

1. Kelly's Mountain
2. Maritime Stone
3. Rhodena Rock
4. Queensport



5. Eastern Shore
6. Port Mouton Island
7. North Mountain
8. Aspotogan

Queensport Shore (*South of Martin Marietta*)

- deep water
- no overburden
- unlimited tonnage
- grey granite, LA abrasion in low 20's
- very strong local support



Sites of Interest

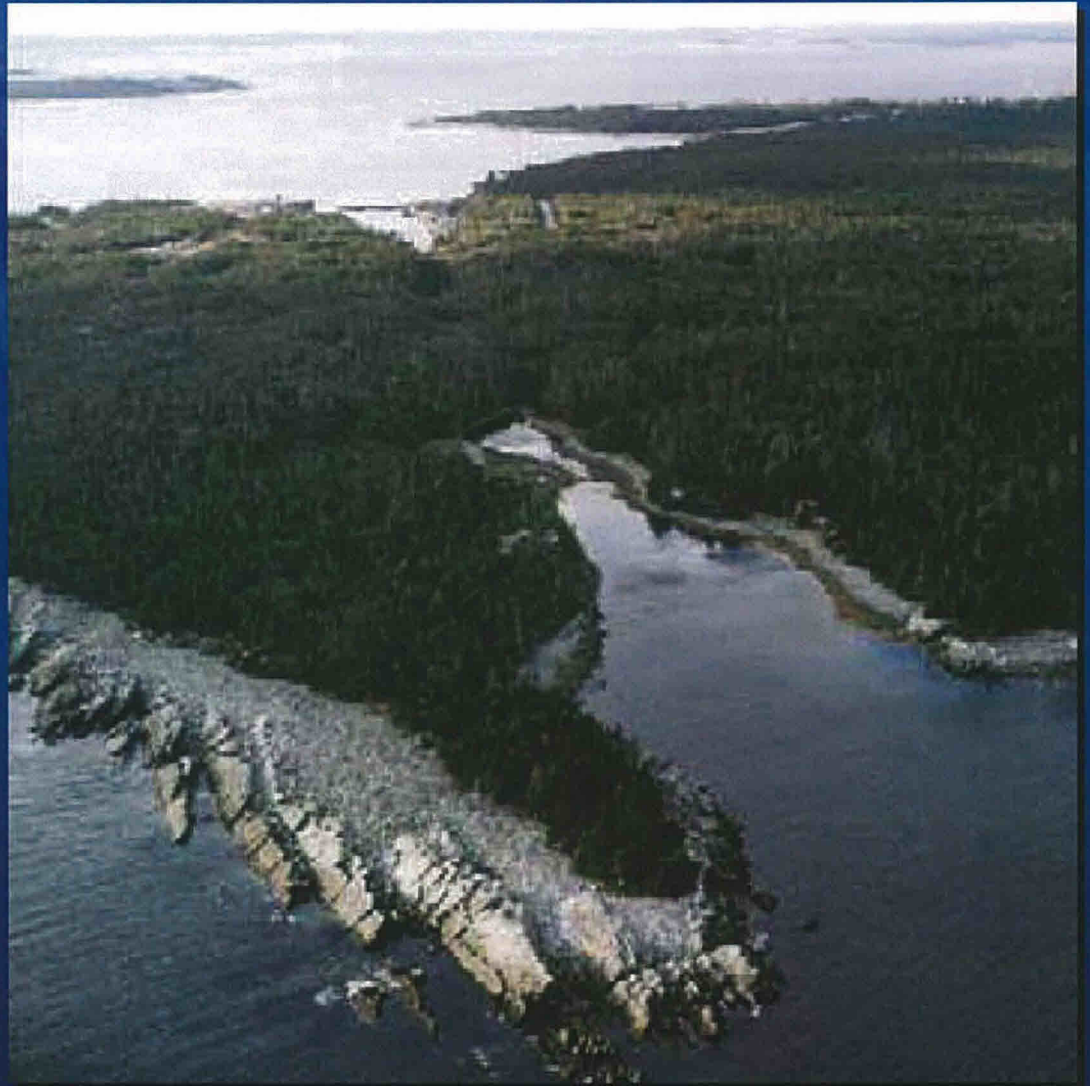
1. Kelly's Mountain
2. Maritime Stone
3. Rhodena Rock
4. Queensport



5. **Eastern Shore**
6. Port Mouton Island
7. North Mountain
8. Aspotogan

Eastern Shore

- grey metasediment
- variety of locations with deep water
- LA abrasion 17 - 20
- alkali reactivity

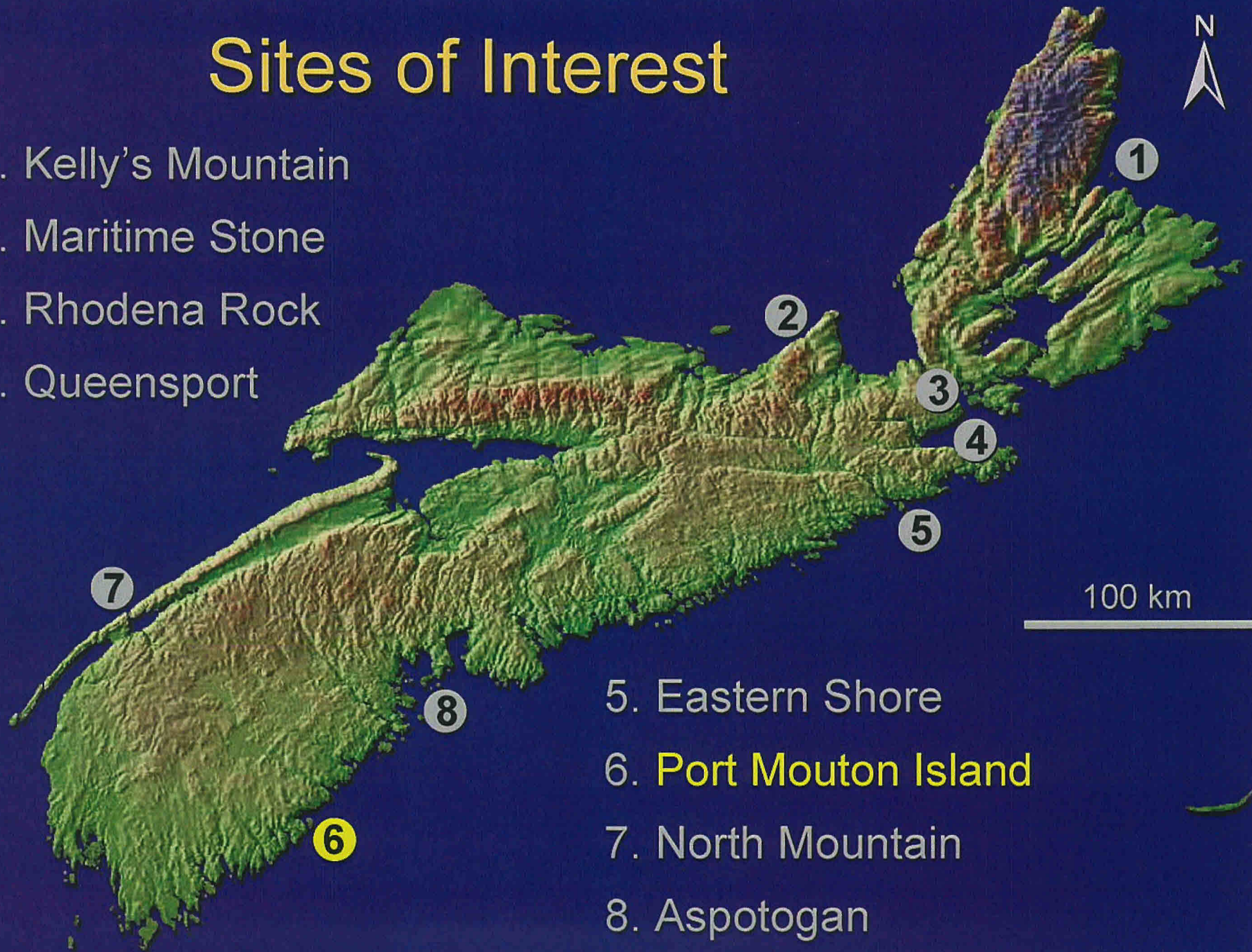


Natural Resources


NOVA SCOTIA

Sites of Interest

1. Kelly's Mountain
2. Maritime Stone
3. Rhodena Rock
4. Queensport



5. Eastern Shore
6. **Port Mouton Island**
7. North Mountain
8. Aspotogan

Port Mouton Island

- elevation up to 50 m
- fine grained grey granite
- LA abrasion in mid-20's



Port Mouton Island

- 100% Swiss owned
- available
- an island?
- beside a Federal Park
- require a different way of thinking



CONFIDENTIAL

Port Mouton Island

- closer to US than other sites
- make it a park?



Natural Resources


NOVA SCOTIA

Sites of Interest

1. Kelly's Mountain
2. Maritime Stone
3. Rhodena Rock
4. Queensport



5. Eastern Shore
6. Port Mouton Island
7. **North Mountain**
8. Aspotogan

North Mountain - Digby Area

- unlimited amounts of trap rock



Natural Resources


NOVA SCOTIA

Sites of Interest

1. Kelly's Mountain
2. Maritime Stone
3. Rhodena Rock
4. Queensport



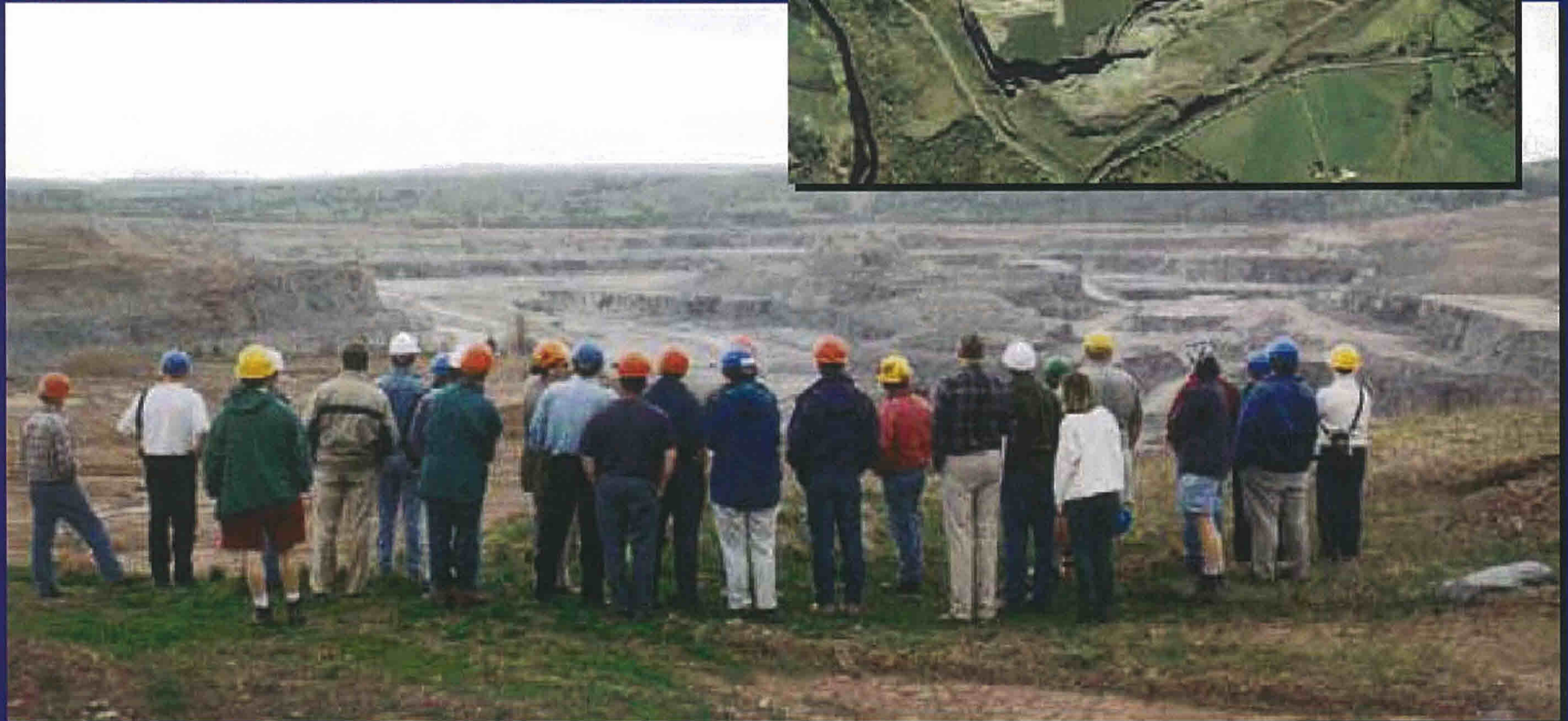
5. Eastern Shore
6. Port Mouton Island
7. North Mountain
8. **Aspotogan**

Aspotogan - The Lodge

- grey - buff granite
- deep water
- LA abrasion in low 20's
- impossible to permit



Can you permit a quarry in Nova Scotia?

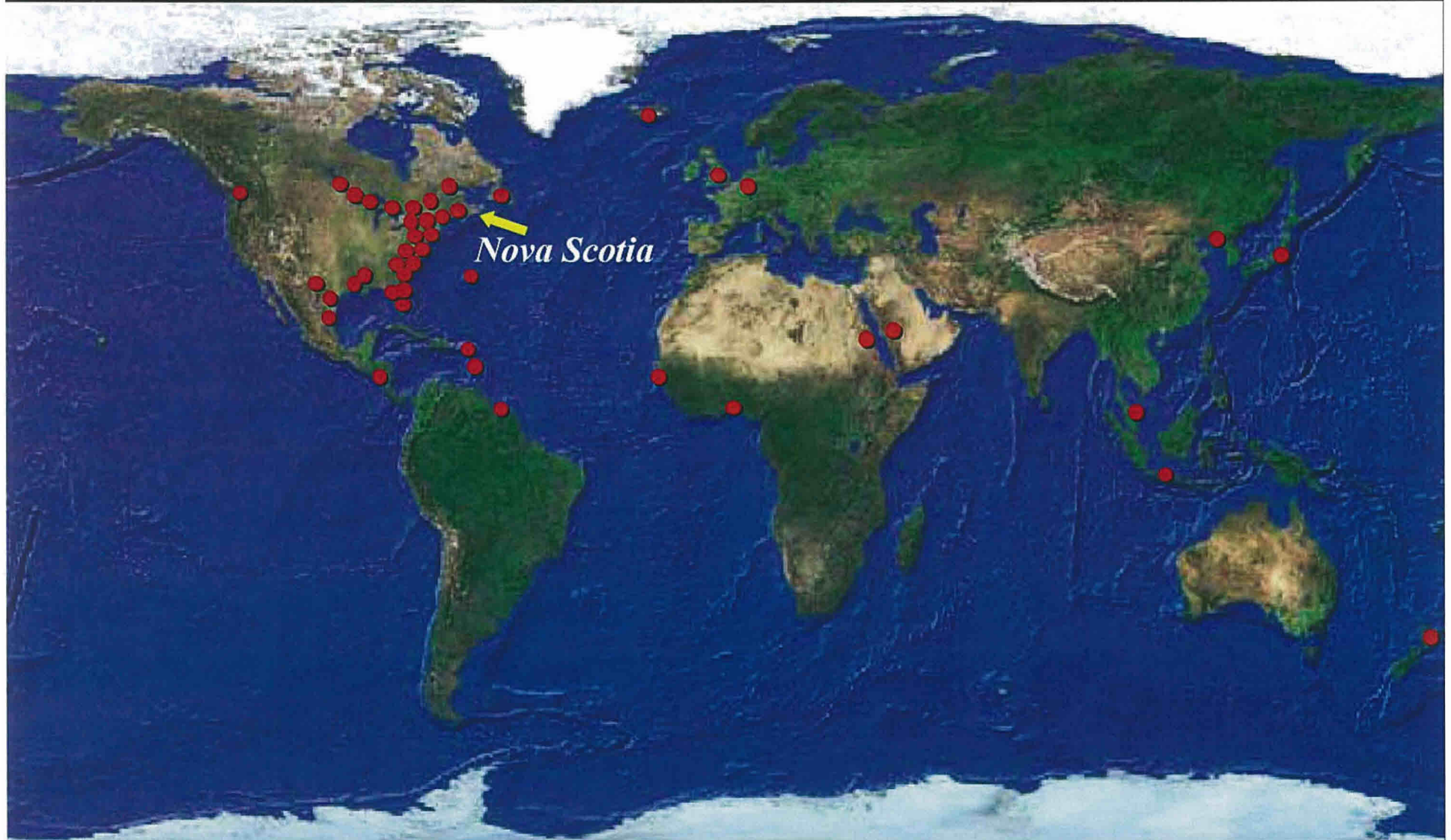


Black Bull Resources

- Silica mine
- 100 m wide zone
- bounded by kaolinized granite
- mining to within 5 m of protected area
- permitted 27 Apr/04



Destinations for Nova Scotia Mineral Products



Deep, Ice-free harbors provide Nova Scotia's mineral products with window on the world.

Nova Scotia Geology

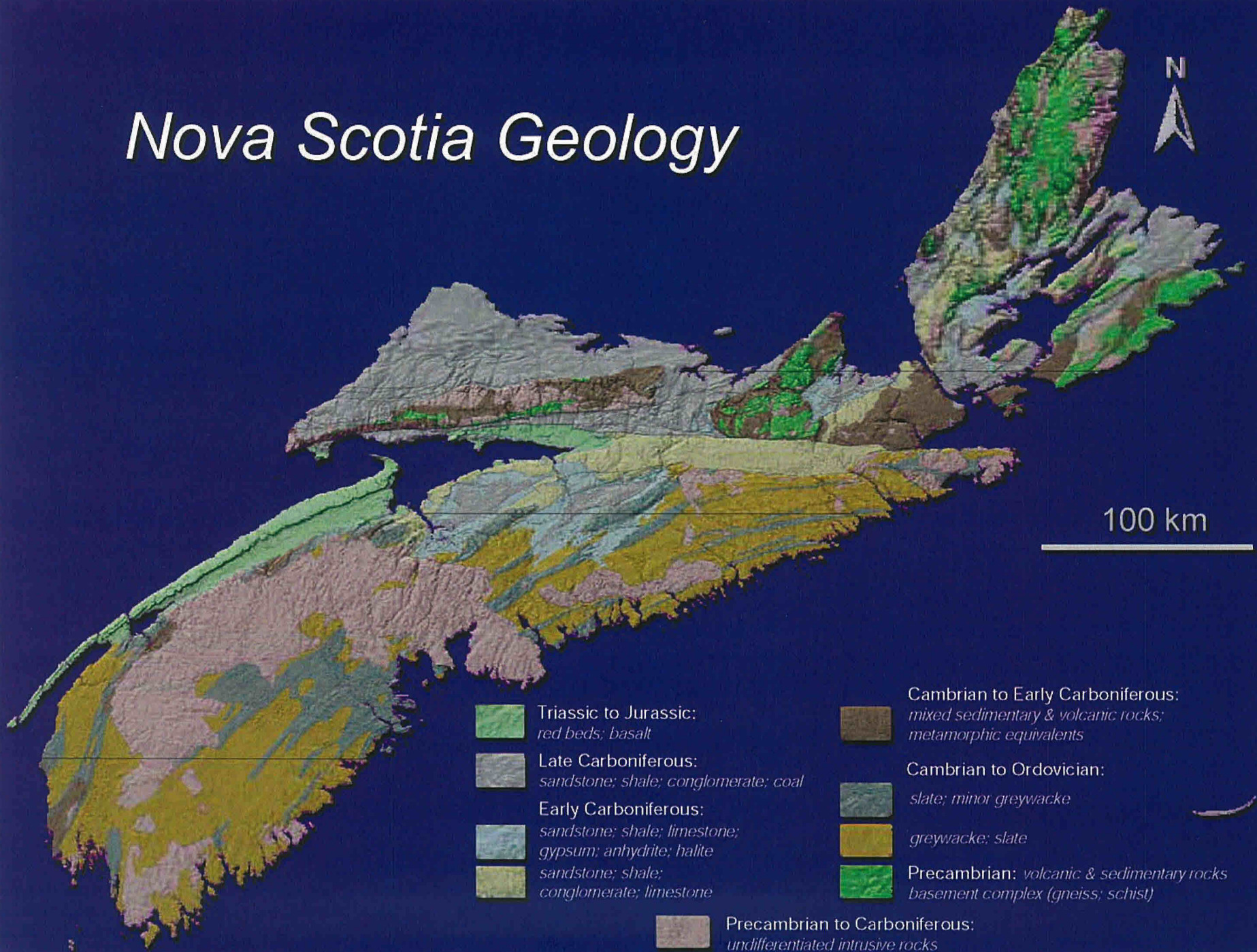


EXHIBIT 8

WITNESS STATEMENT OF DAN FOUGERE

An Overview of the Industrial Mineral Potential of the North Mountain Basalt

G. Prime

Introduction

The Jurassic North Mountain Basalt is one of the youngest igneous rock units found in Nova Scotia. This hard, erosion-resistant rock underlies the North Mountain (Fig. 1), forming a protective cap that allows this upland to exist. The volcanic origin of the basalt has provided the rock with some unusual characteristics and mineralogy that make it suited to a variety of industrial applications. The hardness and impermeability of the rock permit it to be used for construction stone such as aggregate, rip rap and armourstone, all of which have played a significant role in the development of communities and the protection of coastal areas. The unusual joint patterns in the rock result in naturally shaped quarry blocks which can be used for building stone applications. A small local market for these products currently exists, but there may be greater opportunities in the export market. There is also the potential for research and development of other stone and mineral products for use in the environmental and sustainable agriculture industries. This report will review the body of research that has been conducted on the North Mountain Basalt in recent years and discuss it in the context of potential development opportunities.

Physiography and Geological Setting

The North Mountain is a prominent upland in western Nova Scotia which stretches for 200 km along the Bay of Fundy coast (Fig. 1). This cuesta generally rises steeply along the north wall of the Annapolis Valley and forms an escarpment which gently slopes north to the Bay of Fundy (Fig. 2). It has a maximum width of about 8 km in the east and tapers in the west to about 2.5 km. The mountain rises to a maximum of 225 m above mean sea level in the east and tapers to as little as 50-100 m high in the west. It has three topographic breaks that

extend below sea level along its length at Digby, Tiverton and Freeport.

The mountain reflects approximately 250 million years of geological history, during which time significant tectonic movement, deposition and erosion took place. Deposition began in the Early Triassic when fissures developed along the eastern edge of North America while it was still part of the supercontinent Pangea. As the fissure system grew, a huge rift valley formed from the Gulf of Mexico to Greenland (Olsen *et al.*, 2005). Stretching and thinning of the crust at this time created a series of rift basins and sub-basins which became repositories primarily for continental sedimentary and volcanic rocks. The largest of these basins is the Fundy Basin where sediments and volcanic flows accumulated, followed by deep erosion. Today the vast majority of this remnant sedimentary basin underlies the Bay of Fundy. In Nova Scotia, however, the rim of the basin and its associated sub-basins are exposed on land along the North Mountain, the Annapolis Valley and various locations around the Minas Basin.

The oldest rocks that occur at the base of the North Mountain are redbeds exposed on its south side at locations such as Blomidon, Kings County, and The Seawall, Digby County. They comprise Triassic-Jurassic fluvial and lacustrine sedimentary redbeds composed of sandstone, siltstone, shale and conglomerate. Overlying these rocks are tholeiitic basalt flows which were deposited during a brief period in the Jurassic. Dated at 201 million years ago it is speculated that the entire 400 m thickness of volcanics was emplaced over a period of <0.5 million years (Kontak, 2003). Unconformably above the volcanic rocks is a veneer of terrestrial sedimentary rocks (limestone, siltstone and chert), which are exposed on the North Mountain in a very limited area between Baxters Harbour and Scots Bay, Kings County. Since the deposition of this more or less horizontal sedimentary/volcanic sequence, the strata

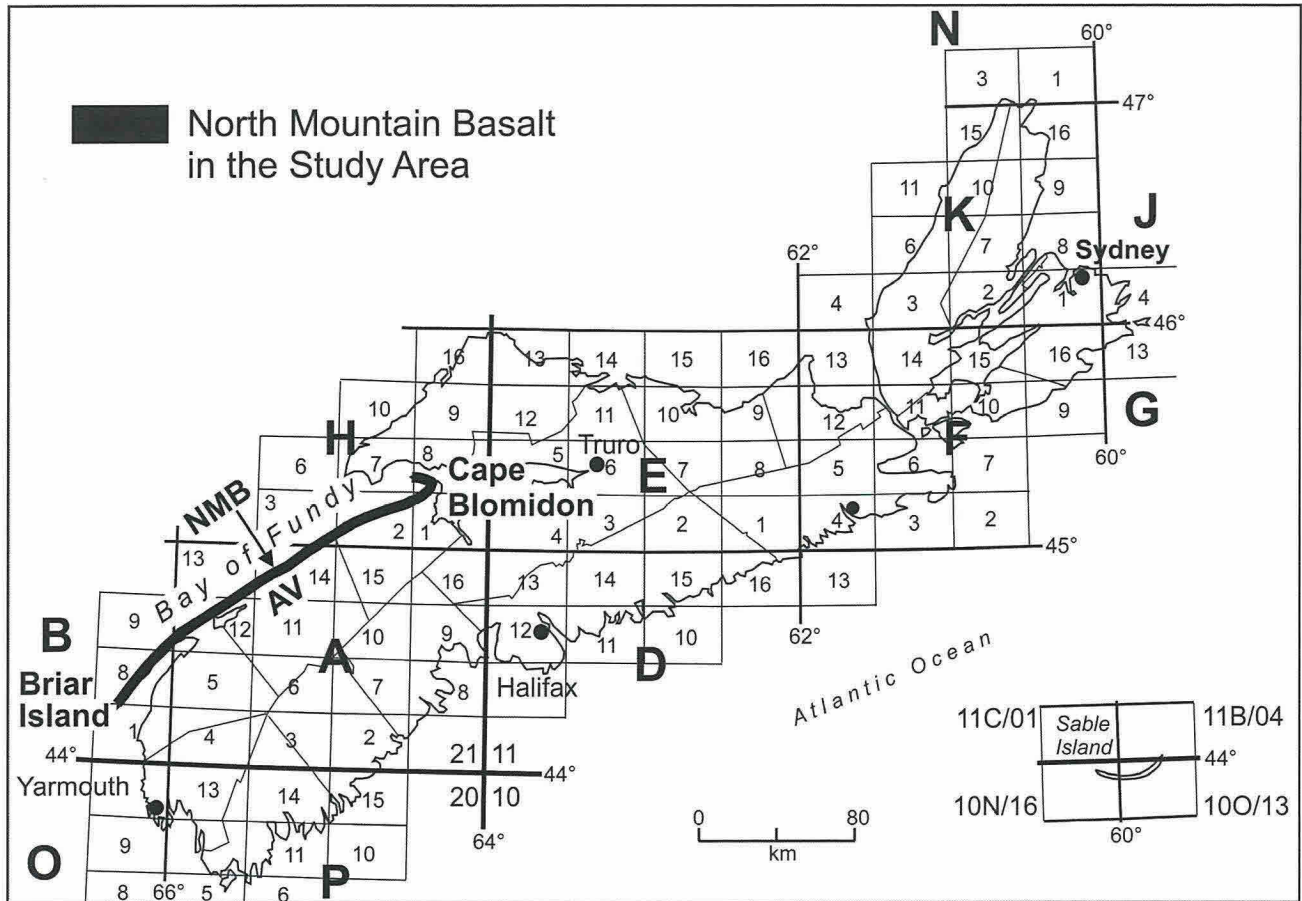


Figure 1. The North Mountain Basalt (NMB) underlies North Mountain between the Annapolis Valley (AV) and the Bay of Fundy.

- Jurassic Sedimentary Rock
- Jurassic North Mountain Basalt
- Triassic Sedimentary Rock

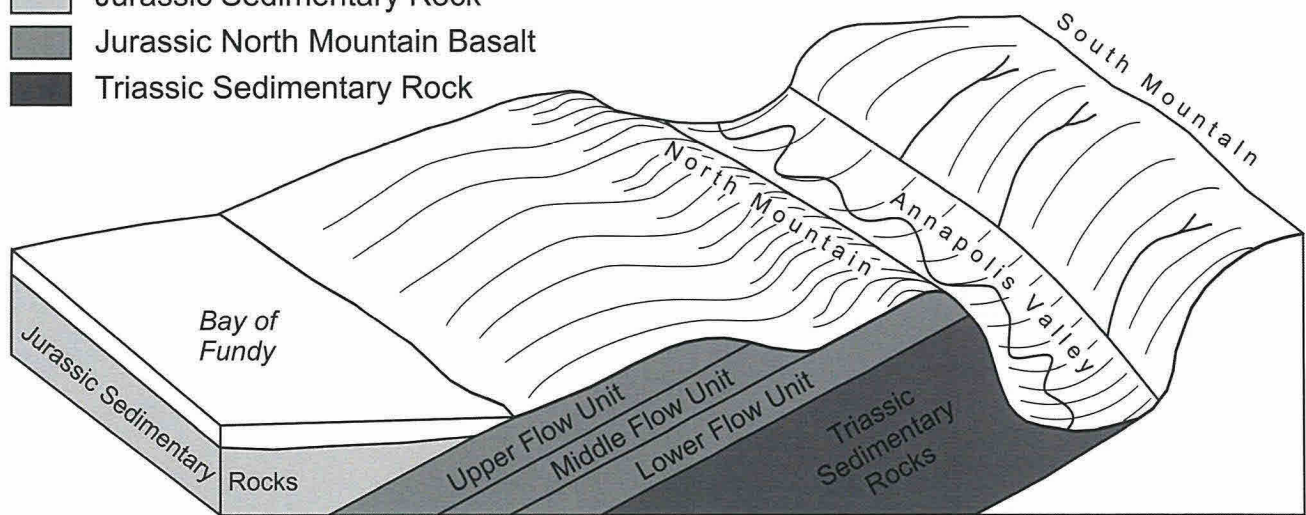


Figure 2. A schematic diagram illustrating the stratigraphy of the North Mountain Basalt. The Lower Flow Unit is exposed primarily on the south side of the mountain with the Upper Flow Unit occurring near the Bay of Fundy coast. The more easily eroded Middle Flow Unit, which commonly occurs as dips in the topography that can be detected and delineated using air photo interpretation and LiDAR DEM data (see Webster, 2005).

underlying the North Mountain have been tilted so that today they gently dip northward and under the Bay of Fundy (Fig. 2).

Although there is a major stratigraphic time gap above the Jurassic rocks on the North Mountain, the rock record elsewhere in the province, in the Bay of Fundy and on the Scotian Shelf, suggests that there may have been other periods of deposition on top of the Jurassic sedimentary rocks during the Jurassic, Cretaceous and Tertiary. The rock record on the North Mountain tells us, however, only that there has probably been a great deal of erosion in the area until relatively recent times. This wearing down of the landscape continued into the Quaternary with the activity of several episodes of glaciation over much of the last 2 million years. This erosion preferentially sculpted the landscape according to the susceptibility of the bedrock to wear.

At the end of the last glacial episode a covering of till was deposited unconformably over much of the bedrock. These unconsolidated sediments vary from a veneer to significantly thick deposits. Some areas have remained as glacially scoured bedrock surfaces to the present. During this final glacial melting more than 10 000 years ago, some of the rock debris and fines in the ice were incorporated into meltwater channels where they were sorted into sand and gravel. On land the sediments formed eskers, kame fields and outwash deposits. At the land/sea interface, deltaic and shoreline beach sand and gravel were deposited. Glaciomarine shoreline deposits that formed at sea level were subsequently uplifted following deglaciation as crustal rebound outpaced sea-level rise. This resulted in the formation of numerous raised beach deposits and erosional terraces along the Fundy coast. Over the last 10 000 years modern streams, sea-level rise and coastal erosion have modified the landscape to its present day appearance. For a detailed discussion of bedrock and surficial land form interpretation as delineated by high resolution laser altimetry, refer to the research of Webster (2005).

Geology of the North Mountain Basalt

The North Mountain Basalt consists of 400 m of continental tholeiitic basalt flows which have been mapped and divided into three units by Kontak

(2003): the Lower Flow Unit, the Middle Flow Unit and the Upper Flow Unit (Fig. 2 and 3). During emplacement and solidification, these flows were subjected to variable rates of cooling, degassification and thermal contraction. In general the Lower and Upper flow units are very similar, each consisting of a thick, massive medium-grained flow which is characterized by columnar-jointed fracturing. When the molten magma was extruded and deposited as lava flows, relatively fast cooling produced contraction fractures around a series of cooling centres which have a polygonal pattern in plan view (Figs. 4a, b). As the cooling proceeded, solidification and contraction deepened into the magma flows or in a direction perpendicular to the temperature gradient. As a result these tensional joints produced three-dimensional columnar structures or elongate blocks (Figs. 4c, d). In general the columnar-jointed pillars formed vertically and, due to subsequent tilting of the strata, are observed today in a subvertical orientation. There are numerous locations in the North Mountain Basalt, however, where the columnar joints occur in inclined to subhorizontal orientations (see Figs. 6d and 6g in Kontak, 2006). The columnar jointing can be divided into two types: closely spaced entablature joints (<40 cm) and widely spaced collonade joints (<2.5 m). Kontak (2006) observed that some quarries in the Lower Flow Unit consist of one type while other sites are a complex mixture in terms of the size of the pieces and their orientation.

The Middle Flow Unit is different from the other two units in terms of flow architecture and physical properties. It consists of numerous thin sheet flows (>16 according to Kontak, 2003) characterized by zeolite-bearing amygdules throughout much of each flow. The flows vary in thickness from 12-15 m with zoned, classic basalt flow vesicle distribution. The vesicles were formed by gas bubbles entrapped in a lava flow. Gas, due to its low density, rose to the top as molten basalt flowed out over the landscape. The highest concentration of vesicles (30-50%) are found in the upper 1-3 m of each flow, and in bubble trains or pipes (cylinders) that acted as migration channels for the entrapped gas as it worked its way toward the flow top or surface. The empty gas vesicles were filled by zeolite minerals when mineralized fluid passed through the basalt flows over an

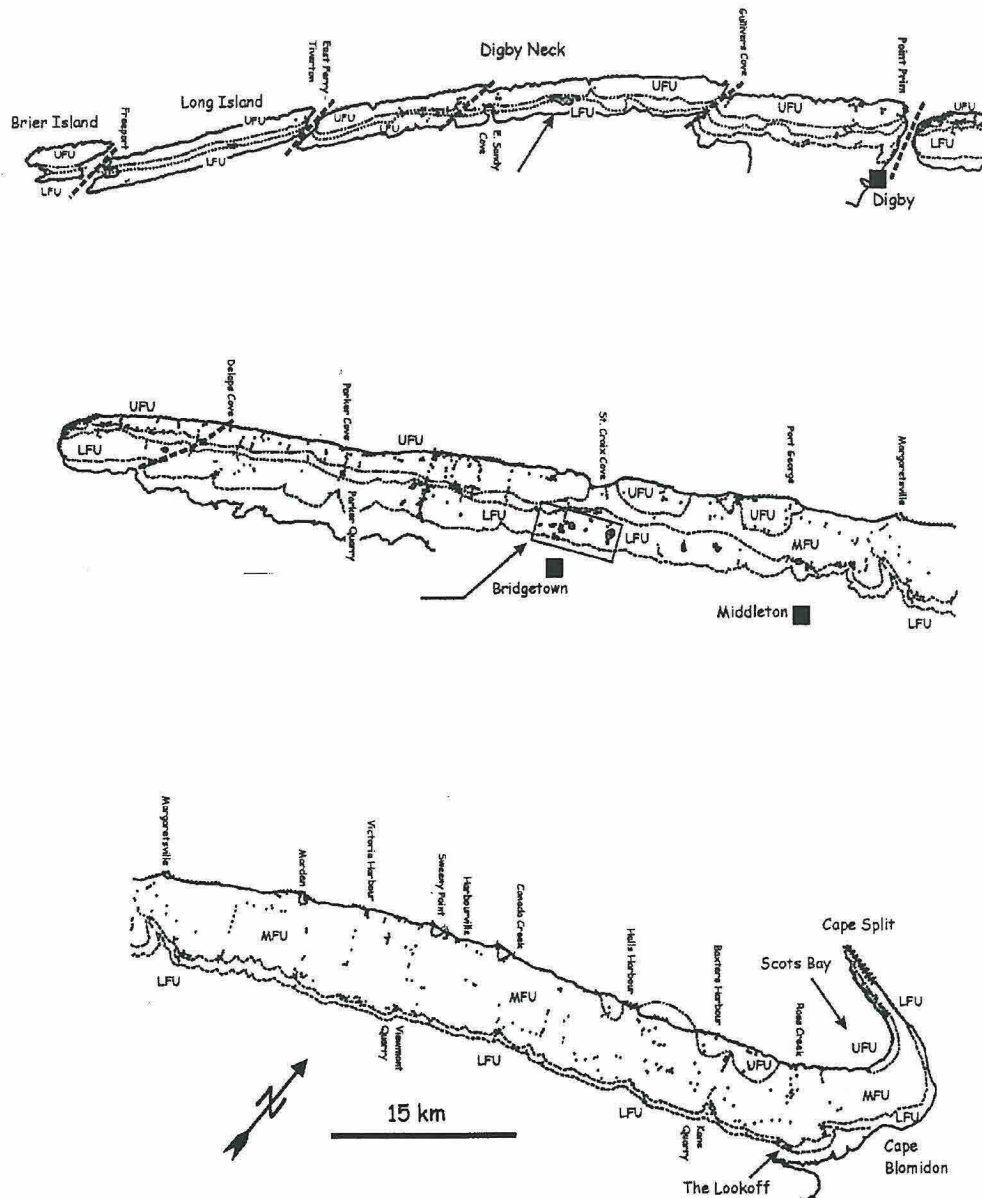


Figure 3. Geological map of the North Mountain Basalt, which is subdivided into the Lower Flow Unit (LFU), Middle Flow Unit (MFU) and Upper Flow Unit (UFU) (from Kontak, 2006).

extended period of time following their emplacement and cooling (Kontak, 2006). The round or oval shape of the zeolite-filled vesicles, the light colour of the zeolite minerals, and their crystalline textures make it easy to identify the zeolite-enriched zones in the Middle Flow Unit. Although individual flow composition and characteristics are complex, Kontak (2006) has divided a sheet flow into five distinct zones based on the distribution and features of the amygdules and vesicles. In ascending order they are (1) the

chilled base, (2) the core zone, (3) the vesicular cylinder zone, (4) the vesicle sheet zone and (5) the upper crust zone. Zeolite-filled amygdules are abundant in all of the zones except the core zone, which has a massive texture. Columnar joints are rare in the Middle Flow Unit and are generally observed in the core zone. Subhorizontal joints were also observed by the author in coastal sections of the core zone. For a detailed geological description and discussion of the North Mountain Basalt refer to Kontak (2000 and 2006).

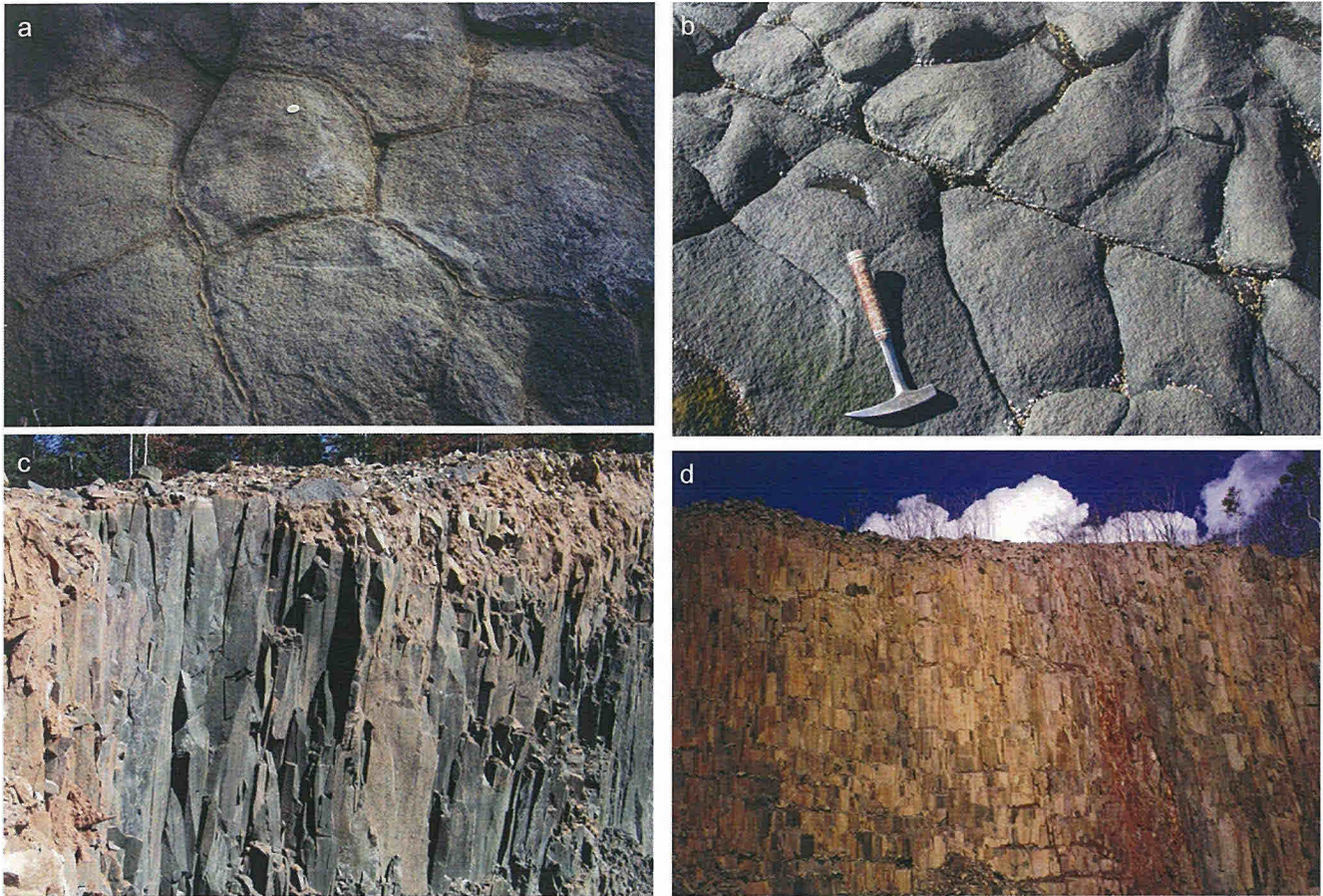


Figure 4a, b. Examples of basalt outcrop with columnar jointing in plan view. These 4-6 sided joint fractures project subvertically into the subsurface bedrock, producing polygonal-sided, elongate blocks or columns. Two dollar coin for scale in Figure 4a. **c.** A quarry face exposing approximately 6 m of columnar-jointed basalt in the Lower Flow Unit near Forest Glade, Annapolis County. Note there is no obvious subhorizontal fracture system in these rocks. **d.** Columnar-jointed basalt in the Lower Flow Unit with a subhorizontal joint fracture system. The quarry is located near Granville Ferry, Annapolis County.

Potential for Industrial Minerals

The depositional origin and composition of the North Mountain Basalt has resulted in properties that give the rocks a high stone resource potential. Depending on the flow unit this can include the uniform freshness (lack of significant alteration) of the rock, its massive fine-grained texture, its impermeability to water, the joint fracture system and an abundance of zeolite minerals. Products that have already been successfully used include bedrock aggregate, dimension stone and armourstone. Possible future uses for the basalt are zeolite products and soil amendments. Some aspects of the resource have been discussed previously by Kontak

(2000 and 2006) and Prime (2005); this report will provide a broader overview of the stone resource and its implications for the future.

Aggregate Potential

Aggregate is a nonrenewable resource which is used for all aspects of construction and many specialty stone products. The primary applications include road base, bituminous concrete, Portland cement concrete and back fill. There are also many other uses, such as traction sand, mortar sand, roofing gravel, landscape stone, erosion control and pea gravel for playgrounds. Historically sand and gravel were the primary source of aggregate, which reflected the ubiquitous presence of glacial materials and their

ease of extraction. Due to the depletion of glacial deposits and more demanding materials standards, however, bedrock aggregate production dominates the market today. In 2006 approximately 73% of aggregate in the province came from bedrock quarries (from Natural Resources Canada web site <http://mmsd1.mms.nrcan.gc.ca/mmsd/production/2006/web06.pdf>). The need for bedrock aggregate in the province will most likely continue to rise in the future.

The North Mountain Basalt is an important component of the bedrock aggregate resource. Commonly called trap rock by the industry, it has been used to produce crushed stone for several decades, as witnessed by the presence of numerous active and abandoned quarries along the mountain length. (Note: Many of these extraction sites are referred to by others as pits, but the author considers any site where bedrock materials are being extracted as a quarry.) Some of the quarries were operated by blasting the bedrock and many more sites were ripped using excavators and dozers. Under most circumstances aggregate quality can be determined by the method used to loosen and extract the stone. As a rule of thumb, bedrock that can be ripped is unsuitable for high quality aggregate because there are characteristics in the rock that cause it to be structurally weakened (e.g. abundant fracturing, soft alteration minerals or a metamorphic fabric). Conversely, rock that has to be blasted is commonly hard and durable, characteristics that are desirable in construction stone today.

The basalts are an anomaly to these rules because some of the rock that can be ripped makes durable aggregate products. This is a result of the very regular, closely spaced, columnar jointing present in some of the flows. In places where the fracture system is open, the rock is loose enough to remove using heavy equipment. This can probably only be successfully accomplished along steep slopes, such as the ridge along the south side of the North Mountain or along the flanks of deeply incised stream valleys. Although the reasons for this are beyond the scope of this report, the author speculates that this is probably related to the opening of joint fractures, which are commonly sealed by iron or silicate minerals. The edges of these ridges were probably vulnerable to the opening of the near-surface joint fractures because

of the continuous pressures and vibration of ice movement along the edge of this topographic high during periods of glacial advance. Near-surface groundwater fluctuations, freeze-thaw cycles and the periodic effects of permafrost over hundreds of millennia probably also contributed to the opening of the fractures. Evidence for looseness of this rock along exposed ridges is observed in the common presence of major talus slopes (Fig. 5) along the south margin of the columnar basalts (see map of Stea *et al.*, 1992). Conversely the more gently sloping topography to the north (and away from the stream valley walls) was less exposed to the glacial forces and remained solid near the surface.

In general, the rock on the North Mountain that can successfully be used to make high quality construction aggregate is found in the columnar-jointed basalt of the Upper and Lower flow units. The qualities in the rock that make it suited to aggregate are the relatively fine grain size (medium grained or finer), massive texture and generally fresh (unaltered) mineral composition. These characteristics make the rock reasonably hard, durable and resistant to water entry and freeze-thaw cycles. Although the presence of alteration minerals can negatively impact aggregate quality, they are typically limited in the basalt to narrow zones along the columnar joints. Kontak (2006) observed that they are restricted to a 4-5 mm zone and suggests that they may consist of "silica and a red-brown alteration selvage." When columnar-jointed rock is crushed for aggregate, such a thin zone of altered materials would proportionately represent a very minor component of the materials. Furthermore, many alteration minerals are not harmful to aggregate potential. Silica minerals would most likely be hard and not have a negative impact on aggregate quality. The author speculates that the best areas to obtain the highest quality columnar-jointed rock are on top of the mountain and away from steep slopes. The rock is probably freshest in these locations, although it is acknowledged that sloped locations are currently preferred due to the economics of market proximity.

The Middle Flow Unit, on the other hand, is generally unsuitable for construction grade aggregate. This reflects the abundance of zeolite-bearing amygdules that are found in these comparatively thin flows. Although most of the



Figure 5. Basalt scree slope beside a deep stream-cut valley in the North Mountain near Melvern Square, Annapolis County. The angular stone blocks are 0.5-1 m wide.

vesicles are filled, there are also partially filled and empty vesicles as well. Collectively the abundance of amygdules causes the rock to be mechanically weakened with a propensity for water entry and susceptibility to freeze-thaw cycles. The dull to earthy appearance of some of the zeolitic rocks can also be an indicator of rock softness and poor performance as construction aggregate. These characteristics would suggest that the Middle Flow Unit is only suitable for applications where quality considerations are minimal, such as the construction of woods access roads. The exception may be the Middle Flow Unit flow sheets where the massive-textured core zones are unusually thick (5-10 m) and can be quarried without encountering the less durable vesicular/amygdular rock. It remains to be determined, however, through sampling and testing in 2008 whether or not the massive rock in the core zone is acceptable for the

production of high quality aggregate. Extraction in most of the zeolitic basalt quarries has been accomplished by ripping equipment which, unlike the majority of the columnar basalt, indicates a very friable rock. The shallow nature of the quarries suggests that near-surface weathering is a significant contributor to the weakening of the stone. At 2-3 m depths the rock is relatively solid but unlikely suitable for construction aggregate. This does not apply to the massive texture zones in the Middle Flow Unit which the author speculates would, generally speaking, be quite solid and durable even at the surface. The competence of this rock in combination with a low frequency of joints and fractures would probably require blasting to quarry.

A primary concern in rock being considered for construction aggregate is the presence of the weathered zones in the North Mountain Basalt

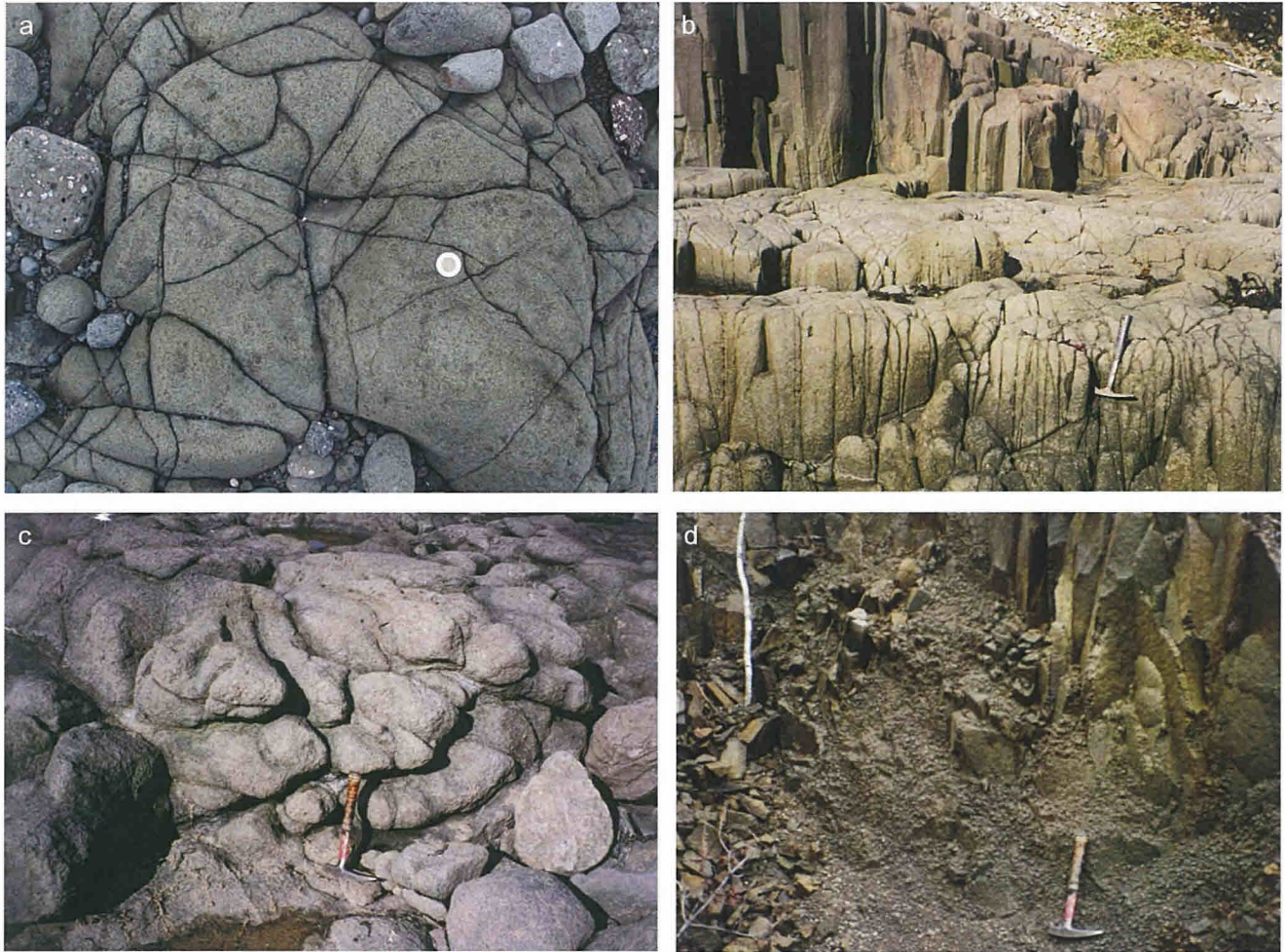


Figure 6. Various stages of weathering and precursors to weathering in the North Mountain Basalt. The precise mechanism of weathering is unknown, but it appears to be primarily related to profusely fractured rock and the voluminous water entry along those pathways. The actual weakening and disaggregation of the rock probably is a combination of the chemical breakdown of the constituent minerals and mechanical pressures such as freeze-thaw cycles over the millennia. **a, b.** Examples of highly fractured, columnar-jointed basalt in plan and side views. This rock is susceptible to water entry and weathering. **c.** Fracture-related weathering observed in the tidal zone bedrock at Cottage Cove Provincial Park, Annapolis County. The rock has been sculpted into rounded stone that eventually separates from the outcrop and produces boulders (lower right). **d.** Example of weathered columnar-jointed basalt on Long Island, Digby County, where some of the rock is very friable whereas adjacent rock appears solid.

which contain weakened stone that is friable and prone to water absorption. These characteristics negatively impact stone in most construction aggregate applications, causing the structures (e.g. highways) to perform poorly and fail prematurely. Highly weathered zones or saprolites were observed by the author in all three flow units and at numerous locations along the length of the mountain. The intensity of the weathering varies from minor effects in highly fractured but intact bedrock (Figs. 6a, b), to rock with significant weathering along fracture planes (Fig. 6c), to very

friable bedrock (Fig. 6d), to classic corestone and grus deposits where the most of the rock consists of disaggregated materials lacking original bedrock features (Fig. 6g). Some of the most highly weathered bedrock observed by the author was found on Long Island and Briar Island.

Mafic rocks such as basalt appear to be particularly susceptible to weathering. Basalt clasts in till and gravel commonly have a single exfoliation shell such as observed in Figure 6h. Given that this was not observed in any other rock types in the till, it suggests that basalt is one of the



Figure 6. (cont'd).

e. Exfoliation shells in this basalt outcrop near Blomidon, Kings County, appear to be the early stages of weathering in tightly fractured bedrock. Eventually the outer portion of this rounded rock will break down to produce a small corestone similar to those observed in zeolitic basalt near Ross Creek, Kings County, in Figure 6f. **g.** Corestone and grus which appears to be in highly weathered columnar-jointed basalt of the Upper Flow Unit on Long Island, Digby County. Weathering is so pervasive that none of the original bedrock characteristics, such as fractures, remain. **h.** Exfoliation shell of a basalt clast in till. These shells are common in till and gravel basalt clasts and appear to indicate that basalt is more susceptible to weathering than other igneous rocks.

most weathering-prone igneous rocks in the province. It must be emphasized, however, that this outer rim weathering process occurs on the order of hundreds or thousands of years and would not affect an aggregate clast during its normal life span.

The cause for the weathering that produces these very friable rocks is beyond the scope of this report; presumably it is related to a combination of water access to highly fractured rock and freeze-thaw cycles. Areas of significant weathering should be avoided when looking for construction aggregate deposits. Areas of topographic breaks in the basalts should be approached with caution

because the preferential erosion that has occurred there in the past can be a sign of soft rock. Similarly, many areas where the pit/quarry extraction has been accomplished by ripping may be an indicator that friable rock is present. Examining the geology of these sites for weathered stone should be a priority.

The author is currently conducting a bedrock aggregate sampling program of the North Mountain Basalt. Several samples have been tested for aggregate quality to date and the final samples will be collected for analysis in 2008. It is anticipated that the analytical results will be published in 2009.

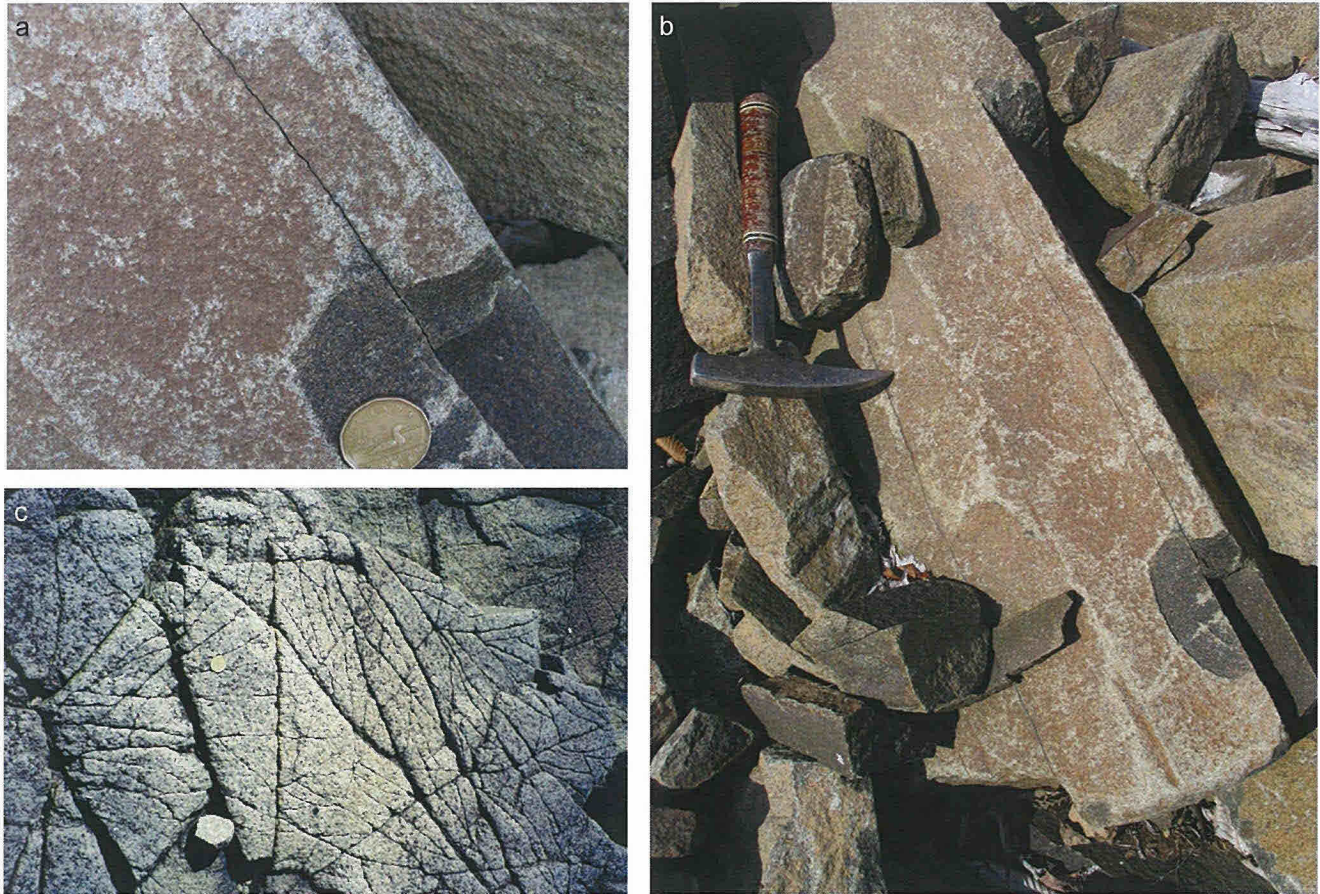


Figure 7a. Secondary sets of hairline fractures are commonly found in the columnar-jointed basalt. **b.** The large piece of columnar-jointed rock that is positioned diagonally across the photo contains two hairline fractures: one to the left of the hammer point and the other near the right edge of the piece of rock. **c.** Plan view of columnar-jointed basalt with pervasive secondary fracturing on Briar Island, Digby County. The fractures would project subvertically into the bedrock and sub-parallel to the long axis of the column block. This degree of fracturing would be unacceptable for dimension stone applications. One dollar coin for scale. **d, e** and **f.** (facing page). Examples of the tabular, blocky, prismatic and flagstone rock that were shaped by fracture systems.

Dimension Stone Potential

Dimension stone can be defined as rock that has been quarried, shaped and finished for a variety of construction applications. This includes products used in a structural capacity, such as load-bearing walls and foundation courses, or in high end finishes where the stone is polished for products such as flooring, wall cladding and kitchen counter tops. Cut and polished stone for monuments is another important use of dimension stone. A great deal of stone is also shaped for landscape purposes such as flagstone walkways, retaining walls and stone fences. Most types of rock in the province have been used for dimension stone purposes. The ability of the rock to suit an application depends on the material specifications of the product and the

knowledge of the stone mason. Desirable or required characteristics can include mechanical strength, colour, shape, texture, resistance to weathering and an absence of sulphides.

Columnar-jointed basalt, primarily from the Lower Flow Unit, has been used for many years as building stone and decorative landscape stone. Most of the dimension stone has been used in the Annapolis Valley region because of its proximity to the basalt quarries. Applications observed by the author include dry-stone (no mortar) retaining walls and fences, mortared walls and fences, fire places, chimneys and building foundations.

Although demand for the basalt as dimension stone is currently quite limited, it is the author's opinion that the market for these materials could be larger. There are several characteristics of the stone



that make it suited to the construction of stone walls and fences. First, the columnar fracturing in the rock produces elongate, polygonal shaped stone which is typically 4-6 sided (Figs. 4b, c). Between the columnar joint fractures are other heat-related fractures (Figs. 7a, b, c), which can break the columnar blocks into other shapes such as prismatic-shaped wedges, rectangular to tabular blocks (Fig. 7d, e) and thin, more or less parallel-faced flagstone (Fig. 7f). One stone mason indicated to the author that the basalt is very easy

to work with in constructing stone walls. The tabular-shaped pieces and flagstone are suitable for wall corners and ends as well as laying a flat-surfaced top (Fig. 8a). Another feature of the columnar basalt that is important to building stone is that the columnar jointing commonly produces elongate blocks (>1 m in length) which can be used for tie stone. These pieces of rock are normally required when stone walls are constructed with two finished faces, separated by a space filled with waste rock or concrete rubble (Figs. 8a, b). If measures are not taken to provide a connection between the inner and outer wall, it is structurally weakened and prone to failure over time. Tie stones or bond stones placed at regular intervals are used to bridge or join the entire thickness of a wall and connect the faces along its length. These pieces not only provide structural integrity to the wall but also act as facing stone on both sides of a wall. Another appealing characteristic of the basalt is the variation in colours. The colours, including stained fracture faces and fresh stone, vary from buff to dark brown to green-black to brown-black. A quarry typically contains more than one colour of stone, which is ideal for producing visually interesting and attractive structures (Fig. 8c). Finally, the rock rarely contains sulphides, such as pyrite or pyrrhotite, which can cause unsightly rust-coloured staining in weather-exposed applications.

Although the existing market for the stone is small, there may be an opportunity to expand it in the future. This might include greater promotion in the Metro area or to the landscaping companies throughout the province. Because the basalt is unusual there may be opportunities to export the stone to other provinces or the eastern seaboard of

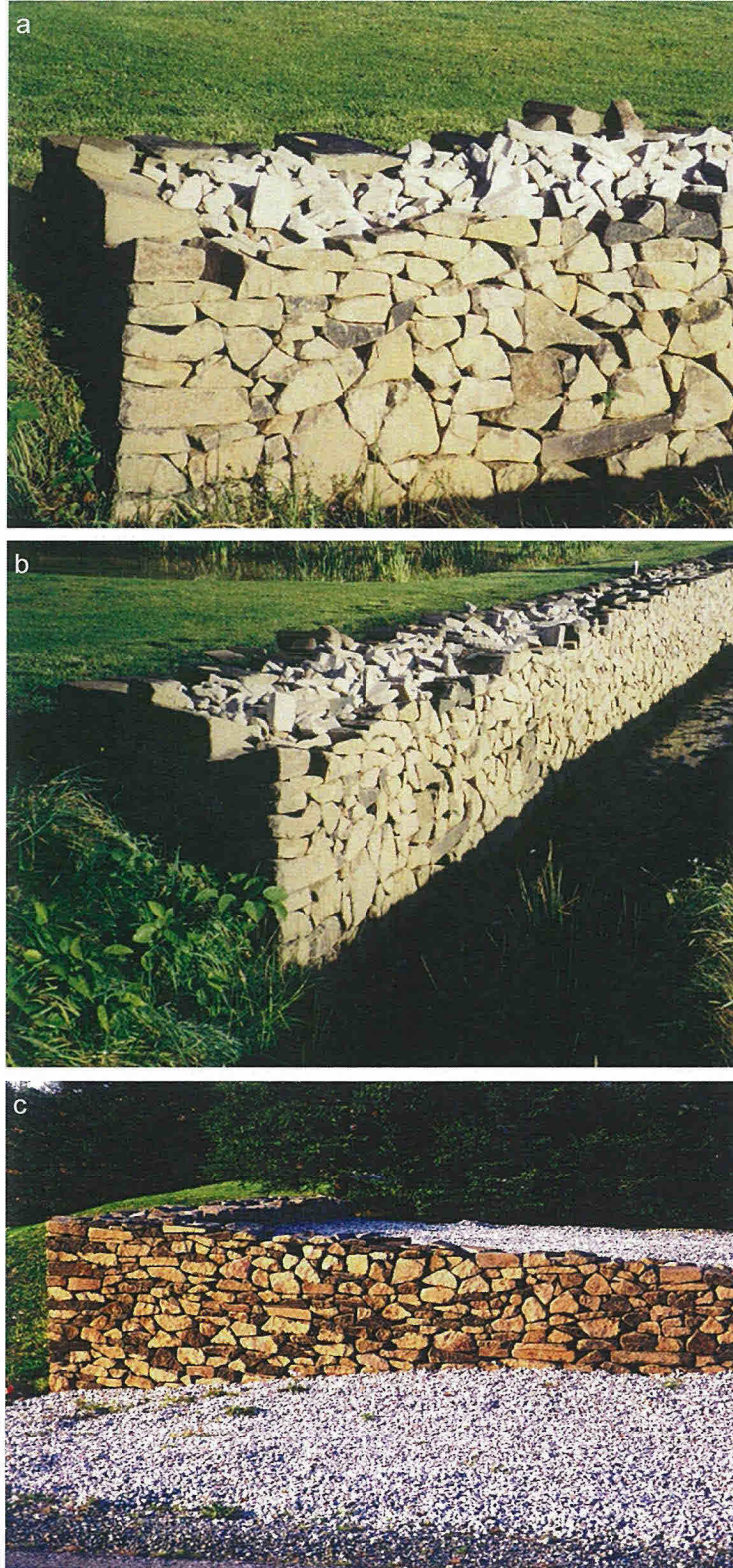


Figure 8a, b, c. Examples of columnar-jointed basalt stone walls. Figures 8a and b show a free standing dry-stone fence (in progress) with two finished faces and a centre filled with rubble. Note the rectangular shape of the corner stone and flat pieces being placed for the top course. Figure 8c is a retaining wall supporting a raised driveway. Notice the variety of stone shapes and colours in this wall as well as the rectangular-shaped corner blocks.

the United States. Many areas in the United States and Ontario, for example, only have limestone as a local product. Transportation of the rock could be accomplished by (1) trucking, (2) trucking to a rail line or (3) possibly trucking the stone to existing wharf/port facilities for barging. Because there are several quarries along the south side of the North Mountain that have the capability of providing this product, it is readily available at the present time to test these markets. A cautionary note about hauling this rock is its high specific gravity (2.8-3.0) compared to other rocks such as granite (2.6) or quartzite (2.7). This increased weight per volume of stone would add significant fuel costs to each truck load of materials. Highway weight restrictions in some jurisdictions might result in a truck not being loaded to maximum capacity.

Armourstone

Armourstone consists of large blocks of stone that are primarily used in the construction of marine and coastal defence structures. This includes shoreline erosion control, the protection of marine structures and dike lands, and providing sheltered harbours for coastal communities. There are also a wide variety of inland applications such as retaining walls, dam structures, erosion control along water courses and the protection of bridge piers and abutments. The size and shape of the blocks vary according to the application, but the large tandem and triaxle dump trucks usually only carry 2-3 boulders. Although there doesn't appear to be a standard definition for block size, according to Smith (1999) the minimum size is 0.25 tonnes(t), with some blocks as large as 20 t. The lower limit overlaps with smaller stone, which is referred to by industry as rip rap, although this term is used to describe larger blocks as well. The upper limit is largely established by geological constraints such as joint fracture spacing, although there are haulage equipment limitations as well. The blocks are typically 5-10 t for most applications. The shape of the rock can also vary from blocky to rounded, depending on the project requirements and stone availability.

Although just about any type of rock has been used for armourstone in the province, this does not mean that all rock is suited for this purpose. Many structures fail prematurely because deleterious rock

was used in situations where a high quality product was needed. Finck (2007) identified stone quality as one of the primary causes for premature failure of stone retaining walls used to prevent coastal erosion. Unmetamorphosed sedimentary rocks and foliated metamorphic rock are examples of rocks that lack strength and are prone to water entry and freeze-thaw cycles. Applications where the rock is exposed to the rigours of weather and hydraulic influences, such as the tidal zone or along a river embankment, require special attention to stone quality. Marine structures in particular require rock that "must be able to withstand rapidly fluctuating and severe hydraulic pressure changes, impact due to movement, abrasion and attrition, wetting and drying, thermal cycling, and possibly freeze/thaw, salt and solution damage" (Smith, 1999, p. 293). Rocks that tend to meet these criteria are igneous and metamorphic rocks that don't contain metamorphic fabrics, pervasive fracturing or other structural weaknesses. Metamorphosed sandstone, igneous intrusive rocks and volcanic rocks are the primary sources of high quality rock.

Although not a primary source of large stone blocks in the province, the North Mountain Basalt has been used for coastal armourstone applications, such as breakwaters (Fig. 9), and preventing erosion of the dyke land (Fig. 10). Characteristics of the basalts that make them suited to the production of this product are durability and impermeability. The Upper and Lower flow units contain rock that is relatively fresh, fine-grained and impermeable to water penetration. These features permit the rock to be resistant to weathering, freeze-thaw cycles, impact forces and abrasion. Conversely, the zeolitic basalt of the Middle Flow Unit lacks durability, is quite fractured in places, and appears prone to water entry and weathering. The exception might be locations where the core zone is uncommonly thick (5-10 m). Rock falls associated with this massive-textured rock in coastal exposures suggest that the joint/fracture system may be conducive to the production of large, competent blocks. These thick core zones are apparently rare and would require expensive exploration and diamond-drilling to locate the test for armourstone potential. Although the Upper and Lower flow units have favourable mineralogical characteristics and grain textures for armourstone, the close spacing of the columnar



Figure 9. A recently constructed breakwater made from basalt armourstone at Tiverton, Digby County.

joint fractures would render much of the rock incapable of producing large blocks of stone. In general, most of the quarries of the Lower Flow Unit tend to produce stone that breaks into small elongate blocks. Conversely, the Upper Flow Unit, in spite of similar fracture systems, has been extensively used to produce large blocks for armourstone purposes.

The reason for the difference between the two units is beyond the scope of this report, but the author speculates that it may have to do with the location of the quarries in the flow units or the size of the columnar-jointed rock they contain. Quarries in the Lower Flow Unit primarily occur along the south edge of the mountain where, for reasons discussed previously, there is loosened, columnar-jointed rock along steep mountain slopes. Conversely, quarries in the Upper Flow Unit generally occur on the opposite side of the mountain where it commonly slopes gently to the Bay of Fundy. Possibly the near-surface bedrock in this area was more protected from ice, water and weather during the Pleistocene and post-glacial

times. As a result, the rock encountered near the surface is less fractured and commonly produces larger, solid blocks. Another unexplored possibility is that the Upper Flow Unit contains more widely spaced columnar jointing than the Lower Flow Unit, which may positively affect the size of the blocks that can be produced. According to Kontak (2006) the widely spaced joints can be as much as 2.5 m apart. Basalt deposits containing the largest columns would most likely be the best choice for producing solid, weather-impervious armourstone.

It is not clear if high quality armourstone can be produced from closely spaced columnar-jointed rock. Due to the hazardous conditions where much of the basalt armourstone is placed, it could not be assessed for the presence of internal columnar jointing in individual blocks or examined for post-emplacement stone deterioration. The author has observed several large quarry blocks and glacial boulders, however, that contain closely spaced columnar jointing (e.g. Fig. 11). Whether or not these columnar joints in tidal armourstone would progressively open, absorb water and cause a



Figure 10. Basalt armourstone used to protect a dyke from erosion at the head of St. Marys Bay near Roxville, Digby County.

breakdown of the rock over time due to freeze-thaw cycles is unknown. The fact that at least some of the tightly jointed glacial boulders survived the forces of glaciation and post-glacial weathering suggests that closely spaced columnar-jointed blocks can be quite durable. This durability would certainly be tested by the extreme forces associated with a marine breakwater in a temperate climate. Any examination of a basalt deposit for armourstone potential should include an evaluation for tightly spaced columnar jointing and the implications it could have on the armourstone product.

Zeolites

Zeolites are crystalline, hydrated aluminosilicates that are classed along with quartz and feldspar as tectosilicates. This group of minerals consists of a three-dimensional framework or lattice of silicon-oxygen tetrahedra, where all four corner oxygen atoms of each tetrahedra are shared with the

adjoining tetrahedra. Although the framework structures of quartz and feldspar are dense and tightly packed, zeolite structures are remarkably open, with significant void volumes that give them the capability of functioning as 'molecular sieves'. This permits the selective capture of cations (based on their molecular dimensions) in lattice channels or tunnels. Cations such as Na^+ , NH_4^+ , K^+ , Ca^{2+} and Mg^{2+} can be loosely held in the molecular structure of the lattice and later released or exchanged for other cations.

The ability to exchange some of their constituent elements without major change of structure makes zeolites effective absorbents and ion exchangers. They are widely used today for applications such as water softeners, water purifiers, detergents, slow-release fertilizers, odour suppressants, feed additives to prevent animal disease, lightweight concrete, catalysts in the petrochemical industry, and pozzolanic materials to prevent alkali aggregate reactivity in concrete. The materials for these applications are obtained



Figure 11. A large block of closely spaced columnar-jointed basalt that could be used for armourstone. It is unknown if this piece of rock would withstand the long term rigours of a marine tidal application. Would water eventually enter these sealed fractures, causing the rock to break down over time as a result of freeze-thaw cycles? Perhaps the placement of this type of rock in a structure such as a breakwater should be avoided because of the potential of premature failure.

(1) from mines where they are extracted and processed from natural mineral deposits, and (2) as a synthetically manufactured product. Naturally occurring zeolite deposits contain a mixture of zeolite and other minerals. Separating the different minerals in natural deposits is often not possible, so companies have devised methods to synthesize specific zeolite minerals that have the properties and very high purity required for some zeolite products. Synthetic zeolites are expensive to produce, however, so natural zeolites are used in market applications where purity tolerances permit their use.

Zeolite minerals (Figs. 12, 13a, b) have been found in the North Mountain Basalt by mineral collectors for more than a century. In 1864, one of

these collectors, Professor Henry How, discovered the new zeolite mineral Mordenite, which was named after the village of Morden, Kings County, where the discovery was made. Scientific interest in the zeolites has spanned more than four decades (e.g. Aumento, 1966; Donahue *et al.*, 1992; Pe-Piper and Miller, 2002; Kontak, 2000 and 2006). In the 1990s, prospector Ian Booth looked at the zeolites from a commercial, industrial mineral perspective. Ultimately his research and promotion of these minerals (e.g. Booth, 1994) encouraged C₂C Mining Corporation to stake ground and conduct an exploration program on the North Mountain. The company's work, which focused on several areas of the Middle Flow Unit, included geological mapping, diamond drilling and outcrop



Figure 12. Specimen of stilbite, a common zeolite in the North Mountain Basalt and Nova Scotia's official mineral.

sampling surveys. Quarried rock and drill-core samples were processed at local labs to separate the zeolite fractions for mineral identification and cation exchange capacity (CEC) tests. The CEC tests, which quantify how well the zeolites perform at exchanging cations, consistently showed higher levels than expected based on the visual estimate of zeolite concentrations in the basalt hand specimens. This perplexing result was examined and explained by Kontak (2000), who found that a significant component of the basalt mesostasis glass and matrix feldspars are altered to zeolite. This discovery enhances the potential of the Middle Flow Unit for future development of this industrial mineral resource. Kontak's (2006) detailed evaluation of zeolite distribution in the Middle Flow Unit will also be beneficial for quantifying the resource.

Although C₂C Mining's work resulted in a mining permit for their Stronach Mountain property, the site has not been developed to date. Recent exploration and scientific studies of zeolites on the North Mountain, however, have encouraged Department of Natural Resources geologist Garth DeMont to re-evaluate zeolite potential from the perspective of small-scale mining to address some of the environmental issues facing Nova Scotians. Possible applications include products that can be used to clean polluted waste water, to suppress unpleasant odours associated with farms and compost bins, to reduce the quantity of water required to irrigate farm fields, and to cleanse heavy metals from sewage sludge so it can be used safely as a source of fertilizer. In order to examine the potential of the North Mountain zeolites in terms of product opportunities, however,



Figure 13a. Hand specimen of zeolitic basalt typical of the Middle Flow Unit.

significant research is required. One concern that needs to be addressed is the often complex mixture of zeolite minerals that are present in the rock. Several zeolite minerals have been identified in the basalt, each of which has its own unique crystal structure, and hence its own physical and chemical properties. Characterization of the zeolite minerals in each deposit is key to describing the marketable properties of the zeolite deposit. This proposed evaluation of the resource would involve techniques such as geological field mapping, trenching and diamond-drilling surveys in order to determine the quality and quantity of zeolites available in each of the defined areas. Laboratory research would be done concurrently to characterize the zeolite minerals. This would be followed by collecting small bulk samples for use in the zeolite application field trials. Currently there are discussions between DNR and an outside

research agency regarding a strategy to carry this research forward (DeMont, personal communication, 2008). If successful, these studies could have important implications for the environment as well as providing other small-scale business opportunities in the region.

Rock Dust as a Slow-release Fertilizer

For millennia traditional methods of farming used a combination of organics and other naturally occurring materials to grow crops and control pests. This changed in the Twentieth Century with the development of mechanization, chemical fertilizers and pesticides, which have permitted intensified farming and dramatic improvements in crop yields. As a result synthetic fertilizers



Figure 13b. Outcrop of zeolitic basalt typical of the Middle Flow Unit.

effectively replaced the traditional methods of fertilization. Unfortunately, there have been environmental consequences such as soil degradation and water contamination in many areas. Recognition of these concerns by environmental organizations and a growing desire by consumers to eat healthier foods has seen a resurgence of more natural ways of farming with the result that the organic farming movement has taken hold in the last few decades.

One aspect of this movement that was brought to the author's attention by an organic gardener in the early 1990s is the use of finely crushed stone powder as a soil amendment. For several decades a small group of organic farmers and gardeners have used rock dust to add nutrients to the soils for the purpose of improving crop growth while maintaining a healthy soil. The premise for these claims is that certain rock types, when finely

ground and mixed with soils, slowly release elements into the soil that can be later used by the plant crops as nutrients. Although agricultural science has proven that rock dusts such as limestone, gypsum and dolomite improve soil productivity, these rock types are composed of reasonably water-soluble substances that readily break down into usable constituents in a relatively short time. The concept of using ordinary rock types (e.g. granite or basalt) for this purpose has largely been dismissed by soil scientists as 'wishful thinking'. Issues such as the low solubility of the materials and the unlikely availability of their component nutrients to the plants are some of the arguments against this idea. But proponents of the efficacy of rock dust argue that intensive farming practises using modern synthetic fertilizers only add a few macronutrients to the soil while ignoring the importance of micronutrients in plant growth

and development. Decades of using super fertilizers and repeated monoculture plantings have achieved high crop yield at the expense of the soils. Through the continuous seasonal removal of biomass by harvesting the crops, there has been a selective depletion of the micro-nutrients naturally present in the soil. It has been purported that this intensive farming has depleted the nutrients to the point that some farm soils are no longer productive. In other soils it is suggested that the nutrients are naturally deficient because of the natural composition of a particular glacial deposit. By applying the dust over many years, perhaps the depleted soils could be 'rejuvenated' and eventually make the land more productive and the crops more nutrient-rich.

Interest in these materials by organic growers has reached the point that a significant industry has developed around the production of rock dust products. At the time that the author was investigating this matter in the early 1990s, rock dust products were being marketed in 33 US states, three provinces, and several other countries around the world. Attendance at a geological conference in the US around this time coincidentally included a field trip to an aggregate operation where they had recently started producing rock dust products. The operations manager at the time said that they were seeing "exponential growth" in sales year to year. Imported products such as basalt have also been sold in local garden centres in the Nova Scotia for than more than a decade.

In terms of evidence of rock dust's effectiveness as a soil amendment, there have been numerous anecdotal claims that support this premise. There are also a variety of testimonials of rock dust producing large, flavourful vegetables filled with nutrients. In terms of scientific evidence a small number of studies have been conducted worldwide over the last century on plants such as coniferous trees, turfgrass, alfalfa and corn. The results generally indicate that rock dust is effective as a supplement to or replacement for synthetic fertilizer. Although the author was somewhat skeptical of these claims at the time, the scientific evidence was encouraging. Furthermore, there was a certain intuitiveness to this concept in terms of geological principles. It is well known that some of the most productive soils contain a high proportion of clay. The flood plains of deltas such as the Nile and Mississippi Rivers are some of the most fertile

farming regions of the world. Similarly, it is well known that the eruption of very fine volcanic ash in volcanically active regions can result in productive farm land a short time later.

Perhaps a similar situation could be achieved artificially by applying crushed rock dust composed of micro-particles that collectively have a huge surface area and possibly an enhanced capability of releasing nutrients to the plants. As a result the author promoted the concept to industry which led to a federal-provincial funded study being conducted by Coastal BioAgresearch Ltd. (Termeer, 1996). The focus of the research was an examination of waste fines generated in pits and quarries to determine if they could be used for slow-release fertilizers. Three sources of rock from quarries in the western region of the province were selected for examination. The solid rock from granite, quartzite (formally called metagreywacke) and basalt quarries was ground into a powder of a texture similar to refined baking flour and added to soils under green house and field conditions. The dust was also mixed with compost to make a synthetic topsoil and tested under the same trial conditions. The results of the research are very encouraging. The report states: "Rock dusts have a very low level of extractable nutrients compared to conventional sources of fertilizer. Yet, this project clearly demonstrated that application of rock dusts to soils can increase crop yields." The report went on to say that "Unprocessed aggregate fines can be used to blend an 'artificial topsoil' by adding organic matter and sand, depending on the aggregate fines characteristics. Since aggregate fines tend to have a higher nutrient extractability than agricultural soils, topsoil produced from aggregate fines will have a higher fertility status" (Termeer, 1996, p. 1).

Although this was a relatively small, short term research project, the author is encouraged by the results. Furthermore a survey conducted by the company of organic farmers at the time suggested that they were quite interested in this product and would use it if it was locally available. In order to prove that rock dust is effective as a soil amendment it is the author's opinion that it would take 5-10 years of research. This long term commitment would help determine if the soils are gradually improved over time, perhaps as a result of weathering and the further break down of the

dust particles in the soil. The field trials might involve fines from several different rock types, different size fractions of the dust, several different crops and applications on more than one soil type.

Based on an examination of the research by others, mafic rocks such as diabase and basalt have been the primary choice for rock dust experiments. It is the opinion of the author that the North Mountain Basalt is the best choice in Nova Scotia for the continuation of this research. The columnar jointed rock was used in the Coastal BioAgresearch study, but zeolitic basalt, with its cation exchange capacity, may be an even better choice as a slow-release fertilizer. Although there is no rock dust research being contemplated at this time, the environmental benefits of such studies have intriguing possibilities. If some of the synthetic fertilizers could be replaced by more benign, natural replacements, there should be a reduction of contaminants in water courses and underground aquifers. This would have human health benefits and help mitigate the eutrophication of streams and rivers in intensely farmed regions. There is also the possibility of increasing yields and nutrient values in the crops. Application of the dust to marginal soils (e.g. coarse gravelly tills) may eventually upgrade the soils to more arable farm land for the future. It's possible that the long term use of these benign materials may also contribute to a more sustainable approach to farming in the province. There may also be small-scale business opportunities to manufacture fertilizer products for the local organic market and possibly as an export to the United States. It is conceivable that a line of rock dust products blended from a combination of rock types could be tailored for specific crops and soil conditions. Perhaps zeolitic basalt dust or coarser stone (sand-sized?) materials could be combined with synthetic fertilizers so that some of the nutrients of the chemical fertilizers could be retained and slowly released due to the cation exchange capacity of the zeolites. The possibilities of this simple concept are significant, but the research would be expensive and require a long term commitment to adequately determine if it has any merit.

Discussion

Quarrying on the North Mountain has been the

topic of much controversy at various times over the last two decades. The most recent example was the failed attempt to establish an export quarry at Whites Point on Digby Neck. At issue were a number of concerns regarding the impact a quarry would have on tourism, the fishery, whale habitat, land values and quality of life. Press coverage suggested that the proposed quarry was "an assault on the physical integrity of Nova Scotia" (Surette, 2006). A Private Members Bill proposing the moratorium of aggregate export from Digby Neck was also introduced to the Nova Scotia legislature (Theriault, 2006). Interestingly, in spite of the relatively modest size of the development proposal (in terms of a mining operation), the controversy received national attention on the CBC radio show *Ideas* and in the magazine *The Walrus* (Richler, 2007). Ultimately the decision by the Federal-Provincial Joint Review Panel authorized by the Canadian Environmental Assessment Agency was to reject the quarry based on issues such as core community values and environmental concerns. The panel also recommended the implementation of a coastal zone management strategy and a moratorium on new quarry developments until a more comprehensive set of guidelines is in place.

Although the author is cognizant of the sensitivities of communities to heavy industry such as quarrying in the region, it also has to be recognized that mining is one of the cornerstones of the rural economy. During the fieldwork phase of this report the author listened to quiet support for the Whites Point project by area residents concerned about the state of employment in the region. Beyond the direct benefits to quarry employees there are many support industries that interact with, or benefit from, aggregate operations. This includes trucking, equipment sales and road builders, to name a few. Ensuring the continued viability and long term success of this industry should be a goal shared by the producers, governments and communities.

In addition to being contributors to the economic prosperity of the region, quarries also are the source of basic construction materials that are strategic to the growth and functioning of communities. High quality aggregate is necessary for all aspects of construction and infrastructure development. But much of the region, such as the lowland areas and Annapolis Valley floor, are

underlain by soft sedimentary rock that is not suitable for the production of construction aggregate. Even the North Mountain Basalt contains a mixture of rock units, much of which will not meet high quality material standards. One might suggest getting the stone from elsewhere, but this can be impractical and costly for the community and the environment. Some of the rock on the South Mountain (to the south of the Annapolis Valley), for example, can also be used for aggregate and armourstone. But this is only effective and reasonable where these quarries are closer to a construction site than North Mountain Basalt quarries. This reflects the high haulage costs of these heavy, bulk materials, which must be obtained as close as possible to the site of their intended use. For an appreciation of the effects that haulage distance has on the price of the landed aggregate, refer to stone haulage rates paid by the province for highway work (Nova Scotia Department of Transportation and Infrastructure Renewal, 2007). Proximity of the source also has environmental implications because of the amount of fossil fuels consumed and air emissions per tonne of stone delivered. For a complete discussion of these issues refer to Prime and Bonner, 2007.

Many of the mining opportunities suggested in this report may benefit other aspects of communities, such as the environment. Perhaps research will show that zeolites can be used as an odour suppressant in composting and livestock farming, or for removing harmful metals from sewage sludge. If zeolitic basalt rock dust can be used as a slow-release fertilizer in organic farming, or as a partial substitute for synthetic fertilizers, it may make an important contribution in the direction of sustainable agriculture. A major research initiative would be required to determine the efficacy of these poorly understood or largely untested concepts.

If the new products are determined to be effective, there is the possibility of extracting and processing the materials using small-scale mining methods and confining the operation to a relatively small area (Garth DeMont, personal communication, 2006). Perhaps the zeolite and rock dust products could be produced from existing zeolitic basalt quarries in the Middle Flow Unit, thus minimizing the number of new quarries in favour of using historic sites where the land has

already been disturbed. Garth DeMont (personal communication, 2006) suggested the possibility of combining zeolite and dimension stone or aggregate production from a site that occurs at the contact between the Middle Flow Unit and the Upper or Lower flow units.

In terms of aggregate, much of the rock of the Upper and Lower flow units of the North Mountain Basalt has properties that make it suited to the production of construction grade stone. From a geotechnical perspective the best materials may occur on top of the mountain, where the rock has a greater likelihood of being fresher near the surface than along the sloped mountain walls. Another advantage of these areas is a matter of view planes. One of the common complaints of communities throughout the province is the visual impact of quarries located on mountain slopes. In the interest of community acceptance, future quarry applicants may want to consider the benefits of a visual barrier to the quarry where possible. The siting of a quarry operation should always be done, if possible, with the neighbours in mind.

Rip rap and armourstone, which protects wharves and shorelines along the Bay of Fundy from storms, can only be produced from high quality stone found in upland settings such as the North Mountain. The soft sandstone, conglomerate and mudstone found in the lowlands would fall apart if quarried and used in a high energy, weather-exposed environment such as the shoreline. The need for the armourstone in the region will only increase as sea levels rise. Recently expressed concerns over the potential future flooding of historic Annapolis Royal and the need for infrastructure upgrades to prevent such a disaster (Flinn, 2008) highlight this need. If these preventive measures are taken, stone would most likely be the primary component of the work (e.g. aggregate, armourstone and concrete) and would have to be obtained nearby. So, ensuring future access to all of these vital construction materials should be part of the dialogue in any coastal protection and management strategy.

Finally, it should be emphasized that industry, communities and individuals have a shared interest in continued quarrying on the North Mountain. These stone resources are vital to the development of the communities, employment and tax revenue in the region. There is also a shared responsibility

in ensuring that the extraction sites are kept clean and protected from the public. Although pit and quarry regulations adequately oversee recent quarry developments, there are a host of older sites where issues such as ponds and unstable quarry walls continue to be a problem in terms of public safety. Openly accessible sites also can become the receptacles for garbage and pollutants, which can quickly and permanently damage underlying aquifers. The same applies to the use of a former quarry by the land owner for storing derelict automobiles and other machinery. Proper protection of the sites from misuse and public access should be the goal of the entire community. The future of industrial mineral mining on the North Mountain will require thoughtful planning to ensure that these vital resources remain accessible for the public good.

References

- Aumento, F. 1966: Zeolite minerals, Nova Scotia; *in* Geology of Parts of the Atlantic Provinces, ed. W. J. Poole; Geological Association of Canada and Mineralogical Association of Canada, Field Trip 3, p. 71-94.
- Booth, I. 1994: Zeolites of the Bay of Fundy; Book privately published, 37 p.
- Donohoe, H. V., Jr., Colwell, J. A. and George, E. 1992: Zeolites of the North Mountain Basalt, Bay of Fundy-Minas Basin region, Nova Scotia; Field trip guide for the Zeolite Association, 9th International Zeolite Conference, Montreal, Quebec, Canada, p. 5-26.
- Finck, P. W. 2007: Factors affecting coastal armour stability along the Amherst shore, northern Nova Scotia; *in* Mineral Resources Branch, Report of Activities 2006; Nova Scotia Department of Natural Resources, Report ME 2007-1, p. 17-32.
- Flinn, B. 2008: Annapolis Royal could be our New Orleans; Daily News, February 5, 2008.
- Kontak, D. J. 2000: Nature of zeolite distribution in the North Mountain Basalt, southern Nova Scotia: field and geochemical studies; *in* Minerals and Energy Branch, Report of Activities 1999; Nova Scotia Department of Natural Resources, Report ME 2000-1, p. 105-124.
- Kontak, D. J. 2006: Geological map of the North Mountain Basalt from Cape Split to Brier Island, with comments on its resource potential; *in* Mineral Resources Branch, Report of Activities 2005; Nova Scotia Department of Natural Resources, Report ME 2006-1, p. 39-66.
- Kontak, D. J and Dostal, J. 2003: Geological setting and petrology of the 201 Ma North Mountain Basalt, southern Nova Scotia; Geological Society of America; Northern Section - 38th Annual Meeting; Session 37, Paper 37-5.
- Kontak, D. J., De Young, M. Y. and Dostal, J. 2002: Late-stage crystallization history of the Jurassic North Mountain Basalt, Nova Scotia, Canada; textural and chemical evidence for pervasive development of silicate-liquid immiscibility; *in* The Canadian Mineralogist, v. 40, p. 1287-1311.
- Nova Scotia Department of Transportation and Infrastructure Renewal 2007: Standard Specification Manual - Highway Construction and Maintenance; Appendix C; Section 5.2; Tonne Kilometre Rates - Gravel; Nova Scotia Department of Transportation and Infrastructure Renewal; p. C-3.
- Olsen, P., Whiteside, J. and Fedak, T. 2005: The Triassic-Jurassic faunal and floral transition in the Fundy Basin, Nova Scotia; Field Trip 7A; Atlantic Geoscience Society Special Publication Number 26; Geological Association of Canada - Mineralogical Association of Canada - Canadian Society of Petroleum Geologists - Canadian Society of Soil Sciences Joint Meeting; Halifax, May 2005; 53 p.
- Pe-Piper, G. and Miller, L. 2002: Zeolite minerals of the north shore of the Minas Basin, Nova Scotia; *in* Atlantic Geology, v. 38, p. 11-28.
- Prime, G. A., 2005: Aggregate program activities in 2004; *in* Mineral Resources Branch, Report of Activities 2004; Nova Scotia Department of Natural Resources, Report ME 2005-1, p. 93-99.
- Prime, G. and Bonner, F. J. 2007: Bedrock aggregate development potential in western Halifax Regional Municipality; Nova Scotia Department of Natural Resources, Economic Geology Series ME 2007-1, 51 p.

- Richler, N. 2007: Rock bottom; The Walrus magazine; December 2007 Issue, 7 p.
- Smith, M. R. (ed.), 1999: Stone: building stone, rock fill and armourstone in construction; Geological Society, London, Engineering Geology Special Publications, No. 16, 478 p.
- Stea, R. R., Conely, H. and Brown, Y. (compilers) 1992: Surficial geology of the province of Nova Scotia; Nova Scotia Department of Natural Resources, Map 92-3, scale 1:500 000.
- Surette, R. 2006: Mega-querries about mega-quarry; Opinion piece, The Chronicle Herald, Saturday, August 12, 2006 Issue, p. 11A.
- Theriault, H. 2006: Bill No. 76: Digby Moratorium Act; An act respecting the Digby rock quarry and North Mountain mining; first reading on November 2, 2006.
- Termeer, W. 1996: Testing the suitability of Nova Scotia aggregate fines as rock fertilizers/soil conditioners; study conducted by Coastal BioAgresearch, 57 p.
- Webster, T. L. 2005: The application of high-resolution LIDAR DEM data to landscape evolution: an example from the Fundy Basin, Nova Scotia, Canada; unpublished Ph.D. thesis, Dalhousie University, Halifax, Nova Scotia, 220 p.

EXHIBIT 9

WITNESS STATEMENT OF DAN FOUGERE



Martin Marietta Materials

by Susan Corning

Great product, people and location. These are classic ingredients for success in business, and ones that the folks at Martin Marietta Materials in Auld's Cove appreciate. The company is a leading producer of construction aggregates—crushed stone, sand and gravel—used to make concrete and asphalt for roads, buildings and infrastructure.

Martin Marietta Materials Canada Limited has operated the Porcupine Mountain Quarry at Auld's Cove, near the Canso Causeway, since 1995. In fact it was the construction of this causeway joining Cape Breton Island to mainland Nova Scotia that led to quarrying in the area in the first place.

Before the 1950s, people travelling between Cape Breton and the mainland had to cross the Strait of Canso by ferry—a journey often treacherous or impossible in winter due to drift ice and currents. A vast amount of stone was needed to create this land bridge, and nearby Porcupine Mountain, looming 500 feet upward and sitting next to the water, was chosen as the source.

Blasting of the eastern face of the Porcupine Mountain revealed a large reserve of high-quality Devonian granite—not suited for ornamental products, but just right for use in construction.

Construction of the causeway had two spin-offs that would enhance the area's development opportunities in the future. During the building phase as the causeway lengthened toward the Cape Breton side, the powerful tidal waters were funneled through an increasingly smaller gap. The force of the water scoured the seabed, making this deep-water channel even deeper—from its previous maximum of 187 feet to 218 feet. The second benefit was the completed causeway's effect as a barrier to winter drift ice coming from the Gulf of St. Lawrence, creating a year-round ice-free port on its south side.

Over 10 million tonnes of stone were removed by the time the causeway was finished in 1955; but this was just a small portion of the mountain's reserve. The potential was there—a large granite formation next to a deep-water ice-free port—yet the quarry was idle until it was purchased by Nova Construction of Antigonish in 1978.

In 1995, Martin Marietta Materials Inc., a company listed on the New York Stock Exchange and headquartered in Raleigh, North Carolina, bought the quarry operation, providing it with access to new markets and funds to modernize equipment and infrastructure.

Administrative Manager Dan Fougère, who has worked with Martin Marietta Materials since 1998, says the company hired the existing workforce when it bought the quarry, and looked at ways to modernize infrastructure to improve economies of scale.

One key upgrade was the construction of a \$10-million steel and concrete wharf in 2005 to accommodate Panamax and Capesize vessels with capacities of up to 70,000 tonnes.

The company purchased new equipment to allow for increased production. "We have moved to larger loaders and haul trucks," says Fougère. "For example, ten years ago we used 35-tonne haul trucks and now we use 100-tonne. That helps achieve economies of scale."

Also, he says they have kept up with technology, introducing tools like remote-controlled equipment, cameras, and laptops. "We can measure and track operations better," he says, "like tonnes per hour and mechanical down-time. That can help with efficiency.

"It's a simple business, but you can still use technology to manage it better," says Fougère.

Fougère says productivity and "through-put"—the amount of material mined and shipped—has increased dramatically over the past 13 years. In 1995, their throughput was 1.2 million tonnes. Since 2005, the quarry has managed 4.0 million tonnes or greater each year. This puts Porcupine Mountain among Canada's top aggregate producers.

It's also one of the top producers in Martin Marietta Materials' network of over 285 quarries, distribution yards and plants in the United States, Canada and the Bahamas. "And that's for a couple of reasons—the reserves, the work schedule and our ability to ship high volumes to market by ship," he says.

Porcupine Mountain is an expansive formation of granite, says Fougère. The quarry covers approximately 765 acres, with most of the operation taking place on the top and behind the mountain face. "It's a high-quality, durable granite well-suited for use in asphalt and concrete mixes," he says. With reserves of over 300 million tonnes of granite, the company estimates the reserves will last at least another 50 years.

The quarry operates 24 hours a day, seven days a week. They produce material nine months a year, and in mid-December stop for planned maintenance. However, because of the ice-free port, they can ship 12 months a year.

The quarry's location next to a water distribution route gives it a cost advantage over operations that have to ship granite by truck or rail, says Fougère. In fact, Fougère says he doesn't know of any other aggregate quarry with such easy access to water. "We have unusual topography here—a mountain quarry site next to a deep water ice-free year round shipping port," he says.

And with the ability to load 60,000 to 70,000 tonnes at a time onto a ship, Fougère says they can move the aggregate as fast as they can mine it. "Not a lot of quarries can say that," he adds.

There is one more important ingredient that Fougère says contributes to the operation's success—the quality of its workforce. Martin Marietta Materials employs 100 people at the Porcupine Mountain quarry. Most of these employees, including him, come from Northeastern Nova Scotia. Fougère says the company is proud of both the loyalty and work ethic of its employees.

On August 23, 2008, the company congratulated the workers for a significant achievement in workplace safety—they reached 1,000 days without a lost-time incident. "In an operation running 24/7, that means 704,000 person-hours," says Fougère. "In our business, that's quite an accomplishment.

"I can't say enough about the quality of our people. We have a great workforce. That has contributed to our success over the years.

EXHIBIT 10

WITNESS STATEMENT OF DAN FOUGERE

BLACK POINT QUARRY PROJECT (INDEX.HTML)

[Project Description \(index.html\)](#)

[Project History \(history.html\)](#)

[Project Details \(details.html\)](#)

[Community Information \(community.html\)](#)



⚙️ Project History

Morien Resources Corp. (Morien), formerly Erdene Resource Development Corp., conducted a multi-year aggregate exploration and reconnaissance program to investigate potential aggregate quarry sites in the Maritimes, concentrating on Nova Scotia due to its southerly location. These investigations included literature research and site-specific evaluations of existing physical, biological and socio-economic conditions.

Because aggregates are a high-bulk, low-cost commodity, the cost of transportation can easily exceed the price of the aggregate. Thus, for a marine quarry which requires considerably more capital than a land-based quarry to be profitable, the aggregate source should be located adjacent to deep water. Black Point was the most suitable site identified by Morien in its program.

⚙️ Black Point Quarry Timeline

February 2014: Morien submitted a Project Description document to the Canadian Environmental Assessment Agency ("CEAA") for the Project

March 2014: CEAA conducted a 45-day review of the Project Description, including a 20-day public comment period, and determine that a federal environmental assessment of the Project was needed

April 2014: Morien and Vulcan formed a joint venture to develop the Black Point Quarry

April 2014: CEAA provided Draft Guidelines for preparation on an Environmental Impact Statement (EIS)

April 2014: The first Black Point Quarry Project open house was held

April 2014: Second public

June 2014: CEAA and Nova Scotia Environment issued the final EIS Guidelines

August 2014: The Black Point Quarry Project Community Liaison Committee was formed

December 2014: Draft EIS is submitted to the government

February 2015: EIS is submitted to the government

February 2015: EIS registered with CEAA and NSE

March 2015: Third public comment period and second open house to be held

January 2016: CEAA issues draft Environmental Assessment (EA); including public comment period

Spring 2016: CEAA issues Final EA

April 26, 2016: Ministerial Approval

2016-2018: Division V Industrial Permits

2016-2018: Market Research Analysis

Spring 2018: Site Construction to commence

Spring 2021: Operations to commence

2070+: Decommissioning



<http://www.vulcanmaterials.com>

EXHIBIT 11

WITNESS STATEMENT OF DAN FOUGERE

Pro Forma Statement of Operations
Five Years ending December 31, 2015
(Financed Through Equity Investment)

December 7, 2016

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Pro Forma Statement of Operations
Five Years ending December 31, 2015

	Annual Volumes				
	2011	2012	2013	2014	2015
Production (tons)					
Shipments (tons)					
Inventory change (tons)					

	Metrics Per Ton				
	2011	2012	2013	2014	2015
Freight adjusted revenue (Page 8)					
Plant operating costs					
Personnel (Note 2)					
Energy (Note 3)					
Supplies and raw materials (Note 4)					
Repairs and maintenance (Note 5)					
Contract services (Note 6)					
Other expenses (Note 7)					
Depreciation (Note 8)					
Production cost per ton					
FIFO adjustment per ton sold					
Cost of sales					
Gross profit					

	Pro Forma Statement of Operations				
	2011	2012	2013	2014	2015
Freight adjusted revenue					
Plant operating costs					
Personnel					
Energy					
Supplies and raw materials					
Repairs and maintenance					
Contract services					
Other expenses					
Depreciation					
Inventory change (Note 9)					
Cost of sales					
Gross profit					
Selling, general & admin					
Pre-tax earnings					
Income taxes (Page 7)					
Net income					

Notes to Pro Forma Statement of Operations Five Years ending December 31, 2015

1) Major assumptions and conditions

Nature of operations

The owner/operator of Whites Point Quarry is Bilcon of Nova Scotia Corporation (“Bilcon Nova Scotia”), incorporated under the Nova Scotia Companies Act on April 24, 2002. The principal activity of Bilcon Nova Scotia is the production and shipment of crushed aggregate to markets in the Northeastern United States.

Scope of operations

Bilcon Nova Scotia planned to construct and operate a basalt quarry, processing facility and marine terminal located on Digby Neck in Digby County, NS, which is conceptually described in the Environmental Impact Statement submitted to the Canadian Environmental Assessment Agency.

First five years of operations

The primary focus of this financial pro-forma is the first five years of operations which for the purpose of this report is assumed to coincide with the 2011 through 2015 calendar years. It is intended that the first five years will serve as a baseline for developing financial projections covering the economic life of the project.

Significant accounting policies

- a. Inventories are carried at the lower of cost or market.
- b. Properties, plant and equipment are carried at cost less accumulated depreciation. Depreciation and amortization are computed over estimated service lives by the straight line method.
- c. Monetary assets and liabilities denominated in foreign currencies are converted to Canadian dollars at rates of exchange prevailing at the balance sheet date. Revenue and expenses are converted at the rates in effect at the date of the transaction.
- d. Investment tax credits are recorded as a reduction in income tax expense using the flow through method.

Selling, general and administrative expense

[REDACTED]

[REDACTED]

[REDACTED]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

	2011	2012	2013	2014	2015
[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]

Operating costs

The costs for personnel, energy, supplies, repairs, contract services and other expenses are as assumed in Notes 2 through 7.

Income tax

The Canada Revenue Agency effective corporate tax rates and regulations for companies engaged in manufacturing and processing activities were used to determine the tax consequences set out on Page 7.

2) Personnel

	2011	2012	2013	2014	2015
Production employees					
Maintenance employees					
Production hours per year					
Maintenance hours per year					
Production overtime hours					
Paid hours					
Tons per paid man hour					
Production ave hourly wage					
Maintenance ave hourly wage					
Payroll Straight time					
Payroll - Overtime					
Total payroll					
Benefits					
Management					
Personnel cost					
Personnel cost per ton					

3) Energy

	Per Ton				
	2011	2012	2013	2014	2015
Diesel					
Electricity					
Gasoline/acetylene/propane					
Total					

4) Supplies and raw materials

	Per Ton				
	2011	2012	2013	2014	2015
Explosives					
Drill steel					
Tires and tubes					
Welding and cutting					
Oils and lubricants					
Manganese					
Conveyor belts					
Screen cloth					
Total					

5) Repairs and maintenance

	Per Ton				
	2011	2012	2013	2014	2015
Production equipment					
Mobile equipment					
Conveyor and shiploader					
Total					

6) Contract services

	Per Ton				
	2011	2012	2013	2014	2015
Waste removal					
Other					
Total					

7) Other expenses

	Per Ton				
	2011	2012	2013	2014	2015
Property related					
Professional services					
Demurrage					
Environmental					
Insurance					
Taxes and licences					
Equipment rental					
Incoming freight					
Royalties					
Reclamation					
Miscellaneous					
Total					

8) Depreciation and Amortization

Description	Estimated Cost	Depreciation	Annual Charge to Operations

9) Inventory change (first in, first out)

	2011	2012	2013	2014	2015
Opening Inventory					
Cost per ton					
Inventory value					
Closing inventory					
Cost per ton					
Inventory value					
Inventory change					

Income tax and Capital Cost Allowance Schedule

	2011	2012	2013	2014	2015

Capital Cost Allowance	2011	2012	2013	2014	2015
Land Improvements Class 17 - 8%					
Plant and Infrastructure Class 29 - 30%					
Mobile Equipment Class 29 - 30%					
Marine Load Out Class 3 - 5%					
Project Development Eligible Capital Expenditure 7% x 75%					
Total					

EXHIBIT 12

WITNESS STATEMENT OF DAN FOUGERE

Whites Point Operating Costs, 2011-2015

All costs in the tables below are in Canadian dollars.

PERSONNEL COSTS					
	2011	2012	2013	2014	2015
Hourly Employees					
Production					
Maintenance					
Hours per Year per Employee - Regular					
Production					
Maintenance					
Hours per Year per Employee – Overtime (Production Only)					
Paid Hours					
Tons per Paid Hour					
Average Hourly Wage					
Production					
Maintenance					
Payroll – Straight Time					
Payroll - Overtime					
Total Payroll					
Benefits ██████████					
Management					
Total Personnel Cost					
Personnel Cost/ Ton					

ENERGY COSTS					
Prices per Ton					
	2011	2012	2013	2014	2015
Diesel					
Electricity					
Gasoline/ Acetylene/ Propane					
Total					

SUPPLIES AND RAW MATERIALS COSTS					
Prices per Ton					
	2011	2012	2013	2014	2015
Explosives					
Drill Steel					
Tires					
Welding and Cutting					
Oils and Lubricants					
Manganese					
Conveyor Belts					
Screen Cloth					
Total					

CONTRACT SERVICES COSTS					
Prices per Ton					
	2011	2012	2013	2014	2015
Waste Removal					
Other					
Total					

OTHER EXPENSES					
Prices per Ton					
	2011	2012	2013	2014	2015
Property Related					
Professional Services					
Demurrage					
Environmental					
Insurance					
Taxes and Licences					
Equipment Rental					
Incoming Freight					
Royalties					
Reclamation					
Miscellaneous					
Total					

EXHIBIT 13

WITNESS STATEMENT OF DAN FOUGERE

Whites Point Repair and Maintenance Costs, 2011-2015

All costs in the table below are in Canadian dollars.

REPAIR AND MAINTENANCE COSTS					
Prices per Ton					
	2011	2012	2013	2014	2015
Production Equipment					
Mobile Equipment					
Conveyor and Shiploader					
Total					

EXHIBIT 14

WITNESS STATEMENT OF DAN FOUGERE

Revenue Matrix Summary, 2011-2015

	2011	2012	2013	2014	2015