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A teachers guide to the geology of York Redoubt National Historic Site of Canada

D.P. Potter and T. Goodwin

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A Teacher's Guide to the Geology of York Redoubt National Historic Site of Canada

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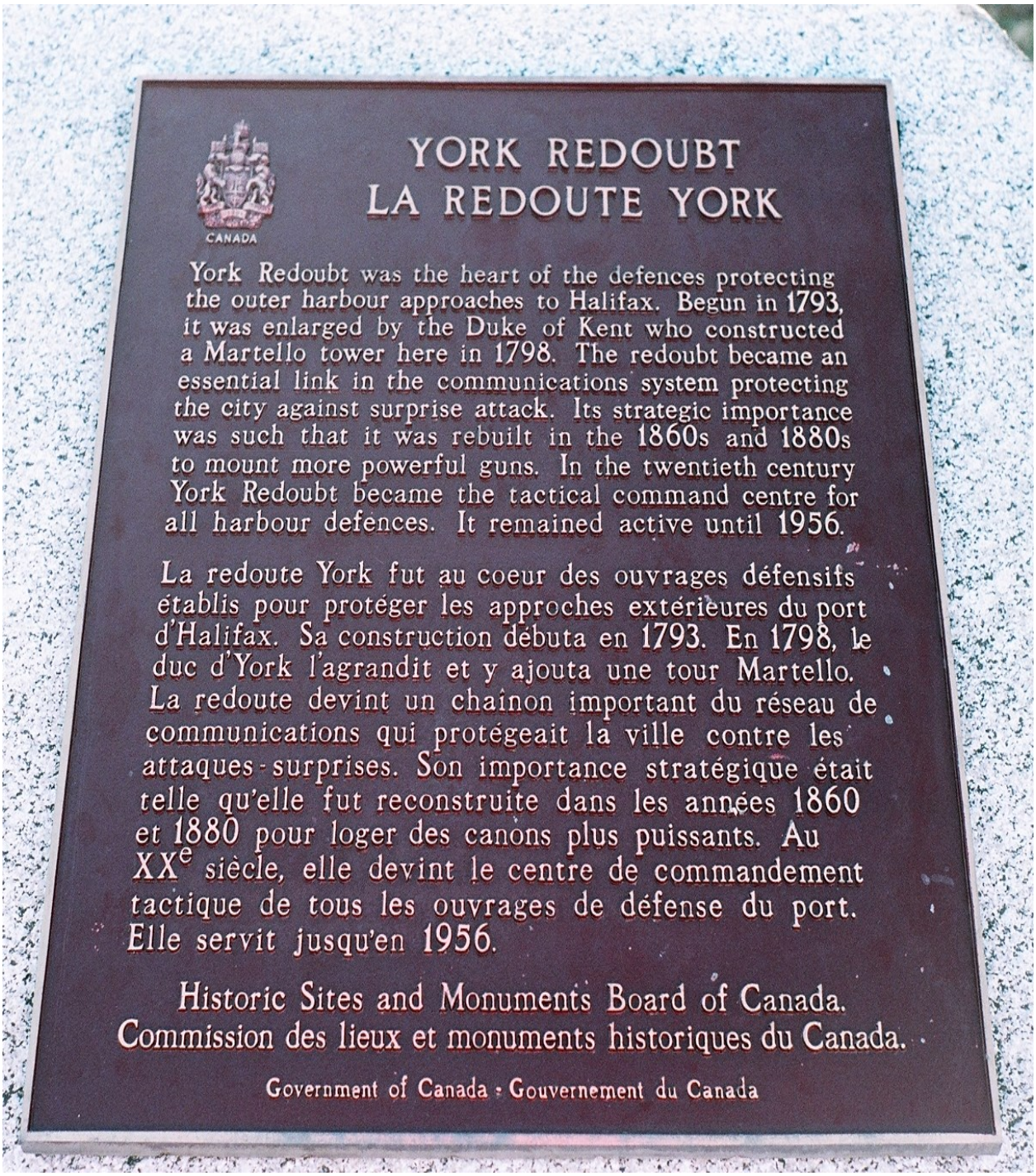
Cover photo: Outcrop at York Shore Battery, York Redoubt National Historic Site of Canada (photo: D.P. Potter)


CANADA
YORK REDOUBT
LA REDOUTE YORK
York Redoubt was the heart of the defences protecting the outer harbour approaches to Halifax. Begun in 1793, it was enlarged by the Duke of Kent who constructed a Martello tower here in 1798. The redoubt became an essential link in the communications system protecting the city against surprise attack. Its strategic importance was such that it was rebuilt in the 1860s and 1880s to mount more powerful guns. In the twentieth century York Redoubt became the tactical command centre for all harbour defences. It remained active until 1956.
La redoute York fut au coeur des ouvrages défensifs établis pour protéger les approches extérieures du port d'Halifax. Sa construction débuta en 1793. En 1798, le duc d'York l'agrandit et y ajouta une tour Martello. La redoute devint un chaînon important du réseau de communications qui protégeait la ville contre les attaques-surprises. Son importance stratégique était telle qu'elle fut reconstruite dans les années 1860 et 1880 pour loger des canons plus puissants. Au XXe siècle, elle devint le centre de commandement tactique de tous les ouvrages de défense du port. Elle servit jusqu'en 1956.
Historic Sites and Monuments Board of Canada.
Commission des lieux et monuments historiques du Canada.
Government of Canada : Gouvernement du Canada

Safety Notes:

Visitors to the York Redoubt National Historic Site of Canada should be prepared for a hike lasting 2-3 hours over sloping terrain with variable footing. Sturdy footwear with good support and non-slip soles is recommended as is a warm jacket. Temperatures at the coast are often several degrees cooler than those experienced inland.

Take care while proceeding down and onto the beach as the footing can be unstable. Also, one should always exercise care when approaching the base of a rock wall as material can break loose at any time. View the walls from a distance whenever possible. It is always wise to check on the tides before you decide to visit any coastal site. Consult the Canadian Hydrographic Service's tide predictions, available online:

http://www.waterlevels.gc.ca/cgi-bin/tide-shc.cgi?queryType=showZone&language=english&region=5&zone=28

Carry a cellphone in case of emergencies

A Teacher's Guide to the Geology of York Redoubt National Historic Site of Canada

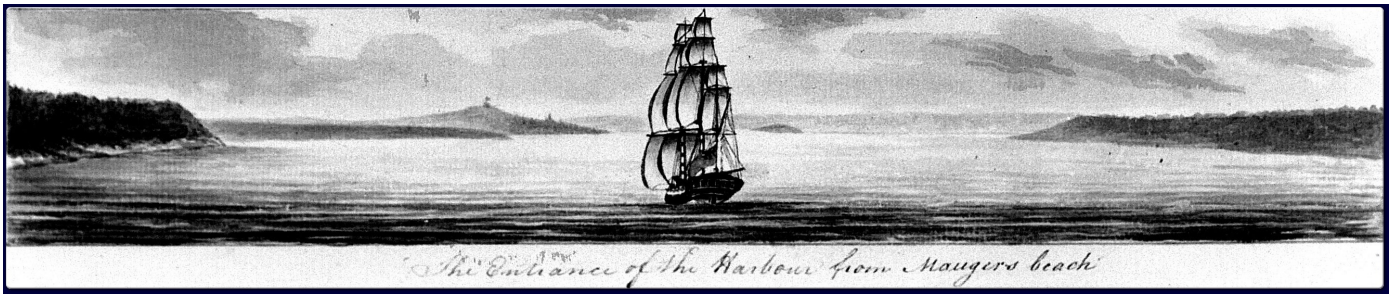


Figure 1. *The entrance of Halifax Harbour from Maugers beach, 4 October 1786, Artist unknown. York Redoubt shore is visible in the left foreground, McNabs Island in the right foreground, and the Halifax Citadel and Georges Island in the left and middle background, respectively.*

Introduction

York Redoubt National Historic Site of Canada stands at the entrance to Halifax Harbour, across from McNabs Island. A field trip to York Redoubt offers a window into local geology for the uninitiated as well as the seasoned geologist. The site is also steeped in cultural and military history, and provides the opportunity to tie elements of natural history to our cultural heritage.

This site provides ample historical information on the fortifications and buildings. There are safe and extensive walking trails accessible year-round while washroom facilities are available during the summer. Consult the Parks Canada website for more information on the site: hours of operation etc. The quantity and variability of exposed bedrock allows visitors to make observations in the field and be introduced to geological mapping. The site also illustrates other aspects of Nova Scotia geology including glacial erosion and deposition and chemical dissolution processes.

Educational Outcomes

This site presents opportunities to achieve various types of educational outcomes. Some obvious ones are related to cultural history and the many Parks Canada interpretive panels are compelling and informative. Other outcomes relate to geology: in the observation, recognition, and measurement of the distribution and orientation of bedrock. Observations of the natural environment such as relief, vegetation, and stream water appearance may also be correlated with geology. Some of the social studies outcomes relate to geography, i.e. recognition of landforms and mapping: orienting oneself on a base map, recording information and codifying it in map form. And, as an Historic Site, there are rich opportunities to explore the cultural and military history of the region revealed through interpretive panels that explain the Redoubt's importance to the Halifax Defense Complex since the 18th century. Many opportunities exist to explore how landforms and morphology are controlled by geology and to ponder how these features played a role in the selection of the area for settlement. Finally, the physical exercise involved in the three hour hike over variable coastal terrain is consistent with an active lifestyle. This exercise can influence the way participants interact with the environment, promoting an increased awareness and connection to the natural world.

Cultural History

Long before European settlers came to these shores, the Mi'kmaq and their ancestors lived on the land around Halifax. The area served as a gateway to inland waterways that lead to the Minas Basin, provided a haven from the sea and a valuable source of food. The Mi'kmaw name for the location is Chebucto.

Figure 2. *Mi'kmaq encampment at Tufts Cove, ca. 1871, Photo: Joseph Rogers.*

Quote 1: "Archaeological sites in the vicinity of McNabs Island provide evidence of prehistoric and historic occupations of the metropolitan area since the retreat of the glaciers 10,000 years ago. Artifacts found at Dartmouth, Hartlen Point, the Esson site, Lake Micmac and Lake Charles, as well as several historic sites, attest to the long and varied occupations of the shores of Halifax Harbour" - Friends of McNabs Island website

In the 1690s, the French established a fishing station across from York Redoubt on what they called the Isle de Chibouquetou (now called McNabs Island). However their plans to establish a settlement on the island with the main fort to be located at the present location of York Redoubt were thwarted with the ceding of mainland Nova Scotia to England in the Treaty of Utrecht in 1713.

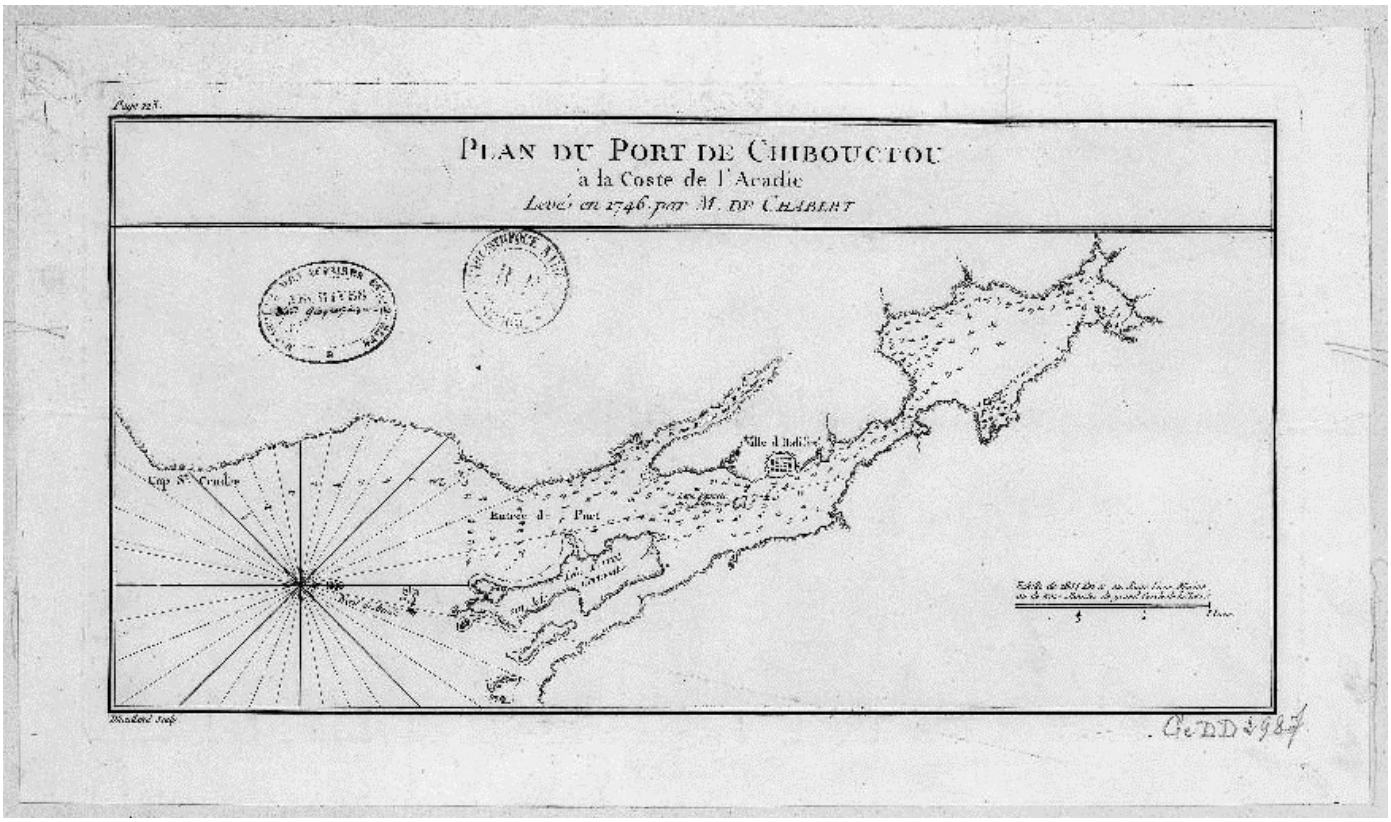


Figure 3. *Chart of the Port de Chibouquetou (Halifax Harbour), M. de Chabert, 1746*

Shortly after the above chart was drawn, Colonel Edward Cornwallis founded Halifax. As hostilities continued with the French and, later, American Privateers, the strategic value of the harbour was recognized and various fortifications of the Halifax Harbour Defense Complex were developed.

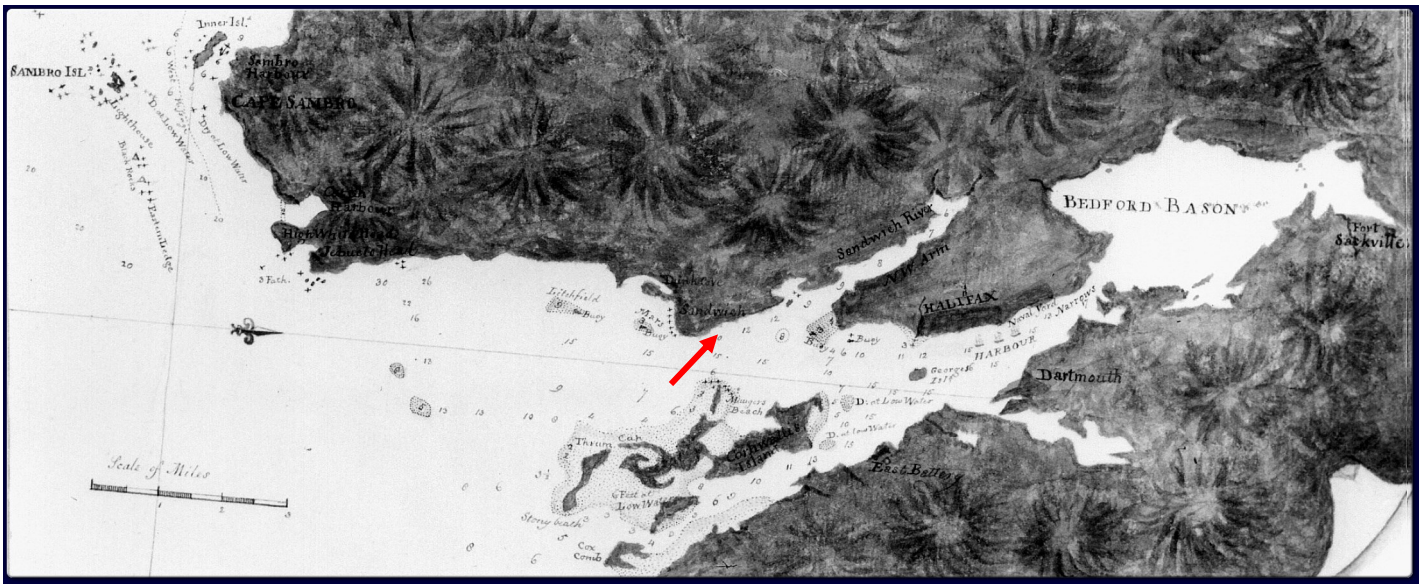


Figure 4. *A Chart of Halifax Harbour ca. 1786, Meres, James S. (1766/1767 - 1836) (Artist). York Redoubt location marked with red arrow.*

Quote 2: “Established in 1793 on a bluff overlooking the harbour entrance, and expanded in the 19th and 20th centuries, York Redoubt was a key element in the defense of Halifax Harbour…this National Historic Site of Canada is part of the Halifax Defense Complex.” - Parks Canada

Other elements of the Halifax Defense Complex include fortifications on Georges and McNabs islands, Point Pleasant Park and the Halifax Citadel. The lines of sight between these prominent vantage points, the depth and orientation of the harbour and local topography can be linked to the geology of the area: the faulting of the bedrock was followed by glacial excavation of the weakened bedrock within the last two million years, creating Halifax Harbour, one of the world’s deepest ports.

Quote 3: “York Redoubt National Historic Site of Canada is comprised of a large, cleared plateau on the west side of Halifax's inner harbour opposite McNabs Island and a gun battery and searchlight positions located close to sea level, reached by a path. The redoubt contains some 27 buildings, related structures, and armament developed over 150 years. The upper portion of the redoubt is located high above wooded cliffs, overlooking the entrance to Halifax harbour which it has protected since the late 18th century.” - Parks Canada

Regional Geology

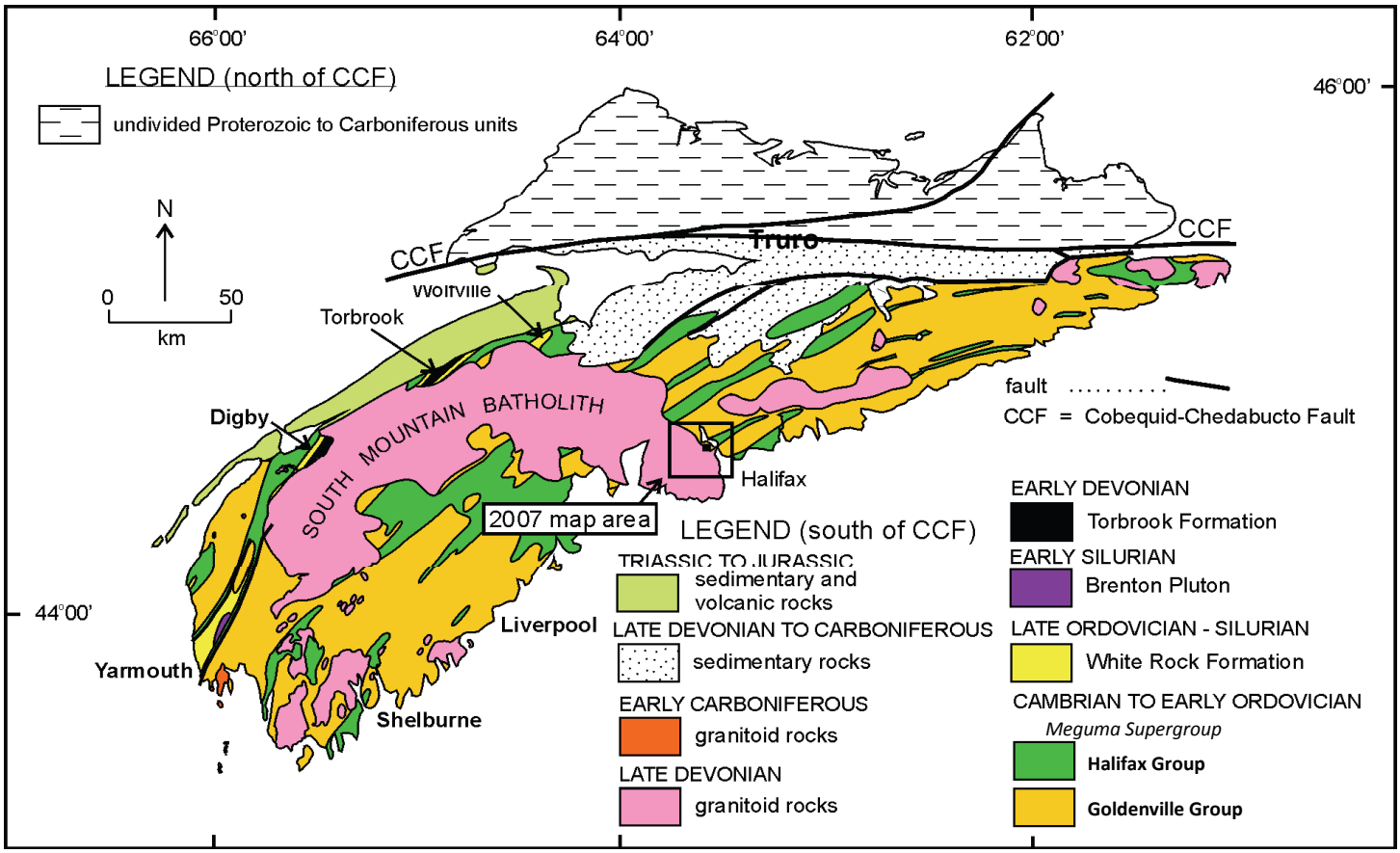


Figure 5. *Simplified geological map of the Meguma Terrane, Nova Scotia (from White et al. 2008)*

Figure 5 shows a simplified geological map of southern mainland Nova Scotia. The large regional fault (Cobequid-Chedabucto Fault—CCF) that runs east-west, just north of Truro marks a difference between the rocks in southern mainland Nova Scotia from those to the north. The geology of the southern mainland of Nova Scotia is dominated by two main rock types: the Meguma Group metasedimentary rocks, shown in green (Halifax Group) and orange (Goldenville Group) and the Late Devonian igneous plutonic rocks of the South Mountain batholith (shown in pink). These granitoid rocks are exposed at York Redoubt alongside rocks of the Halifax Group of the Meguma Supergroup (Figure 6).

Meguma Supergroup rocks were deposited first as marine sediments (predominantly sand and mud) offshore the ancient African tectonic plate (Gondwana). These sedimentary layers were lithified to sandstone and shale, then, many millions of years later, were folded and metamorphosed in the tectonic collision with ancient North America (Laurentia) that produced the Appalachian mountain belt during the formation of the super-continent Pangaea. The heat and pressure of the collisional event metamorphosed the sandstone and shale to (Goldenville Group) metasandstone and (Halifax Group) slate, respectively.

The **Appendix** found at the end of this document lists additional educational resources on regional geology, references, and sources of photos and quotes. Also contained in the Appendix is a Base Map and blank pages for note-taking.

At York Redoubt, two of the three subdivisions of Halifax Group rocks are represented. The manganese-rich Beaverbank Formation sits at the base of the Halifax Group and marks the transition to the lower Goldenville Group beneath. At this location the high metamorphic grade (due to the proximity of the igneous granitoid rocks) has produced distinctive pinkish layers (coticules) containing abundant spessartine garnet (White et al., 2008). Above the Beaverbank Formation, the black, rusty-looking rocks of the Cunard Formation display slaty cleavage and commonly contain cubic voids left by weathered pyrite, arsenopyrite or pyrrhotite. The Cunard Formation is the rock unit associated with Acid Rock Drainage (ARD) (see NSDNR Open File Report 2004-003, T.A. Goodwin: http://www.gov.ns.ca/natr/meb/data/pubs/04ofr03/04ofr03.pdf for more information on ARD)

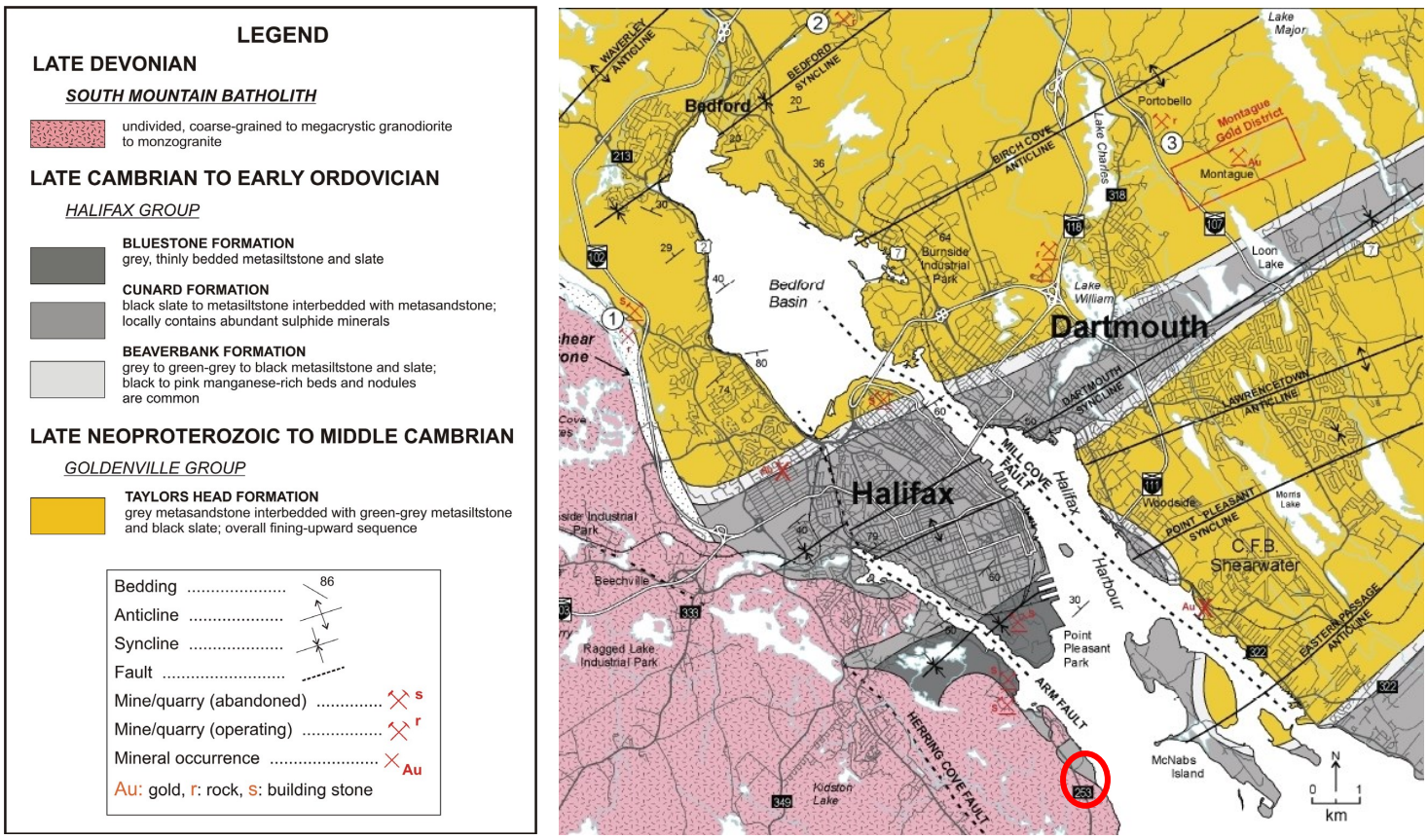


Figure 6. *Simplified geological map of the Halifax Regional Municipality, Nova Scotia, from White et al. 2008. The red circle shows location of York Redoubt and the geologic contact to be mapped in this exercise*

Roughly 100 million years after the Appalachian mountain building event, magma (molten rock) intruded the pre-existing Meguma rocks, then buried at a depth of 10-15 kilometres in the continental crust. Because this occurred at significant depth, the magma cooled slowly, allowing crystals to grow large, producing a coarse-grained, granitoid rock. These rocks have been named the South Mountain Batholith. "A batholith is large body of igneous rock formed beneath the Earth's surface by the intrusion and solidification of magma. It is commonly composed of coarse-grained rocks (*e.g.,* granite)." (Source: http://www.britannica.com/EBchecked/topic/55940/batholith)

Meguma rocks immediately adjacent to the batholith (intruding magma) were 'cooked' by contact metamorphism.

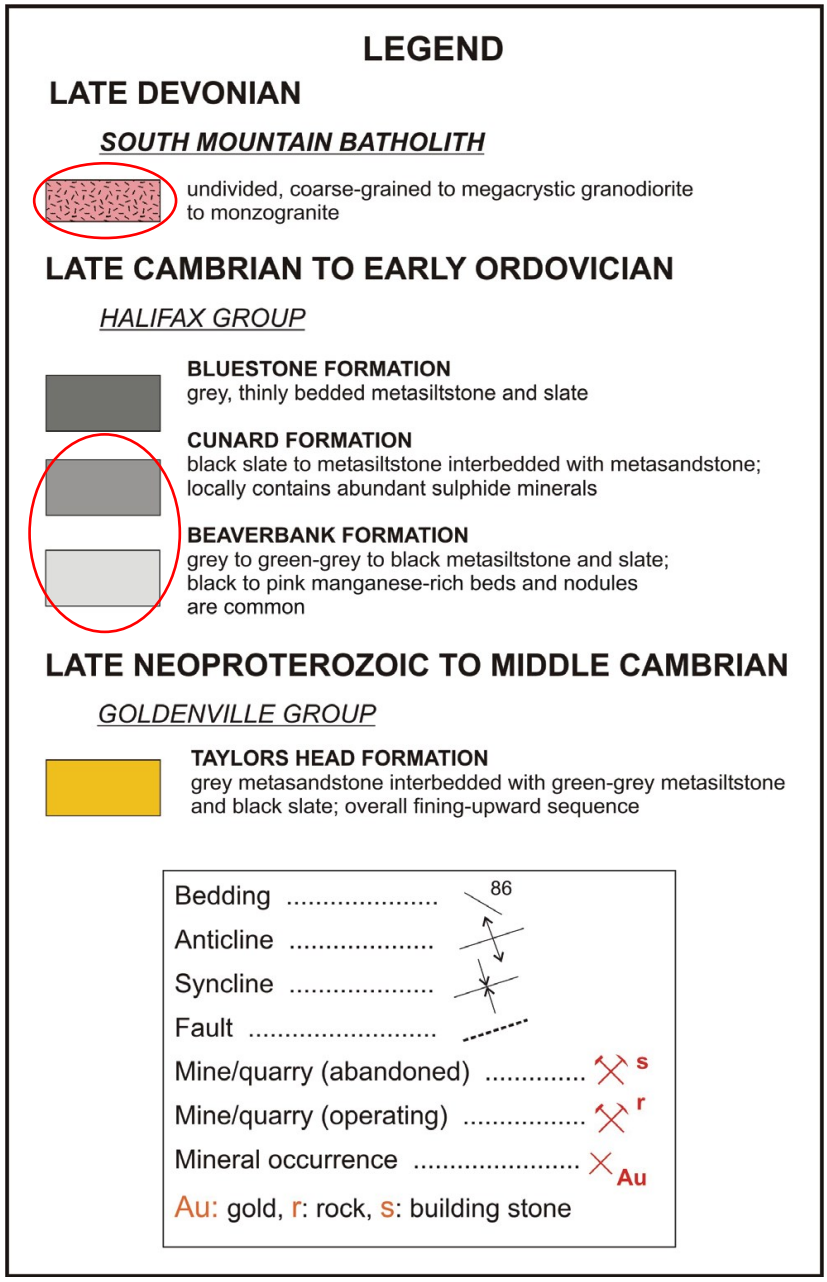
Since the time of emplacement of the South Mountain Batholith, erosional processes, (fluvial and glacial), have removed 10-15 kilometres of overlying rock, depositing the material offshore, and unroofing the rocks that were formed deep in the Earth's crust. Today these rocks are exposed at the surface.

Figure 7. *a) Halifax Group (Cunard Fm) slate; b) Halifax Group (Beaverbank Fm); c) South Mountain granite*

At York Redoubt, visitors may observe and map these two prominent rock types of southern mainland Nova Scotia:

1. Meguma: Halifax Group rocks; Cunard Formation slate (Figure 7a) and Beaverbank Formation metasiltstone (Figure 7b) and,
2. South Mountain Batholith granitoid rocks (Figure 7c)

The legend on the right (repeated from the Figure 6 on the previous page) shows the pertinent rock types circled.



Driving directions to York Redoubt (Fig. 8)

From the Armdale Roundabout (**A** on Fig. 8) take the Herring Cove Road (Route 349) exit, then, turn left onto Purcell's Cove Road (Route 253). Proceed for around 8.5 km and look for the Parks Canada sign for York Redoubt National Historic Site of Canada. Turn left, proceed around 200 m and then turn right (**B** on Fig. 8) . During the summer you may proceed through the park gates to the parking lot. Park outside the gate during the off-season.

If you wish to take the bus, take the Halifax Regional Municipality number 15 bus (Purcell's Cove) from the Mumford Road terminal at the West End Mall. The bus stops in front of the park gates before it turns around and makes the return trip back to the Mumford Road terminal.

Mapping Exercise

Get out the **base map** (Appendix) and find Stop 1. Find this and all subsequent stops on the base map and record your observations the "notes" pages, also in the Appendix. This guide will pose questions for each stop, with suggested answers in *italics*. The appendix also contains a completed base map.

Also included in the Appendix are safety notes and suggestions on what to bring to ensure that the outing is safe and comfortable.

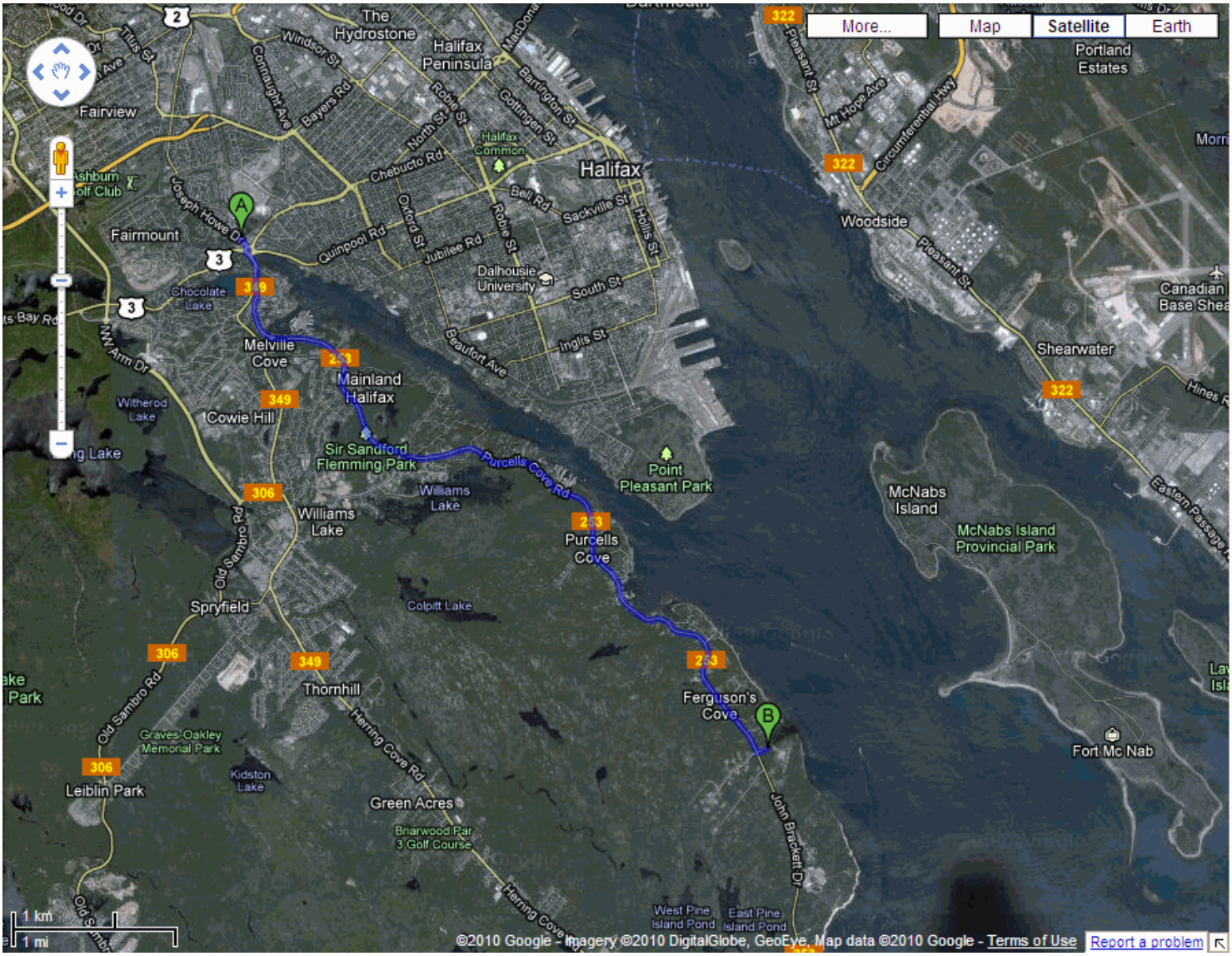


Figure 8. *Map showing route from Armdale Roundabout (A) to York Redoubt (B). (Source: Google Maps, 2010)*

Stop 1: Base of the steps to Position Hill

From the parking lot (facing the water) walk to the right along the gun emplacements. Look for outcrop near the base of a stairway heading up to the top of a hill (Position Hill). Check basemap for location of stops.

Figure 9. *- Stop 1:*

What kind of rock is it? Make note of any observations. Is there bedding visible; if so, in what orientation? What kind of rock is this?

Rusty coloured surface, low relief (not on a wall face), layered rock (slate), cube shaped voids, with beds gently dipping to the northwest.

Proceed up the stairs (Figure 10), taking note of any outcrop along the way.

Was there outcrop? *Yes.*

Where? *Halfway up the steps.*

Was there a change in bedrock type? *Yes.*

How do you know? Describe the outcrop. *Outcrop consists of lighter looking rock containing coarse-grained crystals, absence of bedding/lamination, more "rounded" surface.*

What can we infer from these observations? *The contact is somewhere between here and the last stop.*

Is there a notable change in topography? Does it correspond with a change in bedrock geology? *The change in bedrock corresponds with an increase in elevation.*

Figure 10. *Stairs up to Position Hill*

Stop 2: Position Hill

The Director Tower sits atop Position Hill (Fig. 11). The WWII gun emplacement personnel (down the hill) would receive direction from this vantage point. Consult the interpretive panels at the site for more information.

Figure 11. *View from Position Hill a) 2008 and b) 1873*

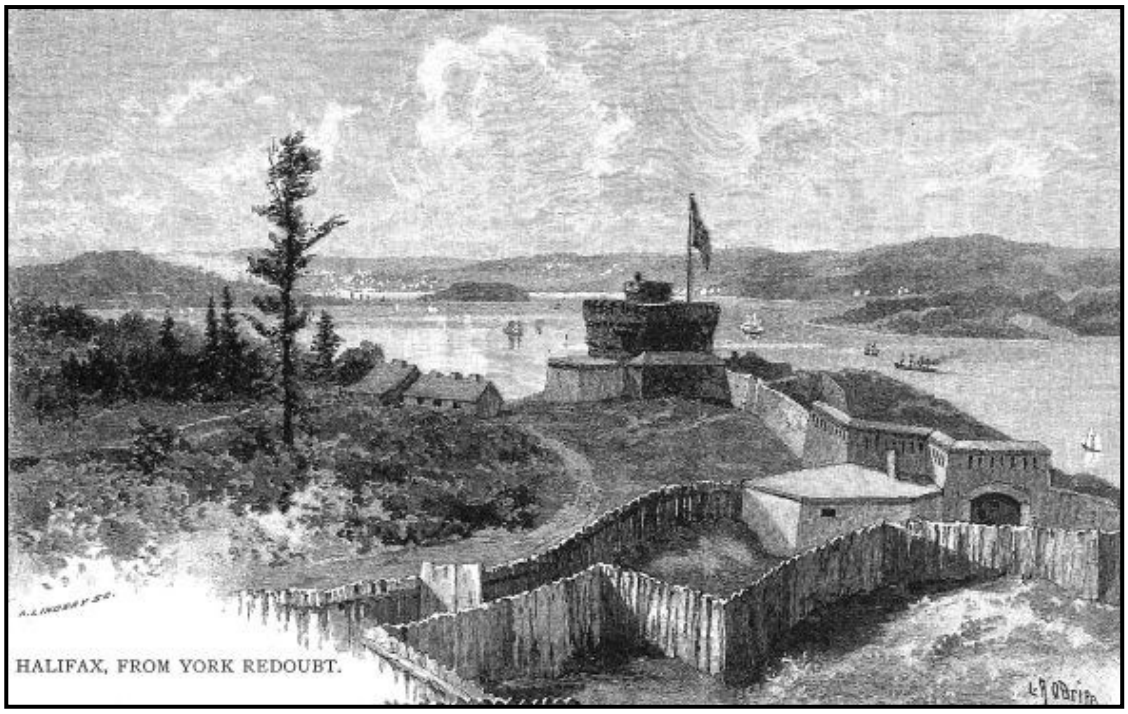


Figure 12. *"Halifax, from York Redoubt", sketch by A. Lindsay, 1882.*

Describe the outcrop. *Light coloured coarse-grained crystalline rock (South Mountain granite). The rock is made up of three different minerals: quartz, (plagioclase) feldspar, and biotite (black mica), see Fig. 13.*

Is there any correlation between bedrock and relief? *Granite corresponds with higher elevation than slate.*

Describe the top surface of outcrop. *Smooth, due to glacial erosion*

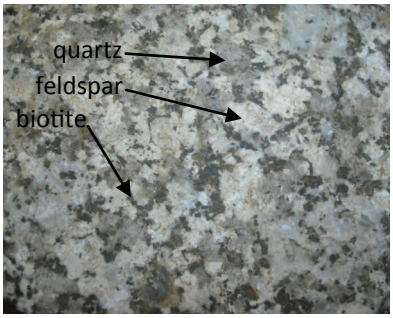


Figure 13. Coarse-grained granite

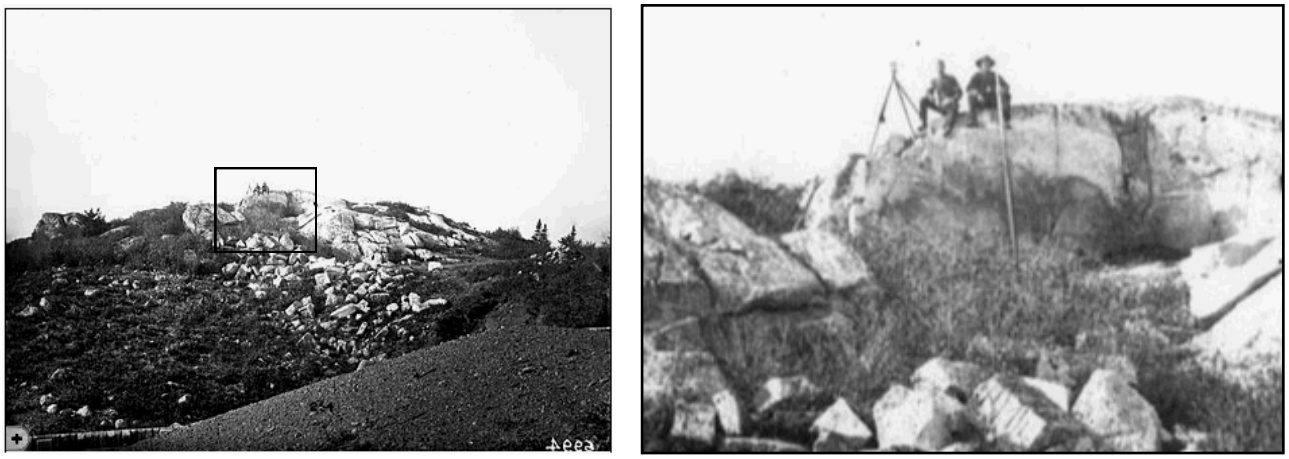


Figure 14. Royal Engineers taking a break from surveying on Position hill – ca. 1880.

Find the Geodetic Survey of Canada triangulation station set into the granite outcrop (Fig. 15).

Figure 15 Triangulation station from the Geodetic Survey of Canada at the top of Position Hill:

Latitude : *N44° 35' 38.48886"*

Longitude : *W63° 33' 14.69489"*

Elevation : *70.771 m*

Natural Resources Canada, Geodetic Survey Division

(Source: http://www.geod.nrcan.gc.ca/index_e.php)

Triangulation stations like this are less important for everyday surveying now with the advent of Global Positioning System (GPS) however they can still be used to verify the positional accuracy of a GPS unit. But not so long ago these, along with survey benchmarks, formed an important network for surveyors to use as tie points for local surveys.

Stop 3 Caponier

Follow the road as it descends from the top of Position Hill. To the left is a concrete caponier (Fig. 15), a type of fortification intended for sweeping fire along an outer ditch to keep the enemy from establishing a position. Look for and identify outcrop on the ground. Notice the large white crystals (phenocrysts) of plagioclase feldspar. Is the orientation of the phenocrysts random? Is there alignment of the crystals? What could cause this?

Crystals do show some preferred orientation. This is likely produced by convective low of magma as it cooled adjacent to the contact with the comparatively cooler Meguma rocks.

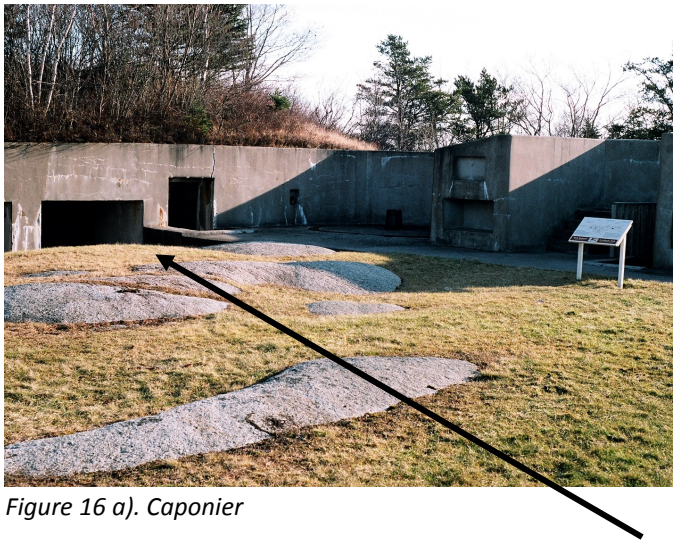


Figure 16 a). Caponier

Figure 16 b). "Stalactites"

Go down the steps on the left side of the caponier into the small recess (Fig. 16 a and b). Observe the features in the ceiling.

What do they look like? *Icicles, stalactites?*

Look at the floor beneath the features. Are there corresponding features on the floor?

How may these features have been formed?

Water percolating through the concrete dissolves some of the Portland cement (calcium carbonate) which forms the matrix of the concrete. As the water seeps out and drips from the ceiling, some evaporation occurs, causing a small amount of the dissolved cement to precipitate, and over time to form small stalactites. On the floor are pancake-shaped stalagmites formed by the fallen drops via the same process.

Return to the path and look across to the other side. You will see a large boulder (Fig. 17).

Figure 17. Boulder

Figure 18. Plagioclase crystals

How did the boulder get there? What kind of rock is it? Is the boulder the same rock type as the surrounding bedrock? Is it rounded or angular?

The boulder is a glacial deposit. Since it is the same rock type as the surrounding bedrock, we don't know how far it has travelled. Figure 18 shows that it also contains large phenocrysts of plagioclase feldspar (like the outcrop at the Caponier) suggesting that the boulder may not have travelled a long way. However the sheer size of it attests to the power of ice to move and erode rock.

Stop 4 Area adjacent to maintenance building

Return to the path and, with the wall on your left, walk down the hill toward the maintenance building. To the left (Fig. 19 a) the rocks display higher relief. Also look for outcrop directly in front of the building in the roadway (Fig. 19b).

Figure 19. a) Outcrop on left side of roadway

Figure 19. b) Outcrop in roadway

Outcrop at Stop 4

Make a note of the location and rock type as well as any inferences that can be made (e.g. location of contact, relief corresponding with bedrock type, etc.). What type of activity was undertaken among the rocks on the left (Fig. 19 a)? Record your findings in your notes or on the base map.

The observation of granite sitting a few metres from the slate exposed in the roadway indicates an intervening geological contact. Once again the granite rocks display higher relief suggesting that these rocks are more resistant to weathering. There is evidence of drilling into the granite (due to quarrying).

Continue along the path leading to the parking lot.

The route to reach Stop 5 varies according to the time of year because the sally port, a passage through the front wall of the fortification, is only open during the summer months (July-August). Consult the base map to find the appropriate route.

Figure 20. Sally port exit at base of wall

Summer: Continue along the path which leads to the parking lot. Cross the parking lot and enter the gate at the other end (see summer route on the base map). Veer left to reach the sally port. Enter the sally port and follow it through to the exit at the base of the wall.

Figure 21. Stella Maris Church, built in 1836

Off-season: Continue along the path leading to the parking lot. Exit the main gate, and turn right , following the path, keeping the wall to your right (see winter route on the base map). As you come to Stella Maris church (now a private home) (Fig. 20), bear right and follow the path along the front of the stone wall until you reach the lower sally port entrance (around 300 metres).

Stop 5 Base of stone wall at lower sally port entrance

The sally port allows passage through the wall of the fortress to the base of the outer wall. The word “sally” in this sense comes from the French *saillir* or “to surge forward”. The sally port was used by defending forces allowing them to leave the walled portion of the fortification to repel attacking forces at the base of the wall.

Figure 22. a) Base of wall at lower sally port entrance.

Figure 22. b) View from sally port looking north towards McNabs Island, 1877, Royal Engineers.

What material was used to construct the wall seen in Fig. 22? What are the qualities of the material that make it a good building material? What are some problems with this building material?

The wall is made from local slate (quarried in nearby Purcell's Cove). The roughly rectangular cleavage (a product of its mineralogy and regional metamorphism) makes it an excellent building material. However the high iron content of the (Cunard Formation) slate and associated oxidation is evidenced by the rust stains and may interfere with the bonding of the mortar in the longer term. It also may contribute to Acid Rock Drainage (ARD).

For more information on ARD see Bedrock, Glacial, Economic and Environmental Geology of the Halifax Regional Municipality *, a Nova Scotia Department of Natural Resources publication:*

http://www.gov.ns.ca/natr/meb/data/pubs/04ofr03/04ofr03.pdf

From the sally port, walk down the steps to the road and turn right. Proceed for ~300 metres until you come to a small bridge where there is a rock wall on the right.

Stop 6 Bridge (Contact)

Take a close look at the rock face. Observe the characteristics of the exposure as you move along it from right to left (Fig. 22). What do you observe: rock type, orientation, qualities? Describe the changes you see. What have you found?

The wall is composed of rusty coloured layered rock (slate), gently dipping to the northwest and displaying good cleavage. As seen in Fig. 23, a nearly vertical contact with granite is visible in the centre of the wall (yellow line). Slate layers are truncated by the granite (suggesting intrusion of granite into slate). In the vicinity of the contact, the granite is stained and dark. The granite displays less iron staining as we move to the left, further away from the contact.

Record these and any other relevant observations on the base map, taking care to mark the location of the contact.

Figure 23. a) Left side

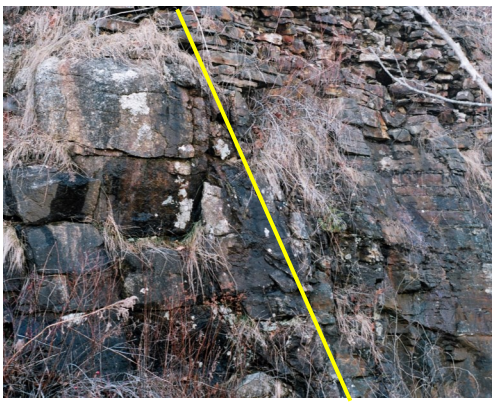


Figure 23. b) Contact

Figure 23. c) Right side

Stop 7 Cubic voids

From the contact retrace your steps back toward the sally port. Follow the path for around 200 m then turn right to take the path down toward the shoreline. As you travel down the path, watch out for outcrop in the roadway displaying cube-shaped voids (Fig. 24 a).

Figure 24. a) outcrop with cubic voids.

Figure 24. b) Pyrite in Goldenville Group metasandstone.

What could the cubic voids in the rock represent? How were they formed? Do they relate to any other observations that have been made so far?

The cubic voids are spaces left behind from the weathering of cubic crystals (iron pyrite) that developed within the slate during metamorphism of the Meguma rocks. This observation is consistent with the iron (oxide) staining seen in the exposures seen earlier in this field trip.

Stop 8 Brook along roadway to York Shore Battery

Continue down the path, looking for outcrop. Watch out for small, subtle exposures here that could be easily missed. Notice a small brook running along the right side of the path. Observe the colour of the water. Rounding a turn to the right, you will see a bench and a look-off to your left while on the right a more prominent rock exposure is visible behind the stream (Fig. 25). Follow this down towards a switchback. What do you notice about the outcrop? How is the rock similar to what you have seen so far? How is it different? Are there any other features visible in the outcrop?

Figure 25. Outcrop along brook.

This exposure is layered, but unlike the slate seen upstream, the iron staining is largely absent. Here the rock has a banded appearance displaying light and dark coloration. Large quartz veins are visible nearby. A large quartz vein is visible in the stream at the bend in the road (Fig. 26). We're now looking at Meguma rocks from the Beaverbank formation which sits beneath the Cunard.

Figure 26. Quartz vein at bend in road.

This is an exposure of Meguma rocks from the manganese-rich Beaverbank Formation. Unlike the Cunard Formation seen above, the rocks display banding, some of which is a pinkish-purple colour due to the presence of manganese-bearing spessartine garnet. At other locations, some distance away from the thermal contact, manganese bearing Beaverbank Formation rocks have a dark, almost black appearance. Close to the igneous intrusive granite, the presence of Spessartine garnet (a mineral that forms at higher temperatures) indicates a high-grade metamorphism, due to the intrusion of the granitic magma into the sedimentary rock.

Continue down to the switch-back in the road, cross the stream and walk 10-15 m down the path leading to the right. On your right you will see outcrop on the steep bank. Describe it.

Both (Meguma) metasedimentary rocks and granite are exposed within a few metres of one another. The contact between the two passes through the site trending obliquely to the slope.

Stop 9 Shoreline

Retrace your steps and walk down the road parallel with the shoreline until you come to a path on your right leading down to the beach. Take care while proceeding down and onto the beach as the footing can be unstable. Appropriate footwear with good support and non-slip soles are recommended. Also, one should always exercise care when approaching the base of a rock wall as material can break loose at any time. View the walls from a distance whenever possible. It is always wise to check on the tides before you decide to visit any coastal site. Consult the Canadian Hydrographic Service's tide predictions, available online:

http://www.waterlevels.gc.ca/cgi-bin/tide-shc.cgi?queryType=showZone&language=english&region=5&zone=28

Figure 27. Access to York Redoubt shoreline.

Once on the beach, look for outcrop. Describe the characteristics of the outcrop: layering, colour, differences from previous stops. Are there any new features visible in outcrop.

The bedrock belongs to the manganese-rich Beaverbank Formation of the Halifax Group (Fig. 28). The pinkish-purple bands in the rock are called coticules and contain spessartine garnet (as seen at stop 8). Tiny crystals of cordierite visible in alternating layers with the spessartine garnet appear as black speckles the size of poppy seeds. On exposed surfaces these crystals have weathered away, leaving the surface pitted. Nearly vertical quartz veins cut through the outcrop at this location. Sharp eyes may pick out worm tubes, borings made in the mud at the seafloor 500 million years ago.

Fig. 28. Beaverbank Formation (Halifax Group).

Facing the water, look down the beach to the right (Fig. 29 b). Can you see where there is a change in the colour of the rocks? It signifies a change in bedrock type. It is not recommended that you travel down the beach toward the contact because the rocks are extremely slippery and the footing is unstable. Fig. 29 a shows the shoreline exposure of the contact.

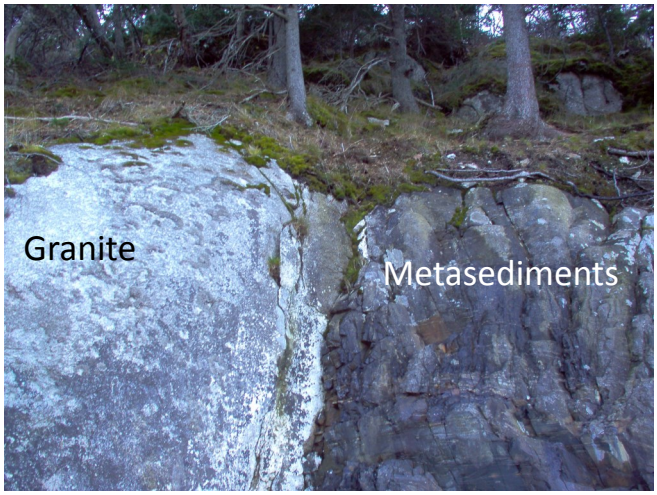


Fig. 29 a) Contact at the shoreline.

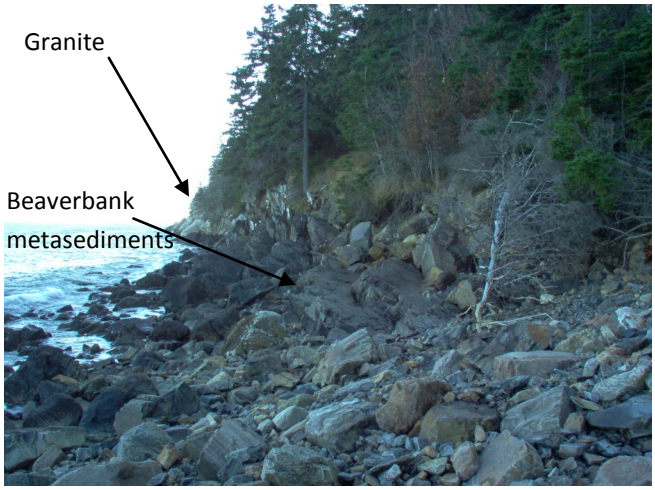


Fig. 29 b) Granite behind Beaverbank Formation

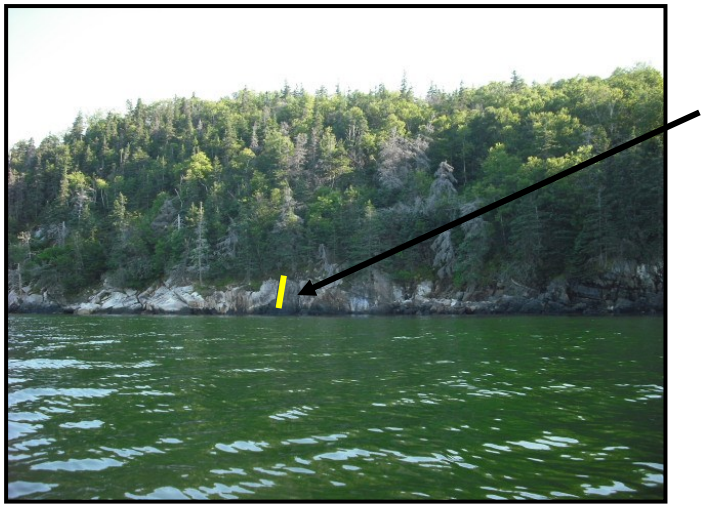


Fig. 29 c) View of shoreline contact from the water.

Now look to the left toward the York Shore Battery.

Fig. 30 a) York Shore Battery, from a distance.

Fig. 30 b) York Shore Battery.

This is the location of the western landfall for the anti-submarine net that stretched across the main harbour channel between McNabs Island and York Redoubt. The net, or boom, was deployed during both World Wars to keep German U-boats (submarines) out of the harbour while convoys, vital to the war effort, were assembled in Bedford Basin before they could be escorted overseas.

Fig. 31 a) Anti-submarine net between Fort York Redoubt and McNabs Island, Halifax NS. May 1942.

Fig. 31 b) WWII convoy in Bedford Basin, 1942 Looking south with Halifax peninsula in background.

Even though the anti-submarine net was removed 65 years ago, scour marks produced by currents flowing around the net moorings remain (fig. 32). Just off the beach, running parallel to the shore, are sedimentary furrows incised by the same currents. Also visible in fig. 32 (further offshore) are shoals representing unconsolidated glacial sediment and exposed bedrock at the seabed. If the sea is rough and especially at low tide, one can see breaking waves on these shoals and in the shallow areas just off the outer tip of McNabs Island (Thrumbcap Shoal).

This location was the obvious choice for a "gate" into Halifax harbour: the peninsula extending westward from McNabs Island made this crossing the shortest span for the submarine net. This, in addition to the vantage provided by the high rocky bluffs overlooking the glacially incised harbour clearly show how much York Redoubt's strategic importance in the defense of the harbour is related to the underlying geology. In fact when we consider the qualities that attracted settlers here from the beginning: a deep, sheltered, ice-free harbour, access to inland waterways, and high relief shorelines that offer good sightlines, geology "underlies" them all.

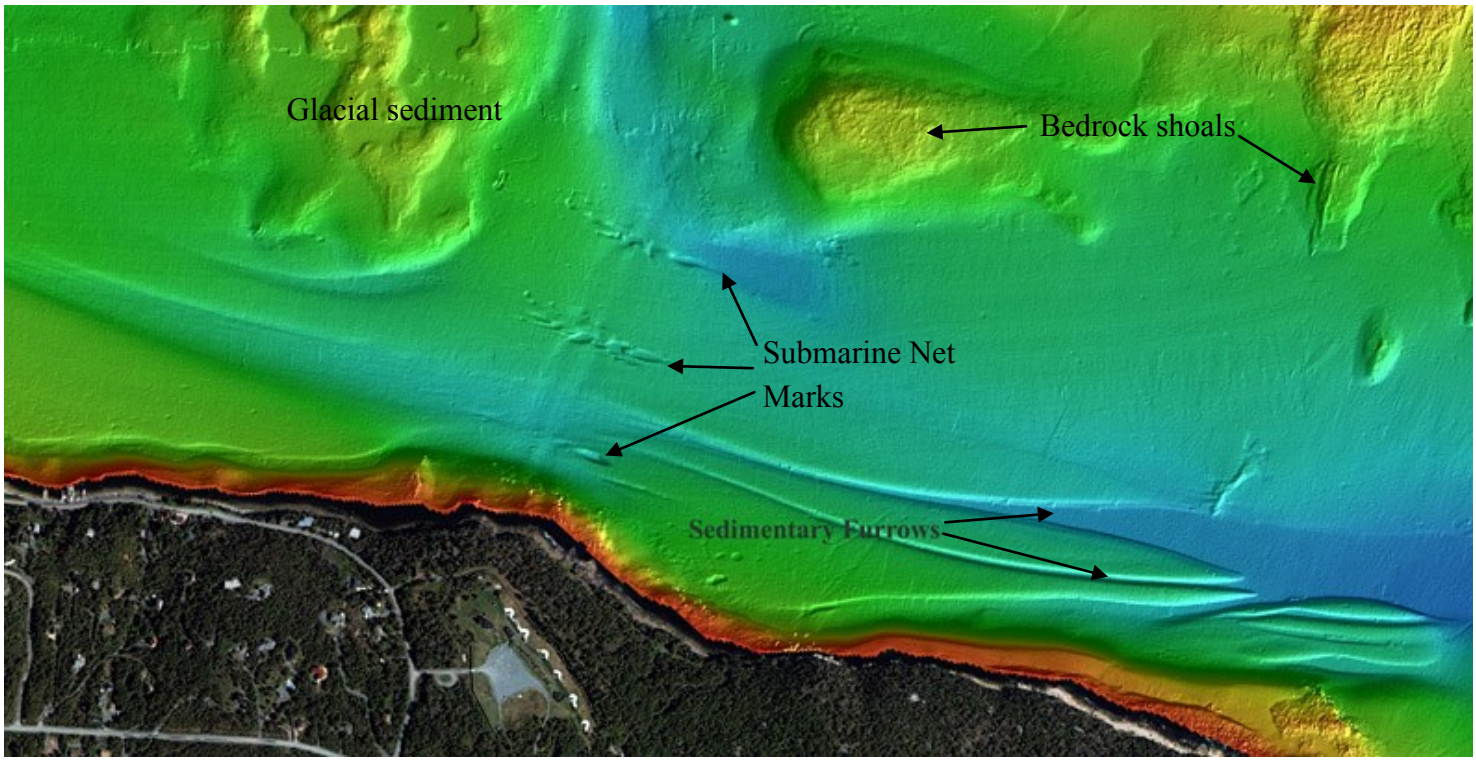


Fig. 32 Bathymetric image showing scouring around submarine net moorings and sedimentary furrows offshore York Redoubt. Yellow and orange colours correspond to shallow depths with green and blue representing deeper areas.

Return

Retrace your steps back up the hill along the same road and make your way back to the parking lot.

Recap

On this outing to York Redoubt you have had the chance to see the two main bedrock types found in southwestern Nova Scotia, to map their distribution in the immediate area, and to observe variation within the metamorphic Meguma Supergroup rocks. You have also seen how the interplay between bedrock geology and erosion, (fluvial and glacial) carved out the harbour. You've explored some of the evidence for glaciation; and even observed examples of stalactites. Along the way, you will have gained an understanding of how the unique features of Halifax Harbour and its cultural history are intimately linked to its geologic history. Now that you know more about their story, the rocks beneath your feet likely hold more interest and, hopefully, geology in general will be more visible in your future excursions.

Acknowledgements

The authors wish to thank Parks Canada for their continuing stewardship of the site and their support in the preparation of this document. Jennifer Bates and Philip Moir provided many helpful comments and their efforts substantially improved this field guide.

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Fisheries and Ocean Canada, Canadian Hydrographic Service: Halifax harbour bathymetric data

Friends of McNabs Island Society: http://www.mcnabsisland.ca/index.html

Google maps: https://maps.google.ca/maps?hl=en&tab=wl

Historic Places Canada: http://www.historicplaces.ca/visit-visite/affichage-display.aspx?id=7746

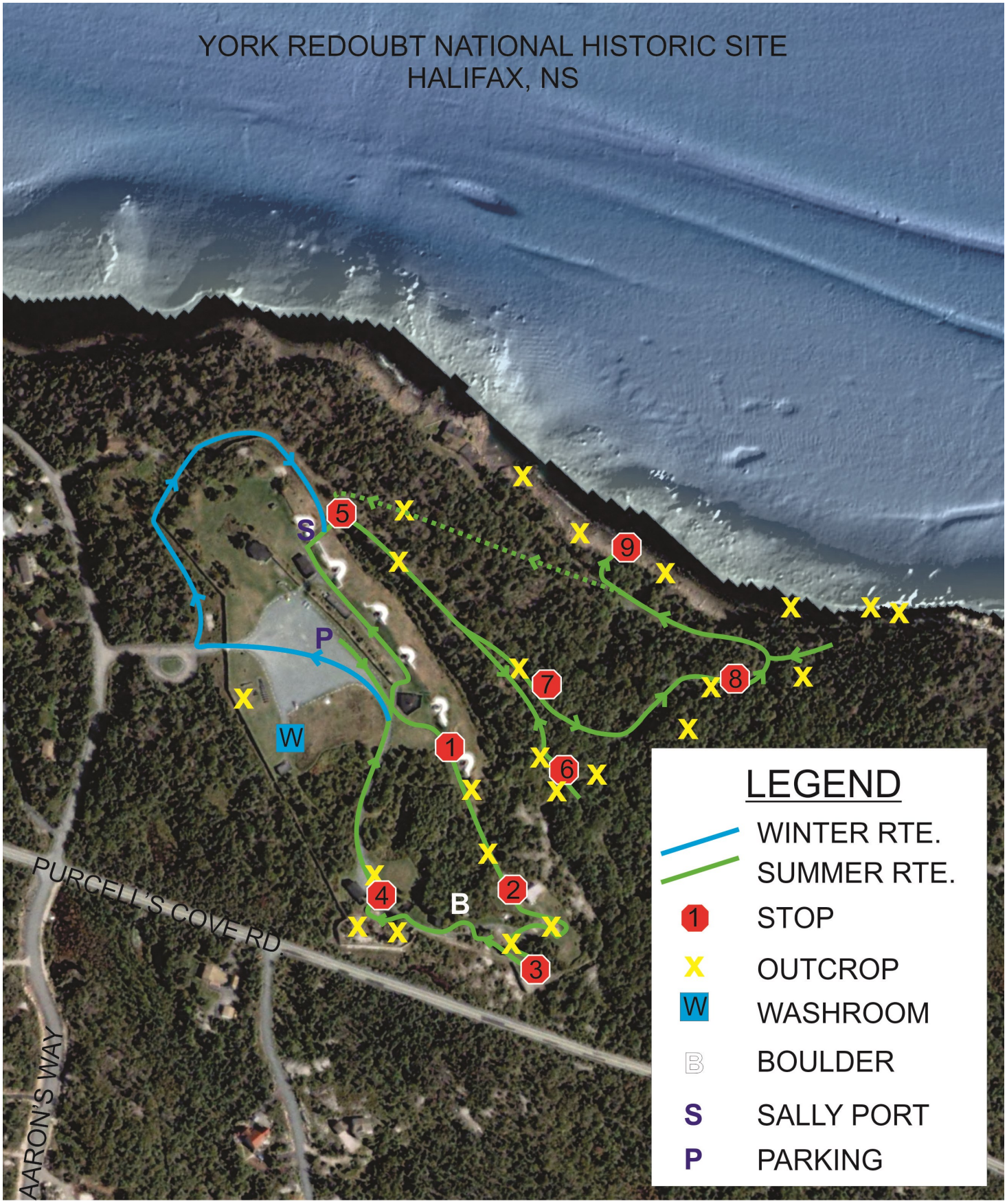
Natural Resources Canada: Geodetic Survey Division: http://www.geod.nrcan.gc.ca/index_e.php

Nova Scotia Archives: http://www.gov.ns.ca/nsarm/virtual/

Parks Canada: http://www.pc.gc.ca/eng/lhn-nhs/ns/york/index.aspx

Royal Canadian Navy: http://www.navy.gc.ca/project_pride/photo_archive/photo_archive_e.asp

Royal Engineers: http://www.gov.ns.ca/nsarm/virtual/royalengineers/default.asp


YORK REDOUBT NATIONAL HISTORIC SITE
HALIFAX, NS
PURCELL'S COVE RD.
AARON'S WAY
LEGEND
WINTER RTE.
SUMMER RTE.
STOP
OUTCROP
WASHROOM
BOULDER
SALLY PORT
PARKING

Base Map

Completed map

Additional Geological Resources

The geological history of Nova Scotia is an interesting story. For a more detailed account, consult "**The Last Billion Years**", published by Nimbus books for the Atlantic Geoscience Society (AGS) and Nimbus Publishing. You may also wish to look at other AGS products, such as "**The Geological Highway Map of Nova Scotia**" and "**Halifax Harbour: A Geological Journey**" on DVD and the brochure "**Nova Scotia Rocks**". See the AGS website for details: http://ags.earthsciences.dal.ca/AGS_Pubs.php

Use GEOSCAN to search for bibliographic information (and in many cases downloadable documents) relating to Earth Sciences Sector products from Natural Resources Canada:

http://www.nrcan.gc.ca/earth-sciences/esic/geoscan_e.php/4684

For an environmental perspective on Halifax geology, see a guidebook for a previous EdGEO fieldtrip around the Halifax Regional Municipality (Bedrock, Glacial, Economic and Environmental Geology of the Halifax Regional Municipality)

http://www.gov.ns.ca/natr/meb/data/pubs/04ofr03/04ofr03.pdf

For more detailed and technical information, Nova Scotia Department of Natural Resources (NSDNR) publishes digital data, GIS coverage, maps and other material on Nova Scotia geology. Much of this material is available for download:

http://www.gov.ns.ca/natr/meb/pubs/pubs3.asp

The geology of the Halifax regional municipality is described in a recent report by C.E. White et al. and is available for download : http://www.gov.ns.ca/natr/meb/pdf/08re01/19White.pdf

In 2008 the Friends of McNabs Island Society published "Discover McNabs Island", a useful guide on the natural, cultural and military history of McNabs Island. They also have produced other useful educational resources:

http://www.mcnabsisland.ca/Content/Educational_Resources.htm

Photo sources:

Figure 1: http://www.navy.gc.ca/project_pride/photo_archive/photo_archive_description_page_e.asp?ImgNegNum=C-002549-4

Figure 2: http://www.gov.ns.ca/nsarm/virtual/halifax/archives.asp?ID=141

Figure 3:http://gallica.bnf.fr/ark:/12148/btv1b6700143g

Figure 4:http://www.navy.gc.ca/project_pride/photo_archive/photo_archive_description_page_e.asp?ImgNegNum=C-002556

Figure 5:http://www.gov.ns.ca/natr/meb/pdf/08re01/19White.pdf

Figure 6:http://www.gov.ns.ca/natr/meb/pdf/08re01/19White.pdf

Figure 7 a), b), c): Photos taken by P. Potter

Figure 8: http://maps.google.ca/maps?hl=en&tab=wl

Figures 9, 10: Photos taken by P. Potter

Figure 11 a): Photo taken by P. Potter, b): http://www.gov.ns.ca/nsarm/virtual/royalengineers/archives.asp?ID=228

Figure 12: http://www.cmhg.gc.ca/cmh/image-350-eng.asp?page_id=411

Figure 13: http://www.gov.ns.ca/nsarm/virtual/royalengineers/archives.asp?ID=127

Figures 14-20: Photos taken by P. Potter

Figure 21 a): Photo taken by P. Potter, b) http://www.gov.ns.ca/nsarm/virtual/royalengineers/archives.asp?ID=67

Figures 22-30 Photos taken by P. Potter

Figure 31 a), http://www.navy.forces.gc.ca/project_pride/photo_archive/photo_archive_description_page_e.asp?ImgNegNum=PA-105924

b): http://www.gov.ns.ca/nsarm/virtual/eastcoastport/archives.asp?ID=181

Figure 32: http://www.nrcan.gc.ca/halifax/DVD/fig74-eng.php

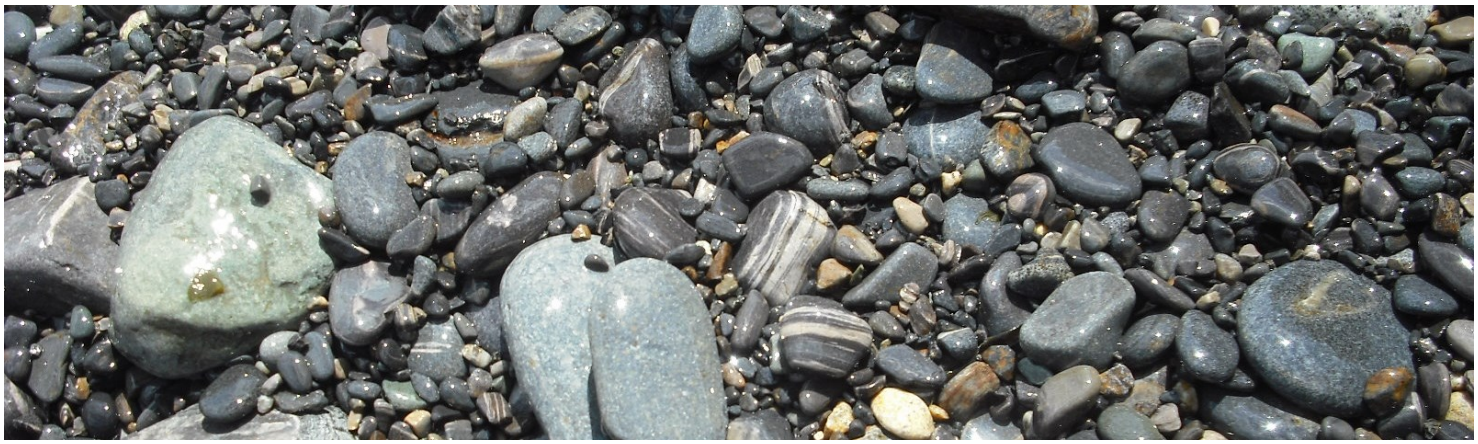
Figure 33: http://www.nrcan.gc.ca/halifax/DVD/fig34-eng.php

Quote sources:

Quote 1: http://www.mcnabsisland.ca/history/hist-s2.html

Quote 2: http://www.pc.gc.ca/eng/lhn-nhs/ns/york/index.aspx)

Quote 3: http://www.historicplaces.ca/visit-visite/affichage-display.aspx?id=7746



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