SURFICIAL GEOLOGY MAP of the PORT HAWKESBURY AREA (11F/11)

NOTES ON QUATERNARY HISTORY

This map depicts the nature, distribution and thickness of surficial (unconsolidated) deposits in the Port Hawkesbury map area of southwest Cape Breton Island (NTS 11F/11). Surficial deposits are classified with their host landforms. The broadest division of landforms in this area separates uplands and lowlands (Grant, 1994), over which the style of surficial landforms and deposits vary markedly. The Creignish Hills, for example, are characterized by a veneer (<1 m) of glacial drift, over granitic and metamorphic bedrock. The River Inhabitants Lowlands (Fig. 1), the major lowland region in the map area, has >100 m of Quaternary drift cover.

Surficial landforms and deposits are classified according to morphology and origin, using a system developed by Goldthwait (1989), and then further subdivided into formations (e.g. Sugar Camp Till), defined by the North American Stratigraphic Code (1983) as regionally mappable layers of drift that are distinguished on the basis of lithic characteristics and stratigraphic position. What follows is a summary of glacial history. Further information on the mapping methods and detailed descriptions of type sections and economic geology are available on the Targeted Geoscience Initiative (TGI) project web page: http://www.gov.ns.ca/natr/meb/tgi/tghome.htm.

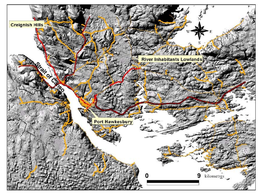

Fig. 1. Digital terrain model showing the main physiographic subdivisions of the Port Hawkesbury area. Coloured lines represent roads.

QUATERNARY EVENTS

The fault-bounded uplands and lowlands were formed in the Late Mesozoic after a major period of tectonism and uplift, and subsequently the topography was exhumed from beneath a thick cover of Mesozoic sediment (Stea and Pullan, 2001). During the Quaternary Period in North America, ice sheets advanced and retreated during ~16 major glacial periods over ~2 million years. The record of glaciations in Cape Breton Island, however, spans only the last 200,000 years (see legend for Quaternary formations and ages).

Sangamonian Interglaciation (128-75 ka)

Organic materials (e.g. peat, organic clay and wood) relating to the last interglacial period are found at several localities in the map area, including a drillhole (BR-01-1), the Sugar Camp gypsum quarry, and River Inhabitants reference sections. An impressive number of sites in Cape Breton feature non-glacial sediments of the warm period that pre-dates the main Wisconsinan glaciation (Grant, 1994). The type locality of interglacial deposits in Cape Breton is at East Bay, where three layers of organic beds, interrupted by fluvial gravel deposits, record a progressively cooling climate from temperate to boreal/tundra (Mott and Grant, 1985; Grant, 1994).

For access to reference sections and drillhole data visit: http://www.gov.ns.ca/natr/meb/tgi/tghome.htm.

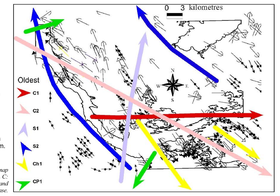

Fig. 2. Ice flow history of the Port Hawkesbury map area. See map legend for explanation of symbols. C: Caledonia Phase (C1 and C2); S: Scotian Phase (S1 and S2); Ch: Chignecto Phase; CP: Collins Pond Phase.

Caledonia Phase (1 and 2: Early to Middle Wisconsinan)

The first major glacial advance during the Wisconsinan glaciation on Cape Breton Island moved toward the east-southeast, depositing a thick silty till termed the Richmond Till (Grant and King, 1984). The provenance and fabric of Richmond Till in the the River Inhabitants Lowlands imply an early eastward flow (090-120°, C1; Fig. 2), as do the orientations of striae and drumlins. A similar glacier flow history was noted in the River Denys Lowlands to the north (Stea et al., 2003). Ice flow then changed to a more southeastward orientation (140-160°; C2; Fig. 2). Richmond Till forms the core of many drumlins in southeast Cape Breton Island (MacClenaghan and DiLabio, 1996; Grant, 1994). Stea et al. (1998) designated the early flow as the Caledonia Phase, deriving the term from Rampton et al. (1984), who proposed that a major southeastward ice flow (140-160°) crossed the Caledonia Highlands of New Brunswick. Grant (1994) termed these early flow phases "Phases B and C" in Cape Breton Island. The early eastward flow (C1) seems more extensive and consistent than in Grant's (1994) reconstruction.

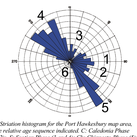

Fig. 3. Striation histogram for the Port Hawkesbury map area, with the relative age sequence indicated. C: Caledonia Phase (1 and 2); S: Scotian Phase (3 and 4); Ch: Chignecto Phase (5); CP: Collins Pond Phase (6). 100 sites measured.

Scotian Phase (3 and 4: Late Wisconsinan)

The River Inhabitants and Sugar Camp Quarry sections exhibit two till units that can be related to regional ice flow events, mapped by striae and landform trends. The uppermost unit at the sections (Sugar Camp Till) provides evidence of southern bedrock sources, with the introduction of coal clasts derived from the Port Hood Formation, which outcrops around Inhabitants Bay. This flow direction also produced the Creignish Hills Till on the highlands of southwestern Cape Breton Island, associated with ribbed moraine, north-westward trending striae, and meltwater channels (Stea and Feetham, 2003). In southeast Cape Breton, McClenaghan and DiLabio (1996) described a till sheet formed during this northward ice flow phase.

Northwestward flow across the study area can be traced across 300 m highlands and represents a major glacier flow phase that was directed into the Cape Breton Channel, possibly to merge with Laurentide ice in the Laurentian Channel. Stea et al. (1998) correlated these flow directions in southern Cape Breton (Grant, 1994; Phase D) with glacier flow on the mainland of Nova Scotia also directed into the Cape Breton Channel through Georges Bay. They termed the event the Scotian Phase. There appears to have been a precursor event to the main Scotian Phase, a flow directed to the northeast (S1, Fig. 2).

Fig. 4. Drumlin orientations for the Port Hawkesbury map area. Note the close correspondence with the striation measurements above. Clearly the major drumlin-forming ice flows in the region are the Scotian and Chignecto phases relating to local ice caps. n=120 measurements.

Chignecto Phase (5: Late Wisconsinan)

Grant (1994) mapped a series of temporally distinct glacier flow patterns in Cape Breton (Phases E-F-G) that post-date the Scotian Phase. Similarly, in northern Nova Scotia, Myers and Stea (1986) mapped a strong southwestward ice flow (Ice Flow Phase 4) that post-dated the Scotian Phase, and produced till and eskers in mainland Nova Scotia. Stea et al. (1998) termed the event the Chignecto Phase. At several localities in the map area a southeastward flow from an ice divide in the Bras D'Or Lakes (Grant, 1994; Phase E) is recorded, which followed the northwestward flow (Scotian Phase). The Bras D'Or centre may have been coeval and coincident with an Antigonish Highlands centre for the Chignecto Phase. The Chignecto Phase southwest flow pattern was traced to a morainal belt off the Eastern Shore of mainland Nova Scotia, which was dated between 12.7 ka and 14 ka* (~15-16.7 CAL*; Stea et al., 1996). Josenhans and Lehman (1999) presented evidence for a significant re-advance in the Cabot Strait ca. 13.5 ka (~16.0 CAL) which Stea (2001) linked to local glaciers by pebble lithology.

*(ka=radiocarbon years; CAL=calibrated to actual years before present)

Glacial Lake Dawson 1

Glaciolacustrine deposits in the River Inhabitants area relate to the retreat of Chignecto Phase glaciers from the lowlands. Grant (1994) envisioned remnant ice in the Bras d'Or Lakes, to explain an ice-dammed lake in these lowlands. The age of this ice-dammed lake in western Cape Breton is older than 11.8 ka, based on radiocarbon dates of a paleosol overlying lacustrine silty clay (Stea and Mott, 1998). Radiocarbon dating of Chase Pond east of the map area suggests an even earlier deglaciation (~13 ka) making a remnant ice cap in the lakes a remote possibility (Stea and Mott, 1998). Ice probably receded to the south and southwest as ice streams through the Cabot Strait and into Chedabucto Bay cleared ice from the region. A retreating tongue of ice in Inhabitants Bay dammed the River Inhabitants Lowlands, creating Glacial Lake Dawson 1, whose outlets were the narrow corridors beside the North Mountain and Creignish Hills.

Collins Pond Phase (6: Younger Dryas event)

The last ice flow features along the Atlantic coast are poorly defined southwestward trends in the Inhabitants Bay area, based on the dispersal of mafic pegmatite boulders from possible sources in the Lennox Channel area (Chris White, pers. comm., 2003) and striae on till-embedded boulders. These trends, however, match ice flow indicators at the Collins Pond type section south of the map area (Stea and Mott, 1998).

On the Gulf of St. Lawrence coast, Grant (1994) mapped striae from onshore-flowing ice. After an initial pulse of flow inland this glacier receded back from the coast leaving room for the development of Glacial Lake Dawson 2 on the lowlands west of the Creignish Hills (Stea and Feetham, 2003). The age of this event, determined by radiocarbon dating of buried peat sections, is 10.8-10 ka (~13- 11.4 CAL) . For more information visit: http://www.gov.ns.ca/natr/meb/stop20.htm.

ECONOMIC GEOLOGY

Surficial materials provide a direct economic benefit as a supply of construction aggregate and other industrial materials for the region. Glaciofluvial and alluvial deposits provide the best quality sand and gravel aggregate, and are quarried throughout the map area. Glaciolacustrine clay deposits have potential as ceramic art and structural products. The economic potential of similar clay deposits on NTS map area 11F/14 is described in detail on the TGI web page (http://www.gov.ns.ca/natr/meb/tgi/tgiclay.htm) and in Stea et al. (2002). Aquifers in surficial deposits locally provide high-quality groundwater.

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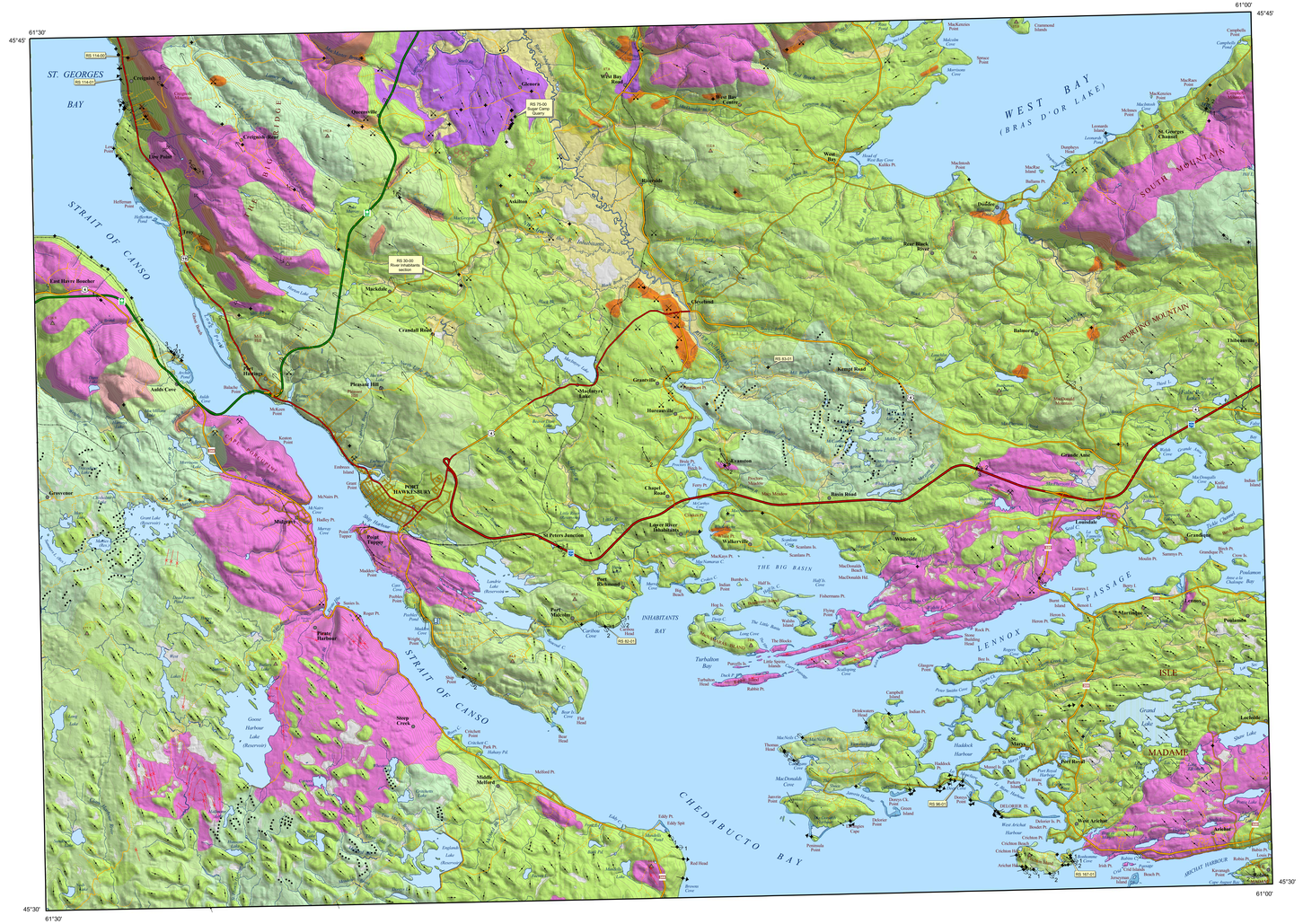

Nova Scotia Department of Natural Resources
Mineral Resources Branch

Open File Map ME 2004-2

Surficial Geology Map of the Port Hawkesbury Area (NTS 11F/11)
Inverness, Richmond, Guysborough and Antigonish Counties, Nova Scotia

R. R. Stea

1 0 1 2 3 km

Scale 1 : 50 000
Contour Interval 10 metres

Halifax, Nova Scotia
2004

NOVA SCOTIA
Natural Resources

Major sources of geological information

1. Grant, D. R. 1994: Quaternary Geology, Cape Breton Island; Geological Survey of Canada, Bulletin 482, 159 p. (accompanied by GSC MAP 1631 A).

2. Cann, D. B., MacDougall, J. I. and Hilchey, J. D. 1963: Soil survey of Cape Breton Island, Nova Scotia; Nova Scotia Soil Survey Report no. 12, 85 p.

3. Pullan, S. E., Hunter, J. A., Burns R., Douma, M. and Stea, R. R. 2001: Testing of shallow seismic reflection techniques, Cape Breton Island (NTS 11F/10, 11F/11, and 11F/14); in Minerals and Energy Branch Report of Activities 2000, ed. D. R. MacDonald; Nova Scotia Department of Natural Resources, Report ME 2001-1, p. 73-82.

Disclaimer

The Nova Scotia Department of Natural Resources does not assume any liability for errors that may occur. This map is intended for use at the published scale of 1:50 000.

This map and legend were printed using dye-based inks which are subject to fading. It is recommended that you store out of direct light when not in use to lengthen the life of this product.

Map Notes

Universal Transverse Mercator (UTM) Projection, Zone 20, Central Meridian 63°00' West.

North American Datum (NAD) 1927.

Base data derived from the Nova Scotia Topographic Database (NSTDB). Copyright Her Majesty the Queen in Right of the Province of Nova Scotia. The NSTDB is available from Service Nova Scotia and Municipal Relations (SNSMR), Land Information Services Division (LIS), Nova Scotia Geomatics Centre (NSGC), Amherst, Nova Scotia.

Further digital map compilation, database development, and map production by the Nova Scotia Department of Natural Resources.

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Map accompanies NSDNR Economic Geology Series ME 2005-1.

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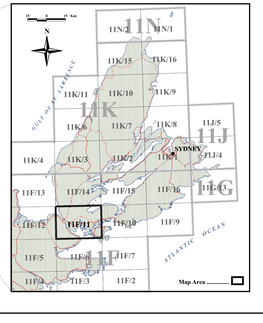
Regional Key Map

Cultural Features

- Settlement
- Spot Elevation (m)
- Trans-Canada Highway
- 100 Series Highway
- Trunk Highway
- Collector Highway
- Hard Surface Road
- Loose Surface Road
- Cart Track
- Resource Access Road
- Railway Active
- Railway Inactive
- Coast/Lake/River
- Topographic Contour (10 m interval)



LEGEND

QUATERNARY

Holocene (10-0 ka)

Marine deposits
Gravel, sand; forming barrier bars and spits; fine sand, silt, organic clay, peat in adjacent lagoons and salt marshes (2-10 m thick).

Organic deposits
Sphagnum and Carex peat, gyttja, clay; forming bogs, fens and marshes (1-15 m thick).

Fluvial deposits
Gravel, gravelly sand, sand, silt, minor clay and organic material; forming river point bars, channel and bank deposits, fine-grained deposits in floodplains (sand/silt/clay; 2-15 m thick).

Paraglacial alluvial fan deposits
Boulders, diamicton gravel, gravelly sand, sand; forming fan-shaped lobes at the mouths of incised valleys at highland slopes (4-20 m thick).

Colluvial deposits
Gravel, sand, silt, organic material; a complex mixture of unsorted glacial deposits, gravelly slopewash, and weathered bedrock formed by periods of mass wasting along steep valley walls (1-10 m thick).

Late Wisconsinan (23-10 ka)

Glaciolacustrine (glacial lake) clay plains

Glaciolacustrine deposits
Stony silty clay (diamicton), silty clay, laminated clay-silt/sand, massive clay, minor sand-gravel at basin margins; forming flat or gently rolling terrain in topographic basins (3-15 m thick).

Outwash fans and valley trains

Outwash deposits
Gravelly sand, sand, silt and clay; cut and fill channel structures; coarse facies: gravelly sand, openwork gravel, cross-bedded medium to coarse sand; fine facies: normally graded sand beds; valley-side terraces (valley train); flat-topped deltaic deposits graded to former glacial lake levels (3-30 m thick).

Kame fields and terraces

Ice contact stratified drift
Gravel, gravelly sand, sand, silt and clay; abrupt changes in grain size between facies; channels common in coarser facies; faulting and slumping (contorted beds); diamicton facies commonly interfinger with gravel deposits, forming hummocky terrain or individual conical hills (kames), and valley-side terraces (kame terraces, 4-30 m thick).

Stony till plain and ribbed moraine

Creignish Hills Till
Grey-brown, clast- to matrix-supported, stony, sandy till; clasts are predominantly local rocks; forming ground and ribbed moraine (2-15 m thick).
Reference section: Creignish Hills (11F/14;106/00) (http://www.gov.ns.ca/natr/meb/tgi/tgimap.htm)

Silty till plain and drumlins

Sugar Camp Till (with drumlin facies)
Reddish-brown, matrix-supported, silty till; moderately compact, massive, polymictic with sedimentary and igneous rock types, ground moraine and drumlins (3-10 m thick); reference section: Sugar Camp Quarry (75/00) (http://www.gov.ns.ca/natr/meb/tgi/SC.htm).

Cover moraine

Till veneer
Upland areas where only 1-2 m of brown sandy till are found overlying bedrock; terrain mimics bedrock structure, till usually stonier and more locally derived than in lowlands; interspersed, undifferentiated outcrop.

Early to Late Wisconsinan (75-23 ka)

Richmond Till *
Grey to red-brown, silty till (in section only); compact to very compact, massive; forms the core of many drumlin landforms (in section only, 5-30 m thick); reference section: Sugar Camp Quarry (http://www.gov.ns.ca/natr/meb/tgi/SC.htm).

Glaciolacustrine sediments *
Brown silty clay, silty sand, sand, minor gravel (in section only,10-60 m thick); reference section: Big Marsh drillhole (BM-01-1; 11F/14) (http://www.gov.ns.ca/natr/meb/tgi/rd.htm).

Sangamonian (128-75 ka)

Peat, with wood fragments, grey silty clay, sand, minor gravel (in section only, 1-3 m thick); reference section: River Inhabitants Section (30/00) (http://www.gov.ns.ca/natr/meb/tgi/rb.htm). *

Illinoian? (320-128 ka)

"Lower Till" *
Grey silty till (in section only, 2-5 m thick); reference section: Big Marsh drillhole (BM-01-1) (http://www.gov.ns.ca/natr/meb/tgi/rd.htm).

PRE-QUATERNARY

Residuum or regolith
Fragmented, mechanically and chemically weathered bedrock, rubble with interstitial fine mud and debris with a discontinuous veneer of stony till; forms an irregular upland topography with ~40% bedrock exposure (2-10 m thick).

Bedrock
Exposed bedrock with a discontinuous veneer of stony till; forms knobs and basin topography; exposed, glacially scoured, bedrock covers ~40% of region, obscured by forests and bogs.

SYMBOLS

drumlin, fluting, elongate hills and ridges parallel to ice flow; ice flow direction known, unknown; crag and tail hill

glacial striae, relative ages of striae, 1 being older, dot at location

till-embedded boulder striae, roches moutonnées

moranal landforms, ridges perpendicular to ice flow; ribbed moraine

meltwater channel, spillway

terrace and scarp

bedrock strike ridge

sinkhole

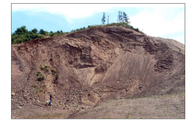
location of field stop with special significance (SS 00-01)

rock quarry

sand and gravel pit

* Note: drumlin units are found only in stratigraphic section and do not outcrop in map area.
Note: drumlin and striae measurements in part derived from Grant (1994) as noted in the databases accompanying digital product DP ME 060.

Marine gravel-barrier deposits on Isle Madame (Stop RS 96-01).



Kame exposure in a gravel pit near Creignish (Stop RS 114/00).

Mound or hummock of Creignish Hills Till in a borrow pit near Evanston (Stop RS 83-01).

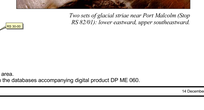
Sugar Camp Till in a drumlin exposure along the Atlantic coast near Arichat (Stop RS 96/01).

Veneer of Sugar Camp Till over bedrock near Port Hawkesbury (Stop RS 75-01).

Carboniferous bedrock (1), overlain by Richmond Till (2) then bouldery Sugar Camp Till (3) near Creignish (Stop RS 114/01).

Palimpsest drumlins south of Goose Harbour Lake formed by flow from two separate ice movements, eastward then northwestward.

Roches moutonnées (smooth side facing toward the glacier) on Crichton Island (Stop RS 167/01).



Two sets of glacial striae near Port Malcolm (Stop RS 82/01): lower eastward, upper southeastward.

14 December 2004