SURFICIAL GEOLOGY MAP of the WHYCOCOMAGH AREA (11F/14)

CLASSIFICATION OF SURFICIAL LANDFORMS AND DEPOSITS

This map depicts the nature, distribution and thickness of surficial (surface-unconsolidated) deposits in the Whycocomagh map sheet of southwest Cape Breton Island (NTS 11 F/14). Surficial deposits are classified with their host landforms. The broadest classification of landforms in this area are the uplands and lowlands (Grant, 1994) over which the style of surficial landforms and deposits vary markedly. The Creignish Hills and North Mountain, for example, are characterized by a thin veneer (<1 m) of glacial drift, over granitic and metamorphic bedrock. The River Denys Lowland (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 (Sugar Camp Till) defined by the North American Stratigraphic Code (1983) as regionally mapable layers of drift that are distinguished on the basis of lithic characteristics and stratigraphic position. What follows is a brief elaboration on the surficial units, and a summary of glacial history. Further information on the mapping methods, detailed descriptions of type sections and economic geology are available on the Targeted Geoscience Initiative project web page: (HTTP://www.gov.ns.ca/natr/meb/tgi) .

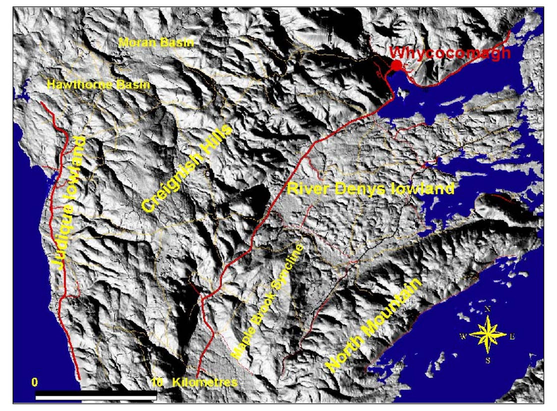

Fig. 1. Digital terrain model showing the main physiographic subdivisions of the Whycocomagh map area.

BEDROCK

Rock outcrop is common on the Creignish Hills and the North Mountain. Small-scale glacial erosional forms such as striae, grooves, and crescentic chatter marks are commonly found under a till veneer. These outcrops may display asymmetric profiles, with abraded, gently dipping stoss sides and steep, rough lee slopes (roches moutonèes). On several outcrops two or more striation directions can be measured (Fig. 2). Often, the younger ice flow will abrade an older striation on its up-glacier facing slope while leaving the older striations in a lee side shadow. The contact between the two ice flow patterns is often a sharp bevel (Fig. 2). A relative ice flow chronology can be established from these intersecting erosional facets (Stea, 1994).

Fig. 2. Outcrop showing two directions of ice flow: an older eastward flow -Caledonia Phase (pencil) followed by southeastward-Chignecto Phase (Brunton-Photo from Isle Madame, NTS 11 F/11).

RESIDUUM

Residuum, or thoroughly disaggregated bedrock, is found at a few localities in the map area. This is bedrock that has been both mechanically weathered by processes such as frost shattering and thermal expansion, and chemically modified by hydrolysis and oxidation (for example, kaolinization of feldspars). The thickness and extent of residuum depends on the nature of the rock material and the efficacy of glacial erosion. At Upper Glencoe (Site 26/00) 3-4 m of residuum overlies slate bedrock and is used as a source of aggregate.

GROUND MORAINE AND STREAMLINED DRIFT

Most of the Whycocomagh map area is covered by ground moraine, which is a non-linear, smooth or hummocky glacial drift cover, composed of subglacial lodgment or melt-out till (unsorted boulders, sand and mud deposited under a glacier by melting or "plastering-on"). Some areas feature elongated hills (drumlins, streamlined drift) which trend in the direction of ice flow. The ground moraine areas can be subdivided into three landform types: cover moraine, silty and stony till plains.

Cover Moraine (ALVARS)

Cover moraine is patchy, thin till (till veneer) overlying bedrock. Bedrock structure is discernable in air photographs through the veneer of glacial deposits. A good example of cover moraine is the Maple Brook Syncline area south of River Denys (Fig. 1) where a circular pattern of bedrock strike ridges outlines a large, closed synclinorium.

Silty Till Plain and Drumlins

The silty till plain is a slightly to strongly rolling plain, composed of thick, fine-grained glacial drift cover, averaging 10 m and attaining thicknesses of 100 m. The till plain is composed of stacked, multiple tills, sometimes underlain by glaciolacustrine and glaciofluvial gravel, sand or mud, masking underlying Paleozoic bedrock. The surface till unit is the Sugar Camp Till. The silty till plain is occasionally moulded into drumlins, which parallel the direction of glacier flow and locally increase drift thickness by up to 30 m. Eastward-trending drumlins are found in the River Denys lowland (Fig. 1).

Stony Till Plain and Ribbed Moraine

The stony till plain is found on the Creignish Hills in the western portion of the map area developed over Proterozoic and Paleozoic metamorphic and igneous bedrock. It is characterized by hummocky terrain, with local development of arcuate, en-echelon ridges (ribbed moraine, Fig. 3). These ridges are from 500 m to 1.5 km long with amplitudes of 5-10 m. The surface of the ridges is strewn with boulders 0.5-5 m in diameter. The Creignish Hills Till is the till formation that constitutes these ridges.

Fig. 3. Morainal ridges (ribbed moraine) near Rear South Judique (Site 80/00: see main map for location).

GLACIOFLUVIAL AND GLACIOLACUSTRINE LANDFORMS AND DEPOSITS

About 15 percent of the map area is covered by sediments deposited by glacial meltwater streams (glaciofluvial deposits) under (eskers), on (kames) or in front of (outwash fan, valley train) retreating glaciers, or in impounded glacial lakes (glaciolacustrine) deposits. These are composed mostly of well-sorted sediments.

Kame Fields and Terraces

These landforms appear as small hills or hummocks and short ridges in any direction, located on valley floors or on the sides of hills (kame terraces, Fig. 4). The best exposure of kames in the study area is an aggregate quarry at Seal Cove (Site 196/01) which reveals three major facies: (1) cobble gravelly sand fining upwards into planar fine-grained sand-silt beds forming the core of ridges, (2) planar-bedded medium to fine sand and (3) silt/clay and sand rhythmites which lap over the coarse ridge sediments cut by many high-angle faults.

Fig. 4. Kame terrace on the south flank of the Creignish Hills near Upper River Denys (Site 194/01).

Outwash Fans and Valley Trains

Outwash fans are gently sloping, fan-shaped plains consisting of coarse gravel at the head (closest to former ice sheet) and finer sand deposits at the outer edge. Valley trains are belts of outwash confined to valleys, sometimes pitted with kettle holes. It is sometimes difficult to distinguish between low relief, ice contact stratified drift and outwash. In the map area gravel deposits are associated with glaciolacustrine deposits as fan-deltas. Near River Centre (Site 52/00) bouldery, gravelly sand deposits overlie fine-grained glaciolacustrine clay and show a northward coarse to fine facies gradation indicating an ice sheet to the south. At Iron Mines (Site 197/01), valley-train massive bouldery gravel overlies channellized gravelly sand, without any faulting or disruption of beds.

Glaciolacustrine Lake Bottom Basins

Former glacial-lake bottom basins are characterized by flat to slightly rolling topography covered with lacustrine sand/silt and clay. Shorelines of the former glacial lakes are marked by terraces and common glaciofluvial fan-delta deposits. Linear meltwater channels and sand and gravel deposits mark meltwater spillways which fed into the former lakes. The clay deposits found in these basins are unusually fine-grained and massive, lacking the graded beds with coarse silt and sand that often characterize glacial lake sediments (varves), and have a low percentage of dropstones (dropstones are larger rocks that have been carried into the lake via floating ice and later dropped by melting). The implication is that active glaciers were not directly calving into these water bodies, but had dammed the basin outlets at lower elevations. The glaciolacustrine deposits north of Judique infill bowl-shaped topographic lows informally termed the Moran and Hawthorne basins (Fig. 1).

Meltwater Channels

Meltwater channels are abundant in the map area and consist of parallel, straight valleys without floodplains, 0.5-4 km in length, incised in bedrock hills and crossing modern stream valleys.These channels trend northwestward, parallel to late ice-flow features. These features (also called tunnel valleys) likely formed at the glacier base, although some may have formed as spillways for proglacial meltwater in front of a retreating glacier, which terminated in glacial lake basins.

HOLOCENE LANDFORMS AND DEPOSITS

Holocene sediments were deposited after the final retreat of glaciers starting about 11,000-10,000 years ago. These consist of valley slope colluvium, marine bar and estuary, river (alluvial and deltaic) and organic (bog, fen) environments. Colluvial deposits are found on steep valley slopes and consist of a variable mixture of weathered rock talus, slumped till, sheetwash and organic horizons produced by mass wasting. Marine landforms in the region include barrier bars and spits whose coarse gravel and sand are derived from erosion and longshore drift from moraine/drumlin and rock headlands. These bars sometimes enclose lagoons with finer grained sand and organic silty-clay deposits. Holocene fans consist of conical fan deposits of coarse gravel and sand at the mouths of steep river courses in the Creignish Hills and North Mountain. Alluvial landforms are river channels and bars with gravel and sand, levee, splay and adjacent floodplain deposits of coarse to fine sand and silty-clay.

Fig. 5. Gravelly point bars on the Mabou River near Glencoe.

STRATIGRAPHY AND GLACIAL HISTORY

The Quaternary history and stratigraphy of the map area are best recorded in the two lowland areas with the thickest deposits of Quaternary sediments: the River Denys and Judique lowlands.

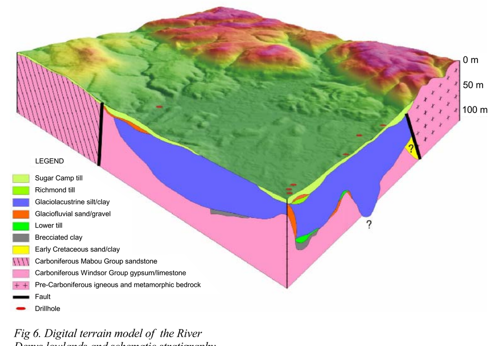

Fig 6. Digital terrain model of the River Denys lowlands and schematic stratigraphy.

River Denys Lowland

The stratigraphy of the River Denys Lowland is demonstrated by the oblique-view digital elevation model and schematic stratigraphic section shown in Fig. 6. In several drillholes, Carboniferous gypsum, limestone and mudstone were encountered under as much as 88 m of glacial deposits, and seismic surveys (Pullan et al., 2001) across the basin revealed surficial deposits to a depth of 140 m. A brecciated clay is often found interlayered with bedrock.
The oldest Quaternary unit is a matrix-supported silty diamicton (Lower Till) with limestone and igneous erratics. Above this till is a thick sequence (13-80 m) of fine-grained sediments including thinly bedded and massive, silty and sandy clay with a few dropstones interpreted as glaciolacustrine sediments. These are succeeded by two till units: a lower till sequence with local sedimentary and metasedimentary clasts (Richmond Till); separated by fine- and coarse-grained waterlain sediments from the uppermost Sugar Camp Till with abundant granitic and dioritic erratics as well as local sedimentary rocks. Some of the mafic erratics in the Sugar Camp Till are derived from the North Mountain (Site 164/00).

The lowest till unit in the River Denys Lowland is interpreted as pre-Early Wisconsinan, probably Illinoian (200 ka), representing an early regional ice flow. A section at Whycocomagh (Site 198/01) discovered by D. G. Kelley in 1955 revealed two tills separated by a peat-wood organic horizon dated at >44,000 yr B.P. (GSC-290). A boreal pollen assemblage and infinite age suggests that the organics were deposited at the end of the Sangamonian Interglacial (128-75 ka) (Mott and Grant, 1985). The thick fine-grained sequence above was deposited in glacial lake of probable Early-Middle Wisconsinan age (75-30 ka) when a glacier advancing over the channels draining the Bras D' Or Lakes impounded a glacial lake in the River Denys Lowland. Tills in the River Denys Lowland contain abundant erratics of older lithologies typical of the Creignish Hills as well as local basin lithologies. Abundances of Creignish Hills lithologies in the Richmond Till suggest that it was deposited during an eastward to southeastward ice flow (Caledonia Phase, Fig. 7). The overlying Sugar Camp Till in the River Denys Lowlands, is a hybrid till whose composition is in part derived from earlier flows across the Creignish Hills and later reworked by shifting ice flows to the northeast and northwest (Grant, 1994). The Creignish Hills Till was formed during the Scotian Phase (Fig. 7) by northwestward ice flow over the Creignish Hills, and is composed almost entirely of locally derived metamorphic and igneous lithologies.

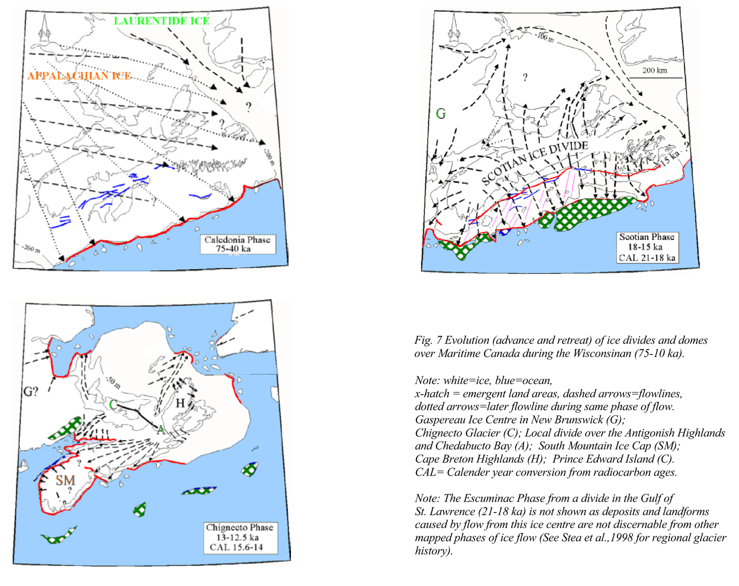

Fig. 7 Evolution (advance and retreat) of ice divides and domes over Maritime Canada during the Wisconsinan (75-10 ka).

Note: white=ice, blue=ocean, x-hatch = emergent land areas, dashed arrows=flowlines, dotted arrows=later flowline during same phase of flow. Gaspereau Ice Centre in New Brunswick (G); Chignecto Glacier (C); Local divide over the Antigonish Highlands and Chedabucto Bay (A); South Mountain Ice Cap (SM); Cape Breton Highlands (H); Prince Edward Island (C). CAL= Calender year conversion from radiocarbon ages.

Note: The Escuminac Phase from a divide in the Gulf of St. Lawrence (21-18 ka) is not shown as deposits and landforms caused by flow from this ice centre are not discernable from other mapped phases of ice flow (See Stea et al.,1998 for regional glacier history).

Judique Lowland

Coastal exposures in the Judique Lowland show glaciolacustrine deposits that can be further subdivided into several lithostratigraphic units (Fig. 8). The surface unit (Unit 4, Fig. 9) is draped over the lowland topography and consists of two main facies: a parallel-laminated, coarse to fine sand overlain by a massive, red-brown, blocky silty clay. It overlies a peaty soil layer (Unit 3) with radiocarbon ages spanning the Allerød Interstadial. Further north along the coast, the sandy facies of Unit 4 pinches out over older silty clay rhythmites and bouldery gravelly sand (Unit 2). Unit 4 can be traced inland to elevations of between 60 and 70 m (Fig. 8), where there are prominent erosional terraces. A site in Judique (184/00) reveals 3.4 m of massive clay (Unit 4) overlying a thin peat layer, and glaciolacustrine clay (Unit 2) from a previous glacial lake phase. The clay deposits cannot be marine in origin due to their elevation (+70 m) and because data in the Gulf of St. Lawrence suggests that after 12 ka, sea levels had dropped to between 50 and 100 m below present (Josenhans and Lehman, 1999). The terrestrial paleosol beneath the clay sediments implies a precipitous drop and rise in relative sea level not documented elsewhere in the Gulf. Open work gravel and rhythmites in the lower waterlain sediments (Unit 2) are characteristic of proximal subaqueous fan deposits and distal glacial lake bottom sediments (Ashley, 1995). Figure 8 shows the development of ribbed moraine perpendicular to Scotian Phase NW ice flow across the Creignish Hills. Subglacial meltwater channels parallel to this flow are also well developed. A section of interglacial peat can be found at Long Point (44/01) buried by marine?sand and till.
For more information see HTTP://www.gov.ns.ca/natr/meb/tgi/lp.htm

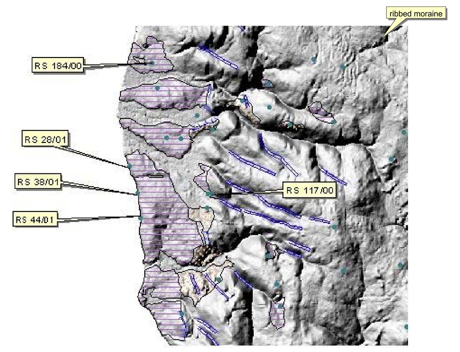

Fig 8. Digital terrain model of the Judique Lowland showing the locations of sections in Fig. 9.

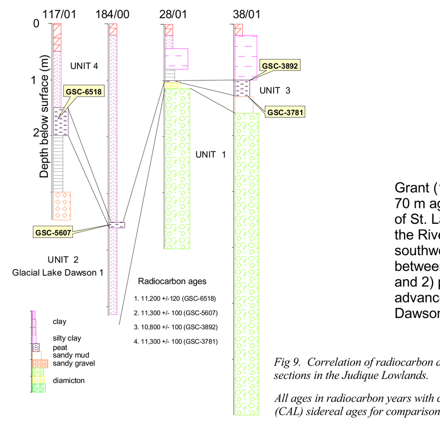

Fig 9. Correlation of radiocarbon age-dated sections in the Judique Lowlands.

All ages in radiocarbon years with calibrated (CAL) sidereal ages for comparison.

Grant (1994) postulated that in order to dam a body of water up to 60-70 m against the Creignish Hills, a glacier must have existed in the Gulf of St. Lawrence. He used the term "Glacial Lake Dawson" for a lake in the River Inhabitants lowland, which we have extended to encompass the southwest coast of Cape Breton. Our finds of a radiocarbon-dated paleosol between two glacial lake deposits (Units 1 and 4; Glacial Lake Dawson 1 and 2) put these lakes in temporal context. The proposed extent of ice advance during the Younger Dryas glaciation and extents of Glacial Lake Dawson (2) are shown on Fig. 10.

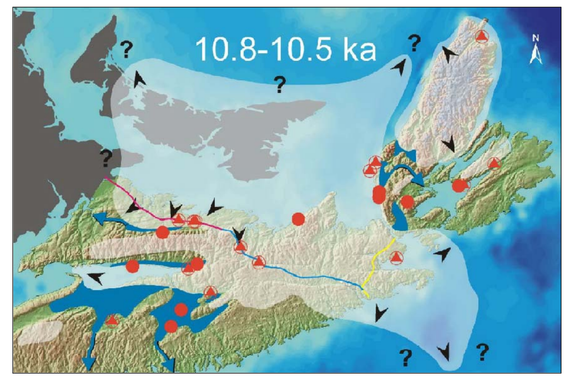

Fig 10. Paleogeography during the Collins Pond Phase (Younger Dryas Stadial).

Figure 10 illustrates the maximum glacier extent during the Younger Dryas Stadial (Collins Pond Phase) (10.8 -10 ka; 12.8-11.5 CAL), the last major ice advance during the Wisconsinan. Red dots are sites where glaciolacustrine and glaciofluvial sediments overlie peat from the previous warm Allerød Interstadial interval. Red triangles are sites where till overlies the Allerød paleosol. Black arrows denote flow directions.

Lowland areas with extensive glacial lakes are shown in dark blue, along with proposed spillways as arrows.

Economic Geology

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

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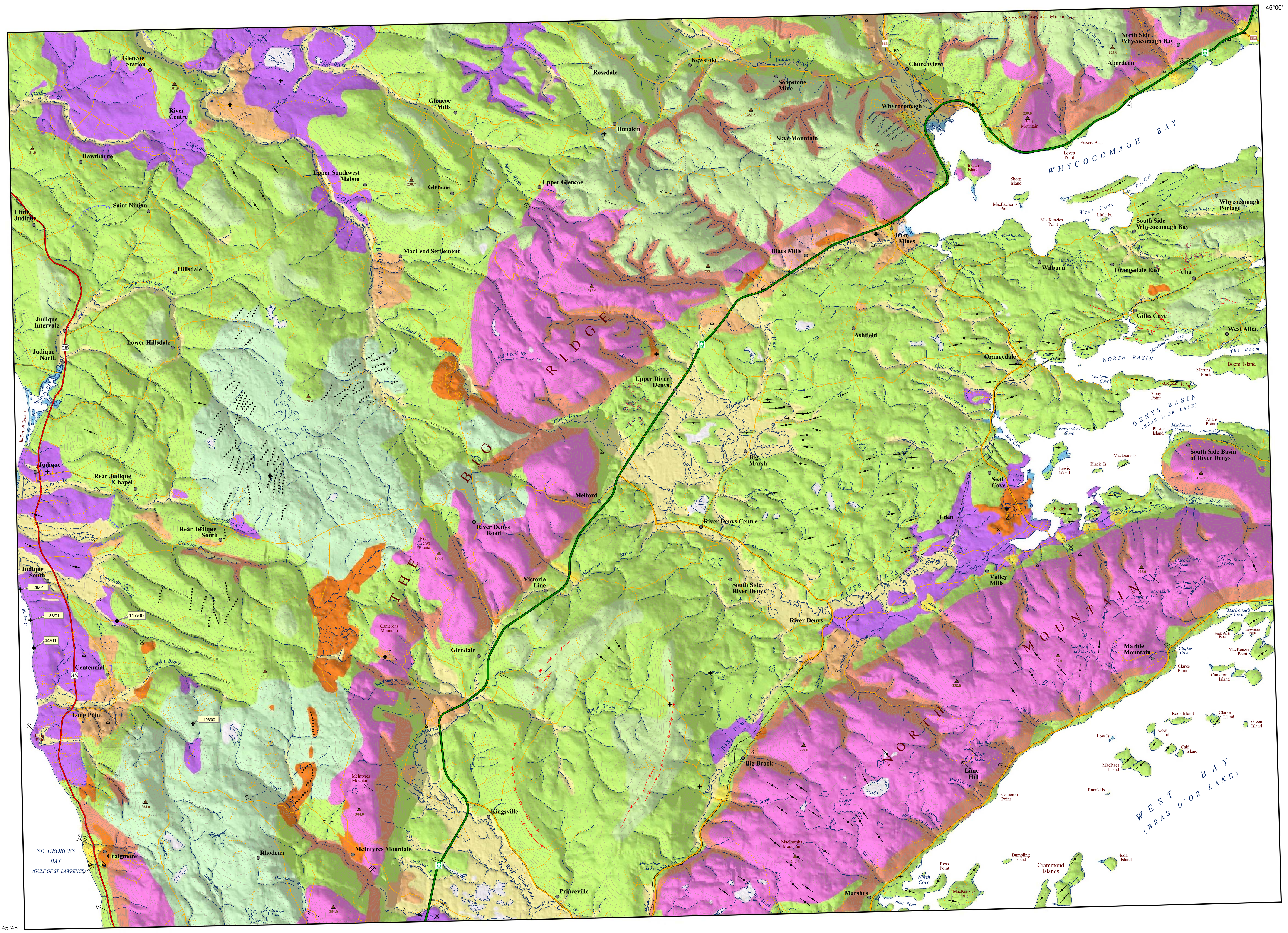

Nova Scotia Department of Natural Resources
Mineral Resources Branch
Open File Map ME 2003-1

Surficial Geology Map of the Whycocomagh Area (N.T.S. 11F/14) Inverness County, Nova Scotia

R. R. Stea and M. Feetham

1 0 1 2 3 Km

Scale 1 : 50 000
Contour Interval 10 Metres

Halifax, Nova Scotia
2003

NOVA SCOTIA
Natural Resources

Major sources of geological information

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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, Douma, M. and Stea, R. R. 2001: Testing of shallow seismic reflection technique, Cape Breton Island (NTS 11 F/10, 11 F/11, and 11F/14); In D. R. MacDonald (ed), Minerals and Energy Branch Report of Activities, 2000 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 life of product.

CANADA 1842 GEOLOGICAL SURVEY - COMMISSION GÉOLOGIQUE

Map Notes

Universal Transverse Mercator (UTM) Projection, Zone 20, Central Meridian 63º00' 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.

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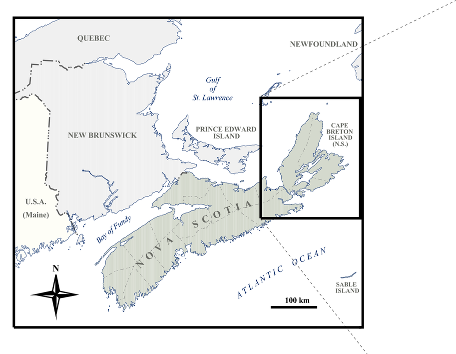
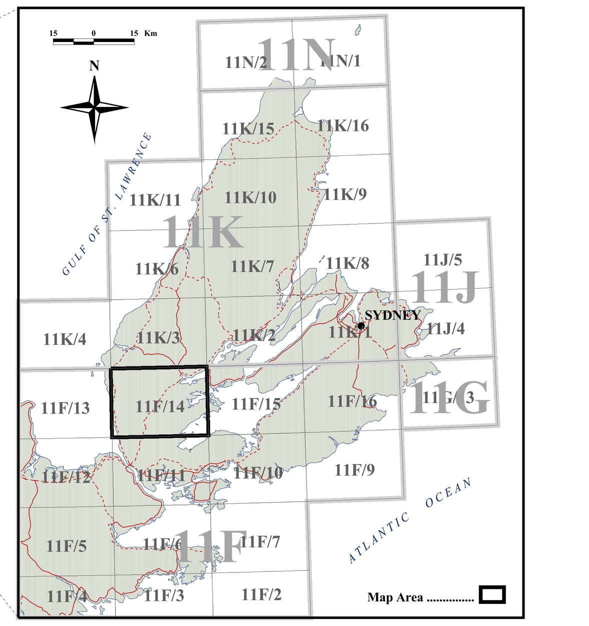
A digital version of this map information may be downloaded from the Nova Scotia Department of Natural Resources, Minerals and Energy Branch web site at: http://www.gov.ns.ca/natr/meb/

This map was produced as part of the joint federal-provincial Targeted Geoscience Initiative (South-central Cape Breton Island). Additional information can be found at: HTTP://www.gov.ns.ca/natr/meb/tgi

Regional Key Map





Settlement	
Spot Elevation (m)	
Trans-Canada 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)

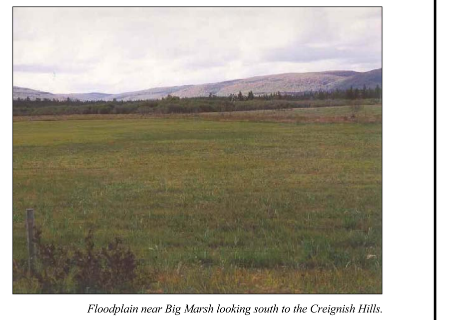
Marine deposits
Gravel, sand; forming barrier bars and spits; fine sand, silt, organic clay, peat in adjacent lagoons and salt marshes (2-10 m thick).

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 (2-15 m thick).

Paraglacial alluvial fan deposits
Boulders, gravel, gravelly-sand, sand; forming fan-shaped lobes at the mouth 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 rock formed by periods of mass wasting, downslope creep, along steep valley walls (1-10 m thick).



Floodplain near Big Marsh looking south to the Creignish Hills.

Coarse colluvium in a roadcut exposure near Victoria Line (Site 147/00).

Late Wisconsinan (23-10 ka)

Glaciolacustrine lake bottom deposits

Glaciolacustrine deposits: Glacial Lake Dawson (Phases 1 and 2 undifferentiated)
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). Extent of glacial lake deposits related to each lake phase uncertain. Details of late-glacial (14-10 ka) stratigraphy documented on side panel.

Massive fine clay from glaciolacustrine deposits near Glencoe (Site 55/00).

Outwash fans and valley trains

Outwash deposits
Gravelly sand, sand, silt and clay; cut and fill 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
Boulders, gravelly sand, sand, silt and clay; abrupt changes in grain size between facies; channels common in coarser facies; faulting and slumping of beds, diamicton facies commonly interfinger with deposits; forming hummocky terrain or individual conical hills (kames), and valley-side terraces (kame terraces, 4-30 m thick).

Gravelly-sand and gravel from valley train outwash near Iron Mines (Site 197/01).

Stony till plain and ribbed moraine

Creignish Hills Till
Grey-brown, clast, or matrix, supported, stony, sandy till; lithologies predominantly local igneous rocks; forming ground and ribbed moraine on the Creignish Hills (2-15 m thick).

Creignish HillsTill from Site 106/00.

Silty till plain and drumlins

Sugar Camp Till
Reddish-brown, matrix-supported, silty till; moderately compact, massive, polymictic with sedimentary and igneous rock types, shell fragments (Mercenaria sp.) and coal dispersed by northwestward flow; ground moraine and drumlins (3-10 m thick).
Reference section: Sugar Camp Quarry
(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 bedrock outcrops.

Sugar Camp Till near the Big Brook Quarry (Site 164/00). Note the diorite boulder within the till transported northward from MacIntosh's Mountain.

Early to Late Wisconsinan (75-23 ka)

Richmond Till
Grey-red brown, silty till (in section only); compact to very compact; massive; forms the core of many drumlin landforms (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: River Denys
(HTTP://www.gov.ns.ca/natr/meb/tgi/rd.htm)

Till veneer from Site 163/00.

Illinoian? (320-128 ka)

"Lower Till"
Grey silty till (in section only; 2-5 m thick);
Reference section: River Denys
(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, 40% bedrock exposure, discontinuous veneer of stony till (2-10 m thick).

Bedrock
Exposed bedrock; 40% of region, obscured by forests and bogs, rugged topography, bedrock generally weathered, moss covered, glacially scoured bedrock, knob and basin topography, discontinuous veneer of stony till.

Regolith of pyritic slate overlying slate bedrock at Upper Glencoe (Site 26/00).

SYMBOLS

- Drumlin, fluting, elongate hills and ridges parallel to ice flow; ice flow direction unknown
- Glacial striae, relative ages of striae, 1 being older, dot at location
- Morainal landforms, ridges perpendicular to ice flow; ribbed moraine
- Meltwater channel, spillway
- Terrace and scarp
- Bedrock strike ridge
- Sinkhole
- Location of field site with special significance (164/00)
- Rock quarry
- Sand and gravel pit

Meltwater channel (spillway) north of Glencoe Station.

Note: Many drumlin and striae measurements derived from Grant (1994).

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