NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY

MAP 87 - 1

GLACIAL GEOLOGY
OF

MOUNT UNIACKE

(N.T.S. SHEET 11D/13 WEST HALF)

NOVA SCOTIA

P.W. FINCK and R.M. GRAVES

SCALE 1:50 000

Miles 1 0 1 2 Miles

Kilometres 0 1 2 3 4 Kilometres

NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY

HONOURABLE KEN STREATCH
MINISTER

JOHN J. LAFFIN, P.ENG., FEIC
DEPUTY MINISTER

HALIFAX, NOVA SCOTIA
1987

LEGEND

SURFICIAL UNITS

Quaternary

Late Wisconsinan

Greywacke Till C: loose; olive grey (5YR5/1)[1]; sandy matrix; clasts are angular Meguma Group greywacke cobbles and boulders comprising greater than 75% of the till; hummocky morphologic expression.

Granite Till B: loose to moderately compact; moderate yellowish brown (10YR5/4) but may vary from greyish orange (10YR7/4) to dark yellowish brown (10YR4/2); matrix is 80% to 90% sand, 10% to 20% silt and clay; washed sandy zones around boulders and clay skins on pebbles are common; till is stony though the matrix to clast ratio is variable; clasts are dominated by a single granite type and commonly a minor second granite type; Meguma Group and foreign clast content is highly variable; granite clasts are angular to subangular; Meguma Group and foreign clasts vary from pebbles to boulder size, may be faceted and striated.

Greywacke Till B; loose; light blueish grey (5B7/1); matrix to clast ratio is highly variable; clasts are predominantly Meguma Group greywacke; may contain local granites in contact areas.

Slate Till B: loose; light olive brown (5Y5/6); sandy matrix; clasts are typically greater than 50% angular Meguma Group slate; may contain local granites in contact areas.

(Note: Granite Till B, Greywacke Till B and Slate Till B are lateral equivalents)

Lawrencetown Till: moderately compact, cohesive; moderate brown (5YR4/4 to 5YR3/4); matrix may be massive though fissility is common; facies gradation from brown, compact silt-sand till to reddish, moderately compact mud till; sandy till matrix is 50% sand, 35% silt, 15% clay; mud till matrix is 25% sand, 50% silt, 25% clay; matrix to clast ratio is high, clasts are often less than 5% of the till; greenish mottles are common in the weathering zone; pebbles are predominantly Meguma Group and foreign with varying amounts of local and far travelled granites; Meguma Group and foreign clasts range in size from pebbles to boulders and are usually faceted and striated.

Undivided Tills[2]: Contains Granite Till A, Lawrencetown Till and Granite Till B; due to limited areal extent individual tills do not form mappable units; in general dominated by Lawrencetown Till.

Pre-Quaternary

Bedrock: areas where B soil horizon is developed to bedrock; weathered, shattered bedrock is common; thin till may occur in bedrock hollows; striations may be seen on unweathered outcrop; bedrock structure is easily observed on air photographs.

[1]Colours after Goddard *et al.*, 1980.
[2]No stratigraphic order implied.

SYMBOLS

Striations: sense of ice flow (known, unknown, numbers represent relative ages, 1 being the oldest) 1 2

Contact between major surficial geological units (gradational) ....

Exposed and glacially scoured bedrock ....

Till veneer: discontinuous till cover, outcrop common ....

Geological boundary between Meguma Group rocks and South Mountain Batholith granitic rocks (defined, approximate) ....

Lineations: may or may not be structurally controlled, possible ice scour along structurally weakened zones ....

Drumlin, solid boundary defines flanks, bar defines orientation of major axis ....

Ablation till ....

Location of stratigraphic section and till fabric site (see Figure 3) .... ⑤

Till fabric rose diagram .... N

Location of polished outcrops (see Figures 1 and 2) .... **A, B**

Planimetric base produced by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF ENERGY, MINES AND RESOURCES. Updated from aerial photographs taken in 1977. Culture check 1977. Published in 1980.

MRMS Cartography by:
Maritime Resource Management Service Inc.
Amherst, Nova Scotia

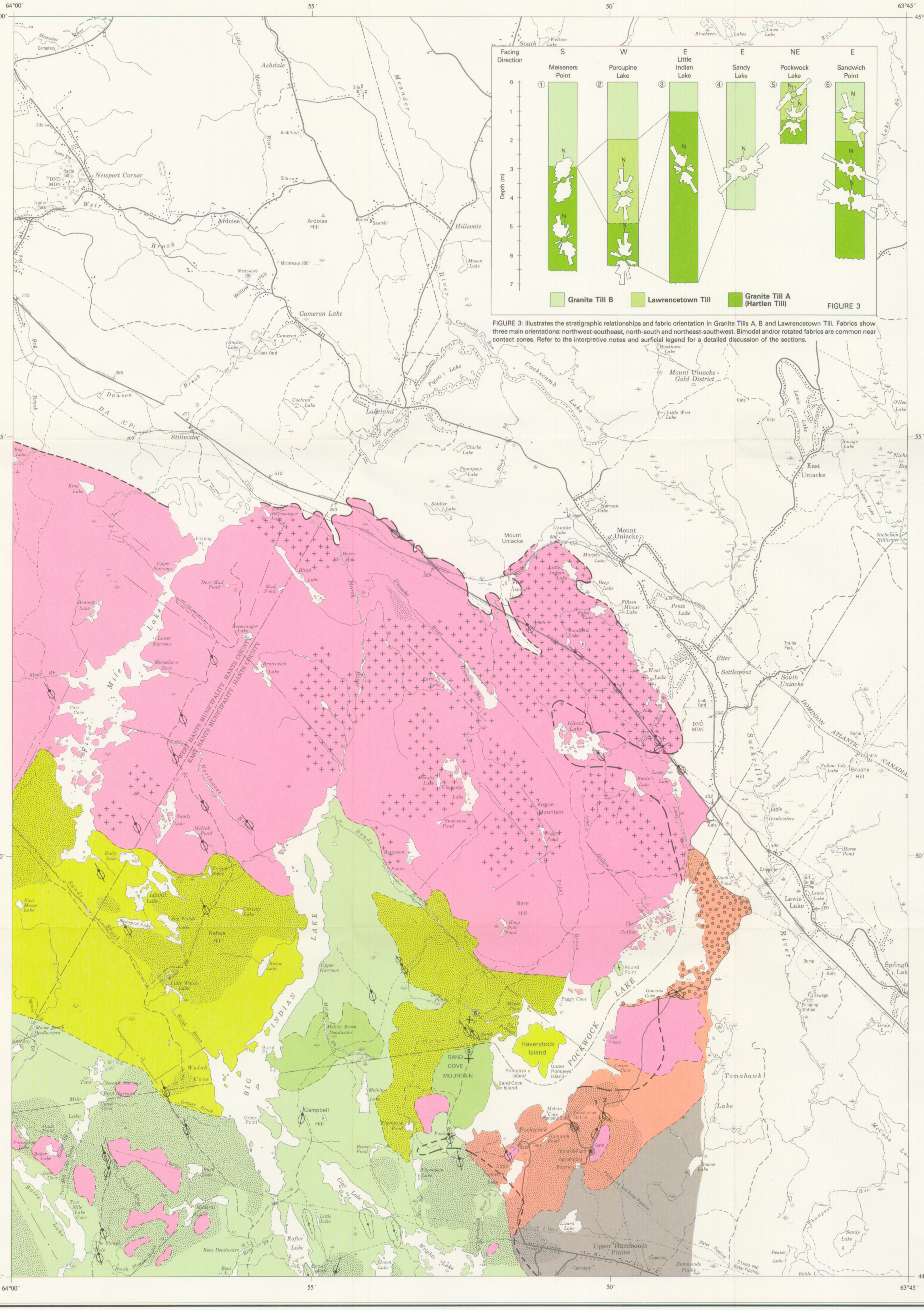
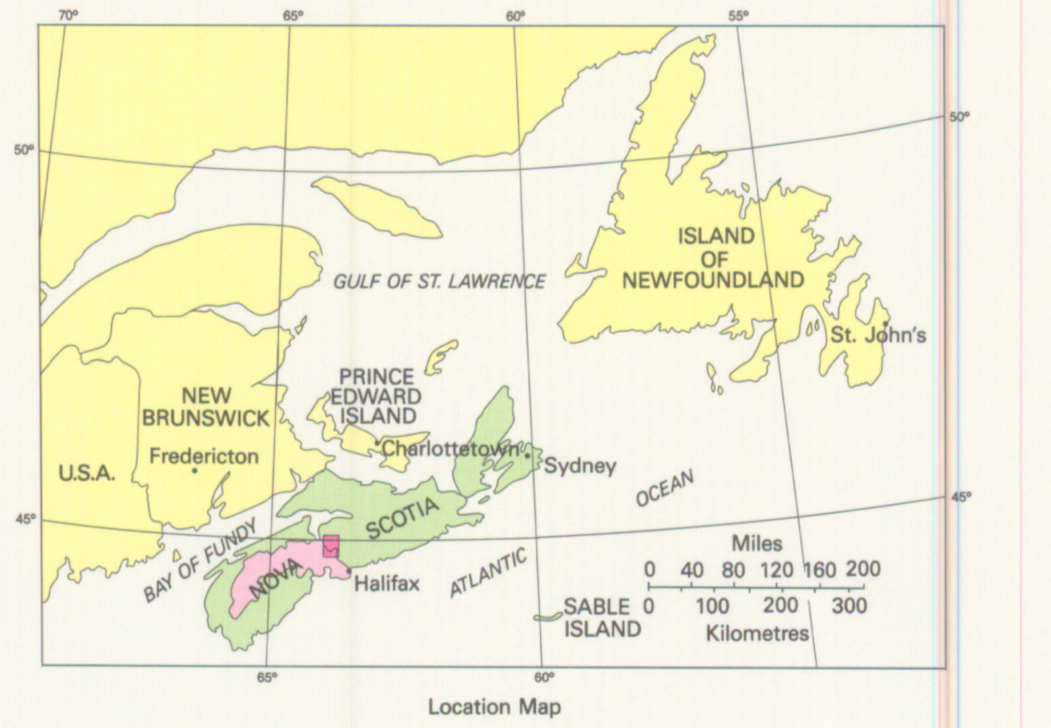
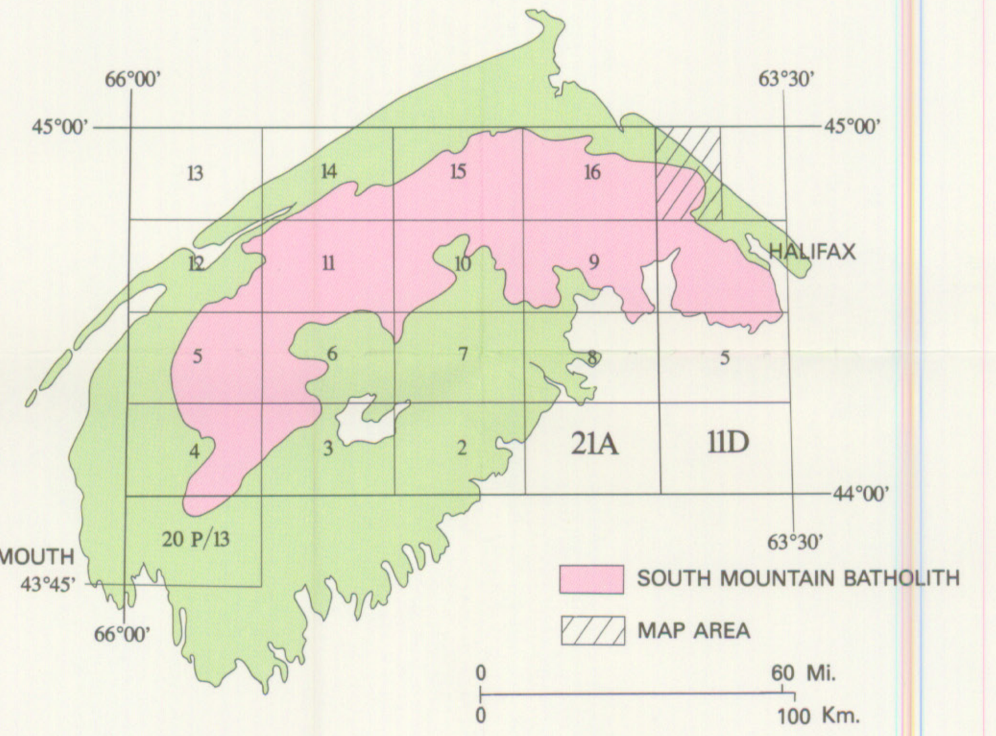


FIGURE 3: Illustrates the stratigraphic relationships and fabric orientation in Granite Tills A, B and Lawrencetown Till. Fabrics show three main orientations: northwest-southeast, north-south and northeast-southwest. Bimodal and/or rotated fabrics are common near contact zones. Refer to the interpretive notes and surficial legend for a detailed discussion of the sections.





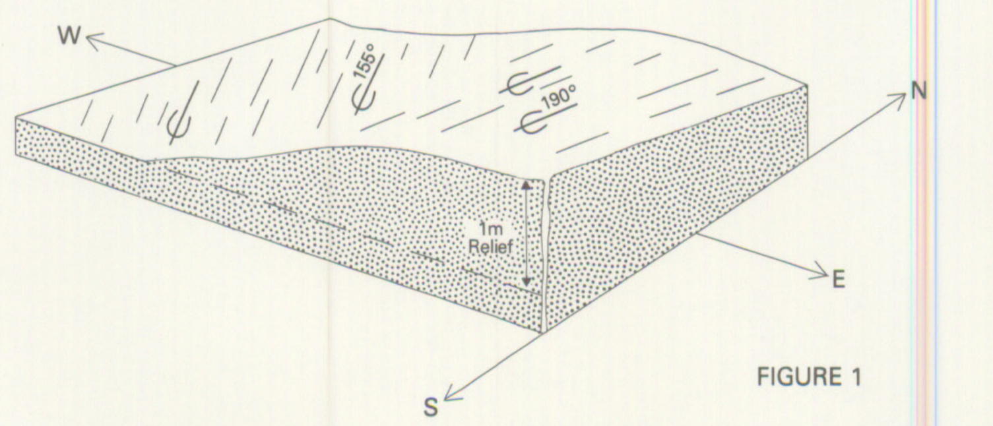


FIGURE 1: (Location A) Illustrates the relationship between 155° trending striations that correlate with Granite Till A and 190° trending striations that may correlate with Lawrencetown Till. The height and facing direction of an outcrop strongly influences the formation and preservation of striations (refer to Interpretive Notes). The 190° trending striations are younger than the 155° trending striations. Striation sets relating to different ice flow events are commonly preserved on different faces of the same outcrop without any apparent crosscutting relationships. Crosscutting relationships are commonly used as an indication of age differences but the absence of such relationships does not imply that all striations on an outcrop are related to the same erosional event. This polished outcrop is located at the base of a three metre section of Lawrencetown Till in a gravel pit southeast of Harrietsfield, on map sheet 11D/12.

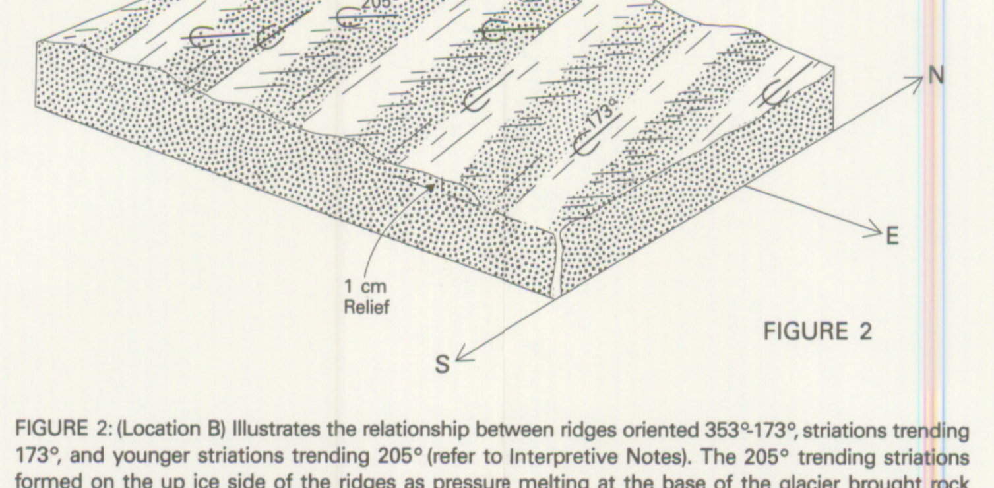


FIGURE 2: (Location B) Illustrates the relationship between ridges oriented 353°-173°, striations trending 173°, and younger striations trending 205° (refer to Interpretive Notes). The 205° trending striations formed on the up ice side of the ridges as pressure melting at the base of the glacier brought rock debris entrained in the ice in contact with outcrop. Striations relating to the 205° trending movement formed a skip zone in the grooves between the ridges where the pressure decreased and freezing occurred. Though no crosscutting relationships are seen, the direction and relative age of the 205° trending striation set is apparent. This polished outcrop is located east of Lewis Lake along Highway #103, on map sheet 11D/12.

SUMMARY OF PREVIOUS WORK

Two "major" glacial events have been recognized in previous studies of Nova Scotia glacial geology.

(1) A major southeast-trending ice movement that deposited till and strongly striated and sculptured the underlying bedrock. This movement has been termed ice flow phase 1 (Stea and Finck, 1984) and was responsible for deposition of the Hartlen Till (Stea and Fowler, 1979).

(2) A younger, generally southward ice flow deposited some of the exposed surface tills of northern and central mainland Nova Scotia and formed drumlin fields along the southern coastline. This flow has been called ice flow phase 2 (Stea and Finck, 1984) and deposited the Lawrencetown Till, first described by Grant (1963).

Detailed mapping by individual workers has resulted in the recognition of more recent and local ice movements. Grant (1976) noted west and southwest ice movement off the South Mountain Batholith. MacNeil and Purdy (1951) and Hickox (1962) noted a late ice movement flowing northward off the South Mountain Batholith. Stea and Finck (1984) extended this northward ice flow (flow phase 3), mapping its influence across the central Cobequid Highlands and the northern Carboniferous lowlands. They also recorded a west to southwest ice movement (flow phase 4) in the Hants-Colchester lowlands that postdates the northward ice flow.

INTERPRETIVE NOTES

Erosional Indicators Of Ice Flow

The three main ice flow phases recognized in the study area trend southeast, south and southwest.

The most widespread and common ice flow trends southeast from 134° to 165°. This flow traversed the entire study area and is correlative with flow phase 1 of Stea and Finck (1984). Striations relating to this event are best preserved on northwest-facing stossed outcrops.

A second group of striations (correlative with flow phase 2, Stea and Finck, 1984) trend from approximately 170° to 195° and are preserved on north-facing outcrops. Striations formed during this erosional event are mainly restricted to map sheet 11D/12 with isolated striated outcrops on map sheet 11D/13. These striations are best preserved along Highway #103 north of the Head of St. Margarets Bay and near Lewis Lake.

A third group of striations trend southwest from 200° to 250° and probably correlate with flow phase 4 (Stea and Finck, 1984). The striations were mapped on the north part of map sheet 11D/12 and on the south-central region of map sheet 11D/13. Southwest-trending striations are usually only preserved on the northeast sides of hills and outcrops.

Flow phase 3 (Stea and Finck, 1984), a northward ice flow stemming from the South Mountain Batholith, was not mapped in the study area. To the west the authors have mapped this advance at Windsor Forks and Black River. Stea (pers. comm.) suggests that a late Wisconsinan ice divide had its axis on the South Mountain Batholith upland. Ice divides are characterized by non-deposition and non-erosion (Hughes, 1981) which may explain the region of thin till and exposed bedrock southwest of Mount Uniacke (map sheet 11D/13). Deposition and erosion by north-flowing ice would only be observed north of the ice divide, which is outside the study area. Simultaneously, south of the ice divide the effects of south-flowing ice would be superimposed on previous deposits and erosional features, making discrimination of different flow events difficult.

Age Relationships

Southeast-trending striations are the oldest observed in the study area. This is illustrated on an outcrop east of Pockwock Lake (map sheet 11D/13) where striations trending 134° are cut by 189° striations. Further evidence of this age relationship can be seen on an outcrop near Harrietsfield (map sheet 11D/12). Striations trending 155° are well preserved on an outcrop at the base of a Lawrencetown Till section. On top of the same outcrop striations trending 186° to 190° are seen where the bedrock is overlain by thinner till (Fig. 1). Striations oriented 004°-184° were also observed on a metagreywacke boulder lodged in the overlying Lawrencetown Till. This suggests that the 186° to 190° striations were not formed by southeastward ice flow that deflected around or over the bedrock relief but represented a younger distinct ice flow event that formed or modified the overlying till.

At Bedford a northwest-facing outcrop is grooved and striated with directions varying from 135° to 155°. The striations are stained (manganese oxide?) along their length contrasting with the fresh appearance of the outcrop surface. At the top of the outcrop unstained striations trending 181° are preserved on the fresh stossed rock surface. The 181° set is inferred to be younger than the 135° to 155° set.

Along Highway #103 north of Lewis Lake striations and grooves on a flat outcrop are oriented 353°-173°. The top and northeast sides of the ridges, separating the grooves, are cut by striations trending 205° (Fig.2). This indicates that the 205° striation set is younger than the 353°-173° oriented set.

The sequence of ice movements mapped in the study area is from oldest to youngest: (1) southeastward (2) southward (3) southwestward.

Till Units

Mapping has revealed four major lithologically and texturally distinct till units overlying part of the eastern South Mountain Batholith. These tills are, from oldest to youngest: (1) Granite Till A (2) Lawrencetown Till (3) Granite Till B (4) Granite Till C. On Figure 3 six till sections illustrate the stratigraphic relationships among these till units.

Granite Till A

Granite Till A is compact, yellowish-brown to moderate brown and moderately stony with a sandy matrix. In drumlin sections it reaches thicknesses of 5-6 metres and is overlain by younger tills, whereas in areas of abundant rock outcrop it may occur as a thin till veneer (1m) in bedrock hollows. Based on regional stratigraphic evidence it is believed to be the oldest till exposed in the study area. Fabric mode in Granite Till A is oriented northwest-southeast at Little Indian Lake and Meiseners Point.

Granite Till A occurs at the base of thick drumlin sections at Porcupine Lake, Meiseners Point, Little Indian Lake, Hackets Cove, Sandwich Point and as an exposed surface till at Glen Haven. On map sheet 11D/13, in the area mapped as undivided till, it occurs sporadically.

Clasts in Granite Till A are dominated by underlying and up-ice granites. There are also significant amounts of Meguma Group and other allochthonous clasts. Stratigraphic, till fabric, and erosional evidence indicate this till was formed by southeast flowing ice. At Porcupine Lake Granite Till A contains 50% fine-medium grained two-mica monzogranite derived from the underlying Tantallon Intrusive Suite of MacDonald and Horne (1985). Biotite monzogranite comprises 25% of the clast content, the nearest up-ice source being the Sandy Lake Monzogranite mapped by MacDonald and Horne (1985) 4 km to the northwest.

Lawrencetown Till

Lawrencetown Till is cohesive and reddish-brown with a muddy matrix. In drumlin sections it may reach thicknesses of 4 metres. As a ground moraine it usually has a thickness of 1- 2 metres. It is younger than Granite Till A. At Sandwich Point Lawrencetown Till overlies a till that is tentatively identified as Granite Till A (Fig. 3). The sections at Porcupine Lake and Pockwock Lake (Fig. 3) are each composites of two separate till cuts; the contact between Lawrencetown Till and Granite Till A was not directly observed. A fabric in the Lawrencetown Till at Porcupine Lake strikes north-south. At Sandwich Point the fabric is oriented 345°-165°. The unit is only one metre thick and the fabric probably does not represent regional ice flow. A fabric measured in this unit at Simms Settlement (located west of the study area on map sheet 21A/09) had a strong north-south orientation. At Meiseners Point a north-south rotation of the northwest-southeast fabric in Granite Till A is evident. Though Lawrencetown Till is not present in this section, it is believed that overriding ice associated with the Lawrencetown movement reoriented the fabric in Granite Till A.

Lawrencetown Till occurs as drumlins and as a surface moraine on north-central and eastern map sheet 11D/12. Till in drumlins is muddy and contains fewer granitic clasts than the sandier ground moraine.

The Lawrencetown Till is characterized by its high non-granitic pebble content. This fraction varies from 40-100%, generally decreasing with distance transported southward across the batholith. South of Hammonds Plains minor amounts of diorite, diabase, rhyolite, sandstone and siltstone clasts in the till are interpreted as having bedrock sources in the Cobequid Highlands and Windsor Basin. This implies that the Lawrencetown Till was transported in a general southward direction.

Undivided Till

A large area from Five Mile Lake east to Pockwock Lake is mapped as Undivided Till. All four major till units, except the Meguma Group tills, occur in this area. The areal extent of any particular till is limited and does not form a mappable unit.

Granite Till B

Granite Till B is loose, yellowish-brown and stony with a sandy, generally structureless matrix. In drumlin sections it is usually less than 2 metres in thickness. As a ground moraine it may reach thicknesses of 3-6 metres. It is younger than the Lawrencetown Till. In thick till sections (Fig. 3) it overlies Granite Till A and Lawrencetown Till. The stratigraphic relationships agree with those established by Stea and Fowler (1979). Fabrics are usually difficult or impossible to measure due to the lack of elongated clasts. However a northeast-southwest fabric, which may correlate with flow phase 4 of Stea and Finck (1984), was measured in Granite Till B at Sandy Lake on map sheet 11D/12 (Stea, pers. comm.).

Granite Till B is the most widespread surface till in the study area. It occurs as a rolling ground moraine that infrequently forms drumlins. As a surface till it drapes older drumlin tills, however it was not part of the same drumlin forming event. Isolated deposits of Granite Till B have been identified within the large area of Lawrencetown Till extending from Harrietsfield to Hammonds Plains.

The clast geology of Granite Till B is generally dominated by local bedrock lithologies. Oligomictic till is common where the presence of older tills and variable bedrock geology does not influence the till clast content. At Sandwich Point Granite Till B is underlain by a greywacke diamict possibly derived from Lawrencetown Till. The erosion of this diamict by ice flow phases 3 or 4 may have incorporated Meguma Group clasts into Granite Till B. Regionally, the dominant granitic clast type will represent underlying bedrock geology. Southeast to southwest of bedrock contacts the transport distance of clasts is generally less than one kilometre. Dispersal distances are variable. While mapping it was noted locally as being a few hundred metres. Based on provenance the authors are unable to assign Granite Till B to a particular ice flow phase, but because it overlies the Lawrencetown Till with an erosive contact, it is believed to have been formed during ice flow phases 3 or 4.

Granite Till C

Granite Till C is loose, greyish-orange to yellowish-brown and often clast poor with a sandy washed matrix. This till varies in thickness, ranging from 1-6 metres. Granite Till C is interpreted as the youngest till unit in the study area. Fabrics were not measured in this unit due to its sandy nature and the lack of elongated clasts.

Granite Till C forms isolated ablation mounds interspersed with Granite Till B. An ablation boulder lag in the study area is believed to be correlative with Granite Till C. This unit is generally restricted to the western half of map sheet 11D/12. Bedded sand and sandy gravel, interlayered with stony granite till, is exposed in a pit on the north side of Highway #103 at Ingram River. The till thins up-slope and grades into a granite boulder ablation lag overlying Granite Till B. The terrain near Smelt Brook Lake, south of Highway #103, is hummocky. The hummocks are ablation till mounds. The largest area of Granite Till C occurs near Hubley Big Lake where an ablation boulder lag and isolated hummocks are interpreted as mantling Granite Till B. In this area the contact between Granite Till B and Granite Till C was not directly observed.

Ablation till may display a multimodal clast population. At Hubley Big Lake and Smelt Brook Lake local two mica monzogranite is diluted by significant amounts of up-ice granite, Meguma Group and other allochthonous clasts. Due to poor exposure and lack of samples the provenance of this unit is poorly understood. West of the study area at Millet Lake (map sheet 21A/09) ablation till has a south direction of transport. The authors correlate this ablation till with Granite Till C and infer a southward direction of transport for Granite Till C in the study area.

Summary

Granite Till A, the oldest till in the study area, exhibits properties characteristic of a lodgment till (Dreimanis, 1976) and is correlative with the Hartlen Till of Stea and Fowler (1979). Clasts in Granite Till A are dominated by underlying and local up-ice granites. It was transported generally southeast across the study area, correlating with ice flow phase 1 of Stea and Finck (1984).

The Lawrencetown Till (Grant, 1975), intermediate in age, is interpreted as a basal melt-out till (Nielson, 1976). It is characterized by its non-granitic pebble content that varies from 40-100%. It was transported in a southward direction in the study area and correlates with ice flow phase 2 of Stea and Finck (1984).

Granite Till B is tentatively interpreted as a basal melt-out till and is generally correlative with loose, sandy tills mapped by Grant (1963) and Stea and Fowler (1979). Clasts are derived from nearby bedrock sources with dispersal as limited as a few hundred metres. Although the direction of transport is problematical, the stratigraphic position implies its formation be attributed to ice flow phase 3 or 4.

Granite Till C is interpreted as an ablation till and is spatially associated with locally derived Granite Till B. Ablation mounds may exhibit a multimodal clast population. The direction of transport in this till unit is southward.

REFERENCES

Dreimanis, A.
1976: Tills; their origin and properties; *in* Glacial Till, an interdisciplinary study; The Royal Society of Canada Special Publication, No. 12, p. 11-49.

Goddard, E.N., Trask, P.D., De Ford, R.K., Rove, O.N., Singewald, J.T. Jr., and Overbeck, R.M.
1980: Geological Society of America Rock Color Chart Huyskes-Enschede, Netherlands, 10 p.

Grant, D.R.
1963: Pebble lithology of the tills of southeast Nova Scotia; M.Sc. thesis, Dalhousie University, Halifax, Nova Scotia; Nova Scotia Department of Mines and Energy, Thesis 129, 235 p.
1975: Glacial style and the Quaternary stratigraphic record in the Atlantic Provinces, Canada; *in* Report of Activities, Part B; Geological Survey of Canada, Paper 75-1B, p. 109-110.
1976: Reconnaissance of early and middle Wisconsinan deposits along the Yarmouth-Digby coast of Nova Scotia; *in* Report of Activities, Part B; Geological Survey of Canada, Paper 76-1B, p. 363-369.

Hickox, C.F., Jr.
1962: Late Pleistocene ice cap centered on Nova Scotia; Geological Society America Bulletin, v. 73, p. 505-510.

Hughes, T.J.
1981: Numerical reconstruction of paleo-ice sheets; *in* The Last Great Ice Sheets, eds. G.H. Denton and T.J. Hughes; John Wiley and Sons, New York, p. 221-261.

MacDonald, M.A. and Horne, R.J.
1985: The geology of the South Mountain Batholith, NTS sheets 11D/05 and 11D/12; *in* Mineral Resources Division, Report of Activities, 1985; Nova Scotia Department of Mines and Energy, Report 86-1, p. 119-135.

MacNeil, R.H. and Purdy, C.A.
1951: A local glacier in the Annapolis-Cornwallis Valley; (abstract); Proceedings of the Nova Scotian Institute of Science, v. 23, pt. 1, p. 111.

Nielsen, E.
1976: The composition and origin of Wisconsinan tills in mainland Nova Scoita; Ph.D. thesis, Dalhousie University, Halifax, Nova Scotia; Nova Scotia Department of Mines and Energy, Thesis 277, 256 p.

Stea, R.R. and Finck, P.W.
1984: Patterns of glacier movement in Cumberland, Colchester, Hants, and Pictou Counties, northern Nova Scotia, in Current Research, Part A; Geological Survey of Canada, Paper 84-1A, p. 477-484.

Stea, R.R. and Fowler, J.H.
1979: Minor and trace-element variations in Wisconsinan tills, Eastern Shore Region, Nova Scotia; Nova Scotia Department of Mines and Energy, Paper 79-4, 30 p.

ACKNOWLEDGEMENTS

The authors would like to thank R.R. Stea of the Nova Scotia Department of Mines and Energy for his critical guidance in the production of this map and for the innumerable discussions regarding Nova Scotia Pleistocene geology. Able field assistance was provided by E. MacDonald and S. Young. Editorial assistance was provided by D. MacDonald.

Nova Scotia Department of Mines and Energy

Energy, Mines and Resources Canada — Energie, Mines et Ressources Canada

Geological Survey of Canada
Commission géologique du Canada

Canada — Nova Scotia
Mineral Development Agreement