Current Research (1992) Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 92-1, pages 23-26

QUATERNARY GEOLOGICAL MAPPING, SOUTHWESTERN AVALON PENINSULA

N.R. Catto
Department of Geography
Memorial University of Newfoundland, St. John's, A1B 3X5

ABSTRACT

Mapping of the southwestern Avalon Peninsula, at 1:50 000 scale, has resulted in the identification and delineation of nine major types of geological units. Glacigenic deposits are the most common surficial materials. These diamictons form veneers and blankets over bedrock, and also compose hummocks, flutings, drumlinoid features, and Rögen moraines. The distribution and orientations of these glacigenic landforms indicate that glacial ice accumulated over the northern St. Mary's Bay area and flowed radially to the southwest, west, northwest, and northeast. Separate glaciers occupied the Isthmus of Avalon. The northwesternmost part of the Dildo map area was covered by ice originating from the northwestern side of Placentia Bay.

Exposed and veneered bedrock represent the second most commonly exposed surficial unit. In coastal areas, and in the southern parts of the peninsula, bedrock is the most common material on the surface. Organic deposits are also common throughout the southwestern Avalon Peninsula. Fibric, mesic, and humic sediments are associated with fens and bogs developed over bedrock and glacigenic sediments. Exploitation of peat is presently occurring in several areas. Colluvial, fluvial, marine, glaciofluvial, aeolian, and lacustrine sediments and landforms occupy lesser areas. Glaciofluvial deposits are currently being exploited for aggregate.

INTRODUCTION

Between 1989 and 1991, a series of investigations of the Quaternary geology of the southwestern Avalon Peninsula were undertaken, building on the pioneering work of Henderson (1972). The areas of Dildo (NTS 1N/12), St. Mary's (NTS 1K/13), St. Brides (NTS 1L/16), St. Shotts (NTS 1K/12), Argentia (NTS 1N/5), Placentia (NTS 1N/4), and Ship Cove (NTS 1M/1) have been mapped in detail (Figure 1). This work involved mapping from aerial photographs, followed by detailed stratigraphical and sedimentological field investigations and laboratory analyses of the sediment texture and mineralogical composition. The detailed surficial geology maps produced from this work are designed to be of practical use to industry, government, and the general public.

This paper is intended to accompany the maps, and discusses the composition, material properties, and genesis of the major types of Quaternary geological units identified throughout the seven map areas.

Intensive investigations of the Quaternary sedimentology and stratigraphic framework of the southwestern Avalon region have been actively ongoing since August 1989. Recent data obtained during the 1991 field and laboratory investigations, which resulted in the identification of the ice-flow directions and the extent of interaction between several ice masses centred over St. Mary's Bay, the Avalon Isthmus, and ice originating from glaciers centred in south-central Newfoundland, will be discussed extensively in a forthcoming publication by this author.

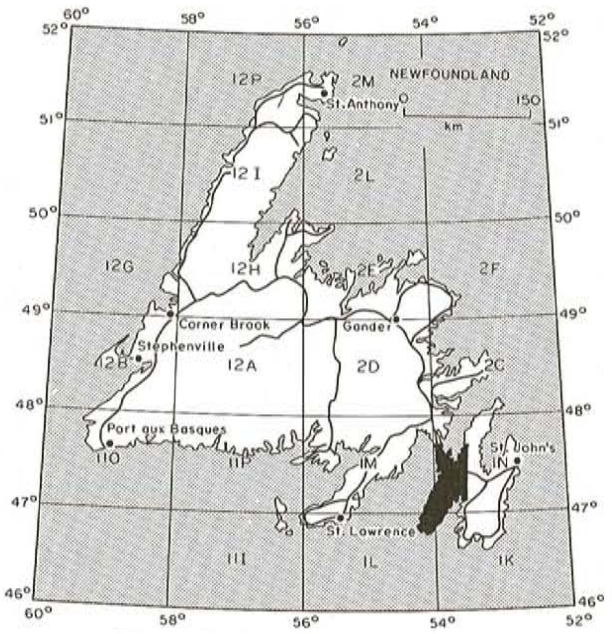

Figure 1. *Location of study area.*

DESCRIPTION AND ANALYSIS OF QUATERNARY GEOLOGICAL UNITS

The terminology and symbols used for designation of the map units uses the system developed for Quaternary geological mapping by the Newfoundland Department of

Mines and Energy. Map units are classified in terms of dominant genetic process and surface expression.

Throughout the southwestern Avalon Peninsula, examples of complex sedimentary successions were encountered along incised valleys adjacent to the coastline, or in areas where mass-movement activity and alluvial reworking was prevalent. In these areas, the symbols are unavoidably complex, and the areas represented by each map unit relatively small.

In locations where two or more sediment types are exposed within the boundaries of a single map unit, a composite unit symbol is used, with the dominant unit listed first. In areas where a unit is stratigraphically beneath a veneer or blanket of another, but influences the topographic expression or tonal qualities visible on aerial photographs, a compound symbol is used with the underlying unit symbol in the denominator.

The number of map units represented by distinct terrain classification symbols precludes discussion of each individual unit. The discussion, which follows, is therefore based upon the dominant genetic processes that each unit type represents. The unit types are discussed in order of diminishing prominence and areal extent.

1) Glacigenic Units (T)*

Sediments mapped and interpreted as glacigenic units are the most common surficial material in the region. These units are extensively exposed throughout. In coastal areas, glacigenic sediments commonly are veneered or blanketed by marine, fluvial, colluvial, or aeolian deposits.

Sediments mapped and interpreted as glacigenic are diamictons, containing significant quantities of sandy silt, sand, and larger clasts. These diamictons were formed by several genetic processes, including: 1) direct deposition from ice during glacial advance or recession (true glacigenic units or 'tills'); 2) deposition by sediment gravity flow beneath or on the surface of glacial ice; 3) deposition from the ice margin into marine waters by sediment gravity flow or other mass-movement processes; and 4) initial deposition by one of these three processes, followed by substantial modification in a marine environment.

These qualifications allow the glacigenic units to be treated for geological mapping in terms of their geomorphic expression and texture, without specifying the precise mode of genesis. Although diamicton units that have undergone any substantial modification after deposition from glacial ice cannot be classified as tills, and are technically not glacigenic deposits, the units throughout the southwestern Avalon region have broadly similar physical properties. Therefore, for practicality and ease of general discussion, all of the diamicton units which predate marine, fluvial, or aeolian deposition were mapped as glacigenic units, and will be treated collectively in this paper. Diamictons deposited by postglacial colluviation are treated separately, as colluvial deposits.

Depositional analysis of the diamicton sediments in the southwestern Avalon Peninsula is a complex process requiring intensive examination of numerous individual outcrops. Intensive sedimentological analyses are currently being undertaken.

Texturally, the diamictons vary in matrix composition from sandy silt to fine granules. The proportion of pebbles and larger clasts commonly varies between 35 and 65 percent. Throughout the region, the pebbles and cobbles are derived from locally outcropping Upper Proterozoic and Cambrian rock units.

The internal structures within the diamictons show a wide range of styles. Although most of the diamictons are generally texturally homogeneous, without distinctive lenses or stratification, some beds contain sand and silt lenses. The lenses are commonly thin (less than 10 cm thickness) and laterally discontinuous (less than 50 cm maximum dimension). The majority are internally structureless, although rare examples of structures indicative of flowing water (such as crudely defined cross-stratification and graded bedding) are rarely present.

At several exposures, the alignment of the large pebbles and cobbles was measured, in order to ascertain the direction of sediment transport and to assist in interpretation of the genesis of the diamictons. Results from these clast-fabric analyses were variable for the region's diamictons, with vector orientation strengths varying from weak (principal eigenvalue = 0.4) to well-oriented (principal eigenvalue = 0.8). These variations indicate that the sediments mapped here as 'glacigenic' or 'till' represent many styles and processes of deposition.

Veneers (symbol 'v') and blankets (symbol 'b') are the most common surface expressions involving morainic material, especially in interior areas. The topography of these sediments reflects that of the underlying bedrock. Slopes vary from gentle to moderate. Most of the deposits are dominated by coarse pebbles and cobbles, and have undergone some measure of post-depositional weathering.

Many morainic units throughout the region are marked by hummocky (symbol 'h') or eroded and dissected hummocky (symbol 'he') surfaces. The hummocks are generally poorly defined, and range from 2 to 10 m in height and from 5 to 30 m in width. Smaller hummocks are more common. Areas of hummocky topography are marked by gentle to moderately steep slopes.

Flutings, or oriented lineations of diamicton, are represented by the symbol 'l'. Flutings are present in several parts of the region, but are particularly prominent in the northern parts of the Argentia map area, and in the Dildo

* Symbols used in this paper refer to a forthcoming map publication by the author.

map area. The largest flutings have maximum heights of 8 m, widths exceeding 20 m, and lengths in excess of 300 m. Slopes are moderate to steep.

Areas of drumlinoid topography (symbol 'd') are also present in the southwestern Avalon, but are less prominent than the fluting areas. Drumlinoid features are relatively poorly developed, and many have bedrock cores. Maximum heights and widths reach 7 m and 15 m respectively. Slopes are moderate to steep. The orientations of the flutings and drumlins throughout the region indicate formation beneath a glacier that formed over the northern part of St. Mary's Bay and flowed toward the west, southwest and north. This pattern of flow conforms with those determined from the striation orientations, from clast-fabric studies, and from consideration of the lithology of the clast assemblages in the diamictons. Areas of ridged topography (symbol 'r') are also present throughout the region, but are particularly prominent in the eastern part, in the vicinity of Whitborne. The geomorphic form, marked by crescentic ridges oriented with the horns of the crescents generally aligned parallel to the local ice-flow direction, indicates that these features are subglacially formed Rögen moraines. The Rögen moraines have maximum heights of 12 m, and maximum lengths of 100 m. Slopes are moderate to steep.

The precise mechanism of formation of Rögen moraines is a matter of considerable controversy. Further research is currently being undertaken to attempt to resolve the problem of Rögen moraine origin, and to clarify the relationship between their orientation and striation and diamicton clast-fabric measurements.

2) Exposed and Veneered Bedrock ('R')

Exposed and veneered bedrock represent the second most common surface material in the southwestern Avalon Peninsula. The bedrock units throughout the region have been mapped previously by King (1988).

In many coastal areas, and in the southern parts of the region (St. Bride's and St. Shott's map areas), exposed bedrock dominates the surface. In these locations, the bedrock commonly is capped with a thin veneer of broken clasts derived from frost weathering (symbol 'Rw'). The presence of distally derived clasts within the frost-weathered mantles, however, indicates that the areas have been glaciated during the Quaternary.

3) Organic Units (O)

Organic units are defined as those composed largely of organic materials resulting from the accumulation of plant material, containing at least 30 percent organic material by weight (Expert Committee on Soil Survey, 1987). They are associated with fens and bogs developed above relatively impermeable bedrock and glacigenic materials. The surfaces of the units are generally level, forming veneers ('v') and blankets ('b').

The organic deposits are classified according to the system of the Expert Committee on Soil Survey (1987). Fibric deposits are the most common surface forms. The majority of the fens are dominated by *Picea mariana* (black spruce) and *Larix laricina* (tamarack), and often contain standing water. Peat deposits from these fens are dominated by weakly decomposed (1 to 3 on the Von Post scale, as used by the Expert Committee) spruce, tamarack, and sedge fragments. Peat deposits associated with these fens are thin (generally less than 2 m), and are not suitable for agricultural or heating purposes.

Mesic deposits, associated with active and formerly developed bogs, display an intermediate degree of decomposition (4 to 6 on the Von Post scale). These units are composed of decomposed arboreal fragments. Active exploitation of these deposits, along with scattered humic units (those with Von Post decomposition values of 7 or greater), is occurring at several locations in the southwestern Avalon Peninsula, notably in the St. Shotts area.

4) Colluvial Units (C)

Units mapped as colluvial are predominantly diamictons. Surface washing, and to a lesser extent sorting during colluviation, has resulted in a concentration of coarser clasts on the surfaces of many colluvial units. The colluvial units are thus generally coarser than the glacigenic diamictons.

The colluvial sediment is derived from a number of sources, but most deposits incorporate glacigenic material. Marine, fluvial, and previously colluviated sediment is also commonly involved in mass movements in the short, steep valleys that mark the Placentia Bay coastal zone. The geomorphic expression of these units is somewhat variable, but most are roughly undulating or hummocky blankets and veneers, having steep or moderately steep slopes. Eroded surfaces are common, and active colluviation occurs in many localities.

5) Fluvial Units (F)

Fluvial units are produced in the narrow, steep valleys of braided streams throughout the region. Geomorphically, the deposits commonly form veneers or blankets over glacigenic materials or bedrock. Fluvial plains (symbol 'p') are present in the bottoms of the largest valleys, in areas adjacent to the coast.

Texturally, the fluvial deposits vary from medium sand to grain-supported pebble and cobble gravel. Fine gravel units are the most common types present. Generally, the deposits are moderately to well sorted. All of the mappable fluvial units were formed postglacially.

6) Marine Units (M)

Marine units represent both deposits formed during higher sea-level stands (terraces, symbol 't'; and eroded terraces, symbol 'te'), and deposits currently forming at sea level (beach ridges, symbol 'r'). All of these deposits are dominated by coarse sand and gravel, and fine marine sediments are not present in successions associated with high sea-level episodes.

The chronology of marine events in the region is still unclear, and investigations are ongoing. Evidence collected suggest that sea levels were higher than present during the latest stages of deglaciation and during the early Holocene, 10,000 to 8,000 years BP. The highest marine deposits and terraces indicate sea levels approximately 15 to 20 m above present. Subsequently, sea level dropped below the present surface. Currently, sea level is slowly rising around the southwestern Avalon, as indicated by submerged terrestrial peat deposits at several localities.

7) Glaciofluvial Units (G)

Glaciofluvial landforms include ridged esker deposits (symbol 'r'), esker and fan-delta blankets and aprons overlying glacigenic materials and bedrock (symbols 'b' and 'a'), and eroded gravel and sand units (symbol 'e'). These deposits, composed of sand and gravel, represent the main sources of aggregate in the region. The largest glaciofluvial deposit, the esker fan delta at Point Verde, is currently being exploited for aggregate, and other deposits between Placentia and Colinet have been exploited in previous years.

The glaciofluvial deposits represent sedimentation by streams associated with glaciers in subglacial, supraglacial, and ice-marginal environments. Analysis of the environments of sedimentation of these deposits is currently in progress.

8) Aeolian Units (E)

Aeolian units are uncommon in the southwestern Avalon Peninsula. Dunal deposits are largely confined to Lance Cove. The dunes are small, poorly developed domal features, formed by onshore winds. Sediments associated with the dunes are well- to moderately-sorted sand, generally in structureless beds. Extensive modification by lesser velocity winds has resulted in the development of blowouts over the dune surfaces. Aeolian erosion continues today in unvegetated or cleared areas.

Thin veneers of aeolian silt and silty sand loess occur as caps over marine, glacigenic, and glaciofluvial sediments. These cliff-top loess deposits are thickest at the cliff edges, decreasing exponentially in thickness with distance from the escarpment. Generally, they occur only within 30 m of cliff edges.

9) Lacustrine (L)

Units mapped as lacustrine were deposited in shallow lakes that do not owe their existence to blockage of the regional drainage by glaciation. The lacustrine units, composed of silt and silty clay, are of very limited areal extent. The surface expression commonly is a small, featureless plain, bordering an existing pond.

SUMMARY

Mapping of the southwestern Avalon Peninsula at 1:50 000 scale has resulted in the identification and delineation of nine major types of geological units. Glacigenic deposits are the most common surficial materials. These diamictons form veneers and blankets over bedrock, and also compose hummocks, flutings, drumlinoid features, and Rögen moraines. The distribution and orientations of these glacigenic landforms indicate that glacial ice accumulated over the northern St. Mary's Bay area and flowed radially to the southwest, west, northwest, and northeast. Separate glaciers occupied the Isthmus of Avalon. The northwesternmost part of the Dildo map area was covered by ice originating from the northwestern side of Placentia Bay.

Exposed and veneered bedrock represents the second most commonly exposed surficial unit. In coastal areas, and in the southern parts of the peninsula, bedrock is the most common material on the surface.

Organic deposits are also common throughout the southwestern Avalon Peninsula. Fibric, mesic, and humic sediments are associated with fens and bogs developed over bedrock and glacigenic sediments. Exploitation of peat is presently occurring in several areas. Colluvial, fluvial, marine, glaciofluvial, aeolian, and lacustrine sediments and landforms occupy lesser areas. Glaciofluvial deposits are currently being exploited for aggregate.

Ongoing research in the southwestern Avalon involves assessment of ice-flow directions and relative chronology, analysis of the environments of formation of glacigenic sediments, investigation of the history of sea-level changes, and aspects of formation and development of marine, glaciofluvial, and aeolian deposits.

ACKNOWLEDGMENTS

This research was supported by the Natural Sciences and Engineering Research Council of Canada. I am indebted to Dr. Dave Liverman, Martin Batterson, and all my colleagues of the Newfoundland Department of Mines and Energy, for extensive consultations during all stages of the research. Capable field assistance was supplied by G. Thistle.

REFERENCES

Expert Committee on Soil Survey
1987: The Canadian System of Soil Classification. Agriculture Canada, Publication 1646, 2nd edition, Ottawa, 164 pages.

Henderson, E.P.
1972: Surficial geology of Avalon Peninsula, Newfoundland. Geological Survey of Canada, Memoir 368, 121 pages.

King, A. F.
1988: Geology of the Avalon Peninsula, Newfoundland. Geological Survey Branch, Newfoundland Department of Mines and Energy, Map 88-1.