SURFICIAL AND GLACIAL GEOLOGY OF THE WATERFORD RIVER BASIN, ST. JOHN'S, NEWFOUNDLAND: A SUMMARY

by

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Introduction

This project represented the first tentative steps during summer 1982, by the Provincial Departments of Mines and Energy, and Environment, toward the use of detailed surficial geology as an aid to hydrologic studies. The Waterford River Basin Urban Hydrology Study is a joint Federal/Provincial Environment Departments project designed to trace the effects of rapid urban expansion on stream water quantity and quality.

The Waterford River Basin covers an area of 60.75 km^2, and is situated immediately west-southwest of St. John's Harbour. Although more than 60% of the basin remains under a natural cover, this is being actively diminished by the expansion of the city of St. John's and the town of Mount Pearl. The overburden mantle often provides a filter for precipitation, and also introduces a lag between percolation of water into the mantle and the entry of this water into the stream system. Removal of such a mantle often produces "flashy" streams with the consequent increased frequency of flooding, as well as alteration of stream morphology and geochemistry. For such reasons a surficial mapping program was initiated, the results to be correlated with data collected on water flow rates, geochemistry and ground water levels as part of the Hydrology Study.

For detailed hydrological considerations the reader is referred to Batterson (1982). This report represents a summary of the surficial geology aspects of the project, and offers some suggestions of the possible effects on stream hydrology of altering the surficial mantle within the Waterford River Basin.

Bedrock Geology

Three lithological groups of Precambrian age are represented in the field area (Hsu, 1976). Green-gray, red, thin to medium bedded siltstone and shale of the Conception Group occur in the west and north, while interbedded gray to black sandstone, siltstone and shale of the St. John's Group dominate the eastern and central areas of the basin. The higher elevations of the South Side Hills are comprised of relatively resistant red and green-gray sandstones of the Signal Hill Group.

Previous Research

Detailed research into the glacial geology of the St. John's Peninsula is scant and therefore only a generalized statement may be made. It has been suggested that only the northern part of the peninsula was affected by ice radiating from the main ice dome over the head of St. Mary's Bay (Vanderveer, 1975). The remainder was influenced by thin, local ice which spread east and west from a minor ice cap straddling the spine of the peninsula. Ice direction was consequently topographically controlled rather than imposed by pressure gradients within the main ice mass. The major effects of glaciation in this area were the deposition of till and the modification of drainage, rather than any significant erosional activity. The till had the effect of smoothing the surface relief by the infilling of depressions, and till thicknesses are characteristically variable. Due to the thin nature of the ice, deglaciation was probably rapid, a view confirmed by a date of 9270 + 150 years from Sugar Loaf Pond northeast of St. John's (MacPherson, 1982), the oldest date for vegetation regeneration from the Avalon Peninsula.

WATERFORD RIVER BASIN *M.J. Batterson*

Methods

Mapping was completed at 1:12,500 scale and followed standard investigative procedures. Detailed profile examination and overburden thickness calculation were carried out across the basin, and included 195 site descriptions and 68 samples. Due to the lack of sections down to bedrock across much of the basin interior, overburden depth data was obtained using a Huntec FS-3 portable hammer seismograph.

Samples from each stratigraphic unit identified were sieved and pipetted (<63 μm fraction), and results were plotted as grain size distribution curves using a Hewlett-Packard desk top computer. Pebble analyses were conducted on the 16 mm retained fraction of field samples.

Results

a) Overburden Thickness

The overburden topography is extremely variable in the Waterford River Basin, ranging from 0-5 m. Numerous rock outcrops occur across the basin but nonetheless an overburden thickness map was prepared, which attempted to illustrate trends rather than to provide specific on-site values (Fig. 1). The map shows that areas of zero overburden are confined to the summits of Kenmount Hill and the South Side Hills, and to the lower reaches of the Waterford River and its major tributary, South Brook. Areas of thicker till (3-5 m) are located in the central and central-southern parts of the basin, with an anomalous area to the northeast of Kenmount Hill, which probably represents a lee-side till element. The remainder of the basin, essentially the moderately sloping areas surrounding basin highs, is characterised by overburden depths of 0-3 m.

b) Overburden Texture

Three till units, beneath the soil horizons, can be identified across the Waterford River Basin, although rarely do they occur in a single stratigraphic section.

Directly overlying the bedrock in all cases, the most ubiquitous deposit can be described as an overconsolidated, slightly fissile, light gray, very poorly sorted lodgement till. The till matrix is poorly developed and exhibits a bimodal grain-size distribution. The unit is dominantly clastic with an average silt-clay content by weight of 10%. Clasts are all of local provenance, and represent transportation distances of less than 2 km.

In the western half of the basin and on the South Side Hills, a pale olive to light yellowish brown, poorly sorted, clast-supported till is present. Any matrix is coarse to medium sand in texture, with very little associated silt and clay (average 3.7% silt plus clay), the silt often concentrated in thin lenses. The deposit is a supraglacial facies formed by a melt-out process.

Over the part of the basin where a supraglacial till is not evident, a compacted, light gray to white, poorly sorted till is exposed, overlying the lodgement till unit. The deposit has a higher (18.1%) silt-clay content than does the underlying till, and a grain-size distribution which is bimodal to polymodal in nature. These characteristics, plus a lack of fabric or structure, and the presence of striated clasts and an often thick (>0.5 mm) silt-clay coating around clasts, lead to the conclusion that this deposit is a subglacial melt-out unit.

c) Ice-Flow Indicators

Features recording the direction of glacial events are relatively rare across the basin. In the west and north of the basin, striae record an ice-flow direction consistent with valley orientation, while to the east poorly developed lineations trend in a northerly to northeasterly direction.

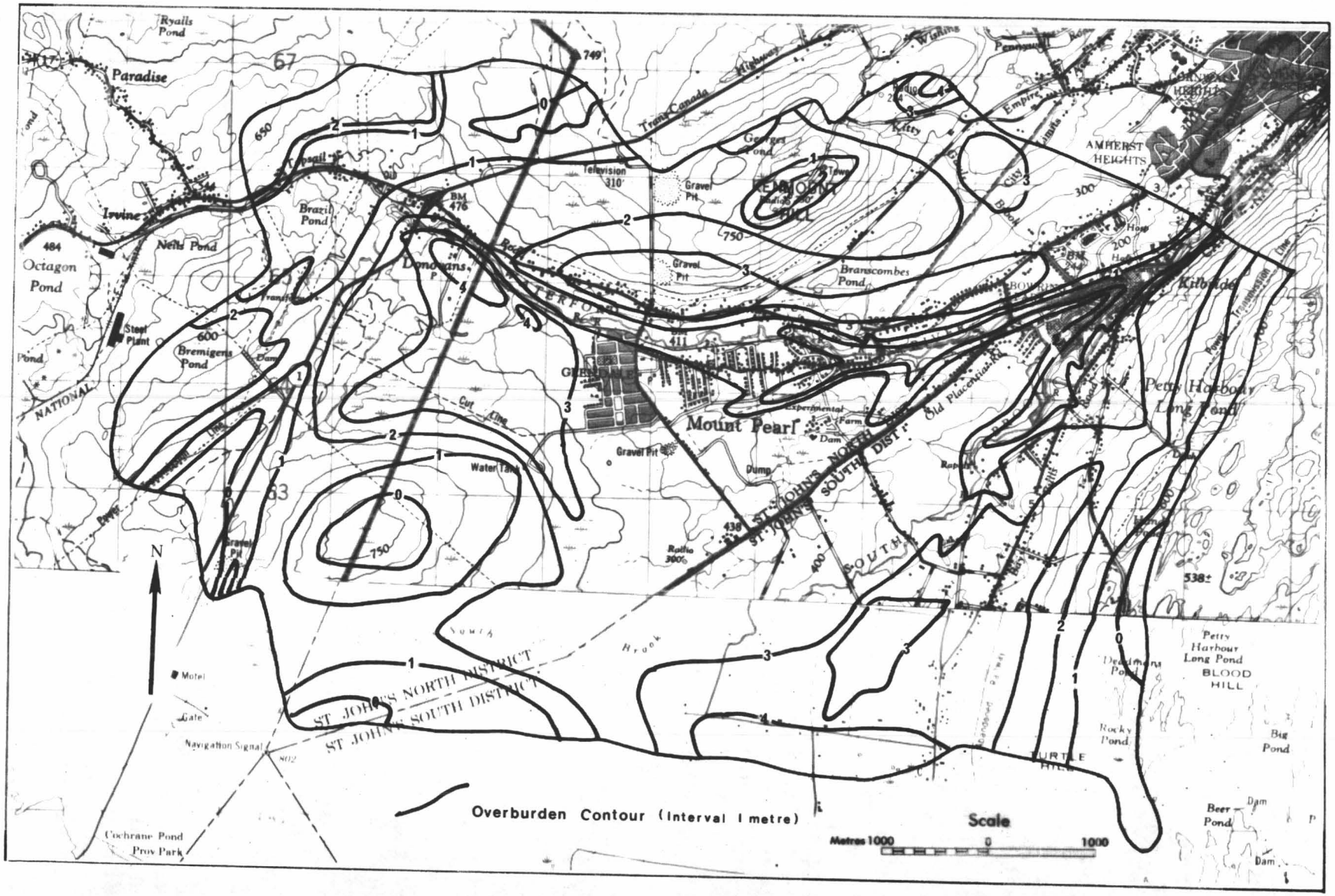

Fig 1. Summary of Overburden Thicknesses in the Waterford River Basin.

Summary of Glacial Events

The contrast in till units across the Waterford River Basin provides an insight into the glacial activity of the area. It is likely that a more active ice-flow occurred over the low-lying areas west of the South Side Hills, which deposited thicker tills and provided lineation of the till surface. This ice originated to the south or southwest of the basin. Similar lineations are not recorded in the west, although thick tills are evident there. Furthermore, the development of terraces along the South Side Hills and Kenmount Hill may be evidence of ice downwasting in this area. Meltwater was concentrated between the ice and the South Side Hills during deglaciation, forming a series of terraces. Similarly, the abundant meltwaters may explain the lack of supraglacial deposits in the area. To the west meltwaters were less abundant, possibly because of the shadowing effect from surrounding hills, and a supraglacial mantle was emplaced upon the underlying units. Ice in the west was probably stagnant while that in the east was still active.

In general, the evidence within the Waterford River Basin conforms with the accepted ideas of the glacial history of this part of the Avalon Peninsula - a thin ice cover, the flow lines of which followed the pre-existing topography in a roughly southwest to northeast direction. Tills are short-distance-transported and poorly developed, and are variable in thickness. However, it has also been noted that a more active flow in the east produced lineation of the till surface followed by meltwater concentration along the South Side Hills, while to the west more stagnant ice conditions prevailed and the deposition of a full suite of glacial deposits occurred. That active ice flow in the east and more stagnant conditions in the west were contemporaneous cannot be stated with certainty.

Hydrological Conclusions

Since this report is designed as an aid to the Waterford River Basin Urban Hydrology Study, it seems appropriate that some conclusions of a hydrological nature drawn from this project should be presented at this time. Two major conclusions may be suggested:

1) Till unit variations across the basin produce hydrological differentation, especially between the highly compacted lodgement till which is enriched in fines compared to the overlying less compacted, coarser supraglacial unit. Percolation into and through the upper layer would be relatively unimpeded compared to the lower lodgement till where pore spaces are small due to the higher silt-clay content and overconsolidation. Similarly, discharge from the lodgement till is also slow, but probably continuous even through long periods of drought. This till contains no fractures through which rapid discharge may be facilitated. During periods of precipitation the upper supraglacial unit is rapidly saturated, developing a perched water table and often producing surface ponding of water. In the remainder of the area where the supraglacial unit is absent, ponding of water will also occur in topographic lows underlain by the subglacial till. Similarly, due to the thinness of the overburden in all cases, bedrock control over water movement is critical. The hydrological response of the drainage basin to precipitation event is therefore rapid.

2) Urban development now and with further expansion will affect the movement of water through the basin. Initial removal of vegetation speeds the surface transmission of water into the drainage system, while urban construction either affects or

removes the critical supraglacial layer, thereby reducing the overall storage ability of the groundwater environment. The effects are to increase runoff and flooding potential, factors which are compounded in the lower Waterford River Basin due to the narrow, incised nature of the basin at this point. Increased flooding is more likely to occur in this and other areas across the basin in the future.

This rapid discharge of water into the stream system following precipitation events will have the combined effect of increasing incision of the stream channel into the overburden mantle and also increasing sediment content. Similarly, the geochemistry of the stream will change since the filtering effect of the till is removed.

In general the thinness of the overburden and the compaction of the subglacial unit are the major influences affecting groundwater movement throughout the Waterford River Basin.

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