LATE WISCONSINAN ICE ON THE SCOTIAN SHELF

by

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ABSTRACT

Reinterpretation of the uppermost glaciomarine stratigraphy of Northeast Emerald Basin indicates the presence of a short-lived Late Wisconsinan terrestrial ice cap (approximately 10.0 to 10.5 ka), that may have covered much of the emerged bank areas of the Scotian Shelf that were apparently already undergoing a marine transgression. As the ice receded, the glacial erosional surface on the banks was transgressed by a rising sea level, and the newly deposited glacial debris was reworked, contributing further to the development of the Sable Island Sand and Gravel formation.

INTRODUCTION

The Labrador Sector, including the local Appalachian ice caps of the Laurentide Ice Sheet, was the last glacier complex which affected northeast North America, following the Sangamon interglacial. The ice terminus and history of the glacial advances and retreats are not well understood, and a knowledge of offshore stratigraphy can contribute significantly to a better solution to these problems. Of greatest immediate potential are the basinal areas of the Scotian Shelf, which contain a lithofacies association of glacial and glaciomarine deposits representing events during retreat of the Wisconsinan ice (King and Fader, 1986). A till stratigraphy, based on a study of till tongue deposits, helps depict the ice margin history in spatial and relative temporal terms, while the contemporary, fossiliferous, ice-proximal glaciomarine deposits (Emerald Silt, facies A) fulfill the requirements for dating purposes. The advent of the AMS ^{14}C dating technique (not available to King and Fader, 1986, at the time of compilation) is helping to provide a more precise chronology for this facies, as well as for the overlying ice-distal facies (Emerald Silt, facies B).

The purpose of this open file communication is to provide: (1) a brief discussion of our present understanding of previously published (King and Fader, 1986) Middle and Late Wisconsinan dates from the Scotian Shelf; and (2) a revised interpretation for a late glacial advance in NE Emerald Basin, and its relationship to the age and significance of a widespread unconformity previously dated (King and Fader, 1986) at approximately 30.0 ka.

The location of the present study area is shown in Figure 1, together with bathymetry, position of samples, and seismic control. A map, showing the distribution of surficial geological formations for the area is found in King (1970).

CHRONOLOGY

The Middle Wisconsinan chronology of King and Fader (1986) for NE Emerald Basin, which was based on ^{14}C determinations on total organic carbon, has been questioned by several workers (Piper et al, 1988; Gipp and Piper, in prep; Oldale, in prep; Dredge and Thorleifson, 1987; and Andrews, 1987). We have recently obtained ten AMS shell dates from NE Emerald Basin, chosen at horizons at or close to previously dated (total organic carbon) samples. These dates are shown in Table I, and include material from LaHave Clay, Emerald Silt facies B, and the upper section of Emerald Silt, facies A. King and Fader (1986) previously suggested a retreat of the ice on the central Scotian Shelf by about

32.0 ka, except for one short advance at approximately 30.0 ka associated with a widespread unconformity. The new results from NE Emerald Basin demonstrate that the total organic carbon dates are in error, and that at least the upper portion of the glacial section is Late Wisconsinan in age.

TABLE I - ^{14}C AMS Shell Dates for Glaciomarine and Marine Sediment from NE Emerald Basin

Core # and Depth Below Seabed (cm)	Formation	Age (B.P.)
79-011-1P (27)	LaHave Clay	6130 ± 150
79-011-1P (338)	LaHave Clay	7740 ± 170
79-011-1P (557)	LaHave Clay	9450 ± 100
79-011-1P (701)	Emerald Silt, facies B (upper)	10580 ± 110
79-011-1P (815)	Emerald Silt, facies B	18260 ± 350
82-003-4s (210)	Emerald Silt, facies B	13550 ± 150
82-003-6s (285)	Emerald Silt, facies B	14250 ± 130
79-011-10 (552)	Emerald Silt, facies A (upper)	14600 ± 150
79-011-10 (386)	Emerald Silt, facies A (upper)	14680 ± 120
79-011-11 (495)	Emerald Silt, facies A (upper)	14850 ± 170

Our new data help to confirm the recent results of Gipp and Piper (in prep.) and Piper et al (1988) who have obtained AMS ^{14}C dates on mollusc shells from long cores which penetrated the entire sediment sequence above glacial till in SW Emerald Basin. Their dates show a constant increase in age with depth in the seismic stratigraphy, suggesting that the shells are not reworked. An age of 17.5 to 18.0 ka is estimated for the top of the till, based on an extrapolation of a constant sedimentation rate below the deepest date of 17380 $\pm$ 300 a B.P. The shallowest till tongue, at a basin margin, has an interpolated age of 15.0 ka, indicating that the ice did not retreat permanently from the central continental shelf before about 15.0 ka. These data clearly indicate the presence of Late Wisconsinan ice in SW Emerald Basin. It is also important to note that Bonifay and Piper (in press) interpreted late glacial (11.5 to 12.0 ka) deposits on the slope off St. Pierre Bank, which they suggest may correspond to the late readvance recognized by Brookes (1977) in southwestern Newfoundland, and to a climatic deterioration across Atlantic Canada at about 11.0 ka (Mott et al, 1986).

A later communication will analyze the new dates in greater detail and consider their implications to the chronology and Quaternary history of the Scotian Shelf.

REGIONAL UNCONFORMITY

Seismic Stratigraphic Position of Unconformity

Our earlier interpretation of the unconformity (King and Fader, 1986) indicated its occurrence near the top of Emerald Silt, facies A where it shows a clear angular relationship to the draping beds of this facies (Profile D, Fig. 2). In many areas, Emerald Silt, facies B section which normally overlies facies A has been completely removed, and we did not recognize the full significance of the missing section. In a more recent examination of the high resolution seismic profiles, we have followed the unconformity to a stratigraphic position near the top of Emerald Silt, facies B. On Profile A (Fig. 3) it shows as a weak seismic event with only slight angular discordance, and in some areas the same horizon shows no discordance. Seismic control in the basin is too sparse to map the effects of erosion, but in general, appears to have been quite variable. Along the eastern flank of the basin (Profile B, Fig. 4) Emerald Silt, facies B is approximately 5 m thick at the site of core 79-011-1P, and the thickness removed by erosion appears to have been minimal. In this area, facies B overlies a thick section of facies A which is interbedded with several till tongues. Seismic profile C of Figure 5 crosses Profile B of Figure 4, and is normal to the edge of the bank. Erosion increases progressively to the east in the areas of shallower depth cutting deeply into the till tongue succession underlying the bank. The interpreted Late Wisconsinan sea level position of Milliman and Emery (1968) occurs between 110 and 120 m water depth on profile C, figure 5. Within and above this level, the unconformity occurs close to the seabed, and is overlain by a veneer of Sable Island Sand and Gravel. LaHave Clay wedges out below the interpreted marine terrace. Figure 6, Profile E south of Middle Bank, shows the unconformity cutting a thick section of Emerald Silt, facies A, and is overlain by LaHave Clay. The unconformity occurs close to the seabed at the northern edge of Sable Island Bank. On the southern flank of Middle Bank a deposit interpreted as glacial till overlies the unconformity. The regional unconformity may correlate with a widespread reflection, R_1, developed across Banquereau and Sable Island Banks (Amos and Knoll, 1987; Amos and Miller, in prep.).

Areal Extent of Unconformity

Boundaries for the extent of the unconformity expressed on soft sediment deposits cannot be delineated at the present time because of the sparsity of high resolution seismic coverage, nevertheless, a plot of known occurrences on such deposits (Fig. 7) indicates that it was of broad extent. If we are correct in our suggestion that the unconformity correlates with reflection R_1 of Amos and Knoll (1987) for Banquereau, the other banks: Emerald, Middle, Sable Island, Misaine and Canso, were also probably affected.

Age of Unconformity

Because our examination of the seismic profiles shows that the unconformity occurs in very late Emerald Silt, facies B time, an age of approximately 10.0 to 10.5 ka can be estimated from Table I where the unconformity is bracketed by dates of 10580 ± 110 a B.P. in the uppermost Emerald Silt, facies B and 9450 ± 100 a B.P. in the lowermost LaHave Clay sections.

Till Deposits Associated With the Unconformity

King and Fader (1986) described the regional unconformity north of the Country Harbour Moraine including the northern flank of the moraine. They reported thin deposits interpreted as glacial till resting on the unconformity and associated with thin deposits of Emerald Silt, facies A and B. On the southern flank of Middle Bank (Fig. 6, Profile E) a deposit interpreted as till rests on the unconformity and may represent either a till tongue or lense of till. From borehole data on Sable Island Bank, Amos (1988) discussed pro-glacial marine deposits overlying the regional reflection, R_1. These deposits are truncated by transgressive lag gravel.

Origin of Unconformity

Based on the evidence for glacial till overlying the unconformity north of the Country Harbour Moraine, King and Fader (1986) suggested the return of an ice sheet to parts of the inner and central shelf for a short period of time at about 30.0 ka rather than at approximately 10.0 to 10.5 ka as we now suggest. They also suggested that bottom currents were responsible for the formation of the erosional surface, but we now suggest an origin associated with glaciation.

With the new timing for the erosional event (10.0 to 10.5 ka), together with the fact that Late Wisconsinan sea levels during the time interval of 10.0 to 15.0 ka, were much lower than present levels, large areas of the Scotian Shelf would have been exposed. Canso and Middle Banks would have in effect formed a discontinuous bridge between the mainland and the larger outer banks which would have existed as islands near the present shelf edge. Possibly ice caps nucleated on the shelf islands, nurtured in part by a thin flow of ice from the mainland. The ice was sufficiently thick on some banks (Fig. 5, Profile C) to effect significant erosion of competent glacial till and glaciomarine beds deposited during an earlier stage of the Late Wisconsinan glaciation. Ice thickness in the adjacent basins, such as NE Emerald Basin, was probably of the order of 40 to 50 m to effect erosion of soft sediment in many areas.

Implications Regarding the Sable Island Sand and Gravel Formation

The suggested origin for the Sable Island Sand and Gravel Formation (King, 1970), that is, basal transgressive deposition, does not appear to have been seriously affected by the very Late Wisconsinan (10.0-10.5 ka) ice which we have postulated. Shorelines associated with the early phase of Sable Island Sand and Gravel deposition probably coincided with the minimum stand of the Late Wisconsinan sea level as previously suggested but the transgression across the banks may have been interrupted by the presence of the late ice. In most areas, the Sable Island Sand and Gravel lies above the unconformity as a well-sorted deposit ranging from a veneer to several metres thickness on Middle Bank, and up to 40 to 50 m on Banquereau and Sable Island Bank (Amos and Nadeau, in press). Sea level rise continued following the 10.0 to 10.5 ka glacial event, transgressing the erosional surface, and probably eroded and reworked much of the newly deposited glacial debris.

CONCLUSIONS

Thin Late Wisconsinan ice occupied parts of NE Emerald Basin and adjacent Middle Bank during a short interval at about 10.0 to 10.5 ka, and may have covered large areas of Banquereau and Sable Island Bank and possible banks of the western portion of the Scotian Shelf. This event appears to correlate with a period of climatic deterioration between 11.0 and approximately 10.0 ka which

Mott *et al*. (1986) postulated for Atlantic Canada and correlated with the beginning of the Younger Dryas event of northwestern Europe.

The erosional surface of the latest glacial event was transgressed by the Holocene rise in sea level in the bank areas; continuing deposition of the Sable Island Sand and Gravel Formation.

ACKNOWLEDGMENTS

We are grateful to Drs. K. Howells and A. McKay of the Nova Scotia Research Foundation Corporation for the high resolution seismic profile south of Middle Bank, to Drs. Carl Amos and Mike Lewis of the Atlantic Geoscience Centre, Bedford Institute of Oceanography for review of the manuscript, and to R.O. Miller for technical support.

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Figure 1

Index map of Northeast Emerald Basin showing the core locations (solid circles) and illustrated seismic sections (solid lines).

Figure 2-6

High resolution seismic reflection profiles. For location, see index - figure 1.

Figure 7

Western half of the Scotian Shelf showing the distribution of known areas of erosion of Emerald Silt, facies A and B resulting from Late Wisconsinan shelf glaciation.

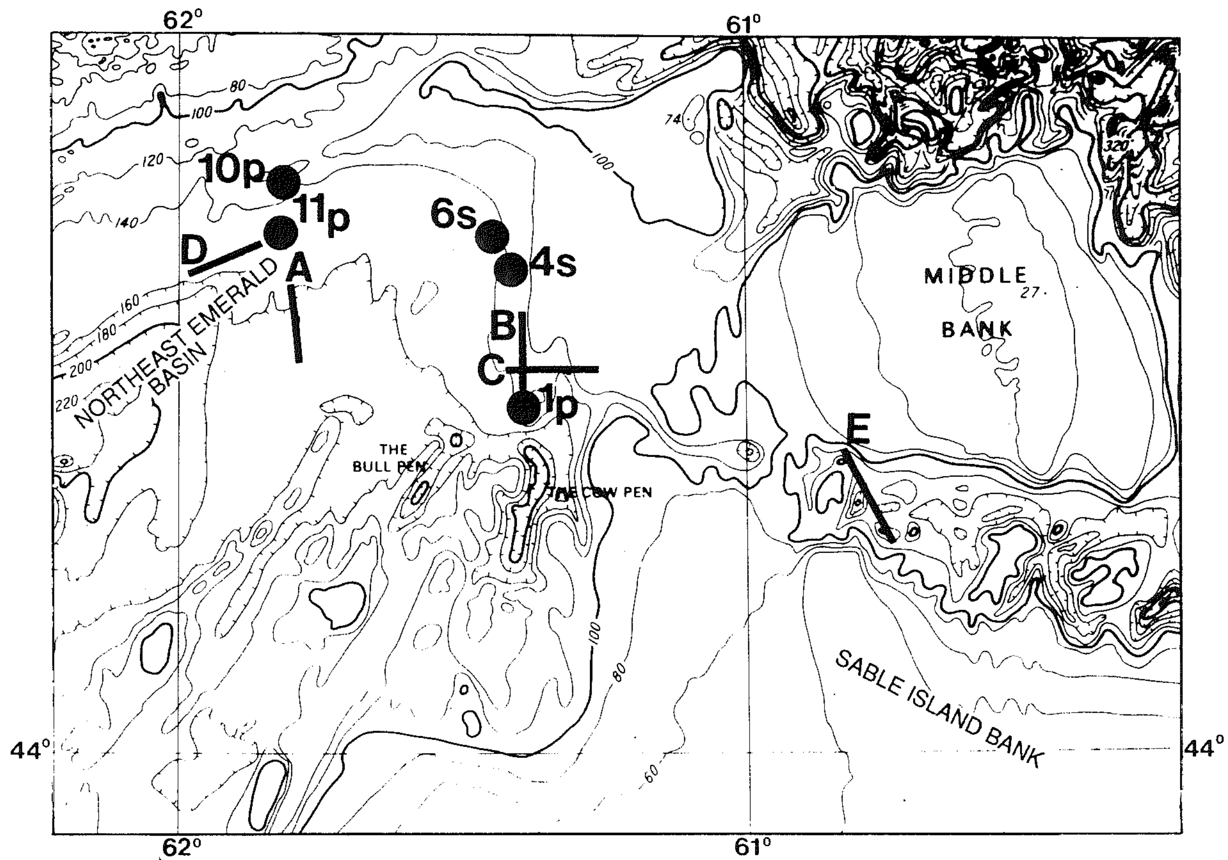
62°
61°
44°
10p
11p
6s
4s
1p
A
B
C
D
E
NORTHEAST EMERALD
BASIN
THE
BULL PEN
THE COW PEN
MIDDLE
BANK
SABLE ISLAND BANK
80
100
120
140
160
180
200
220
74
60
320
27

FIG. 1

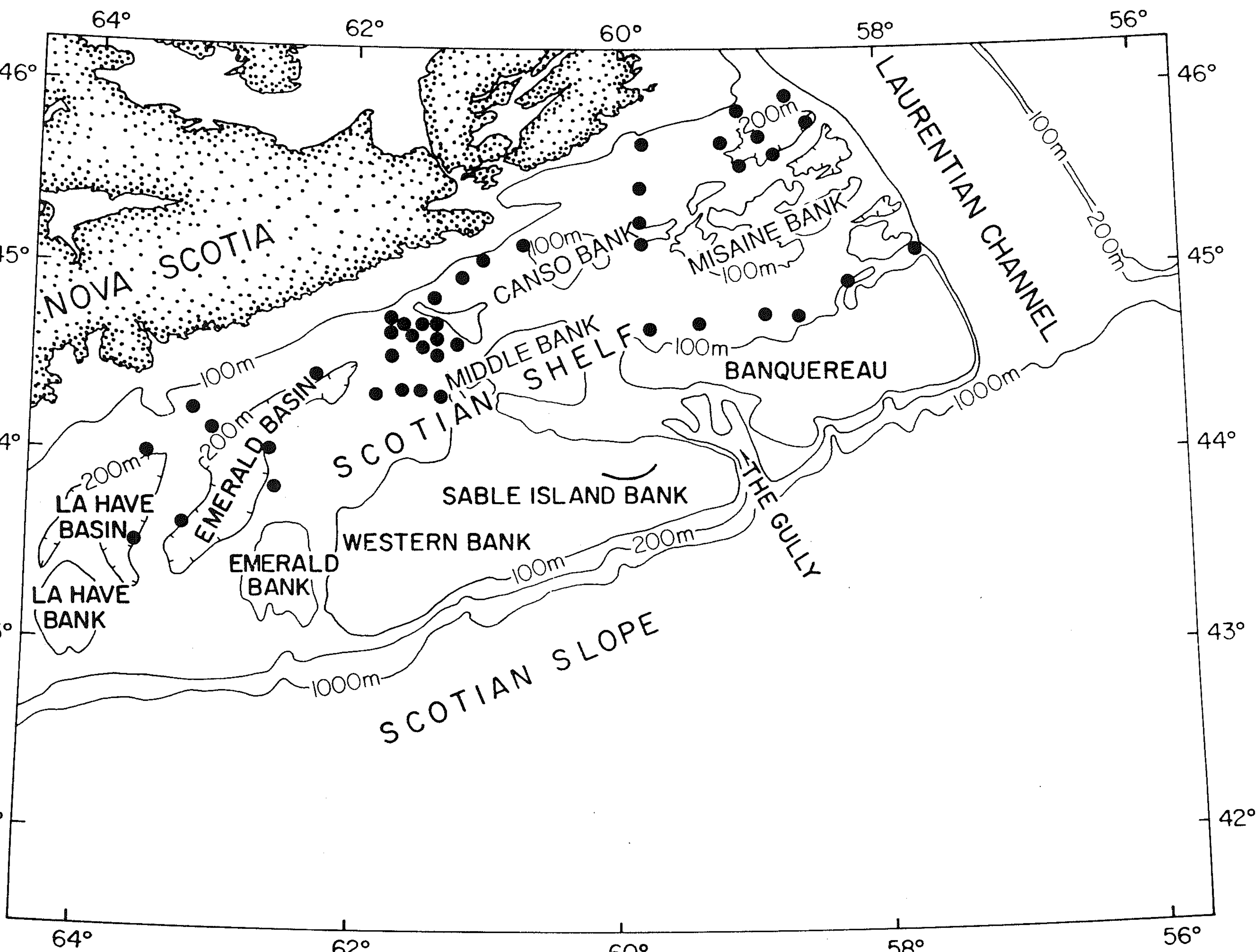
NOVA SCOTIA
LAURENTIAN CHANNEL
MISAINE BANK
CANSO BANK
MIDDLE BANK
SCOTIAN SHELF
BANQUEREAU
THE GULLY
SABLE ISLAND BANK
WESTERN BANK
EMERALD BASIN
EMERALD BANK
LA HAVE BASIN
LA HAVE BANK
SCOTIAN SLOPE
100m
200m
1000m
64°
62°
60°
58°
56°
46°
45°
44°
43°
42°

FIG. 7