OCEAN DRILLING PROGRAM

LEG 105 PRELIMINARY REPORT

BAFFIN BAY - LABRADOR SEA

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December, 1985

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Preliminary Report No. 5

First Printing 1985

Distribution

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D I S C L A I M E R

SCIENTIFIC REPORT

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INTRODUCTION

The Labrador Sea and Baffin Bay are small ocean basins confined between the coasts of Labrador and Baffin Island on the west, and Greenland on the east. At present the Labrador Sea and Baffin Bay form the western branch of the North Atlantic Ocean. Prior to the formation of the Greenland and Norwegian Seas, these basins probably formed the main conduit between the Arctic and Atlantic Oceans. Thus drilling in the Labrador Sea and Baffin Bay provided an excellent opportunity to obtain data for studying the early tectonic and paleoceanographic history of the North Atlantic and its connection to the Arctic Ocean.

The objectives of Leg 105 were three-fold:

1. to study the tectonic development of the Labrador Sea and Baffin Bay,
2. to examine the history of paleocirculation through these regions and their connection to the Arctic and Atlantic Oceans,
3. to study the timing and nature of major paleoclimatic changes, and the frequency of oscillations between glacial and interglacial cycles which prevailed in the region.

Leg 105 of the Ocean Drilling Program (ODP), which began on August 29, 1985 in St. John's, Newfoundland, Canada, and ended on October 27, 1985, in St. John's, drilled three sites in Baffin Bay and the Labrador Sea (Figure 1). Site 645 lies on the continental slope of southern Baffin Island in Baffin Bay. Results from this site provide a late Miocene to Recent paleoceanographic and tectonic record of this high latitude basin. Site 646 is located off the southern tip of Greenland, just north of the Eirik Ridge, in the Labrador Sea. Double advanced piston cored (APC) holes in the high sedimentation rate deposits at this site contain a nearly complete paleoceanographic record back to 1.2 Ma. Deeper drilling results at this site provide ages for prominent regional seismic reflectors R2 and R3/R4 which have been correlated to reflectors in the eastern North Atlantic. These dates allow a reassessment of the history of bottom current deposits in the North Atlantic. The final site drilled during Leg 105, Site 647, is located 100 km south of the Gloria Drift in the southern Labrador Sea. Drilling to basement at Site 647 provided a nearly continuous Eocene through Oligocene paleoceanographic record as well as yielding a determination of the age of the oceanic crust at this location. This age places constraints upon the sea-floor spreading interpretations of the marine magnetic anomaly patterns observed in the Labrador Sea.

Drilling at these high latitude sites proved a challenge to JOIDES Resolution, but in spite of the continued threat of ice-bergs in Baffin Bay and persistent gale force winds and high seas in the Labrador Sea, Leg 105 was successful in reaching many of its primary objectives.

DRILLING RESULTS

Site 645: Baffin Bay

Prior to the separation of Eurasia from Greenland in the late Paleocene to early Eocene, Baffin Bay may have formed the main conduit for the exchange of water between the Arctic and Atlantic oceans. The nature of this exchange of water can only be ascertained by establishing the subsidence history of the Baffin Bay and Davis Strait regions as well as by studying the planktonic and benthic fauna and flora from these regions. No age control for seismic stratigraphy previously existed in these basins to constrain subsidence history. Furthermore, the origin of Baffin Bay has been a subject of much debate; a divergence of opinion revolves around whether Baffin Bay formed by sea-floor spreading or foundering and thinning (Keen and Barrett, 1972; Srivastava et al., 1981). The prime reason for the lack of consensus has been the absence of clearly recognizable seafloor spreading magnetic anomalies and the absence of crustal structure resembling typical oceanic regions in this area. Yet indirect evidence, such as the presence of a deep graben in the center of Baffin Bay recognized in seismic reflection and gravity data, the presence of a very thin crust under the Bay and the amount of opening required in this region by plate kinematic solutions for the adjoining regions (Srivastava and Tapscott, in press), argue in favor of a sea-floor spreading origin for this region. Drilling in Baffin Bay was designed to establish its tectonic history and the timing of rifting as well as to provide data to study paleoclimates and paleocirculation in and through this region.

Site 645 lies on the continental slope off southern Baffin Island in water depths of about 2020m (Figure 1). Gravity and magnetic data near the site, together with seismic refraction measurements north of the site, suggest that the site lies near the continent-oceanic crust boundary. A number of multichannel seismic reflection profiles have been shot in this region by Petro-Canada, and these show the presence of down faulted basement blocks covered by a substantial amount of Cretaceous and younger sediments west of the site.

The sequence recovered at Site 645 has a pronounced terrigenous character with surprisingly sparse planktonic biota (Figure 2). The average sedimentation rate for the sequence is 50 m/m.y., but it ranges from 40-130 m/m.y. (Figure 3). The sparse siliceous and calcareous planktonic assemblages and evidence of reworking make precise age assignments difficult. Dinocyst and benthic foram age picks, with a few tie points from calcareous nannofossils, diatoms and magnetostratigraphy provide the stratigraphic control at this site. Further shorebased studies of fairly abundant dinocysts will undoubtedly improve the stratigraphic resolution.

Recovery in the uppermost sediments at Site 645 was poor, probably because of the unusual firmness of the sediment and the abundance of glacial dropstones. Piecing together recovery from Holes 645A, 645B, 645C, 645F and 645G for the upper 25 m of APC and extended core barrel (XCB) cores, and careful correlation of distinctive lithologic units gives a nearly complete sequence (upper part of late Pleistocene) enabling high resolution studies of glacial-interglacial changes in paleoenvironment. Rhythmic sedimentation is very evident throughout the late Pliocene to Pleistocene sediments, but unfortunately, the recovery in the top 170 m is not sufficient for tests of orbital-forcing over long time series in Baffin Bay.

The most characteristic rhythm in the uppermost sediments is interbedded dark gray and light brownish to grayish brown calcareous silty clay or mud. Contacts between each lithology are sharp and bioturbation is minor. The light-colored intervals contain a greater portion of coarser detritus, including silt-sized detrital carbonate. Pebbles and cobbles, interpreted as ice-rafted detritus, are apparently randomly distributed in both lithologies. The cycles average about 1 meter in thickness, which is equivalent to about 8 kyr (given an average depositional rate of 130 m/m.y.). Such a period is much shorter than the 41 kyr period that was suggested by Aksu (1983) from his studies of oxygen isotope stratigraphy in shallow piston cores from Baffin Bay or that predicted by the Milankovitch Theory (Berger, 1978; Ruddiman and McIntrye, 1981). Within the limits of our shipboard age control, these results suggest that melting of sea ice and advance and retreat of glacial ice on the margins of Baffin Bay occurred on a much shorter timescale.

The onset of major glacial ice-rafting in Baffin Bay, as recorded by the first abundant dropstones and other coarse sediment, was at least as early as 2.5 Ma (340 mbsf) and possibly as early as 3.4 Ma (465 mbsf). Therefore the beginning of major glacial activity in this region may have preceded evidence for ice-rafting in the North Atlantic by at least 1 m.y. However, isolated pebbles and granules in strata as old as late Miocene (605 mbsf) could indicate the presence of at least seasonal sea-ice in Baffin Bay as early as 8 Ma. A major unconformity (reflector R-1), observed in a regional multichannel seismic net, probably represents a change in depositional style near the early/late Pliocene boundary. This unconformity is overlain by a thick wedge of upper Pliocene-Pleistocene "glacial" sediment that prograded westward from the West Greenland margin. The upper 160 m of upper Pleistocene sediment is predominantly ice-rafted.

Interpretation of regional seismic lines and sedimentary textures and structures at Site 645 (Figure 4) suggest an unexpectedly pronounced but variable influence of deep "contour-following" currents during deposition of early Miocene to late Pliocene sediments in western Baffin Bay. These features and the rare occurrence of planktonic biota indicative of incursion of warmer North Atlantic waters into the basin, suggest possible southward-directed flow of Arctic water masses to the Labrador Sea since at least the middle Miocene. Calcareous microfossils with North Atlantic warm-temperate affinities occurred in some intervals of the lower Miocene at Site 645, possibly indicating the waning influence of relatively warmer northward flow from the North Atlantic to Baffin Bay at that time.

Reflector R-2 is an erosional unconformity over at least part of the region (Figure 4), particularly on the Baffin Island shelf and slope. Middle Miocene, partly bottom-current deposited strata overlie R-2, suggesting that this unconformity marks the onset of vigorous southward-directed circulation in the basin, coincident with dominance of faunal and floral assemblages indicating mainly cooler climatic conditions after 16 Ma. Evidence for a middle Miocene climatic amelioration observed elsewhere in the circum-North Atlantic region is not immediately obvious at Site 645 although there is some evidence of a relatively high productivity event during that interval.

The paucity of siliceous and calcareous biota, the neritic aspect suggested by those diatoms and dinocysts that are present, the dominance of organic matter of terrestrial derivation and pollen indicating a cool-temperate to boreal climate, suggest the predominance of cool, nutrient poor surface waters characterized by generally low productivity for the most of the Miocene to Recent. However, dissolution and/or diagenesis cannot be ruled out as at least a partial explanation of the poor preservation or absence of calcareous and siliceous faunal/floral remains.

Although we did not reach our deep objectives of reflector R-3 (at about 1540 mbsf) extrapolation of sedimentation rates would give an approximate Eocene/Oligocene boundary age for it. The R-3 reflector extends across Baffin Bay and therefore confirms that seafloor spreading probably ceased by the end of the Eocene in the Baffin Bay region. Subsidence at the site follows a path expected for thinned or thermally disturbed crust which began subsiding between 63 and 55 Ma. Correlation of drilling results, measurements of physical properties and seismics at the site will allow correlation of events across much of the basin. Geophysical logs were obtained only for just over 200 m of the sequence because of hole problems. A detailed set of organic and inorganic geochemical analyses is providing a good understanding of the diagenesis of this terrigenous sequence.

Site 646: Labrador Sea

Site 646 is located on the northwestern flank of the Eirik Ridge in the northeastern Labrador Sea (Figure 5). We chose this location because it lies in a region where the maximum influence from the Norwegian Sea Overflow Water (NSOW) is expected and because the top of the older Paleogene section lies at a relatively shallow depth. This site is also located in the vicinity of a prominent sediment drift deposit. These features made this site an ideal place for studying the onset of deep cold bottom-water currents in the North Atlantic as well as the glacial history of the region.

A sedimentary drift deposit known as Eirik Ridge lies southeast of the site. This ridge was first delineated from a detailed bathymetric survey by Johnson and Schneider (1969), and since then additional seismic and other geophysical data have been collected by different agencies across it. Le Pichon et al. (1971) showed that a basement high, forming part of the Farwell Fracture Zone, underlies this region. From their seismic data they interpreted that the ridge has developed over a flat lying unconformity and as such is not controlled by basement ridge topography. This is contrary to what can be observed in some of the multichannel seismic data from this region (Hinz et al., 1979). The axis of deposition of the Eirik Ridge (Figure 6) lies along the southern flank of the basement high marked by the 5.5 sec depth contour. The major reflector identified as an Oligocene unconformity by Le Pichon et al. (1971) and Miller and Tucholke (1983) lies at a constant distance above the underlying basement, a surface which exhibits substantial relief. Thus we interpret that the basement topography probably controlled the initial development of the Eirik Ridge.

Site 646 is located off the main axis of the Eirik Ridge to avoid the thick sedimentary sequence developed there, but it is located on the northern flank of a subsidiary ridge which, in seismic reflection lines, exhibits characteristics of a drift sequence (Figure 6). Therefore, although we were not able to directly observe the history of the main depositional ridge in the cores from Site 646, we can carry the ages of the main depositional units into the main drift by seismic reflection profiles

(Figure 7).

Over 100 m of double APC cores from Holes 646A and 646B provide a nearly complete, high-resolution record from 1.2 Ma to present. Fluctuations in carbonate content (0-40%), vague color variations, magnetic susceptibility changes, microfossil abundance and diversity, and dropstone abundances record continuous glacial/interglacial cycles. There is probably a continuous record through isotope stage 21 contained in the APC cores. The onset of major ice rafting at about 2.5 Ma (236 mbsf) coincides with a major change in seismic character. General smoothing and continuous sedimentation of the drift sequence occurred during the late Pliocene to Recent.

A significant biotic change occurred at the early Pliocene/late Pliocene boundary (3.4 Ma; 314 mbsf; Figure 8). Biosiliceous material is common to abundant above this depth, whereas calcareous nannofossils and planktonic foraminifers are more abundant below. This event probably represents significant cooling of surface-water masses over the site accompanied by higher productivity of siliceous plankton. The changes in surface waters also closely correspond to a period of apparent intensification of deep circulation, beginning at about 4.0 Ma, reflected by erosional modification of the drift sequence and construction of a pronounced ridge observed in the regional seismic lines.

A generally warm early Pliocene is indicated by relatively high and constant carbonate contents and abundant calcareous nannofossils and dinocysts. The Miocene/Pliocene boundary occurs at about 500 mbsf and approximately coincides with a change to highly variable and generally lower carbonate contents below this boundary. This boundary also coincides with the position of the 'R2' reflector (Figure 6), which was previously thought to be late early Miocene in age. The 'R3/R4' reflector, which was originally suggested to be of late Eocene/early Oligocene age (Miller and Tucholke, 1983), occurs at about 680 mbsf. Although there is no marked change in lithology, the depth of the R3/R4 reflector is closely constrained by velocity information supplied by an excellent sonic log and physical properties data. The reflector (actually a pair of reflectors at 680 and 730 mbsf) appears to correspond to a hiatus at about 7.4 Ma of probable 0.5 m.y. duration. The hiatus is underlain by an at least 50-m thick interval of lower density sediment characterized by low $CaCO_3$ contents. The R3/R4 reflector may signify an important change in bottom-water characteristics and intensification of deep circulation in the late Miocene. A significant change in the benthic foraminiferal fauna above 680 mbsf supports this interpretation.

On the basis of drilling results and interpretation of seismic lines, major drift sedimentation began in this region sometime near the beginning of the late Miocene. Earlier abyssal current erosion and sedimentation in the area is possible, however, but is not constrained by our drilling results. The advent of major drift sedimentation appears to coincide with the increased influx of terrigenous sediments to the region in the latest Miocene. This is earlier than the expected flood of terrigenous material seen elsewhere at about 3.4 Ma in association with the transition to a "glacial" regime. Bottom-current influenced sediments of the late Miocene-Recent drift sequence at Site 646 are bioturbated to somewhat homogeneous throughout and possess no persistent features characteristic or indicative of contourites or current-deposited sediments. The average sedimentation rate is about 91 m/m.y. (9.1 cm/ky) for the entire sequence but bulk accumulation rates decrease in the Pleistocene.

Site 647: Southern Labrador Sea

Site 647 is the southernmost site of the north-south transect of sites drilled during Leg 105. This site is located about 200 km south of the Gloria drift deposit in the southern Labrador Sea (Figure 9). We chose this site for several reasons. This site lies far enough from the Gloria drift deposit to avoid drilling through a thick Neogene section. Basement, as well as the Paleogene sedimentary section, therefore were within reach given the time limitations. Secondly, the magnetic anomalies are well-developed in this region (Figure 10), and the resulting basement age allows us to resolve the tectonic history of the Labrador Sea. And finally the region lies in a position that is sensitive to incursions of warmer North Atlantic waters. Results from this site, combined with previous drilling results from the North Atlantic (Ruddiman, et al., in press; Roberts and Schnitker, 1984) allow us to examine the nature of north-south and east-west paleoclimatic and paleoceanographic gradients. Site 647 and DSDP Site 403, 553 and 555 west of Rockall Plateau, lie over parts of the crusts that formed contemporaneously north and south of the triple junction which existed during simultaneous spreading in the Labrador and Norwegian Sea. A comparative study of the drilling results from these sites will help us to understand better the paleoclimatic and paleoceanographic conditions which prevailed there during the Paleogene.

A nearly complete late Pliocene to Recent (the last 2.5 m.y.) section obtained at Site 647 (rotary and APC) contains recognizable alternations of relatively nannofossil rich, silty clay and more gravel rich, silty intervals that represent depositional cycles related to glacial-interglacial climatic variations (Figure 11). The average sedimentation rate is about 40 m/m.y. (4.0 cm /kyr) (Figure 3). Both bottom-current winnowed beds enriched in biogenic components and turbiditic, detrital calcite-rich sediment derived from spillover from the North Atlantic Mid-ocean Canyon are present in the Plio-Pleistocene sequence. As at Site 646, the onset of glacial ice rafting occurred at about 2.5 Ma. Strata of this age, dominated by terrigenous input, directly overlie a hiatus at 116 mbsf, which encompasses the interval between at least 5.6 and 2.5 Ma. The hiatus forms a prominent regional reflector (R2).

A condensed sedimentary sequence represents the early to late Miocene deposition and contains at least one hiatus between the upper and the lower Miocene (8.2-17.5 Ma respectively). Iron-manganese and phosphate nodules, streaks and bands characterize much of this interval. The hiatuses and slow sedimentation probably indicate scour by strong bottom currents and/or nondeposition in conjunction with low sediment supply during much of the early to late Miocene. This episode approximately coincides with the intensification of deep-circulation and the major drift sedimentation in the North Atlantic. An additional hiatus may be present between the lower Miocene and upper Oligocene.

A continuous, high sedimentation rate, upper Eocene through lower upper Oligocene sequence was recovered at Site 647. The biogenic claystones and clayey oozes were deposited at average rates of about 40 m/m.y. in the late middle Eocene to early Oligocene (Figure 3). These sediments are predominately nannofossil-rich, but biogenic opal occurs in the upper Eocene through lower Oligocene strata. A prominent regional reflector identified as "R4" occurs at the change from siliceous to calcareous biogenic claystones in the lower Oligocene at about 240 mbsf, corresponding to the previous identification of R4 at nearby DSDP Site 112 (Figure 11). The reflector appears to bear no direct relationship to changes in bottom-water circulation. A major but somewhat gradual change in the benthic foraminiferal fauna, from agglutinated to calcareous dominated, occurred during the late Eocene through earliest Oligocene (essentially complete by the Eocene/Oligocene boundary), which is below the level of R4. The benthic faunal transition may indicate a change in bottom-water characteristics, and coupled with high rates of deposition and supply of terrigenous clay may signify increased rates of deep circulation. However, the sediment textures and structures provide no evidence of strong abyssal currents at the site during this time.

The seafloor at the site apparently subsided below a relatively shallow carbonate compensation depth (CCD) during the early to early middle Eocene. An approximately 8 m.y. hiatus (46-54 Ma) occurs at approximately 630 mbsf. The CCD apparently descended during the middle to late Eocene and into the early Oligocene, as indicated by predominance of biogenic carbonate-rich facies and fair to good preservation of calcareous microfossils (Figure 12). Carbonate productivity may also have increased over that time. A climatic optimum characterized by highest diversity of calcareous plankton occurred in the late middle Eocene (about 41 Ma). The early Oligocene episode of biosiliceous sediment deposition probably represents increased opal and decreased carbonate production in surface waters, a trend which began in the late Eocene accompanied by cooling of surface water. Opal accumulation rates increased in that interval, while the carbonate accumulation rate decreased. Organic carbon accumulation rates are at a maximum in the middle Eocene in conjunction with high abundances of agglutinated benthic foraminifers.

The age of the uppermost basaltic basement is 55-56 Ma, as determined on the basis of the oldest sediments immediately overlying it. This age is in agreement with the age assigned on the basis of magnetic anomaly correlations (anomaly 24), thus supporting geophysical data and validating our tectonic model for the evolution of the Labrador Sea (Srivastava et al. 1981). Evidence of some late hydrothermal activity and associated faults and fractures occurs in strata of Eocene age overlying the basement.

SUMMARY

ODP Leg 105, which began on 29 August in St. John's, Newfoundland, Canada and ended in St. John's on October 27, 1985, drilled three sites in the Labrador Sea and Baffin Bay. These sites form a north-south transect recording the details of Miocene to Recent paleocirculation and paleoceanography of these high latitude basins. Results from these sites indicate that major glaciation in this region, as evidenced by the first occurrence of ice rafted debris, began at 2.5 Ma in the south and as early as 3.4 or even 8 Ma in the north. Drilling results at these sites have provided ages for prominent regional seismic reflectors providing stratigraphic control for regional multichannel and single-channel seismic networks. Interpretation of seismic lines allows a reevaluation of the history of bottom circulation in the North Atlantic and the timing of the development of major drift sedimentation which was most important during the late Miocene to Recent. The current influenced sediments at Sites 646 and 647 generally lacked features diagnostic of bottom-current activity and were typically heavily bioturbated. Paleogene sediments cored at Site 647, the southernmost site in the transect, extends the paleoceanographic record to the lower Eocene.

The continuous high-sedimentation rate upper Eocene-lower Oligocene sequence at Site 647 provides an exceptional high latitude record of calcareous and siliceous microfossils and benthic foraminifers. The recovery of basalt, representing the top of the oceanic crust at Site 647 confirms that this crust was formed during Chron 24, about 55-56 Ma. This demonstrates that a major change in direction of seafloor spreading in the Labrador Sea occurred just after that time.

The nearly continuous glacial records from Sites 646 and 647 and a thick but poorly recovered glacial sequence form Site 645 provide unusual resolution of high frequency climatic and oceanographic events and glacial/interglacial cycles. Results from all three sites will provide important insights into the tectonic, climate and circulation changes that took place in the northwestern Atlantic-Arctic corridor in conjunction with overall climatic deterioration since the late Paleogene as a prelude to the glacial epoch.

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FIGURE CAPTIONS

Figure 1. Generalized bathymetry of the Labrador Sea-Baffin Bay region with exploratory wells, DSDP sites, and Leg 105 Sites (645, 646 and 647).

Figure 2. Lithologic units, relative proportion of sand, silt or clay beds, organic carbon, carbonate contents and ages of units at Site 645, Baffin Bay.

Figure 3. Sedimentation rates observed at Sites 645, 646, 647.

Figure 4. Portion of multichannel seismic line 74-51 showing location of Site 645 and correlation of major reflectors and seismic units to lithology at Site 645.

Figure 5. Bathymetric map of the North Atlantic showing the locations of the two major drift deposits (Eirik Ridge and Gloria Drift) and of ODP (646, 647) and DSDP (111, 112, 113) sites.

Figure 6. Bathymetric map showing the location of Site 646, the axis of the Eirik Ridge, magnetic anomalies and fracture zone locations.

Figure 7. Single channel seismic reflection profile 14 (Hudson) showing correlations of minor lithologic units and age boundaries at Site 646 to reflectors.

Figure 8. Lithologic columns, age, organic carbon and carbonate contents for Site 646. Note high resolution carbonate curve for upper 100m.

Figure 9. Bathymetric map of the North Atlantic Ocean showing location of Site 647, Gloria Drift, the NAMOC, magnetic anomalies, and ship's tracks in the vicinity of Site 647.

Figure 10. Patterns and correlation of sea-floor spreading generated magnetic anomalies in the Labrador Sea (from Srivastava and Tapscott, 1985).

Figure 11. Correlation of the lithologic units observed at Site 647 with seismic profile Hudson 84-30 line 8.

Figure 12. Lithologic column, age, bulk density, water content, porosity and carbonate content observed at Site 647.

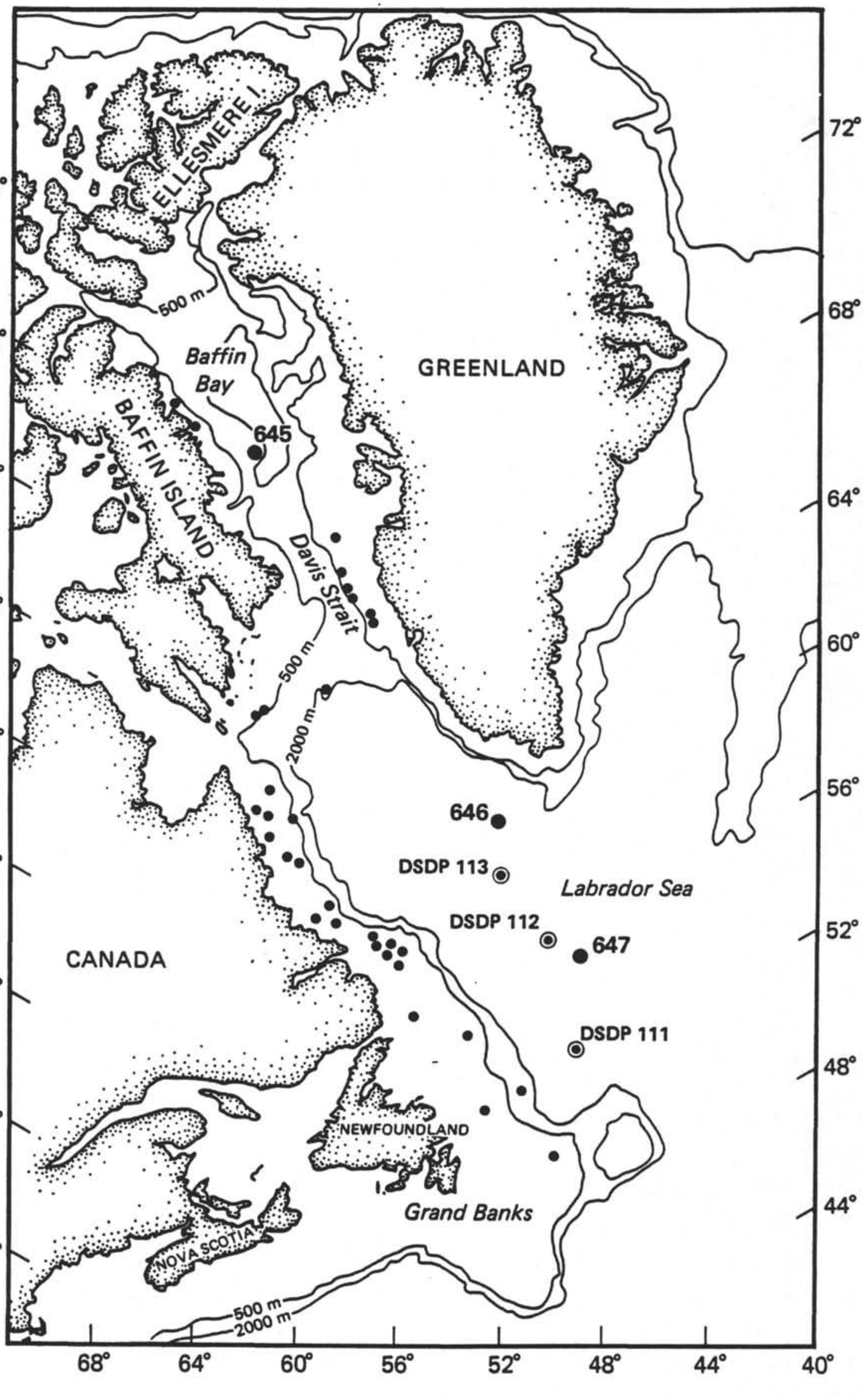

ELLESMERE I.
GREENLAND
Baffin Bay
BAFFIN ISLAND
645
Davis Strait
500 m
2000 m
646
DSDP 113
Labrador Sea
DSDP 112
647
DSDP 111
CANADA
NEWFOUNDLAND
Grand Banks
NOVA SCOTIA
500 m
2000 m
76°
72°
68°
64°
60°
56°
52°
48°
44°
68°
64°
60°
56°
52°
48°
44°
40°

Figure 1

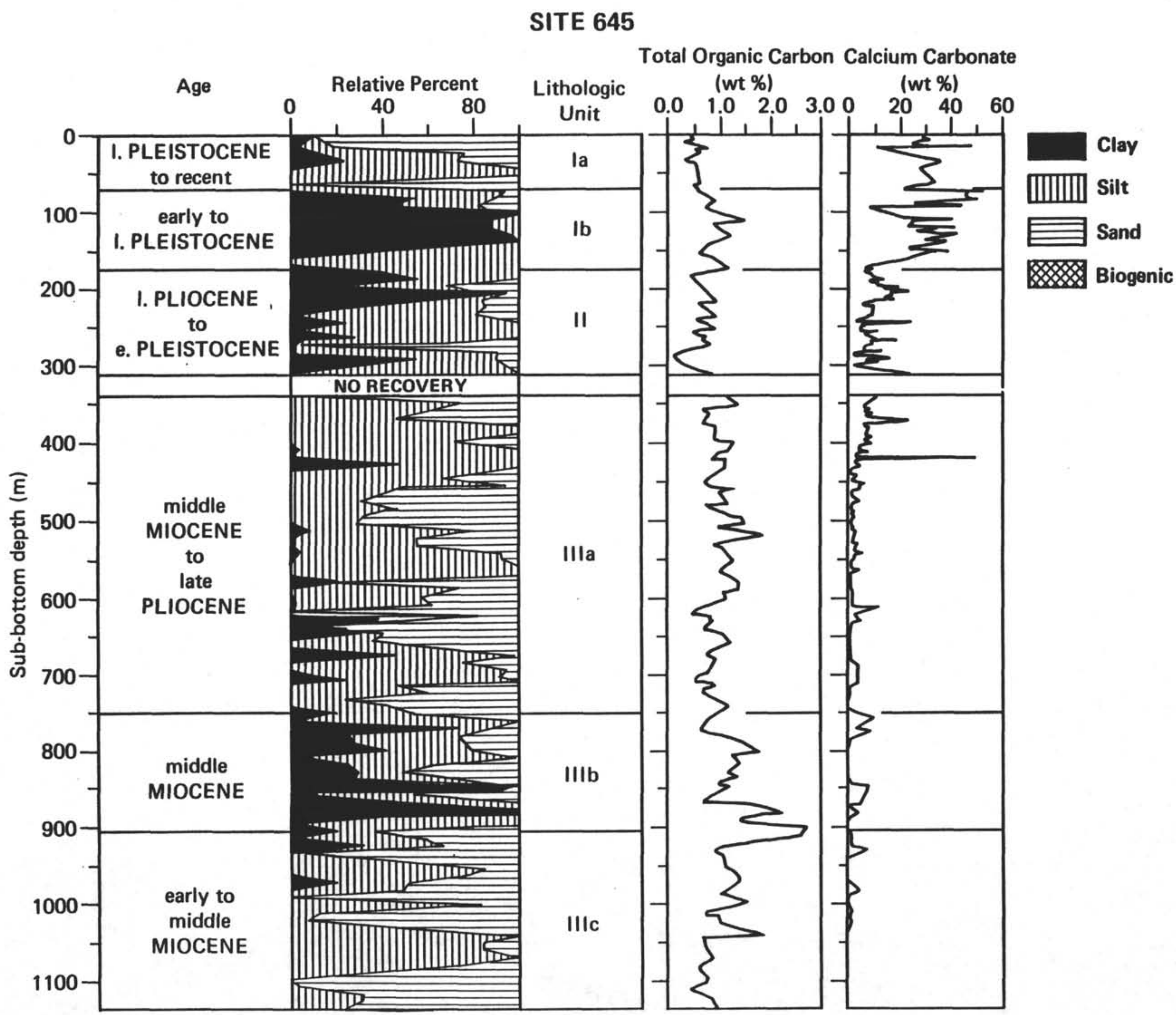

SITE 645
Age
Relative Percent
0
40
80
Lithologic Unit
Total Organic Carbon (wt %)
0.0
1.0
2.0
3.0
Calcium Carbonate (wt %)
0
20
40
60
Sub-bottom depth (m)
0
100
200
300
400
500
600
700
800
900
1000
1100
l. PLEISTOCENE to recent
early to l. PLEISTOCENE
l. PLIOCENE to e. PLEISTOCENE
NO RECOVERY
middle MIOCENE to late PLIOCENE
middle MIOCENE
early to middle MIOCENE
Ia
Ib
II
IIIa
IIIb
IIIc
Clay
Silt
Sand
Biogenic

Figure 2

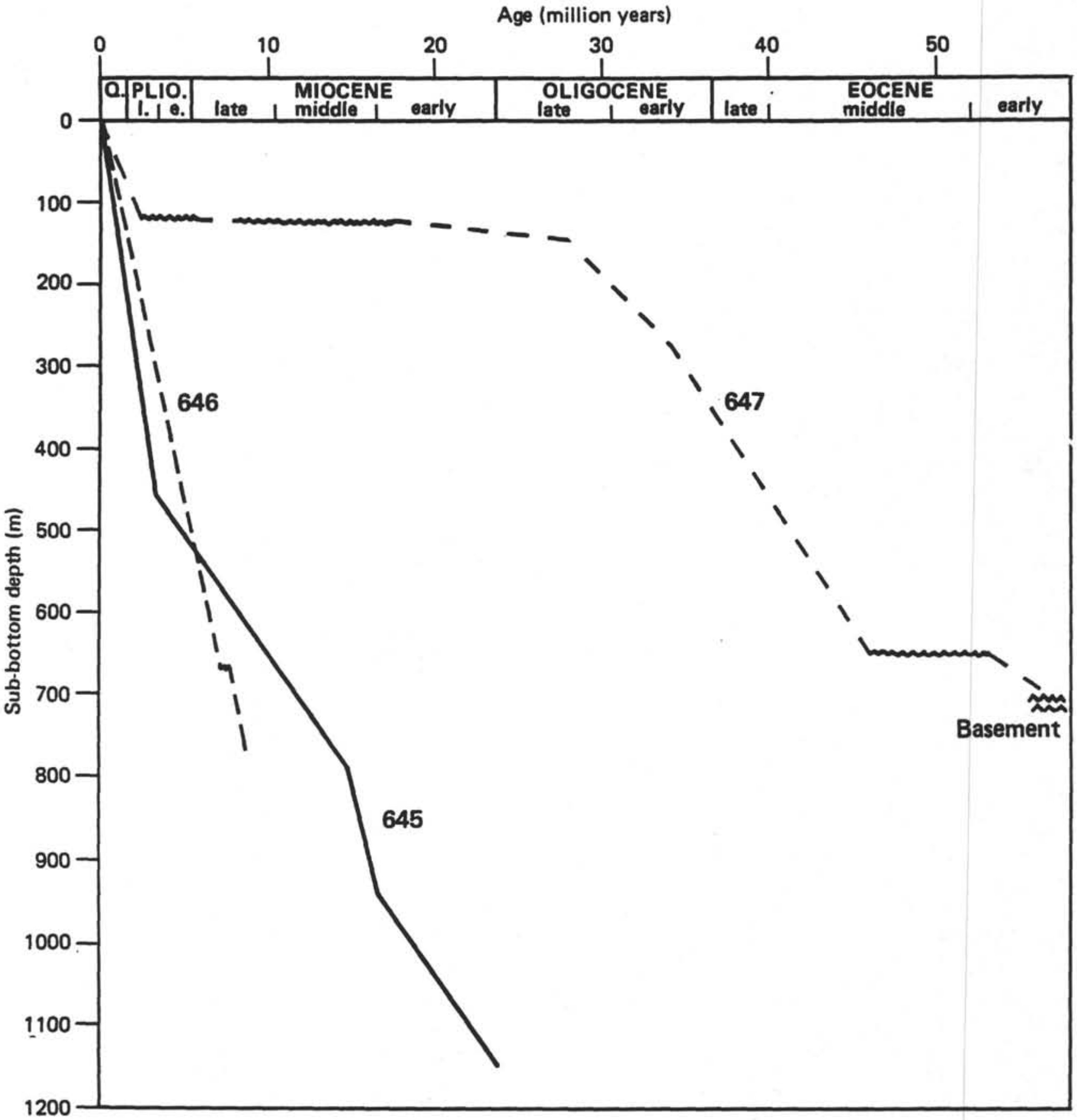

Age (million years)
0
10
20
30
40
50
Q.
PLIO.
l.
e.
MIOCENE
late
middle
early
OLIGOCENE
late
early
EOCENE
late
middle
early
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
Sub-bottom depth (m)
646
647
645
Basement

Figure 3

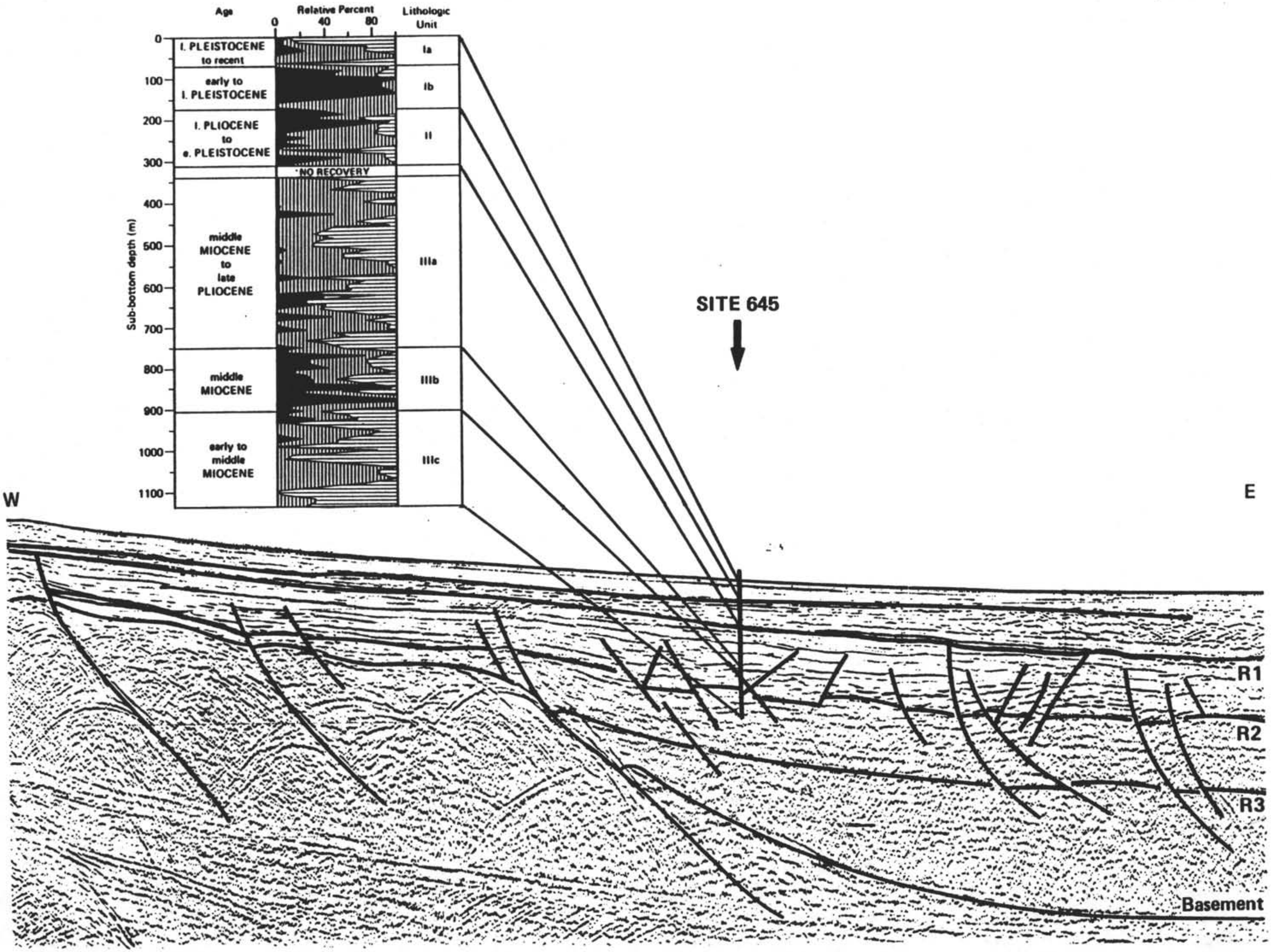

Age
Relative Percent
0
40
80
Lithologic Unit
Sub-bottom depth (m)
0
100
200
300
400
500
600
700
800
900
1000
1100
l. PLEISTOCENE to recent
early to l. PLEISTOCENE
l. PLIOCENE to e. PLEISTOCENE
NO RECOVERY
middle MIOCENE to late PLIOCENE
middle MIOCENE
early to middle MIOCENE
Ia
Ib
II
IIIa
IIIb
IIIc
SITE 645
W
E
R1
R2
R3
Basement

Figure 4

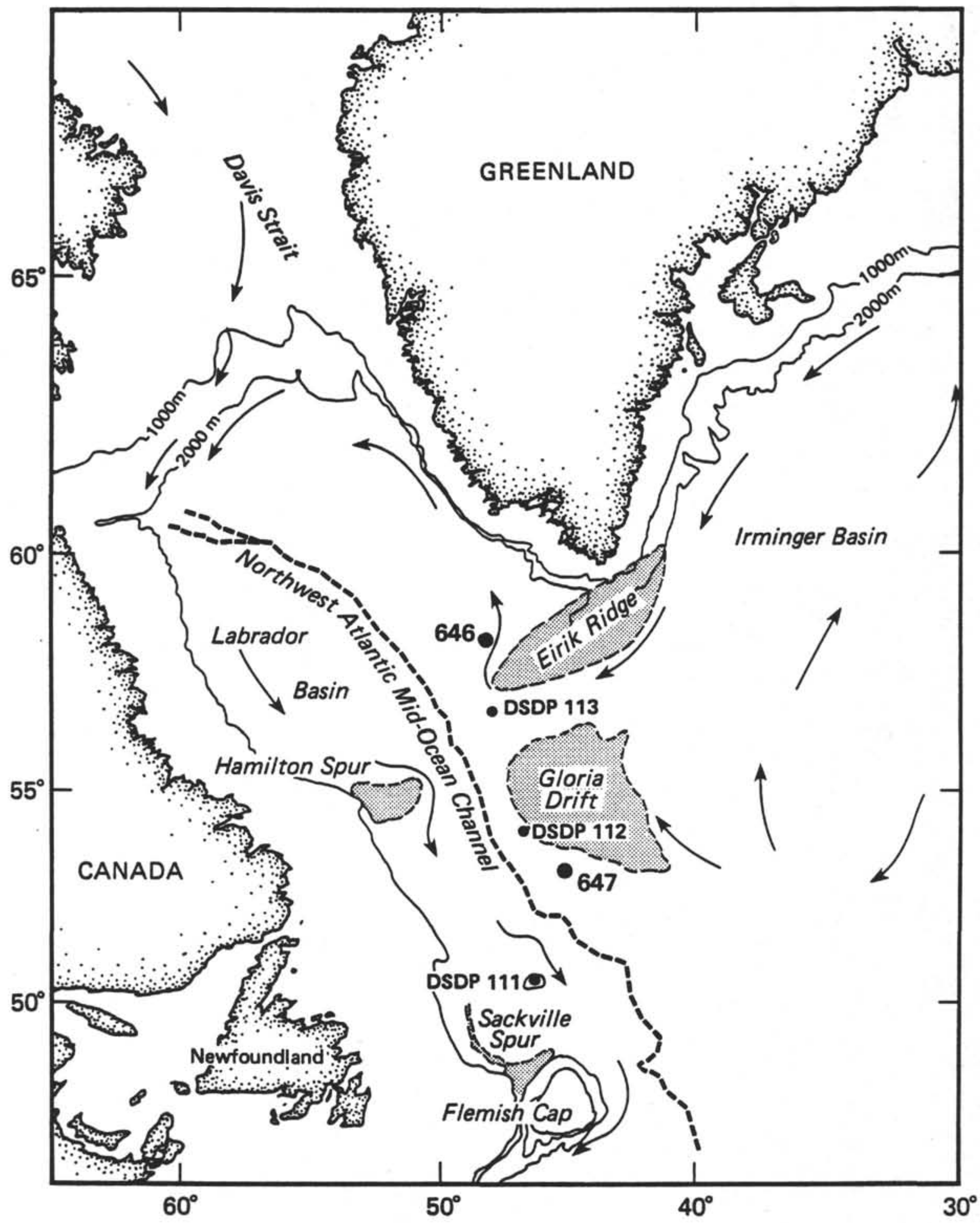

GREENLAND
Davis Strait
65°
1000m
2000 m
1000m
2000m
Irminger Basin
60°
Northwest Atlantic Mid-Ocean Channel
646
Eirik Ridge
Labrador
Basin
DSDP 113
Hamilton Spur
Gloria
Drift
55°
DSDP 112
CANADA
647
DSDP 111
50°
Sackville
Spur
Newfoundland
Flemish Cap
60°
50°
40°
30°

Figure 5


GREENLAND
31
60°
J.F.Z.
31
33
24
Ridge Axis
24
24
646
58°
21
21
M.F.Z.
21
21
DSDP 113
24
L.F.Z.
24
24
21
52°
48°
44°

Figure 6

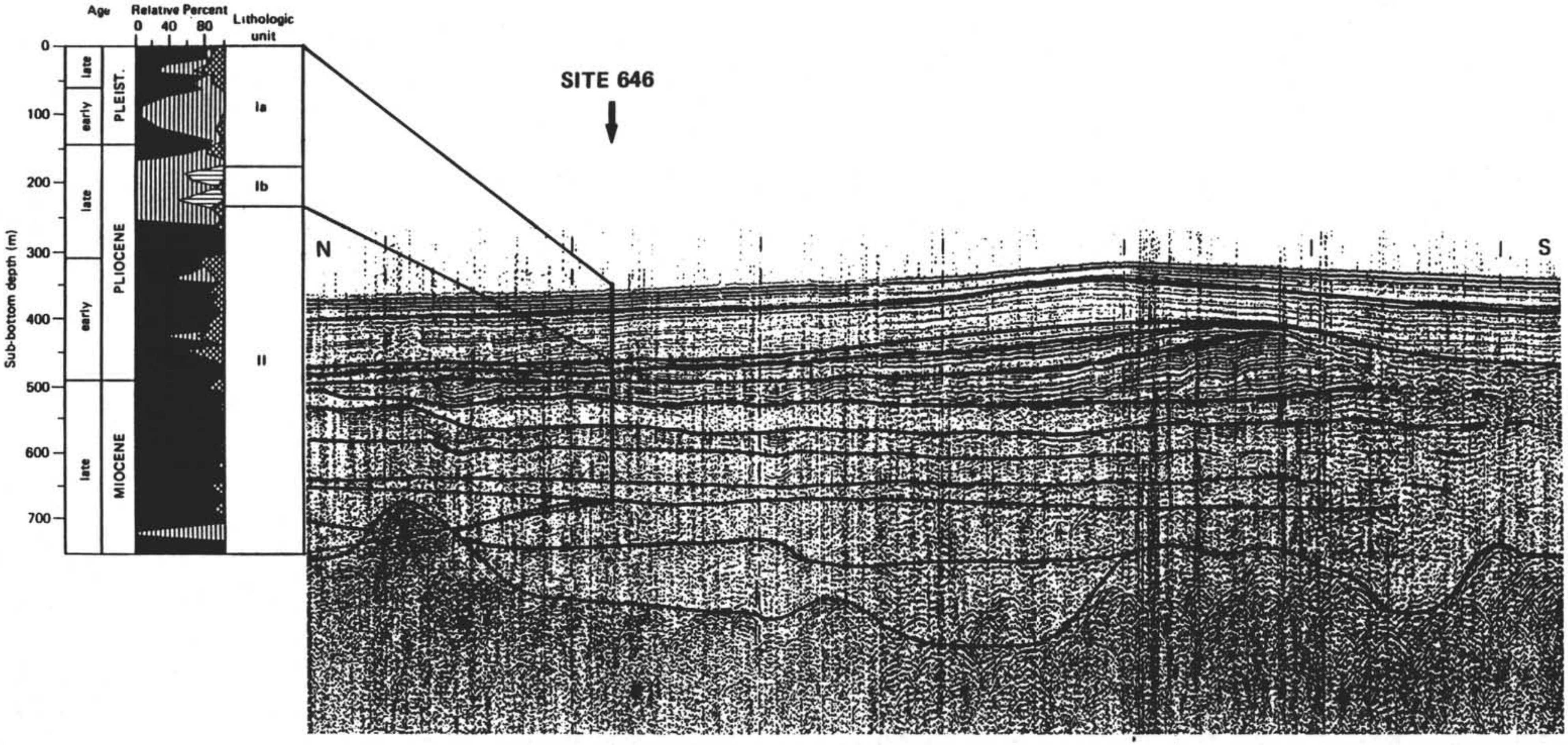

Age
Relative Percent
0 40 80
Lithologic unit
0
100
200
300
400
500
600
700
Sub-bottom depth (m)
late
early
late
early
late
PLEIST.
PLIOCENE
MIOCENE
Ia
Ib
II
SITE 646
N
S

Figure 7

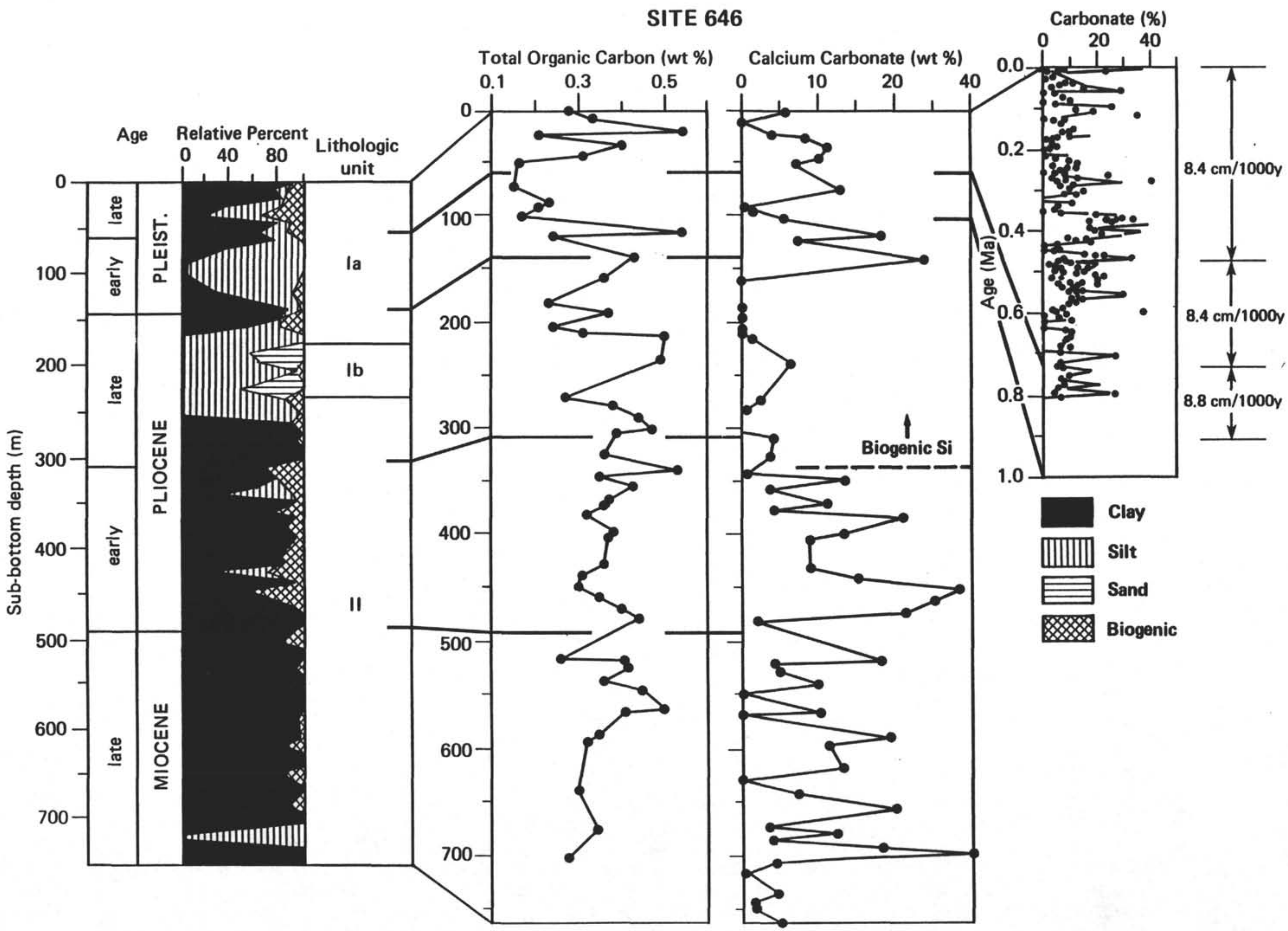
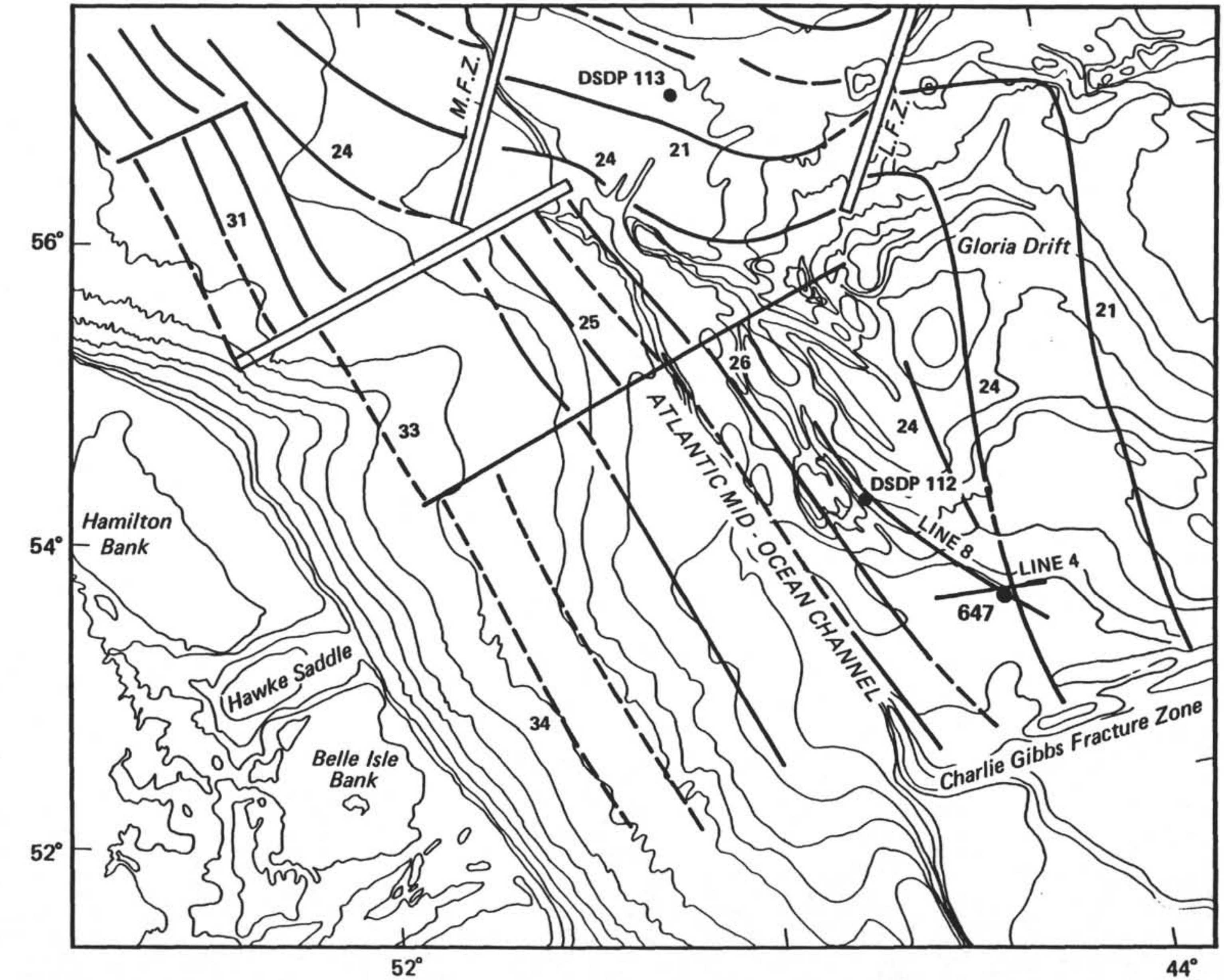

SITE 646
Age
Relative Percent
0 40 80
Lithologic unit
Sub-bottom depth (m)
PLEIST.
PLIOCENE
MIOCENE
late
early
Ia
Ib
II
Total Organic Carbon (wt %)
Calcium Carbonate (wt %)
Biogenic Si
Carbonate (%)
Age (Ma)
8.4 cm/1000y
8.4 cm/1000y
8.8 cm/1000y
Clay
Silt
Sand
Biogenic

Figure 8

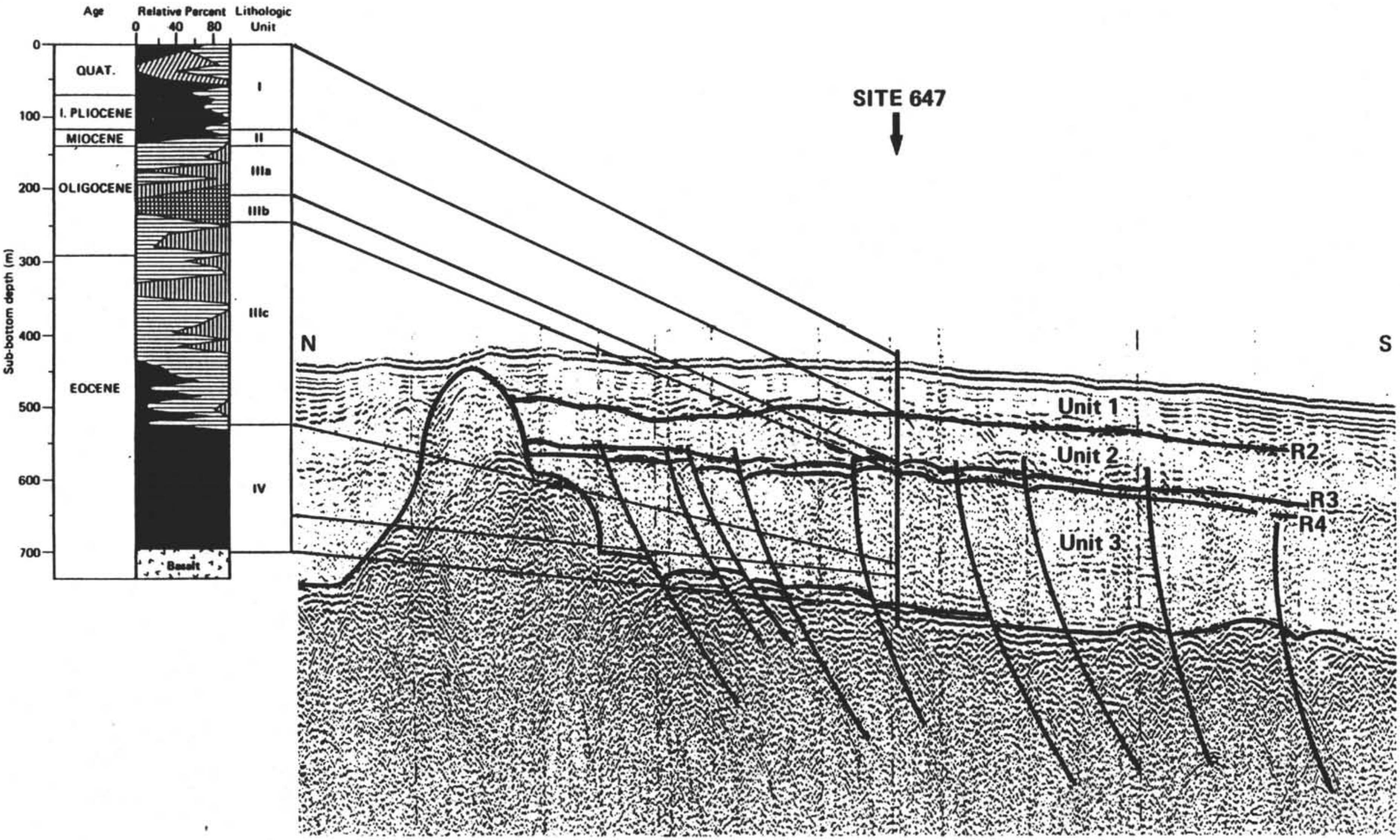


DSDP 113
M.F.Z.
L.F.Z.
24
21
31
56°
Gloria Drift
25
26
24
33
ATLANTIC MID - OCEAN CHANNEL
DSDP 112
Hamilton Bank
54°
LINE 8
LINE 4
647
Hawke Saddle
34
Belle Isle Bank
Charlie Gibbs Fracture Zone
52°
52°
44°

Figure 9


HUDSON F.Z
SNORRI F.Z
EXTINCT
AXIS
JULIANHAAB F.Z
MINNA F.Z
LEIF F.Z
CARTWRIGHT F.Z
CHARLIE-GIBBS F.Z
2000m

Figure 10



Age
Relative Percent
0
40
80
Lithologic Unit
Sub-bottom depth (m)
0
100
200
300
400
500
600
700
QUAT.
I. PLIOCENE
MIOCENE
OLIGOCENE
EOCENE
Basalt
I
II
IIIa
IIIb
IIIc
IV
SITE 647
N
S
Unit 1
Unit 2
Unit 3
R2
R3
R4

Figure 11

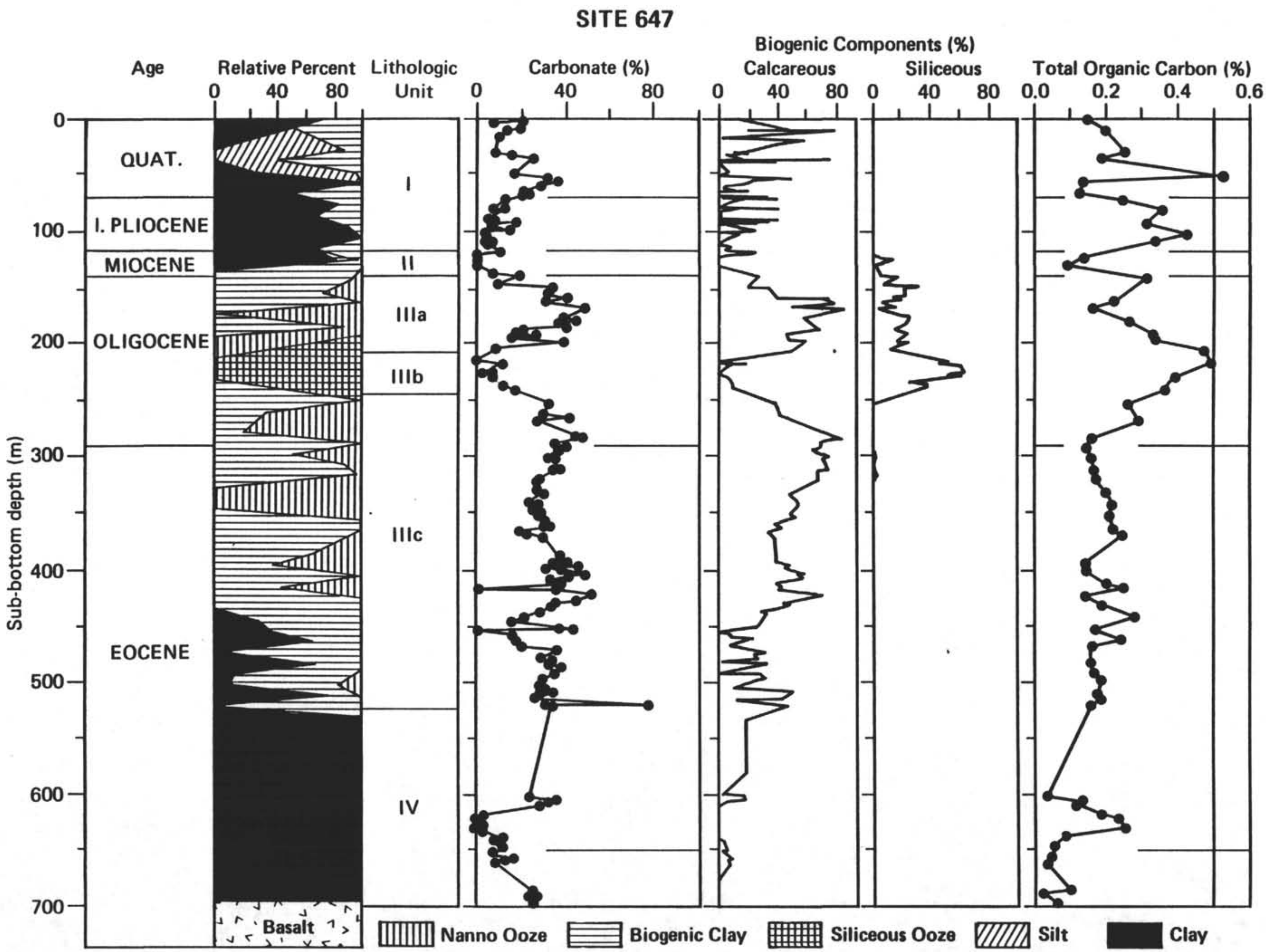

SITE 647
Age
Relative Percent
Lithologic Unit
Carbonate (%)
Biogenic Components (%)
Calcareous
Siliceous
Total Organic Carbon (%)
Sub-bottom depth (m)
QUAT.
l. PLIOCENE
MIOCENE
OLIGOCENE
EOCENE
I
II
IIIa
IIIb
IIIc
IV
Basalt
Nanno Ooze
Biogenic Clay
Siliceous Ooze
Silt
Clay

Figure 12

OPERATIONAL REPORT

The ODP Operations Superintendent aboard JOIDES *Resolution* for Leg 105 of the Ocean Drilling Program was Lamar Hayes.

INTRODUCTION

Leg 105 began on August 23, 1985 at 1930 hours when the first line was brought ashore at St. John's, Newfoundland, and ended 64.5 days later at 0715 hours 27 October 1985 when the first line went ashore at the fuel dock in St. John's, Newfoundland. The leg was the most northerly to date for JOIDES Resolution, venturing far north of the Arctic Circle. The first site for Leg 105, Site 645, was located in the southwestern part of Baffin Bay and was a scheduled re-entry site. After spending a scheduled 25 days in Baffin Bay, the ship spent the remainder of the Leg in the Labrador Sea.

The scheduled port of call at St. John's was extended by three days due to mechanical problems with the heave compensator, both piston rods were changed out in the Western Gear heave compensator. The guide rails and the traveling block/heave compensator dollies were re-aligned to eliminate side loading on the compensator rods. All repairs were completed by 0500 hours, 29 August 1985 and JOIDES Resolution was underway at 0705 hours 29 August 1985.

Time distribution for the leg was 5.5 days in port, 13.6 days cruising and 45.5 days on site. The on site time consisted of 6.96 days tripping the drill pipe, 2.62 days drilling, 27.93 days coring, 0.13 day waiting on icebergs, 2.40 days downhole measurements, 0.14 day mechanical repair time, 1.62 days re-entry time, and 3.70 days for miscellaneous times.

Under Way to Baffin Bay

By 0830 hours 29 August 1985 the tugs were released from JOIDES Resolution and she was on her way to Site BB-3B north of the Arctic Circle in Baffin Bay. The drill site was located approximately 70 miles east of

Clyde River. Thirty minutes out of the port of St. John's, we spotted our first iceberg that had run aground on the coast of Newfoundland. As we turned north, the wind out of the east made the first 6 or 8 hours of the trip uncomfortable for some of the crew members, but for the remaining part of the 5.8 day trip to Baffin Bay we enjoyed nice weather. While traveling through the Davis Straits a few whales and seals were sighted. The most common view from the decks of JOIDES Resolution were icebergs. Just south of the Arctic Circle we spotted 25 icebergs in a 24 hour period.

The ice picket vessel MV Chester was under contract to the Ocean Drilling Program to accompany JOIDES Resolution while working in Baffin Bay. MV Chester arrived on location about 36 hrs ahead of JOIDES Resolution and reported numerous icebergs in the drilling area.

On September 2, 1985 JOIDES Resolution crossed the Arctic Circle and arrived in the area of drill site 645 on September 3. The seismic gear was deployed and the site survey required 6.4 hours. to survey 48 miles. The beacon was deployed at 2145 hours 3 September 1985.

Hole 645A

The beacon was deployed at 5 kts. and the survey gear was retrieved within 30 minutes. JOIDES Resolution returned to the beacon and positioned in 2074 meters (PDR) depth.

MV Chester came alongside to transfer the ice observer/consultant to JOIDES Resolution, and he remained on board for the duration of our work in Baffin Bay. A standard APC/XCB bottom hole assembly consisting of 11 7/16 inch Smith bit, MBR, one smooth bore drill collar, 7 X 8 1/4 inch drill collars and one 7-1/4 inch drill collar (without bumper subs) was to be utilized on the first Baffin Site. The pipe was tripped in to 2070 meters and the top drive was installed. After circulating the drill string for a few minutes the APC core barrel was lowered on the sandline. The core barrel encountered an obstruction at 1990 meters. A mistake of 58 meters in the Matthews Tables interpretation was discovered. The drill string was tripped out and we found what had been suspected. The BHA had broken, leaving the bit, HBR, seal bore drill collar, landing sub, and head sub lying on the sea floor.

The lost components of the BHA were replaced, all the new components were carefully measured and calipered as the BHA was assembled. The pipe was tripped in and the bit positioned at 2014 meters (4 meters above the new PDR depth). The APC piston corer was lowered and the drill string was pressured with 3000 psi, but the shear pins apparently failed to shear. We attempted to retrieve the core barrel, but the barrel was firmly stuck in the BHA. The pipe was tripped out to retrieve the APC barrel and inspect the BHA. The inside diameter of the entire BHA was rechecked and all components were found to be within specifications. The string was tripped to 130 meters below the keel and the APC barrel was lowered. The pins sheared at 1600 psi but the core barrel stuck again. The BHA was tripped out and the lower end of the BHA was again measured and calipered. The smooth bore drill collar was changed out due to a close tolerance in the ID, but was still within specifications. We tripped in the hole and deployed the XCB and cored from 2018 meters to 2022 meters when we had a pressure drop from 1000 psi to 300 psi. The core barrel was retrieved, less everything below the drive mandrel. A nut had stripped off the mandrel. Since the lost part of the core barrel had dropped out through the bit we decided to clear the mudline and drop another XCB barrel to spud Hole 645B. The core barrel was deployed but we were unable to break circulation with 3000 psi and another trip was required to troubleshoot the BHA.

The problem was solved when we discovered an eccentric bore through the head sub causing the APC and XCB barrels to stop before seating. The head sub was replaced, after which the core barrel was passed through the new head sub and seated properly.

Hole 645B

The drill pipe was tripped to 2018 meters, and the pipe was circulated to clean the drill string. Prior to spudding Hole 645B we consulted with our ice advisor about icebergs in our drilling area. We had 6 icebergs within 12 miles, with two of these moving toward the drill site.

Hole 645B was spudded with the XCB at 0530 hours 8 September 1985. Core recovery was poor while penetrating glacially- deposited rocks and gravel, however, recovery improved below 200 meters and hole conditions were good. Core barrel #33 was dropped at 2317 meters (299 BSF). Pressure increased to 3000 psi on the attempt to circulate, then dropped to 600 psi. We retrieved the core barrel and discovered that the nut had stripped off the core barrel mandrel, and the bottom part of the XCB barrel was now in the bottom of the well bore with no chance to fish it out. That was the second failure of the drive mandrel within two days. The string was tripped out to clear the mud line. If the core barrel had not stopped the drilling on Hole 645B, the large iceberg that had moved into the red zone (4.8 miles) would have forced us to abandon the hole.

Hole 645C

While observing the iceberg, we decided to APC core the mudline. Only three cores were attempted before we were forced to give the site to a 4 million ton iceberg. The first core from the mudline resulted in 100% recovery, the second resulted in only 0.3% with a shattered core liner, and the third core netted 6 meters (and again a shattered core liner).

We cleared the mudline and offset the ship 1500 feet for a large iceberg to pass over the drill site, then continued tripping out.

Hole 645D

With the iceberg still in the red zone, the BHA was lowered to 150 meters and the RCB barrel was lowered on the sandline, the pump pressure indicated that the barrel seated properly in the BHA. We retrieved the core barrel and continued to trip the pipe in to the mudline at 2018 meters.

As had become the custom in Baffin Bay, we did an iceberg survey prior to spudding in. Eleven bergs were within 20 miles of the site, but the nearest one was 9 miles away.

The hole was spudded at 0100 hours 11 September. At 2040 meters (22 meters BSF) the bit encountered something very hard. Since only 25% of the BHA was below the mudline, we decided that the danger of breaking the BHA was too great to continue trying to drill through a glacial boulder. The bit was raised above the mudline and we offset the ship 75 feet east to re-spud Hole 645D. While drilling to 2283 meters three multishots were taken at 2107 meters 2-3/4°; at 2223 meters 2-1/4°; and the last one at 2283 meters 2-3/4°. Power to the coring winch was lost while retrieving the center bit; the problem was corrected after 1-1/2 hours of mechanical down time.

As core barrel no. 1 was deployed to start coring at 2283 meters, we had 8 icebergs in the area. Of these two were only one mile beyond the red zone and one was two miles from the red zone (red zone - 4.8 miles). We decided to core ahead on a core-to-core basis while keeping a close watch on berg movement.

The Canadian Coast Guard icebreaker Norman McLead Rogers transferred three photographers and equipment to JOIDES Resolution by helicopter. The icebreaker circled JOIDES Resolution for an exchange of photographs, then headed west to Clyde River.

Cores no. 3 through no. 7 taken from 2300 meters (282 meters BSF) to 2348 meters (330 meters BSF) netted only 0.50 meters of core. The drill string continued to rotate with no indication of extra torque or drag. It was essential that we start recovering cores because there were traces of ethane and methane gases in the small amount of core that had been recovered. From all indications, the bit probably had a glacially deposited rock lodged in the throat of the bit. To dislodge this obstruction, we deployed the center bit and drilled ahead from 2348 meters to 2358 meters.

Core no. 8 produced 4 meters of core. The gray silty clay (almost a shale) cored very well with 20,000 pounds of weight on the bit at 50 rpm, 75 pump strokes producing 650 psi of pump pressure.

Gas samples were extracted from each core as soon as the core liner was pulled from the core barrel. Due to icebergs moving toward the site, the sandline could not be lowered into the drill pipe to retrieve a core barrel without checking the position of icebergs moving in from the north and northwest.

We had recovered core no. 20 from 2483 meters (462 meters BSF) when 2 icebergs moved into the red zone. Since methane and ethane gasses had been encountered, the hole was filled with 174 barrels of 11.5 ppg mud. The pipe was then tripped out until the bit cleared the mudline. While tripping, we were surprised to find that the fresh water mud had frozen to the inside of the drill pipe, long cylinders of frozen mud would slide out on the rig floor as stands of pipe were removed from the drillstring. With two icebergs positioned in the red zone (3 mi. away), we did a soil test to determine the depth that 16 inch casing could be jetted.

The ship was offset 200' east and the pipe was circulated with seawater to wash away any ice that remained in the drillstring that might prevent the center bit from seating properly. We jetted in (without rotating the drill pipe) from the mudline at 2018 meters to 2033 meters and encountered a positive resistance at 15 meters BSF. We cleared the mudline and offset the ship 50 feet east and jetted in from the mudline to 2039 meters (21 meters BSF), firm resistance was again encountered from 12 to 15 meters BSF and again at 20 meters. Normally we would prefer to wash in at least 40 or 50 meters of 16 inch casing while setting a re-entry cone. Only 21 meters of 16 inch casing to hold a re-entry cone upright was certainly questionable but we decided that our chances of washing in more than 21 meters were not very good. With two icebergs still in the red zone the pipe was tripped out to start assembling a re-entry cone.

<u>Hole</u> <u>645E</u>

The pre-assembled re-entry cone was moved over to test on the moon pool doors under the rotary table. Seventeen meters of 16 inch casing were run and landed above the cone throat. We made a up 14- 3/4 inch bit with a jetting BHA (without bumper subs). The weld on the lower end of the 16-3/4 inch housing failed to pass through the re-entry cone and 1-3/4 hrs were lost while grinding off a weld around the housing about 4 inches above the snap ring. After 9-3/4 hours the double "jay" running tool was function tested and the reflectors were installed on the cone. Three of the four reflectors were icosahedrons, the fourth reflector was the ODP design.

The re-entry cone passed through the moonpool at 0945 hours 14 September 1985 and the trip in to the mud line required only 4-3/4 hours.

One iceberg remained in the red zone and was positioned three miles from the drill site. Since the re-entry cone with 21 meters of casing could be raised above the mudline quickly if the berg moved any closer, we decided to try jetting in the re-entry assembly.

Jetting in the 16 inch casing progressed much more slowly than we had anticipated. Stiff resistance was encountered at 12 to 15 meters BSF and again at 19 meters BSF. We released the double "jay" down and drilled ahead to 2060 meters (42 meters BSF), then "jayed" out of the re-entry cone and continued the trip out to change the bit and remove the double jay running tool.

Re-entry No. 1

The rotary coring BHA was then assembled, it consisted of: RBI C-3 9-7/8 bit, HBR, control length drill collar, nine each 8-1/4 inch drill collars and one 7-1/4 inch drill collar.

The drill string was tripped to 2008 meters and was cir- culated to wash out any excess pipe dope that might shield the sonar transducer when scanning. We rigged the logging sheaves, lowered the Mesotech sonar tool and started scanning for the re-entry cone reflectors at 1600 hrs 15 September 1985. The cone was located at a distance of 20 feet but had a very poor presentation. Offsetting the ship 50 feet to establish a better reflector pattern was tried, but the display was still bad. After scanning one hour we attempted to stab but missed the cone. The Mesotech sonar tool was retrieved. We then ran the trusty old EDO tool and started to scan, but had no presentation at all. All the circuitry was checked without locating the problem. We surmised that the transducer was out and the tool was retrieved. The tool was bench tested with no problem found, but a bad p.c. card was found in the EDO console. Again we lowered the same EDO tool, but the signal was very weak. After scanning for about 30 minutes, we decided that a re-entry could not be achieved with the weak presentation that this tool was presenting and retired the Edo tool in favor of the Mesotech. The gains were readjusted as the tool was lowered in the drill pipe and, with an improved presentation, we stabbed and verified re-entry after 20 minutes of scanning.

We deployed the center bit and drilled ahead from 2060 meters to 2319 meters. During this drilling interval multishot surveys were taken at 2164 meters (3/4) and 2319 meters (1/2). Only three cores were taken between 2319 meters and 2348 meters. This interval had been missed on Hole 645D, but, as before, recovery was poor.

The center bit was again deployed and the hole was drilled from 2348 meters to 2473 meters with one multishot survey taken at 2463 meters (1/2).

Coring started again at 2473 meters and continued to 2829 meters, at which time a large iceberg moved into the red zone. The top drive was quickly removed from the drill string and the trip out required only 1-1/2 hours. The iceberg continued to move deeper into the red zone. As Baffin Bay icebergs are unpredictable, it was decided to clear the mudline and finish the trip out and change bits rather than spend 12 to 24 hours waiting for the berg to leave the red zone.

Re-entry No. 2

An RBI C-4 bit was made up on the same BHA that was used on the first re-entry and the pipe was tripped in to 2008 meters. The plan was to re-enter and wait for the iceberg to move out of the red zone, before running to total depth.

We lowered the Mesotech sonar and started scanning and seemed to have an improved presentation. We attempted to "stab in" after scanning 1 1/2 hours, but quickly confirmed we had a mis-stab. The sonar tool was raised above the re-entry cone and after 45 minutes of scanning the second stab was attempted this proved to be another mis-stab.

The Mesotech tool was presenting too many images. We were unable to determine the reflectors from the mud circles, the rim of the cone and other reflectors on the sea floor. Again, we layed out the Mesotech sonar in favor of the Edo tool. Re-entry was achieved after scanning 1-1/2 hours. Since the iceberg had moved outside the red zone (4.8 miles) after 24 hours in residence, the pipe was tripped to bottom.

We had no fill on bottom and coring started at 2829 meters. The silty gray clays cored at an average of 8 minutes per meter with very good recovery. Coring continued without any hole problems until we had exhausted our allotted time for coring in Baffin Bay. After retrieving core no. 78 from 3165 meters (1147 BSF) the hole was circulated for logging.

Re-entry No. 3 (Logging)

A wiper trip up to 2218 meters was made to improve hole conditions for logging. 5000 to 10,000 pounds of drill string weight change was noted while pulling out and tripping back to bottom, with no fill encountered. The bit was positioned 3 to 4 meters above bottom, and a releasing go-devil was pumped down to activate the shifting sleeve of the hydraulic bit release (HBR). When the go-devil was seated in the HBR and the drill string was pressured to 1000 psi, the drill string was lowered until the bit was touching bottom. The bit release failed to separate dispite various combinations of weight applied to the bit and pressure in the drill pipe. The drill string was tripped out to remove the HBR and the rotary core bit. A logging BHA was made up and tripped in to 2008 meters. The logging sheaves were in position and the EDO sonar tool was started down the drill pipe without delay. The tool seemed to seat properly but failed to scan. The EDO tool was retrieved, and it was discovered that the landing ring was oversized, causing the sonar tool to seat too high. The transducer had been scanning inside the BHA. The landing ring was changed and the same tool was again lowered down the drill string. After scanning for 2-1/4 hours, re-entry was achieved on the first attempt. We retrieved the EDO tool and shifted the logging sheaves off to one side of the rig floor to enable the rig crews to trip the pipe in to logging depth. The logging cleanout bit was positioned at 2208 meters. The logging sheaves were repositioned and the Schlumberger logging tools, consisting of the DIL, LSS, GR and MCD, were rigged up and run down the pipe. The logging tools stopped at a firm bridge at 2260 meters (242 meters BSF). The logging tools were retrieved and the drill string was lowered to 2260 meters and cleaned out a three meter bridge. We tripped in to 2500 meters and found no evidence of additional obstructions. The drill string had been tripped out to 2315 meters when the ice observer alerted Operations that a large iceberg (which had been positioned close to the edge of the red zone) was now moving into the red zone. We decided to trip to bottom and displace the hole with weighted polymer mud since small amounts of gas had been measured in the lower 700 meters of the hole. If, for any reason, we were unable to re-enter the hole after clearing the mudline to let the berg pass, the hole would not have been abandoned properly. The hole was filled with 11 ppg polymer mud and the drill pipe was tripped out to 2093 meters. The iceberg passed within 2-1/2 miles of the drill ship but did not necessitate clearing the mudline and offsetting the ship.

The logging sheaves were again rigged up and the same logging tools that were used on the first logging attempt were lowered through the drillpipe. An impassable bridge was encountered at 2369 meters, the hole was logged up to the drill bit at 2093 meters. We retrieved the logging tools and tripped in with the cleanout bit to 2520 meters, then tripped and positioned the logging/cleanout bit at 2379 meters (285 meters lower than on the first logging run). The same logging tools were lowered down the drill pipe; at 2664 meters the logging tool hit a firm bridge and the hole was logged up to the cleanout bit. Due to time constraints, no further attempts were made to log Hole 645E. The drill pipe was tripped out and the hole was left full of weighted polymer mud.

Holes 645F and 645G

With only a few hours remaining before we were scheduled to depart Baffin Bay it was decided to make another attempt at recovering some mudline sediment with the hydraulic piston corer.

We tripped the pipe in with an APC bottom hole assembly and a 11-7/16" F94CK bit that was used previously on Hole 645B.

Hole 645F was terminated after 3 cores, when the bit encountered something hard--probably a glacially deposited rock. Only 23 meters were cored and 12.3 meters recovered. Of the three cores recovered, two had shattered liners. We raised the bit above the mudline to core Hole 645G.

Hole 645G was terminated after two cores (both core liners were badly shattered): 16 meters were cored and 8.1 meters were recovered. The core recovery was sufficiently good to define thin layers of glacial gravel just below the mudline. Since we had exhausted the allotted time for drilling in Baffin Bay, the drill pipe was tripped out and JOIDES Resolution was under way to the Labrador Sea at 1545 hours 28 September 1985.

Site 646

During our 25 days on Site 645, the ice observer plotted the course of 38 icebergs and 7 growlers. They were all moving in a south/southeasterly direction and we expected to overtake some of them on our trip to the Labrador Sea. The ice picket vessel MV Chester that had spent the past 25 days with us in Baffin Bay took a position 3 to 4 miles in front of JOIDES Resolution for the trip south. During the daylight hours JOIDES Resolution adjusted her speed to the speed of MV Chester (10 to 11 kts.); speed was reduced to 5 kts. during the night hours. Several icebergs and growlers were sighted as we moved south out of Baffin Bay. The last ice was sighted in the Davis Straits on 30 September. A medium sized iceberg was apparently breaking apart and had caused a vast ice field of growlers and smaller pieces of ice spreading over several miles.

The effects of Hurricane Gloria remained in the Labrador Sea. The storm crossed Newfoundland and moved to the east into the Labrador Sea. Two days before arriving on Site 646, winds up to 70 mph were reported on the southern tip of Greenland. Seas of 12 to 16 feet greeted JOIDES Resolution 36 hours before Site 646 was reached and remained at the site location for several days after we occupied it. The seismic gear was deployed 30 miles before crossing Site 646. We crossed the site and deployed a beacon at 0323 hours, 3 October, and surveyed on a southeasterly course for one hour before retrieving the seismic gear and returning to the beacon.

Hole 646A

Due to 14 to 16 foot seas, no movement of drilling equipment was attempted until the ship was positioned with an optimum heading. A Monel (non-magnetic) drill collar was added to the APC/XCB bottom hole assembly because core orientation was scheduled for Hole 646B. The pipe was tripped in to a (PDR) depth of 3461 meters.

We shot the mudline with the piston core and established the mudline at 3458 meters. After retrieving core no. 2, it was evident that further drilling without using the heave compensator would probably result in damage to the bottom hole assembly or we would be forced to wait on weather. We decided to try piston coring with the heave compensator in operation, a procedure that had not yet been attempted by the Ocean Drilling Program.

The core winch controls were placed in hoist position and adjusted to hold in a stalled position with about 95% of the core line and the core barrel weight before the coring line BOP closed. As the heave compensator stroked 6 to 8 feet to compensate for the ship's vertical heave the coring winch worked in unison with the heave compensator to maintain constant tension on the coring line above the wireline BOP. Hole 646A was piston cored to 3565 meters (103 meters BSF) with 92% recovery. The heat flow measurements were taken successfully in 16 to 18 foot seas. With the first hole of the double APC site completed, the drill pipe was tripped out to clear the mudline. The only problem encountered on Hole 646A was core liner failures; approximately 60% of the liners either shattered, broke or split. Near-freezing temperature may have caused embrittlement of the liners, or possible manufacturing defects may also have contributed to the failures.

Hole 646B

The ship was offset 100 feet to the northwest from Hole 646A. Gale force winds from the north were gusting over 50 kts and the swells had increased to 20/25 feet. The first two piston cores were taken with the Western Gear Heave Compensator locked. On core no. 3 the same coring procedures of coring with the heave compensator active was implemented. Shattered and broken core liners continued to effect core recovery. Oriented cores were taken on cores no. 12, 13 and 14, but due to the failure of core liners on the 3 attempts the cores were of poor quality. The scribe line was visible but there were strong indications the core was somewhat spiraled.

Before the storm was over the beacon signal was lost for a few seconds due to thruster wash across the hydrophones. The maximum excursion during this storm period did not exceed 300 feet.

At 3589 meters (131 meters BSF), Hole 646B had overlapped the depth of APC coring in Hole 646A. The formation was still nothing more than a firm ooze, but glacial dropstones were starting to appear in the cores. At the request of the scientists, XCB coring was started with core no. 15. The core liner shattering problem continued during XCB coring with frequency of failure about the same as with the APC.

After retrieving core no. 47 from 3904 meters (446 meters BSF), three hours were required to repair a leak between the swivel and the kelly hose. A four-inch thread was stripped out of a coupling. As no high pressure nipple was available the connection was welded. Apparently this failure was caused by the 12 to 14 foot heave of the ship during earlier coring operations. As the clays firmed, the ratio of liner failures was greatly reduced from what we had experienced in the top 300 meters. Coring continued until our projected TD was reached. After recovering core no. 80 the hole was circulated to condition it for logging, and a wiper trip up to 3662 meters (209 meters BSF) was made. The hole seemed to be in good condition, so the shifting tool was lowered to the bottom of the drill string without delay. The mechanical bit (MBR) was actuated on the first attempt with the shifting tool. With the end of the drill string positioned at 3663 meters, the first set of logging tools was lowered thru the drill string.

Run No. 1 (DIL-LSS-GR-CAL), was lowered to 4225 meters and logged up to 3663 meters (very good log).

Run No. 2 (GST-CNTG-NGT) was logged from 4210 meters up to the mudline (very good log).

Since nothing more than a trace of methane was measured on Hole 646B, the hole was abandoned with only seawater.

On the trip out with the drill string, 41 joints of pipe were removed from the drill string and placed in the riser hold, the joints were scheduled to be inspected in St. John's. The ship was under way to Site 647 at 2215 hours, October 14, 1985.

Site 647

As Hole 646B was being logged another front had moved in from the west and, as the ship got underway the swells were 14 to 16 feet. After an hour of trying to maintain a heading of 163 , the heading was changed by 20° to eliminate some of the 9° to 12° roll.

The ship crossed the proposed drill site from the northwest after a 5 hour survey. A beacon was deployed at 5 knots but the signal was lost as the beacon hit the water. At beacon drop the swells were running at 18 feet. The beacon missed the crest of the swell, hit hard in the trough and was probably damaged on impact.

The seismic gear was retrieved without delay and the ship returned to the vicinity of the first beacon drop. After two good satellite fixes, it was discovered that the ship was 0.6 mile from the proposed drill site. Tripping-in operations with a RCB coring BHA started immediately while the ship maintained a heading into the swell, and used the thrusters to port to travel the 0.6 miles. A second beacon was deployed in 3869 meters of water at 0930 hours, October 15. The drill string did not have the proper weight at 1924 meters, and there was evidence that the bit was plugged off. A circulating head was installed on the drill pipe and our suspicions were confirmed. We were unable to circulate with 3000 psi, so the core barrel was retrieved. The drill string was thoroughly circulated with seawater. The core barrel was deployed and normal circulating pressure was confirmed as soon as the core barrel seated.

Hole 647A was spudded at 1800 hours and the mudline was confirmed at 3869 meters.

Another in a series of weather fronts had moved in, and quickly the 50 knot winds had changed the 6 to 8 foot seas into 16 to 18 foot swells. Before this storm moved out, we found ourselves working in winds in excess of 50 knots that caused 25 to 30 foot swells and rolls and pitches of 6°. The heave compensator was stroking 16 to 18 feet. On several occasions we had power shedding when the positioning system required more than the electrical generators on line could produce. During this 72 hour period of heavy seas, there was no loss of beacon signal.

During this storm the coring operations continued without interruption. Recovery was affected because, during the period between swells, the heave compensator was not designed to stroke 18 feet fast enough to eliminate vessel motion. Weight fluctuation on the bit varied from 0 to 20,000 pounds.

By the time core no. 42 was recovered from 4247 meters (405 BSF), the weather had moderated somewhat (the seas were down to 18 to 20 feet). Fortunately this was the last storm for Leg 105.

Glacier-dropped pebbles started accumulating on the bottom of the hole and required drilling 10 meters on two occasions to improve hole conditions and core recovery. The hole was flushed with high viscosity mud on numerous occasions.

Basalt was recovered on core no. 71 from 4568 meters (699 BSF). After coring 37 meters into basalt and achieving our objectives, the hole was prepared for logging by making a wiper trip up to 200 meters BSF. About 17 meters of fill was cleaned out after the short trip. The go-devil to release the HBR was deployed and, when the go-devil seated, the HBR separated immediately with 1700 psi.

The drill string was positioned at 3999 meters for logging.

Logging run no. 1 (DIL-LSS-GR-CAL) hit an impassable bridge at 4088 meters and was logged up. The drill string to was the lowered 4125 meters for a second attempt.

Logging run no. 2 (DIL-LSS-GR-CAL), stopped at 4152 meters and was logged up. Hole conditions were getting very sticky.

No hydrocarbons were encountered while drilling to basement, but to comply with safety regulations, the hole was filled with 11.4 ppg drilling mud. The trip out was completed at 2115 hours October 23, 1985.

Hole 647B

The last hole for Leg 105 was an APC hole to use the last few hours remaining before getting underway to St. John's. The mudline was established at 3869 meters with core no. 1. A total of 11 cores were retrieved before our operational time expired. Core recovery was very good and core liner failure was minimal. Only 103 meters were penetrated and no hydrocarbons were encountered. The hole was abandoned without filling the well bore with drilling mud.

The trip out was completed and the ship was underway to St. John's, Newfoundland at 0915 hours October 25, 1985.

Core Bits

A total of eight core bits were utilized while exploring Baffin Bay and the Labrador Sea. Two of the five RBI bits that were used had oversized jets. To remedy this situation we made 1/2 inch jets in the SEDCO machine shop and welded them in place.

The first RBI 11 7/16 bit, fabricated from scratch by RBI, was used on Site 646A and B and cored 870 meters in a 60-hour period. The bit was released in the hole prior to logging, and therefore we had no chance to evaluate the bit. To efficiently maximize drilling time in Baffin Bay, bit changes were coordinated with iceberg movements rather than rotating hours or meters drilled. A comprehensive evaluation of RBI bits was not possible.

Two MSDS-type bits were used in Baffin Bay. The first bit run in Baffin Bay never had a chance, the BHA was broken due to an erroneous PDR depth reading. The second bit utilized was an 11-7/16 (XCB) core bit. After coring 304 meters in 19-1/2 hours, The bit was pulled because the XCB barrel parted, leaving the lower half of the core barrel in the hole. Three teeth were broken and one cone was very loose.

Unfortunately we didn't have many chances to recover bits for evaluation, as bits were released in the hole for logging. Multiple re-entry holes are about the only time we have a chance to run a bit to its maximum hours and retrieve it for evaluation. In our opinion, RBI bits showed good potential during limited use on Leg 105.

Bit Releases

Two hydraulic bit releases (HBR) were attempted. One attempt was unsuccessful on Hole 645E in Baffin Bay, but on Hole 647A in the Labrador Sea the HBR released within 4 or 5 minutes with 1700 psi.

The failure of the HBR to release on Hole 645E may have been caused by fill under the bit that prevented complete separation and caused formation clays to intrude into the latch segment windows, causing the two halves to jam together. When the HBR was retrieved and disassembled in the shop, we found clay and mud inside the HBR. The sleeve had shifted, but 3000 psi failed to separate the HBR.

On Hole 646B, a mechanical bit release (MBR) was utilized. A wireline trip is required to lower a shifting tool to shift a sleeve in the MBR. After ten minutes the sleeve shifted with only 500 pounds of overpull.

Re-entry Equipment

Two re-entry attempts were made with Mesotech scanning sonar. On the two attempts there were three mis-stabs and one re-entry. Three re-entries were attempted with the EDO Western sonar tool. On the three attempts there were two re-entries and one malfunction in the sonar display and one tool failure. Three icosahedron and one ODP reflector had been installed on the re-entry cone in hopes of improving sonar presentation for re-entries. The Mesotech sonar was utilized on the first re-entry attempt and as scanning for the re-entry cone started, it was evident that the experimental icosahedron reflectors failed to improve the presentation. After scanning for one hour, re-entry was attempted and resulted in a mis-stab. The presentation was cluttered by too many reflectors. Two runs were made with the EDO-Western Tool. Run No. 1 was not successful due to a faulty card in the display console. The same tool was bench tested and used on run No. 2; the signal was too weak to achieve transducer head and the tool body of the Mesotech tool. As the tool was lowered through the pipe, the power was reduced in the internal gain pot until the external gain control required the maximum setting to get calibration. The presentation was improved, but we seemed to have five reflectors instead of four. After scanning less than 1/2 hour, re-entry was achieved. The Mesotech sonar was selected for the next re-entry. After the second bit change, the presentation again was an improvement over the first re-entry attempts. We had no "back-lobeing" reflectors that were a problem on Legs 103 and 104, and most of the clutter was eliminated from the presentation, but we were still confronted with what appeared to be five reflectors, however. Apparently we chose the wrong four because we had two mis-stabs, and on the last attempt we damaged the transducer by hitting the lip of the cone (or it caught in the flapper valve). Re-entry was finally achieved with the EDO-Western tool, but the fifth reflector was very prominent as with the Mesotech sonar.

The last re-entry on Hole 645E was required when the HBR failed to release for logging. The same EDO tool was utilized and re-entry was achieved after 2 1/2 hours of scanning. The extra reflection about 8 to 10 feet from the four reflectors on the re-entry continued to complicate re-entry. We cannot explain what the reflection was or how it got there. Hole 645E was offset 180 feet from any of the previous holes. Apparently piston coring had been attempted by oceanographic vessels prior to the start of Leg 105, and it is possible that a core barrel was left sticking above the mudline.

Both ODP and SEDCO personnel that were involved in re-entry are in agreement that the reflectors should be moved out from the rim of the cone by at least 4 feet. As the sonar approaches the cone this would separate the reflector presentation from other reflections caused by the flat side of the cone, the mud skirt, and the rim of the cone. When the drill pipe is in position to stab all reflectors would be identified, thus eliminating most of the mis-stabs. The reflectors should present a square pattern, not a rectangular pattern as we now have.

Communications Summary Leg 105

During this Leg no communication problems were encountered. The Satellite Communications Terminal had been extensively serviced and tested prior to departure from St. John's. On location at high latitude in Baffin Bay, the coverage of the Atlantic Satellite was sufficient to obtain a good link for telex and voice. Radio-communications were only used as back-up and proved to be unreliable due to constantly changing propagation conditions. Fortunately we did not have to rely on it.

Later on, data-communications were also tested. The Underseas Drilling Office at College Station sends and retrieves data quite frequently. The status on data-communications between the ODP shore computer and shipboard computer is unchanged. The problems are of a complex nature.

Data-communications could play an important role in the near future. When great amounts of data are involved, the savings can be considerable compared with other modes of data transfer.

A new amatuer radio was installed during the transit from St. John's I to Baffin Bay. Over 200 successful phone patches were completed during the remainder of the leg.

Personnel

Leg 105 consisted of two distinct operational problems, the first being the 25 days spent in Baffin Bay while occupying Site 645. Even though the wind rarely exceeded 25 knots, the temperature with the chill factor created a hardship on all crew members. The Labrador Sea, the second challenge, was a test of crew and equipment. During ninety percent of the time spent in the Labrador Sea the ship was on site and positioning in 16 to 30 foot seas with winds approaching 60 knots. The drill crews accepted these harsh condition and did an outstanding job.

Coring operations were never affected by the 6° roll and pitch of the ship. Piston cores were successfully recovered while working in 25 foot swells, rotary coring was never interrupted during one storm that lasted over 72 hours with swells up to 30 feet.

The scientific staff was most cooperative and understanding throughout the leg, and were enthusiastic about the geological success of Leg 105.

The ODP technical staff did an exceptional job in handling and processing the record-setting amount of cores that were recovered.

Morale remained exceptionally high for the entire 64.5 days of Leg 105.

OCEAN DRILLING PROGRAM

TIME DISTRIBUTION

LEG 105

Total Days (August 23, 1985-October 27, 1985)	64.5
Total Days in Port	5.5
Total Days Cruising including Site Survey	13.6
Total Days on Site	45.5
Trip Time	6.96
Drilling Time	2.62
Coring Time	27.93
Logging Time	2.40
Reentry Time	1.62
Mechanical Repair Time	.14
Wait on Weather and Icebergs	.13
Other Miscellaneous	3.70
Total Distance Traveled (Nautical Miles)	2746
Average Speed Knots	10.5
Number of Sites	3
Number of Holes Cored	12
Total Meters Cored	2960
Total Meters Recovered	1884
Percent Recovered	63.6
Total Meters Drilled	720.4
Total Cores Attempted	316
Total Meters of Penetration	3679
Maximum Penetration	1146.9
Maximum Water Depth	3870

OCEAN DRILLING PROGRAM
TIME DISTRIBUTION
LEG 105

DATE	SITE NO.	CRUISE	TRIPS	DRILL	CORE	WOW	WAIT ON ICE	DOWNHOLE MEASURE.	MECH REPAIR	PORT TIME	REENTRY	OTHER	TOTAL TIME	REMARKS
8/23/85										4.50			4.50	Port Call Activities
8/24										24.00			24.00	Port Call Activities
8/25										24.00			24.00	Port Call Activities
8/26										24.00			24.00	Port Call Activities
8/27										24.00			24.00	Repair heave compensator
8/28										24.00			24.00	Repair heave compensator
8/29										7.00			7.00	Repair heave compensator
8/29		17.00											17.00	
8/30		24.00											24.00	
8/31		23.50											23.50	Retard Clock 1/2 hour
9/1/85		24.00											24.00	
9/2		24.00											24.00	
9/3		24.00											24.00	
9/4		3.00											3.00	

DATE	SITE NO.	CRUISE	TRIPS	DRILL	CORE	WOW	WAIT ON ICE	DOWNHOLE MEASURE.	MECH REPAIR	PORT TIME	REENTRY	OTHER	TOTAL TIME	REMARKS
9/4	645A		16.00		5.00								21.00	
9/5			10.50		3.50							2.50	16.25	
9/5	645B		1.50									6.25	7.75	
9/6			6.75		2.50							14.75	24.00	
9/7			3.25		19.00							1.75	24.00	
9/8					24.00								24.00	
9/9			4.50		17.75							1.75	24.00	
9/10			1.75		1.50							1.00	4.25	
9/10	645C		5.50		5.25								10.75	
9/10	645D		9.00										9.00	
9/11			1.00	21.75								1.25	24.00	
9/12					24.00								24.00	
9/13			5.25		11.25							1.00	24.00	Jet in test.
9/14	645E		6.75	7.50								9.75	24.00	Reentry hole.
9/15				12.25							7.00	4.75	24.00	
9/16				14.25	4.00						5.75		24.00	
9/17					24.00								24.00	
9/18					24.00								24.00	
9/19					23.50		.50						24.00	
9/20			8.75		1.00						14.25		24.00	
9/21			1.75		10.25		1.00				4.00	7.00	24.00	
9/22					24.00								24.00	
9/23					24.00								24.00	
9/24					24.00								24.00	
9/25			11.25		6.75							6.00	24.00	
9/26			9.25				1.50	5.25			8.00		24.00	
9/27			4.00				.25	19.75					24.00	
9/28	645F		4.25		5.50								9.75	
9/28	645G		3.25		2.75								6.00	
9/28		8.25											8.25	
9/29		24.00											24.00	
9/30		24.00											24.00	
10/1/85		24.00											24.00	
10/2		24.00											24.00	
10/3		3.50											3.50	
10/3	646A		8.25		8.00							4.25	20.50	
10/4			.75		8.25								9.00	
10/4	646B				13.75							1.25	15.00	
10/5					24.00								24.00	
10/6					24.00								24.00	
10/7					23.25				.75				24.00	
10/8					21.25				2.75				24.00	
10/9					24.00								24.00	
10/10					24.00								24.00	
10/11					24.00								24.00	

DATE	SITE NO.	CRUISE	TRIPS	DRILL	CORE	WOW	WAIT ON ICE	DOWNHOLE MEASURE.	MECH REPAIR	PORT TIME	REENTRY	OTHER	TOTAL TIME	REMARKS
10/12			3.00		9.75			8.25				3.00	24.00	
10/13			9.25					13.00					22.25	
10/13		1.75											1.75	
10/14		24.00											24.00	
10/15		9.50											9.50	
10/15	647A		8.50		6.00								13.50	
10/16					24.00								24.00	
10/17					24.00								24.00	
10/18					24.00								24.00	
10/19					24.00								24.00	
10/20				5.00	19.00								24.00	
10/21				2.25	21.75								24.00	
10/22			4.50		15.50							4.00	24.00	
10/23			6.75					11.50				3.00	21.25	
10/23	647B											2.75	2.75	
10/24			4.00		19.00							1.00	24.00	
10/25			7.75		1.50								9.25	
10/25		14.75											14.75	
10/26		23.50											23.50	Advance Clock 1/2 hour
10/27		7.25											7.25	

OCEAN DRILLING PROGRAM
SITE SUMMARY
LEG 105

HOLE	LATITUDE	LONGITUDE	DEPTH METERS	NUMBER OF CORES	METERS CORED	METERS RECOVERED	PERCENT RECOVERED	METERS DRILLED	TOTAL PENET.	TIME ON HOLE	TIME ON HOLE
645A	20°27.43N	64°39.26W	2017	1	5.	4.9	98	------	5	37.25	37.25
645B	20°27.43N	64°39.26W	2018	32	298.9	171.7	57	------	298.9	108.00	145.25
645C	20°27.43N	64°39.26W	2018	3	23.3	10.9	46	------	23.3	10.75	156.00
645D	20°27.43N	64°39.26W	2018	20	183.2	106.4	58	275	458.2	81.00	237.00
645E	20°27.43N	64°39.26W	2018	78	720.9	536.4	75	426	1146.9	335.50	572.50
645F	20°27.43N	64°39.26W	2018	3	23.	12.3	53	------	23.0	9.75	582.25
645G	20°27.43N	64°39.26W	2019	2	16.	8.1	51	------	16.0	6.00	598.25
646A	58°12.48N	48°22.235W	3461	11	103.5	92.1	89	------	103.5	29.50	29.50
646B	58°12.48N	48°22.235W	3458	80	766.7	402.8	53	------	766.7	229.50	259.00
647A	53°19.902N	45°15.700W	3869	75	716.6	445.2	62	19.4	736.0	206.75	206.75
647B	53°19.902N	45°15.700W	3870	11	103.3	93.2	90	------	103.3	36.00	242.75
			TOTAL	316	2960	1884	63.6	720.4	3679.8		1100.00

OCEAN DRILLING PROGRAM
BIT SUMMARY
LEG 105

HOLE	MFG.	SIZE	TYPE	SERIAL NUMBER	METERS CORED	METERS DRILLED	TOTAL PENET.	CUMULATIVE METERS	HOURS THIS HOLE	TOTAL HOURS	CONDITION	REMARKS
645A	MSDS	11-7/16	F-93	NO S/N	0	0	0	0	0	0	Lost in hole	Broken BHA
645B	MSDS	11-7/16	F-93	S-64	5		5	5		5		
645C	MSDS	11-7/16	F-93	S-64	299	0	299	304.	19.75	19.75		Core Bbl. parted.
645C	MSDS	11-7/16	F-93	S-64	23	0	23	327.	.25	20.00	BT-3B5 TG	APC/XCB
645D	RBI	9-7/8	C-3	AR010	183.2	275.2	462.8	462.8	20.	20.	BT3-B1-IG	Iceberg close by.
645E	Reed	14-3/4	S1BGJ	D05627		42	42	42	7.75	7.75	New	Jet in 16" casing
645E	RBI	9-7/8	C-3	AT 123	385	383.5	811	811	29.50	29.50	T1,B5,IG	
645E	RBI	9-7/8	C-3	AS009	336	0	336	336	19.50	19.50	T3,B1,IG	Good run
645F	MSDS	11-7/16	F-93	S64 RR	23	0	23	359	0	1950		APC
645G	MSDS	11-7/16	F-93	S64 RR	16	0	16	375	0	1950	BT3,B5,1G	APC
646A	RBI	11-7/16	C-4	NFN466	103.5	0	103.5	103.5	1.5	1.5	INC	APC INC.
646B	RBI	11-7/16	C-4	NFN466	766.7	---	766.7	870.2	58.5	60	MBR-LOG	Good run
647A	RBI	9-7/8	C-4	AT 129	716.6	19.4	736	736	33	33		
646A	MSDS	11-7/16	F-93	S64 RR	103.2		103	103	1.5	21	BT3-B5 1G	OK for mud line

OCEAN DRILLING PROGRAM
BEACON SUMMARY
LEG 105

SITE NO.	MAKE	FREQ. KHz	SERIAL NUMBER	SITE TIME HOURS	WATER DEPTH	REMARKS
645	Datasonics	16.5	197	624	2018	Rerun from Leg 104. Used 30 hrs.
645	Datasonics	14.5	195	350	2018	
646	Datasonics	15.5	199	240	3461	
647	Datasonics	15.5	183	0		Hit hard when deployed in 20 ft. seas
647	Datasonics	14.5	182	242	3870	

LOGGING REPORT

Logging personnel aboard JOIDES Resolution for Leg 105 were:

Logging Scientist:	Richard Jarrard
Schlumberger Logger:	Steve Diana

Three holes were logged during Leg 105: 645E (Baffin Bay), 646E (NE Labrador Sea), and 647A (SW Labrador Sea). At all three sites the first logging run was the Schlumberger LSS-DIL-MCD-GR tool. At one site, Site 646, a second logging tool was also used, the Schlumberger GST-CNTG-NGT tool. At all three sites, logging was preceeded by hole conditioning, consisting of raising and lowering the drill string (a wiper trip). At no site were hole conditions favorable enough for logging the hole through the drill string. Breakdowns occupied a combined total of only three hours at the three sites; all involved cable and cable head problems. The wireline heave compensator was used during nearly all logging runs.

At Site 645, a succession of shale bridges were encountered, three times requiring removal of the tool from the hole in order to lower pipe through bridges. A total of 221 meters of usable open-hole logs were obtained, spanning the intervals 200.1-242.9 and 280.5-455.2 mbsf. The resistivity (DIL) and gamma ray (GR) logs were good quality, the caliper (MCD) log was fair while logging down but poor logging up, and the sonic (LSS) was initially fair but improved to good by reprocessing of raw travel times. Of 36 hours allotted for logging this site, 23.5 hours were actually available for logging, due to delays associated with bit release and icebergs.

Scientific results of logging at Site 645 focused on seismic and lithologic unit boundaries. A synthetic seismogram based on the sonic log was consistent with a seismic profile across the site, providing a link from core depth to seismic time and helping to locate a major seismic boundary in the cored interval. Lithostratigraphic studies had previously located a unit boundary, corresponding to the onset of major ice-rafted dropstones, as occurring somewhere within a 30 meter interval with no core recovery. Logs spanning this interval were used to identify a substantial change in log properties that may correspond to this boundary.

At Site 646 very good hole conditions were encountered, permitting logging of nearly the entire cored interval. Cavings stopped both the LSS-DIL-MCD-GR and GST-CNTG-NGT logging runs only about 14 meters from maximum drilled depth. The LSS-combination tool was logged both down and up from the beginning of open hole at 205 meters to 751 mbsf. The GST-combination, consisting of a gamma spectrometry tool (GST), neutron porosity tool (CNTG) and natural gamma ray tool (NGT), was logged up in two passes: from 362 mbsf to 14 meters above sea floor, then from 743 to 234 mbsf. The short interval logged above sea floor was for the purpose of calibrating log responses through pipe. All logs were good to very good quality, with three exceptions: 1) no upgoing caliper was obtained, 2) initial GST reliability was marginal, requiring future reprocessing, and 3) sonic quality was excellent. Eighteen hours were allotted and 20 hours used for logging this site.

The principal scientific contribution of logs from Site 646 was a complete tie between core depth and seismic time, through a synthetic seismogram. Due to time constraints, drilling was terminated at this site without clear indications that the target seismic horizon had been reached. The synthetic seismogram, based on the sonic log, verified that this horizon had been reached. A major change in log responses was identified at 336 mbsf, corresponding with a change from biogenic silica (diatoms) to biogenic calcite. The log responses indicate that a major change in clay mineralogy is also likely at this horizon. Lithologic and porosity changes were also identified at several other seismic, sedimentological, and paleontological horizons.

Site 647 encountered very poor hole conditions despite hole conditioning with pipe. With two logging passes separated by a lowering of pipe past bridges, a total of 146 m of usable open-hole logs was obtained from the interval 114-274 mbsf. Eleven of 16 allotted hours were used. Log quality for the DIL, GR, and MCD logs was good; the LSS sonic was improved from fair to good through reprocessing. The upgoing caliper again failed, due to jamming with mud.

The interval logged at Site 647 corresponds to a lithostratigraphic interval from lowest Unit I to upper Unit III-C. The major scientific result of logging at this hole is the confirmation that Units II to III-B have extremely high porosities (70-90%) and low velocities (1.55 km/sec) in spite of their substantial depth below sea floor; strong seismic reflectors are implied. The abundance of diatoms in these sediments is probably responsible for these anomalous velocities and porosities. At all three sites velocities are found to be primarily controlled by porosity, with lithologic matrix velocity playing only a small role.

In addition to lithologic variations between sites, three factors may help to explain the much better hole conditions for logging at Site 646 than at 645 or 647: 1) Site 646 was drilled with a larger diameter bit (XCB) than the rotary core bit used at the other two sites, 2) Site 645 was filled with mud and Site 647 was flushed with mud, possibly inducing some swelling of clays, and 3) Site 646 employed the most thorough hole conditioning prior to logging. In spite of the problems with bridges at Sites 645 and 647, logs from all three sites were scientifically fruitful.

TECHNICAL REPORT

The ODP Technical and Logistics personnel aboard JOIDES Resolution for Leg 104 of the Ocean Drilling Program were:

Laboratory Officer:	Ted "Gus" Gustafson
Curatorial Representative:	Steve Printz
System Manager:	Dan Bontempo
Chemistry Technician:	Bradley Julson
Chemistry Technician:	Tamara Frank
Electronics Technician:	Randy Current
Electronics Technician:	Dwight Mossman
Yeoperson:	Wendy Autio
Photographer:	John Beck
Marine Technician:	Roy Davis
Marine Technician:	Larry Bernstein
Marine Technician:	Bettina Domeyer
Marine Technician:	Henrike Groschel
Marine Technician:	Harry "Skip" Hutton
Marine Technician:	Jessy Jones
Marine Technician:	Mark "Trapper" Neschleba
Marine Technician:	Frank Rack
Marine Technician:	John Weisbruch
Weather Observer:	Vernon Rockwell

INTRODUCTION

Leg 105 began in St. John's, Newfoundland, on August 23, 1985, and ended 64-1/2 days later in St. John's, after 59 days at sea. The scientific objectives of this cruise called for holes to be drilled above the Arctic Circle and south of the tip of Greenland, to help answer many geological questions regarding the evolution of these small ocean basins. Over 1800 meters of core were recovered from ten holes drilled at three site locations in Baffin Bay and the Labrador Sea. Over 9000 samples were taken for shipboard and shorebased studies. Downhole logging was attempted in three holes. Weather observations were made daily.

While in Baffin Bay and on the transit south to the Labrador Sea, ice observations were conducted from both the rig and our chartered ice picket vessel MV Chester. Underway geophysical data were collected for site survey purposes. Expendable bathythermograph (XBT) data were collected while underway as well as HIGHRES navigation data and satellite position fixes.

ST. JOHN'S PORT CALL I

A total of 5-1/2 days were spent in port prior to embarking on Leg 105. The original departure date scheduled for August 27 was delayed until August 29 due to prolonged repairs to the heave compensator and guide rail alignments. Port call work included routine incoming and outgoing freight shipments, technical representative assistance with streamer cable repairs, and local purchases. Material for modifications to the lab stack air supply line was purchased and a bypass supply line installed to supply the lab stack with uncontaminated air from upstream of the antifreeze injection system. The additional port time was used by the scientific party for meetings. The scientific party was instructed in the use of survival suits and shown safety films on hypothermia. The installation of additional chemistry equipment was started. The rig was visited by representatives of the Canadian Government and a film crew in preparation for various tours scheduled for our return to St. John's.

CRUISE ACTIVITIES

Drilling activities got off to a bad start in Baffin Bay. A computation error of 58 meters when interpreting Matthews Tables predicted the sea floor to be deeper than it actually was. This resulted in a lost bottom hole assembly (BHA). After making up a new BHA, it was impossible to seat or recover either APC or XCB coring tools. This resulted in several round trips until the head sub in the BHA was found to have an out-of-alignment internal bore. Two XCB drive mandrels broke also, adding additional problems. Piston coring attempts resulted in two out of three liners returning shattered. This was no surprise, however, as Leg 104 advised us to expect shattered liners in these cold waters.

A total of six holes were eventually spudded at Site 645 in Baffin Bay. A re-entry cone was deployed at Hole 645E. Re-entry operations were not without problems. A total of six wireline runs were made for the two re-entries on this hole. Both Mesotech and Edo re-entry systems experienced problems. The Edo system had deck console problems which were repaired. The Mesotech system required tuning down the internal gain and reducing the coupled transducer signal. This worked well until the transducer was damaged. There are several suggestions for improving re-entry operations and the Mesotech tool:

1. Return tool to vendor for repairs and possible modifications.
2. Have ODP personnel work closely with vendor to determine what modifications should be made.
3. Make provisions to move reflectors outward from the cone edge. This will help eliminate confusion caused by the close proximity of the reflectors to the angular internal reflecting corners of the cone. Shipboard personnel have already discussed various means of moving the reflectors outward and it appears to be no major problem.

Use of icosahedron reflectors this leg indicates the reflector gives a stronger reflection and a smaller return with no noticeable improvement.

Joining us on location in Baffin Bay was a 3-man film crew who remained with us approximately 12 days, filming virtually all aspects of ship and lab operations. They were transferred aboard via helicopter from a Canadian Coast Guard Vessel and eventually returned to Clyde River via the MV Chester.

Logging was attempted in Hole 645E. Poor hole conditions precluded logging the entire depth of hole. The tool was retrieved from the hole four times to clean out bridges. Polymer mud is thought to have reacted with the hole causing some swelling of the mud and shales.

Deeper scientific objectives could not be reached at this site. The hole was considered successful nonetheless and the scientific and drilling information collected will greatly enhance future interpretations of basin evolution.

Prior to departing Baffin Bay for the Labrador Sea, we were joined on location by the Canadian vessel RV Hudson. Aboard the Hudson were spares for our underway geophysics lab and personal mail for ODP and SEDCO crews. They were transferred to our ship via the ice picket vessel MV Chester. The mail bags provided a morale boost to the crews and efforts on behalf of ODP and SEDCO to make it happen were much appreciated by the crews.

Two site locations were occupied in the Labrador Sea. Site 646 was the northernmost site. Two holes were drilled at this location. It is interesting to note that for the first time ever, the coring winch, due to its unique ability to power down, was used as a motion compensator, allowing the rig to take oriented piston cores and heat flow measurements in gale force winds and 25-foot seas. It should also be noted that the ship was very close to its maximum operating limitations in station-keeping abilities, heave compensation, and human safety factors on the rig floor. Scientific objectives were easily reached at this site. Open hole logging runs were of excellent quality.

Drilling operations at Site 647 were successful. The ship was again pushed to its operating limits by high winds and seas. Deep scientific objectives were accomplished with a single rotary-cored hole to basement. A second hole was cored using the APC for high resolution upper section objectives. Open hole logging was attempted with poor success due to bad hole conditions. It should be noted that the wireline motion compensator developed by Schlumberger was successfully used at both site locations in the Labrador Sea. A visible lack of spare parts could compromise its future use.

Geophysical gear was not routinely deployed on transits except for site selection and related survey requirements. By ODP request, navigation header data was routinely collected on all transits regardless of whether geophysical gear was deployed or not. Current feelings regarding Masscomp crashes are that, most likely, vibration is affecting the Cipher drives, which causes the crash. Dirty power may still be a concern. A new problem has developed with the 3.5kHz sonar system, which should be monitored. A 100k-ohm continuity from the transducer elements to ship's hull has been recently measured. If the problem gets worse individual elements may have to be eliminated from the array. Although little used this cruise, the magnetometer system is operational.

LABORATORY OPERATIONS

Most laboratory operations continued to improve. However, there are some areas of concern:

A. We have tried without complete success to follow catwalk core cutting conventions developed by the shorebased curatorial and computer groups. It was necessary to alter established convention on several occasions to fit shipboard reality in a practical, expedient manner. Our quick fix solutions most likely do not address all curatorial concerns and will be discussed on the beach.

B. There have been and continue to be many problems associated with software developed outside the computer services group. This is reported in detail in the system manager's report for Leg 105. Copies of this report can be obtained from the computer services group or logistics department. The problems noted are perhaps the most visible and glaring ODP shipboard deficiencies to date. These problems should be addressed in the near future as it reflects poorly on several interest groups within ODP.

Overall, the computer facility appears to have reached a steady state operational level. No major hardware or component failures caused system down time. The removable RA-60 disc drive quit working early in the cruise; troubleshooting the problem was impossible, and a service call was scheduled for St. John's. Several Pro-350's failed, but there were sufficient spares for adequate coverage. The small cartridge tape drive is inoperable and scheduled for service in St. John's. Two VT240 terminals failed and will either be repaired in St. John's or shipped home. There have been several printer and plotter problems. The backup VAX was periodically tested. No apparent problems were encountered. Official CSG software did not change much this cruise. Preliminary copies of MODCOR and MODSAM were sent for testing as time allowed. As on all previous cruises, classes were held for scientists and technicians in introductory and advanced CT*OS, P/OS, JAX orientation, SAM introduction, and Vax. A dual density tape drive was supplied by LDGO for the purpose of copying logging tapes. No further progress has been made to date with Modem data communication. The status is as it was on Leg 103. A service representative is scheduled to visit the ship in St. John's. Scientists this cruise made good use of newly acquired graphics and a plotting package after methods were developed by the system manager to adapt it to our specific needs. Several scientists formally requested and were supplied with copies of data tapes which they were using on the ship.

Physical properties equipment suffered a setback when, early in the cruise, attempts to slow the new motorized vane shear resulted in several motor controller components burning out. No spares were available; they have been ordered. The old DSDP vane shear was dusted off and pressed into service. Two sonic velocity transducers were discovered to be inoperable and returned to ODP for repair or replacement. The physical properties specialist wrote several programs on the Pro for use with vane shear and pycnometer data. Problems with other lab equipment were minimal.

The multishot tools were run on numerous occasions with only one malfunction. This occurred due to a loose shaft in the timing mechanism which allowed two of the gears to disengage. The shaft was repaired and the camera used without incident.

The Von Herzen HPC heat flow tool was used on three occasions. Although useful data were produced, the time and effort expended to get it was considered unacceptable. Until WHOI can make the necessary program improvements, the system cannot be considered to be operational. Detailed technical information on the nature of the problems has been given to Elliott Taylor for review and presentation to WHOI.

The magnetics lab was heavily used this cruise. The cryogenic magnetometer is continuing to undergo minor procedural and mechanical improvements. The boil-off problem has been somewhat resolved. Leaking fittings and popoff valves have been a big cause of the boil-off problem. 2G is going to supply us with new popoff valves in the near future. Several pieces of equipment are being returned to 2G for modification, calibration, and testing. Liquid helium will be topped off in St. John's.

The chemistry lab experienced its share of problems. One gas chromatograph (GC) developed troubles which required a service representative in St. John's. The trouble fortunately developed after completing our work in Baffin Bay where the gas chromatographs were used extensively. The source rock analyzer quit operating properly while still drilling in Baffin Bay. The cause of its problem was a faulty heater wire. With no spares aboard, the unit was retired pending the arrival of a new heater wire in St. John's. One of the hydrogen generators has been returned to ODP for repairs. Both of the digital computer driven Cahn balances were broken when a tweezer snagged the weighing stirrup and broke the microspring. The two broken balances have been shipped to ODP for repairs. There was considerable interest in carbonate analysis of the piston cores recovered at Site 646: approximately 300 bomb analyses were requested in excess of the routine analyses. In Baffin Bay, routine monitoring of gasses C_1-C_6 were carried out with vacutainers on GC-2. GC-1 was used for headspace analysis but soon developed problems and became of little use. Hydrofluoric acid was used only once the entire cruise. The safety guidelines developed on Leg 104 were followed. Other preparations using ZnBr or HCl were substituted for hydrofluoric acid by the palynologists. Replacement overhead panels are required for one of the fume hoods and will be ordered.

Filter kits for all thin section lab vacuum pumps have been ordered to help eliminate annoying oil mist vapors and smoke. No major problems were encountered in this lab. The lab workload was very light.

Over 200 X-ray diffraction (XRD) samples were analyzed before troubles forced the unit to be shut down. A technical service representative will make the necessary repairs to the system in St. John's. Troubleshooting efforts at sea were hampered by the lack of proper documentation for our specific goniometer unit.

The scanning electron microscope (SEM) lab was used extensively while drilling in Baffin Bay. The SEM unit caused some difficulties during initial setup and testing. Troubles were traced to an opamp. It was necessary to substitute a replacement opamp as the correct spare was not available. The proper spares and specialty transistors have been ordered. Materials to plumb up our Haskrus heat exchanger pump unit to the chill water system has been ordered by SEDCO.

Photographic lab operations went very well, with few problems with lab equipment. A new core camera was installed in the core lab, as well as additional strobe heads. The camera worked flawlessly and the strobes provided more even lighting. A silver recovery unit was installed on the Kreonite processor. Additional shelving was put in to hold chemicals for the EC-AR process. No equipment problems could be attributed to the rough weather encountered in the Labrador Sea. Dirty potable water still continues to be a problem.

The yeoman reported a series of "diskette crashes" near the end of the cruise. The crashes wiped out numerous Hole Summary reports. The cause of the "crashes" is thought to be increased static electricity, possibly because of extremely low humidity. Xerox problems kept the electronics technicians (ETs) quite busy at times. Proper schooling for all our ETs is recommended, as well as a more comprehensive selection of spare parts and specialty tools for Xerox maintenance.

Lounge furniture may not last as long as expected. Already several wood pieces are showing signs of splitting at glue joints and one couch has required structural repairs. The overhead fluorescent light fixtures have been rewired so that each end of the lounge can be controlled independent of the other. This improvement allows for simultaneous movies and reading or games. An alternative floor cover for the hallway and Xerox room should be considered. The carpet is difficult to maintain and is becoming an eyesore.

STOREKEEPING

Storekeeping still requires significant efforts with both the physical tasks involved and key entry work with MATMAN. These efforts are gradually showing positive results. No major program changes to MATMAN were made this cruise. The organization and labeling of physical storage areas is continuing. A list of improvements suggested by shipboard personnel will be presented to the Logistics Office. If implemented, they should help reduce some of the storekeeping workload on the ship.

PERSONNEL

The technicians are becoming skilled in their areas of assigned responsibilities. We have begun to shift various personnel into other areas of responsibility. This will help strengthen and diversify group skills, making our technicians even more versatile and valuable. It is recommended that technical training and specialty school time be made available as timing and budget permit. It is a credit to the professionalism of the group to have maintained good morale throughout this 59 day cruise under adverse conditions. Mail sent to the rig via RV Hudson and the new ham radio equipment helped to keep spirits high.

SAFETY

Technicians are being rotated through the Marine Emergency Technical Squad responsibilities at the rate of four per cruise. Laboratory safety and emergency procedures are being continually improved upon during training sessions with SEDCO. A M.E.T.S. notebook outlining current emergency safety procedures has been started.

It has recently been brought to the laboratory officer's attention by the chief engineer that water systems servicing the lab stack can be shut down automatically when load shedding. The shipboard electrical supervisor confirms that this can happen. This is felt to be a potentially hazardous situation for those working with chemicals in the lab.

An up-to-date specific list of laboratory deficiencies has been compiled and presented to the Leg 105 Operations Superintendent.

Weather Summary for Leg 105

Low pressure moving into St. John's on the day of our departure brought strong gusty winds and scattered rain showers. As we proceeded north, away from the low, we came under the influence of high pressure centered over Greenland. Our first week on Site 645 brought light winds and calm seas. Only on a few occasions during our visit to Baffin Bay did the weather become disturbed. These disturbances were the result of both low pressure troughing northwestward through Davis Strait and Baffin Bay and the movement of migratory lows across our drilling site.

Although we were in the vicinity of many icebergs, bergy bits and growlers, they had little effect on drilling time. Moving south from Baffin Bay through the Davis Strait we had our final encounter with ice. At the southern end of the straits we passed through a field of numerous growlers and ice chunks of varying sizes. These were apparently the remains of a berg that had broken up.

As we continued our transit south from the Davis Strait we came into the Labrador Sea behind a departing lady named "Gloria". The remains of this hurricane had regenerated upon reaching the Labrador Sea and a tight pressure gradient had developed. The results were gale force winds and fifteen foot seas on our arrival at Site 646 (150 meters southwest of the southern tip of Greenland).

Site 646 produced a challenge for the ship from a weather standpoint. Although we were north of the normal storm track for October, our location was between the low pressure systems moving around us to the south and east and high pressure ridging in from the west. This produced a tight gradient and a strong northwesterly flow. With the exception of one day, our winds were in the 25 to 35 knot range with gusts as high as 51 knots. Our seas averaged 12 to 15 feet with a high of 25 foot swells.

Having gained some experience with strong winds and high seas we were ready for what Site 647 had to offer. As we moved the 350 miles to the southeast we were met with gale-force winds (34-40 knots) and 18 to 20 foot seas. These conditions were produced from a low of storm intensity (winds 48-55 knots) 120 miles to the east of our site.

The marine climatic atlas shows, for the month of October, that Site 647 was located at the convergence of the primary and secondary storm center tracks. Our winds and seas attested to the fact that this was an accurately determined track.

The last site of Leg 105 was a steady procession of low pressure systems. During our first five days we were buffeted by winds of 30 knots or greater. During one 48 hour period, on the 18th and 19th of October, we experienced sustained winds of 35 knots or greater and gusts to 56 knots (that being in the violent storm range).

Our seas usually averaged 15 to 18 feet with the exception of the 48-hour period mentioned above. During this period the seas were 20 to 25 feet, rising as high as 30 feet.

We usually had brief interludes of approximately 12 hours between lows. The strength of the systems was dependent upon the speed and the central pressure prior to reaching the sea.

Baffin Bay Ice Report

Icebergs, bergy bits and growlers--three names that we became very familiar with during the Baffin Bay portion of Leg 105. During the 25 days we spent on site we observed 38 icebergs and several bergy bits, with many growlers and smaller pieces. Some of the large growlers were tracked by radar, but most were too small to appear on radar (attachment 1).

The Greenland Ice Sheet is the largest producer of icebergs in the northern hemisphere, the west coast producing more than the east coast. Those produced on the east coast are in most cases at the landward end of fjords or blocked in by numerous small islands. Sea ice that is carried far southward by the East Greenland Current can also halt the seaward movement of the bergs. During the years when pack ice is minimal, east coast bergs that reach the sea drift southward with the cold East Greenland Current. They continue their drift until they round Cape Farewell. In this region, icebergs are increasingly exposed to deteriorating effects of warmer water and wind waves. A small number survive and begin the drift north in the warmer West Greenland Current.

On the west coast there are nine major iceberg producing glaciers. Of the nine, two are at approximately our latitude of 70 north. These two are the Jacobshavn Glacier and Rinks Glacier. As the bergs are spawned they join the east coast bergs in their northerly movement imbedded in the West Greenland Current. The berg movement continues to the north around Baffin Bay, turning west at the northern tip. They are then carried southward by the Baffin Island Current and continuing east of Labrador as the Labrador Current (attachment 2). There are two major westward branches the West Greenland Current. These branches are located in the Davis Straits and near latitude 70° north.

During the three weeks we spent in Baffin Bay logging icebergs we discovered two things. First, icebergs move in any direction they wish. Second, there are three major influences affecting the direction and speed of this movement. As other studies have shown, the three influences are currents, winds, and tides.

Our observations showed that, with winds 15 knots or greater, the berg movement was controlled by wind direction. For a three day period in early September our winds were from the north-northwest with a speed of 20 to 25 knots and gusting to over 30 knots. Of the thirteen bergs and one growler recorded in this period, all showed a movement to the south-southeast (attachment 3).

A previous report on the tidal effects of movement shows the berg forming a loop as the tide acts upon it. The tide pulls the berg in one direction during low tide and forces it in the other direction during high tide. Our ice maps of September 13th, indicated the pull and push of the berg by the tide (attachment 4).

The third influence of berg motion is currents. Not having current meters on board, we can only assume current influence. However, with the majority of the berg beneath the surface, currents would obviously provide a heavy influence on speed and direction. During periods of calm seas and winds, berg movement would be directed by the currents. Also, while the wind and tide influence can readily be seen, the effect of the currents are subtle movement. Attachment 1 shows a heavy iceberg track oriented northeast through southwest over our position. Can this be attributed to a major current in that area?

As bad as the final iceberg chart looks (attachment 1) we were only forced to move a couple of times to oblige the occasional berg or growler.

All the data I had on the movement of ice was verified by our track maps.

All in all, Baffin Bay proved to be a most interesting part of Leg 105.