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BIOSTRATIGRAPHY (FORAMINIFERA) AND DEPOSITIONAL ENVIRONMENT OF AMOCO IOE EIDER M-75, GRAND BANKS OF NEWFOUNDLAND

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Contents

Abstract

Foraminifera in the Amoco IOE Eider M-75 well, Grand Banks of Newfoundland, have been classified into six benthonic and three planktonic biostratigraphic units. The chronostratigraphic interpretation indicates the presence of almost 9000 feet of Jurassic strata unconformably overlain by approximately 1700 feet of Upper Cretaceous beds. The uppermost samples may be of (?)Tertiary age.

The Jurassic and Late Cretaceous (-?Tertiary) environment was predominantly shallow marine with somewhat deeper, more open marine influences in Bajocian-Bathonian and Coniacian-early Santonian times. Jurassic sedimentation averaged 7 cm/1000 y, and less than 2-3 cm/1000 y in late Cretaceous time.

The Eider M-75 well stands out because of its diversified Bajocian-Bathonian epistominid and globigerinid foraminiferal assemblages.

An appendix lists selected microfossils for each stratigraphic interval.

Introduction

This report describes the foraminiferal biostratigraphy, chronostratigraphy and depositional history of the Amoco IOE Eider M-75 well, located on the Grand Banks, about 125 miles south-south-east of St. John's, Newfoundland, at 45° 34' 54.9"N and 51° 56' 41.5"W (Figure 1). It was spudded the 18 April 1971 in 225 feet of water and drilled to a total depth (T.D.) of 11,582 feet, with casings set at 424, 877, 2175 and 6990 feet. The well was drilled as a new field wildcat. No significant hydrocarbon shows were encountered. The well was abandoned the 9 July 1971 (Amoco Canada Petroleum Company Ltd., 1971).

The geological interpretations described below are based upon the vertical distribution in Eider M-75 of Foraminifera and some other shelly microfossils in cuttings between 900 and 11,580 feet. The cuttings are composite samples of 30 feet of well section taken at increments of approximately 100 feet. Additional data stem from the study of picked slides from 90 sidewall cores (SWC) between 2616 and 11,450 feet on loan from Imperial Oil Ltd., Calgary. All footages were measured from the rotary table standing 98 feet above sea level and 358 above the seafloor.

I am grateful to L. F. Jansa and G. L. Williams, respectively for the lithostratigraphic and palynological data on the Eider M-75 well.

Summary of Chronostratigraphy and Depositional Environments

Depth	Age	Depositional Environment
900/30-990/1020	?Tertiary	?marginal marine
1080/1110-1440/70	Campanian	shallow neritic
1530/60-1980/2010	Santonian	shallow-deep neritic
2070/2100-2160/90	Coniacian-early Santonian	deep neritic-bathyal
2250/80	Turonian	"middle" neritic
2340/70-2610/40	Undetermined	marginal marine
2724 ----------	Avalon Unconformity	----------
2700/30-4060/90	Oxfordian-Kimmeridgian	shallow neritic
4160/90-5360/90	Undetermined	marginal marine
5560/90-6230	Callovian	shallow neritic
6560/90-8260/90	Bathonian	shallow-deep neritic
8360/90-9760/90	Bajocian	shallow neritic
9860/90-11560/80	Toarcian/Aalenian-Bajocian	shallow neritic

A palynological study indicates beds immediately overlying the Avalon Unconformity to be of Cenomanian Age, and Callovian beds to extend as high as 4114 feet (Williams, 1975).

Comments on the Stratigraphy

The lower part of the Eider M-75 succession, between 11,582 feet (T.D.) and 2724 feet, has been referred to four benthonic and one planktonic foraminiferal zones and four formations (see Figure 2). The zones which are used informally follow Gradstein (in prep.); the formations are after Jansa (1974). Chronostratigraphic interpretation indicates the sediments between 11,582 and 2724 feet to be of ?Toarcian/Aalenian to Oxfordian/Kimmeridgian Age, without obvious gaps.

Jurassic Foraminifera are well preserved; abundance of specimens and species diversity greatly fluctuate and are interpreted to reflect changes in environment. The greatest diversity is between 8690 and 7340 feet where a rich epistominid, globigerinid assemblage of Bajocian-Bathonian Age occurs. The lowest diversity is between 5390 and 4160 feet. Below 8690 feet limestone intercalations seem devoid of much fauna. More shaly beds below 8690 feet may show greater diversity but caving obscures much of the original assemblages at this depth.

At 2724 feet, the Avalon Unconformity has been recognized (Jansa, 1974) where Upper Cretaceous beds unconformably overlie Jurassic sediments. The regional significance of this unconformity is discussed in Jansa and Wade (1975) and Gradstein *et al.* (1975). The beds immediately above the unconformity do not contain age diagnostic Foraminifera; a palynological study (Williams, 1975) indicates these beds to be of Cenomanian Age.

In the upper part of the Eider M-75 well, between 2340 and 1080 feet, a diversified and well preserved late Cretaceous foraminiferal fauna occurs. Two planktonic foraminiferal zones and two benthonic assemblages have been recognized (Figure 2). The planktonic zones follow Postuma (1971); the benthos assemblages are informal Grand Banks biozones. The age of the rocks, which Jansa (1974) classifies in the Dawson Canyon Formation, is Turonian to Campanian.

The uppermost samples at 990 and 900 feet contain few Foraminifera. The age maybe Tertiary.

Depositional Environment

The depositional environment of the sediments in the Amoco IOE Eider M-75 well is illustrated in Figure 3. The width of the paleowater depth curve hopefully reflects the "confidence interval" of the interpretation.

Lithostratigraphic unit F and E, corresponding to the Whale Unit of Jansa and Wade (1975) composed of shale, limestone and siltstone of ?Toarcian/Aalenian to Bajocian Age, may be of marginal to shallow marine origin. The foraminiferal assemblage (as far as not masked by cavings) seems of a low diversity, mostly epistominids and some nodosariids, with fewer species downward. Ostracods are more common than above.

Unit D_2 and basal unit D_1, composed of shale and mudstone of Bajocian and early Bathonian age, contain a rich and relatively high diversity assemblage with floods of epistominids and many planktonic *Gubkinella*. Lenticulinids, some arenaceous taxa, crinoids and small molluscs also are common. Jurassic globigerinids probably favoured open marine, normal salinity conditions (see also Gordon, 1970). Their almost total absence to date in Jurassic deep sea drilling deposits (e.g. Luterbacher, 1972) has been explained through dissolution at depth. However, their distribution may well have been patchy in the Jurassic deas.

The paleoecology of Jurassic epistominids is not well understood (Gordon, 1970); on the Grand Banks their frequency increases markedly in some shales.

The coincidence in Eider M-75 of more planktonics and more epistominids, together with the low energy character of the sediments, in our opinion indicates more open marine, possibly somewhat deeper conditions than below and above unit D_2 and basal D_1.

The truly deep marine "bathyal" faunas, as described by Luterbacher (1972) from DSDP leg 11 in the western North Atlantic Ocean, seem rather different from Grand Banks Jurassic faunas. In DSDP leg 11 Jurassic samples, simple arenaceous foraminifers and also lagenids predominate with few intervals with more epistominids, *Nubeculinella* or *Ophtalmidium*. Some samples are rich in *"Spirillina"* or Radiolaria, ostracods, *Saccocoma* spp., aptychi and other organic remains.

The upper part of unit D in the Eider M-75 well, of Bathonian-Callovian Age, is considerably less rich in Foraminifera than the lower part. There are less taxa; planktonics are scarce, so we assume shallow conditions.

The shallowing trend continues further upward where the lower part of the mostly clastic Mic Mac Formation, of Callovian (and possibly younger) Age, is almost devoid of Foraminifera. There are some charophyte sporangia and ostracods. The environment may

have been marginal marine. The upper part of the Mic Mac Formation is of Oxfordian/Kimmeridgian Age. It contains a diversified foraminiferal fauna with *Lenticulina*, Epistomina *Paalzowella*, *Trocholina*, large arenaceous taxa, and some charophyte sporangia, molluscs, crinoids and many ostracods interpreted as of shallow marine nature.

The sandstone and siltstone of the overlying Logan Canyon Formation, of Cenomanian Age (Williams, 1975), probably are nonmarine to marginal marine. Foraminifera seem almost absent or may be cavings; sideritic concretions are frequent.

In the overlying Dawson Canyon Formation, of Turonian to Campanian (or younger) Age, the highest number of globotruncanids is in the lower part - interpreted as outer shelf to slope. Upwards planktonics decrease in diversity and number with benthonics, foraminifers and ostracods being more common (*Epistomina*, *Gavelinella*, some arenaceous); the topmost samples are almost barren. Accordingly, the environment may have become shallower upward.

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Appendix

Stratigraphic succession of selected shelly microfossils (mainly foraminifers) in Eider M-75, Grand Banks. The Jurassic zonation will be dealt with in detail in Gradstein (in prep.); the Cretaceous plankton zones follow Postuma (1971); the two late Cretaceous benthos assemblages are informal Grand Banks "zones". All "zones" are based on last occurrences of taxa. Specimen frequencies are reported as ra (1-5 specimens), co (6-20 specimens) and fr (<20 specimens).

900/30-990/1020' ?Tertiary

Foraminifers: aff. *Globigerina* sp. ra
Haplophragmoides sp. ra

Miscellaneous: concretions fr

1080/1110-1440/70' *Planulina taylorensis* assemblage Campanian

Foraminifers: *Epistomina supracretacea* Ten Dam fr
E. stelligera alveolata Ohm ra
Gavelinella spp. fr
Gaudryina aff. *bentonensis* (Carman) ra
G. sp.2 co
Globotruncana cretacea (d'Orbigny) co
Globigerinelloides messinae (Bronniman) ra
Heterohelix globulosa (Ehrenberg) co
Kyphopyxa christneri (Carsey) ra
Planulina taylorensis (Carsey) co

Epistomina stelligera alveolata, which occurs at and below 1440/70', according to Ohm (1967) ranges from Coniacian-early Campanian, which may well agree with its distribution in this well.

1530/60-2070/2100' *Vaginulina texana* assemblage Santonian

Foraminifers: *Epistomina stelligera alveolata* Ohm co
E. supracretacea Ten Dam co
Dorothia sp. 1 ra
Gavelinella spp. fr
Globotruncana cretacea (d'Orbigny) co
G. marginata (Reuss) co
G. ex. gr. *linneiana* (d'Orbigny) fr
Globorotalites michelinianus (d'Orbigny) ra
Gaudryina austinana Cushman ra
Hedbergella spp. co
Neoflabellina suturalis (Cushman) ra
Rugoglobigerina aprica Loeblich & Tappan co
Vaginulina texana Cushman co

According to Cushman (1946) *Gaudryina austinana* and *Vaginulina texana* in the Gulf Coast region seem to be typical of the Austin Formation which is more or less equated with the Coniacian-Santonian Stages. The highest occurrence of these species on the Grand Banks has been taken as indicative of Santonian.

Grand Banks.

2070/2100-2160/90' *Globotruncana schneegansi and Globotruncana concavata* Zones Coniacian-early Santonian

Foraminifers:
Globotruncana aff. *renzi* Gandolfi ra
G. concavata (Brotzen) ra
G. coronata Bolli co
G. fornicata (Plummer) co
G. cretacea (d'Orbigny) fr
G. ex. gr. *linneiana* (d'Orbigny) fr
G. marginata (Reuss) fr
G. imbricata Mornod ra
Hedbergella bosquensis Pessagno co
Gaudryina austinana Cushman co

In this interval occur both *G. concavata* and a form close to *G. renzi*.

2250/80' *Globotruncana helvetica* Zone Turonian

Foraminifers:
Globotruncana helvetica Bolli ra
G. imbricata Mornod ra
Praeglobotruncana stephani Gandolfi ra
P. stephani var. *turbinata* Reichel ra
Hedbergella planispira (Tappan) co
Lenticulina ex. gr. *ouachensis* (Sigal) reworked

2340/70-2610/40' Undetermined

In this sandy interval occur some *Hedbergella* spp., *Lenticulina*, *Epistomina*, *Gavelinella* and ostracods which may be largely caving. According to dinoflagellate stratigraphy this interval is largely of Cenomanian Age. The abundance of sideritic concretions in the picked slides between 2520 and 2730 feet probably relates to the Grand Banks Avalon Unconformity which from logs appears to be at 2724 feet.

2700/30-4060/90' *Epistomina mosquensis* zone Oxfordian-Kimmeridgian

Foraminifers:
Epistomina mosquensis Uhlig co
E. uhligi Mjatliuk co
E. soldanii Ohm ra
Reinholdella crebra Pazdro ra (reworked)
Valvulina meentzeni Klingler ra
Gaudryina heersumensis Lutze ra
Citharina tenuicostata Lutze ra
Lenticulina tricarinella (Reuss) ra
"Patellina" sp. 3 ra
"Conorbina" sp. 1 ra
Paalzowella feifeli (Paalzow) ra
Tritaxia sp. 2 ra
Ammobaculites spp. co
Eoguttulina sp. ra
Bullopora sp. ra
Trocholina sp. ra

Miscellaneous: charophyte sporangia
ostracod sp. 8 to sp. 17
molluscs
Pentacrinus

4160/90-5360/90' Undetermined

This interval contains Charophyte sporangia, ostracods and isolated foraminifers (mainly *Lenticulina*) which may be cavings in part.

5560/90-6230' *Reinholdella crebra* var. zone Callovian

Foraminifers: *Lenticulina* ex. gr. *quenstedti* (Guembel) ra
Epistomina regularis Terquem co
E. uhligi Mjatliuk co
E. coronata Terquem fr
Reinholdella crebra Pazdro var. co-fr
R. crebra Pazdro ra (at 6230')

6560/90-8260/90 *Gubkinella bathoniana* Zone and *Garantella* zone (p.p.) Bathonian

Foraminifers: *Reinholdella crebra* Pazdro co-fr
R. spp. 3 + 4 + 8 co
R. epistominoides (Kaptarenko) co (top at 7760')
Epistomina uhligi Mjatliuk fr
E. spp. 21 + 24 co
E. coronata Terquem fr
Garantella ornata (Hofker) fr (top at 7560')
G. stellata Kaptarenko co (top at 8260')
Gubkinella bathoniana (Pazdro) ra-fr (fr below 7460')
G. balakhmatovae (Morozova) ra (top below 7460')
Lenticulina quenstedti (Guembel) co

Between 6560 and 7340 feet cuttings and s.w.c. are generally poor in foraminifers. Some samples contain common *Reinholdella crebra* s.s., which together with isolated *Gubkinella bathoniana* suggest a Bathonian Age for this interval (see also Pazdrowa 1969; Pazdro 1969) evidence for Bathonian beds is at and below 7560 feet down to 8260 feet where *Gubkinella bathoniana* is frequent, together with *Garantella ornata* and *G. stellata* of the *Garantella* zone. The highest occurrence of *G. ornata* and *G. stellata* may indicate lower Bathonian beds.

Below 7760 feet *Reinholdella epistominoides* occurs; Kaptarenko (1959) describe this easily to identify form from the Bajocian of the USSR.

8360/90-9760/90' *Garantella* zone (p.p.) Bajocian

Foraminifers: *Garantella ampasindavaensis* Espitalie & Sigal ra
G. sera Pazdro fr
G. ornata (Hofker) co
G. stellata Kaptarenko co

G. aff. *rudia* Kaptarenko ra (top at 9260')
Gubkinella (bathoniana) Pazdro co-fr
G. balakhmatovae (Morozova) ra-co
Lenticulina quenstedti (Guembel) co
Reinholdella media (Kaptarenko) co
R. spp. fr

Miscellaneous: crinoids

The stratigraphically highest occurrence of *Garantella ampasindavaensis* and *G. sera* is taken as indicative of Bajocian beds. The two taxa on the Grand Banks occur with many intermediate forms.

9860/90-11,560/80' *Garantella* zone (p.p.) and *?Lenticulina d'orbignyi* zone Toarcian/Aalenian-Bajocian

Foraminifers: *Garantella* aff. *rudia* Kaptarenko co
G. sera Pazdro co
G. ampasindavaensis Epistalie & Sigal co
Citharina infraopalina Brand ra
Reinholdella dreheri (Bartenstein) ra
?Lenticulina d'orbignyi (Roemer) ra

Ostracods: *Ostracod* sp. 84 Klingler ra
Monoceratina ?ungulina Triebel & Bartenstein ra

The lower limit of the *Garantella* zone in Eider M-75 may be placed at 10,587 feet, as based on the common occurrence of *Garantella* spp. in s.w.c. down to that depth. Below 10,587 feet *Garantella* may well be cavings.

As high as 9860 feet there are some well preserved specimens of *Ostracod* 84 Klingler and *Citharina infraopalina* which according to Simon and Bartenstein (1962) would be of Toarcian/Aalenian Age. *Ostracod* sp. 84 in Murre G-67 occurs in the *Lenticulina d'orbignyi* zone taken as of Toarcian/Aalenian Age.

If the *Lenticulina d'orbignyi* zone occurs in Eider M-75, it is probably below 10,587 feet. The presence of this zone in Eider M-75 is tentative due to the absence of both *Lentiuclina d'orbignyi* (except one poorly preserved specimen of questionable identification at 9860 feet) and *Nodosaria columnaris* Franke.

The presence of *Ostracod* sp. 84 and *Cithorina infraopalina* as high as 9860 feet may either be due to reworking or else these taxa may range in the *Garantella* zone.

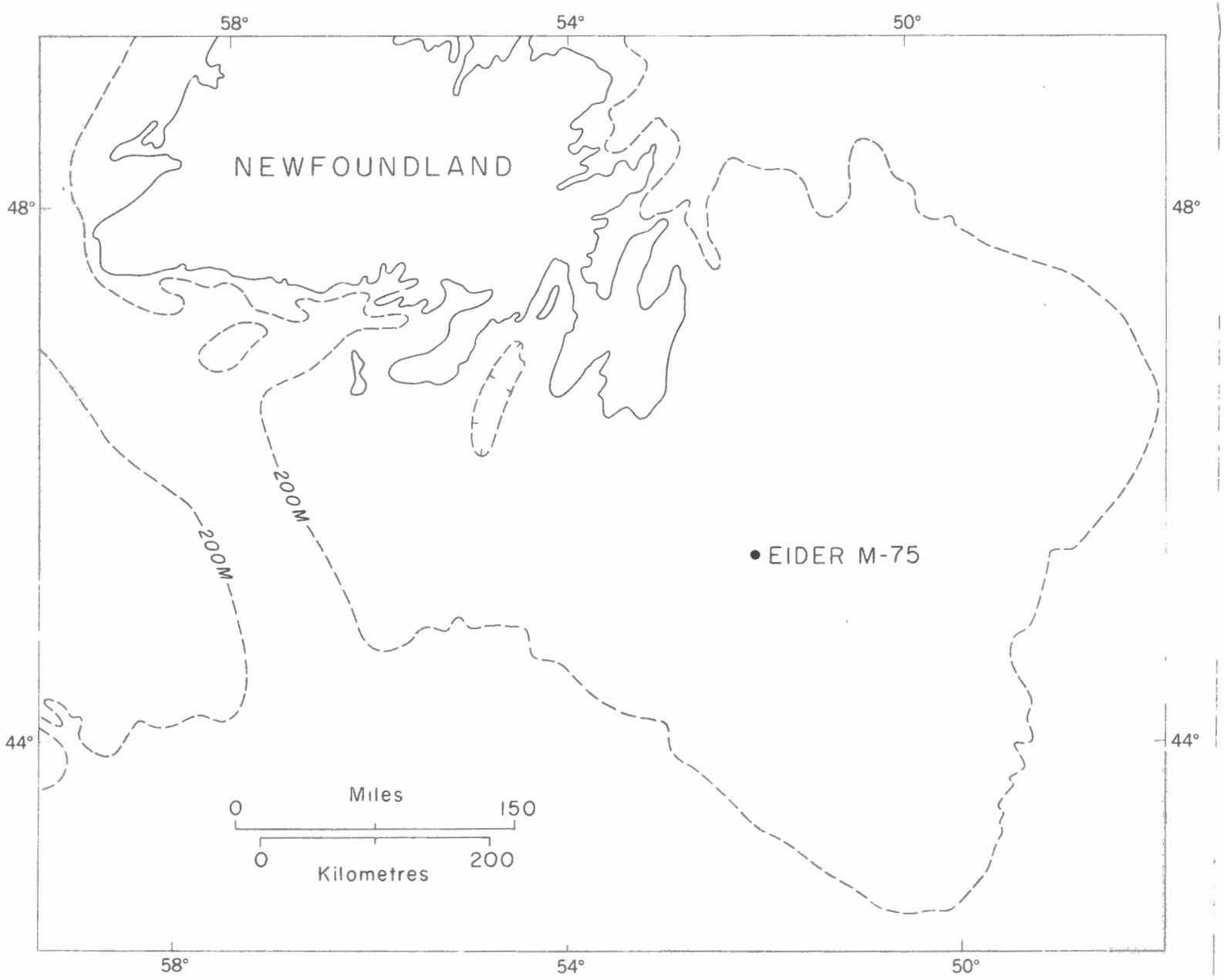
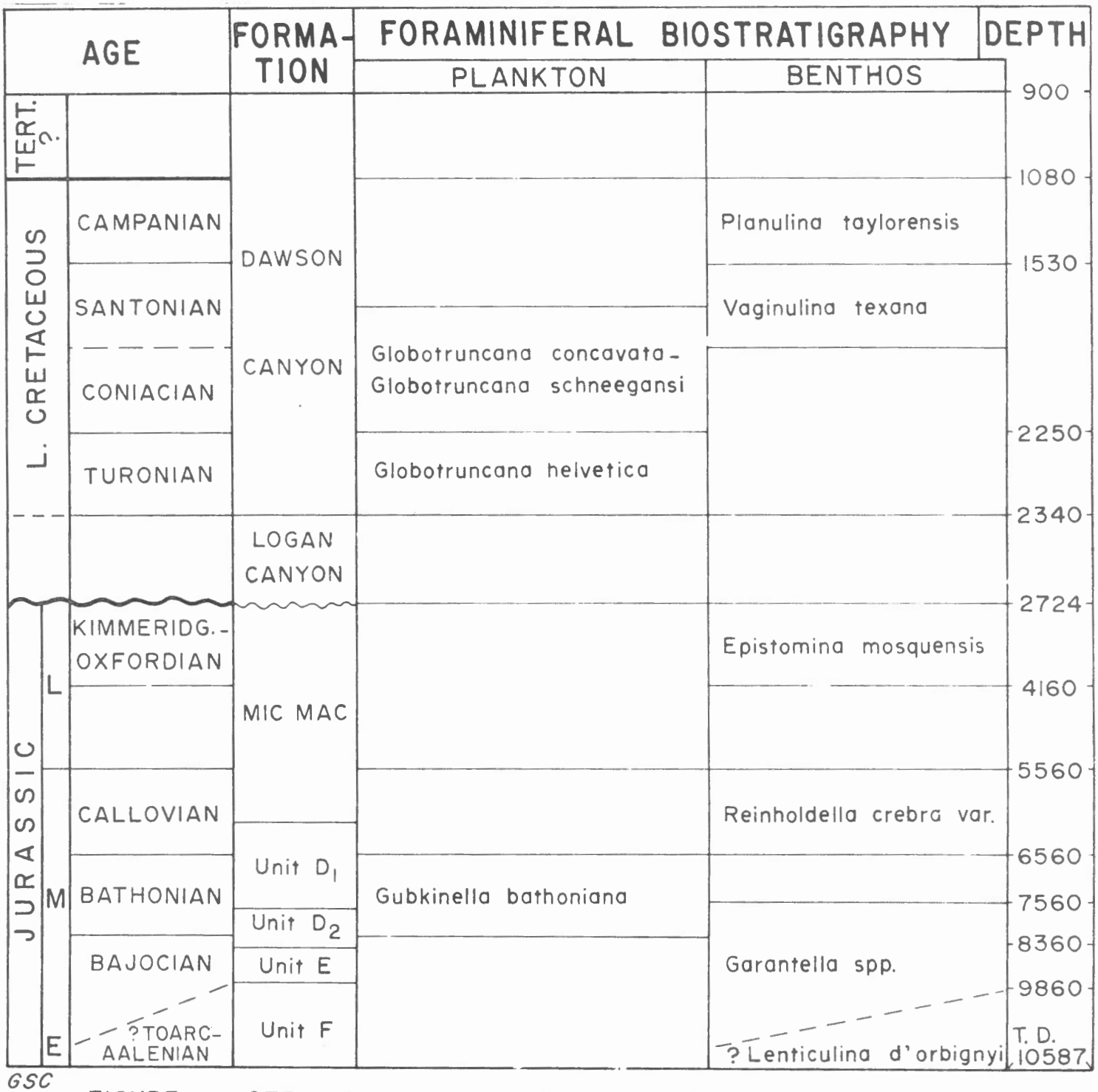
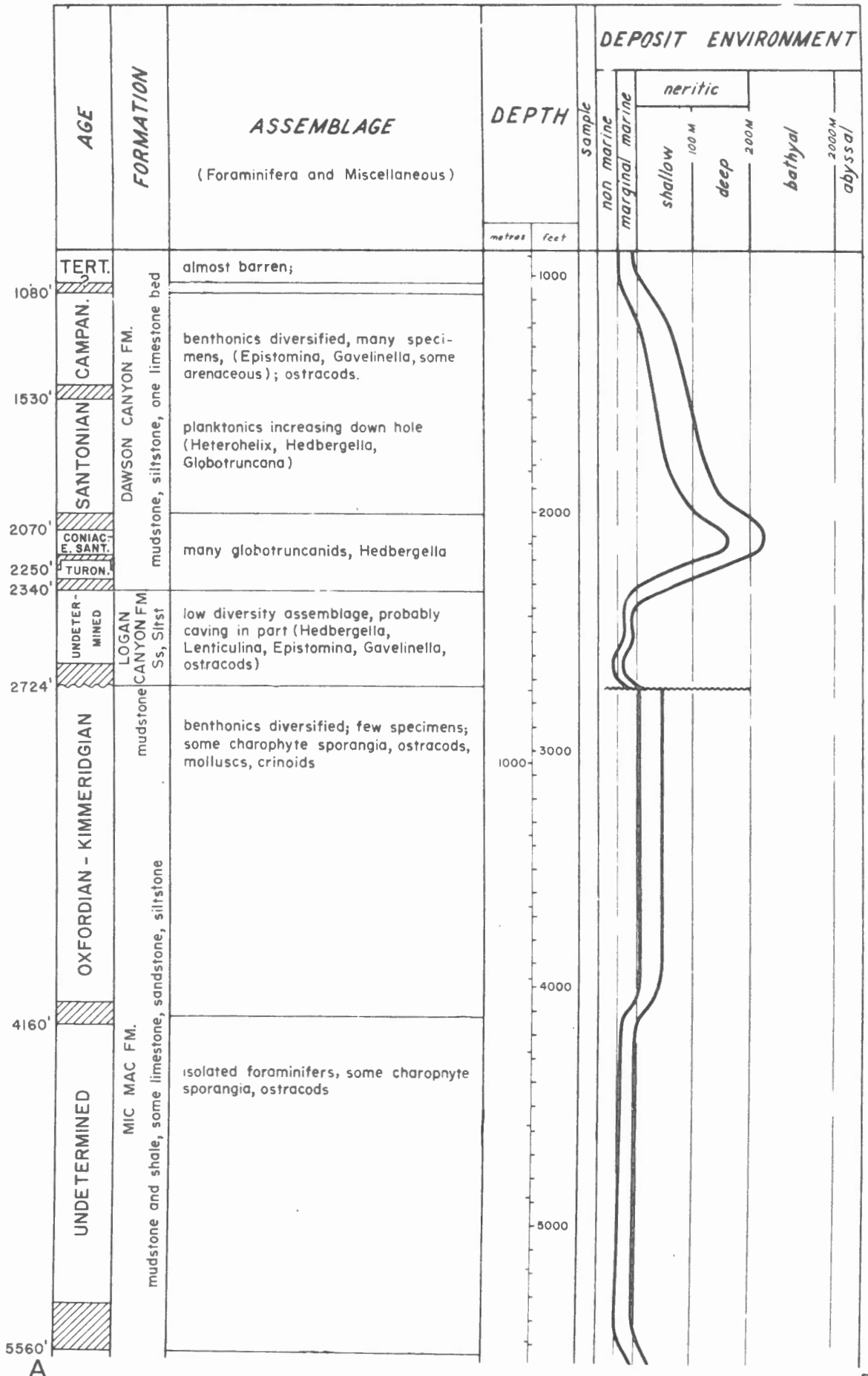


Figure 1. Location of the Amoco IOE Eider M-75 well, Grand Banks of Newfoundland.



GSC

FIGURE 2. STRATIGRAPHY OF THE UPPER MESOZOIC DEPOSITS IN AMOCO IOE EIDER M-75, GRAND BANKS.


AGE
FORMATION
ASSEMBLAGE
(Foraminifera and Miscellaneous)
DEPTH
metres
feet
sample
DEPOSIT ENVIRONMENT
non marine
marginal marine
neritic
shallow
100 M
deep
200M
bathyal
2000M
abyssal
TERT.
CAMPAN.
SANTONIAN
CONIAC.-E. SANT.
TURON.
UNDETER-MINED
OXFORDIAN - KIMMERIDGIAN
UNDETERMINED
1080'
1530'
2070'
2250'
2340'
2724'
4160'
5560'
DAWSON CANYON FM.
mudstone, siltstone, one limestone bed
LOGAN CANYON FM
Ss, Siltst
mudstone
MIC MAC FM.
mudstone and shale, some limestone, sandstone, siltstone
almost barren;
benthonics diversified, many specimens, (Epistomina, Gavelinella, some arenaceous); ostracods.
planktonics increasing down hole (Heterohelix, Hedbergella, Globotruncana)
many globotruncanids, Hedbergella
low diversity assemblage, probably caving in part (Hedbergella, Lenticulina, Epistomina, Gavelinella, ostracods)
benthonics diversified; few specimens; some charophyte sporangia, ostracods, molluscs, crinoids
isolated foraminifers, some charopnyte sporangia, ostracods
1000
2000
3000
4000
5000
1000
A
B

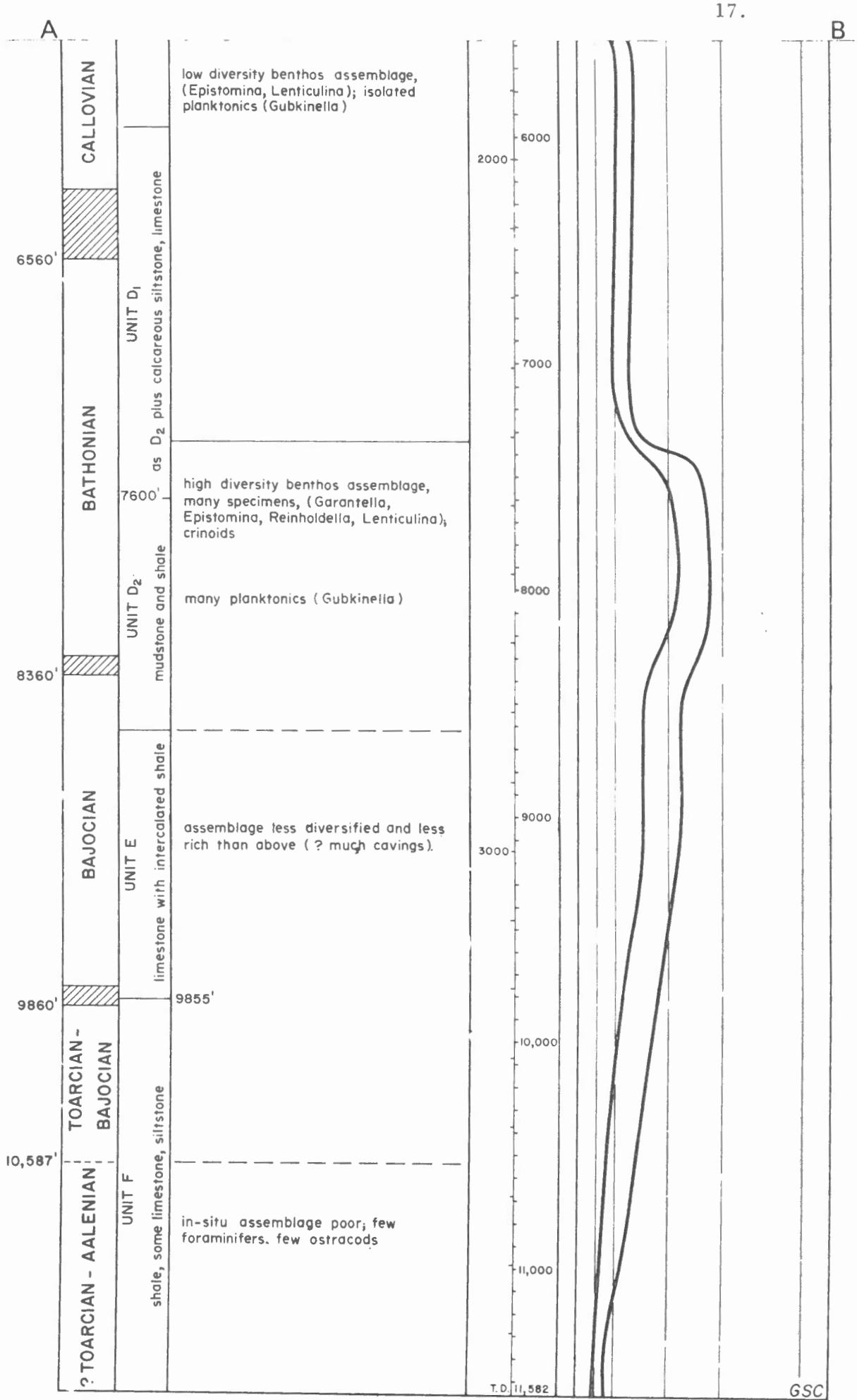


FIGURE 3. DEPOSITIONAL ENVIRONMENT OF THE UPPER MESOZOIC SEDIMENTS IN AMOCO IOE EIDER M-75, GRAND BANKS.