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Richard W. Faas

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Preliminary Report on Foraminiferal Distribution in the Deep Basins in the Gulf of Maine*

RICHARD W. FAAS
Department of Geology, Lafayette College, Easton, Pa.

Introduction

Recent work in the shoaler waters of the Scotian Shelf has indicated that foraminifera occur there in both quantity and diversity. Bartlett (1964) has found more than one hundred species of foraminifera on the southeastern Scotian Shelf. Of these,, thirty species are arenaceous, ten are calcareous imperforate and the remainder are calcareous perforate forms. Sen Gupta (1967) identified seventy-nine species from the sediments of the Grand Banks of Newfoundland. Hooper (1968), in his work between English Point, Quebec, and the southern limit of the Grand Banks, (a total of 300,000 square miles) found seven assemblages of foraminifera, which with the aid of a computer, were shown to be characteristic of different depth zones. (Only forty stations were occupied and the distributional data is considered to be of a very general nature.)

This author has recently had an opportunity to examine sediment samples and cores (averaging 3.3 metres in length) taken from the Wilkinson Basin, Gulf of Maine. The samples were collected as part of a co-operative research project between Lafayette College and Lehigh University which is aimed at establishing an eastern seaboard ocean test range for research, development, testing, and evaluation of undersea systems. This effort was financed by the Sea Grant Program of the National Science Foundation.

Basin Characteristics

The Wilkinson Basin, measured between the 260 metre isobath, is about 65 kilometres long, 10 kilometres wide, and extends in a NW-SE direction. Water depths within the area sampled varied from 254 to 285 metres. In general, the basin is flat-bottomed and consists of fine silts and clays 10-12 fathoms thick that appear to have been winnowed from older Pleistocene glacial deposits and redeposited in the deeper parts of the Basin (Uchupi, 1968). Sediments tested varied from 2/3 to 1/2 clay-sized material. The clay mineral composition is generally more illitic than chloritic, with minor montmorillonite in all samples.

Ross (1970) indicates that sedimentation of fine-grained material began about 10,000 years ago, associated with a rising sea level. Present day sediments are being carried into the Gulf by rivers with still some winnowing of glacial sediments on topographic highs taking place.

Sediment cores were taken from nine localities, all deeper than 240 metres. To date only one core, centrally located in the Wilkinson Basin, and seven core top samples from various parts of the basin, have been investigated. Figure 1 shows the area studied and the approximate location of the samples.

In general, analysis of the basinal sediments indicated a relatively low diversity of foraminifera. A total of forty-five separate species (Table 1) were found in these samples as compared with the large number of species found in shoaler waters (Sen Gupta, 1967; Bartlett, 1964).

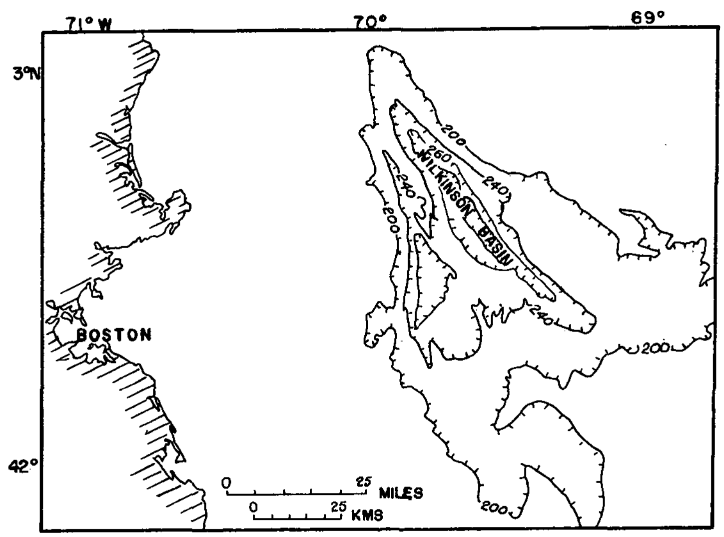

Figure 1: Location map of the Wilkinson Basin, Gulf of Maine.

* Manuscript received June 14, 1971.

Table 1 - Wilkinson Basin Faunal List

Calcareous Species / Samples	2E-1C	2E-4B	2E-5C	2E-7E	2E-8B	2E-8C	2E-9B
Bolivina striatula	19	3	112	63		22	24
Bolivina variabilis	30	7	344	128	1	47	57
Bolivina cf. B. inflata			38	12		22	31
Bucella frigida			1	1			5
Bulimina exilis				2		2	2
Bulimina marginata	16	3	96	55	21	134	37
Cassidella complanata			1	3			
Cassidulina islandica			4				
Cibides lobatulus		1	1	4	17	6	2
Dentalina baggi			2				
Dentalina pauperata			4			1	
Elphidium clavatum			6	1		8	
Elphidium subarcticum						3	
Glandulina laevigata	138	10	163	193	113	6	69
Glandulina sp.					19	4	5
Islandiella teretris						21	16
Lagena gracillima			2				2
Lagena laevis		1	4				1
Lagena mollis			4	4	1	8	6
Nonionella auricula						1	1
Nonionella labradoricum	58	4	167	61	60	12	13
Oolina hexagona						1	
Oolina melo							1
Parafissurina tectulostoma						2	
Pyrgo rotalaria					3		
Quinqueloculina arcticum				1	14		
Quinqueloculina seminulum		2	1	1	12	8	6
Trichohyalus pustulata						3	
Sub Total	263	31	958	522	262	312	280

Arenaceous Species	2E-1C	2E-4B	2E-5C	2E-7E	2E-8B	2E-8C	2E-9B
Alveolophragmium crassa				12			13
Adercotryma glomeratum				22			
Cribrostomoides bradyi		4		133			14
Cribrostomoides crassimargo	13	2		6			2
Cribrostomoides jeffreysi				32			
Hyperammina atlantica							
Hyperammina elongata	8			14	1		
Psamosphaera fusca				8			
Reophax scorpiurus	8			12	1		
Reophax scotti				4			7
Sacammina atlantica	59	3	7	38		1	22
Sacammina sphaerica	4			10			6
Trochaminella atlantica		1		7			
Trochaminella bullata				11			5
Trochammina rotaliformis	3	1		10			
Sub Total	103	11	7	365	2	1	101
Grand Total	366	42	965	887	264	313	381
% Calcareous	71.8	73.8	99.2	57.5	99.2	99.7	73.4
% Arenaceous	28.2	26.2	0.8	42.5	0.8	0.3	26.6

Basin Fauna

The fauna of the Wilkinson Basin consists of both arenaceous and calcareous perforate and imperforate forms. In all cores, five calcareous species, *Nonionella labradorica*, *Glandulina laevigata*, *Bolivina variabilis*, *Bolivina striatula*, and *Bulmina marginata* occurred in the sediments. In one of the seven core top samples the arenaceous species *Cribrostomoides crassimargo*, *C. bradyi*, *Reophax scorpiurus*, and *Sacammina atlantica* occupied 42% of the total fauna with the calcareous species cited earlier making up the remainder.

It is believed that at least a portion of the calcareous fauna represents reworked and relict Pleistocene material that has been winnowed from high areas and redeposited in the deeper parts of the basin. Examination of many of the calcareous species shows them to be covered with a calcitic sheath. This is interpreted as an oxidized surface produced by exposure and subaqueous weathering. *Glandulina laevigata* appears to be most affected by this oxidized covering, although other species are similarly affected. Many tests exhibited pitted surfaces and many had broken chambers. Miliolids appear particularly weather beaten.

On the other hand the calcareous fauna of some samples is completely unweathered in appearance. These are believed to be living in the area today, although a protoplasm dye did not prove definitive. The evidence is interpreted to indicate, that in some samples, the calcareous fauna consists of both living and reworked representatives of some species.

Examination of the samples dominated by arenaceous species leads to two possible interpretations: 1) the arenaceous forms are living contemporaneously with the calcareous forms; or 2) the arenaceous forms are the most recent inhabitants of the bottom and are displacing the older calcareous fauna. The differences in the percentages, with some samples (2E-5C, 2E-8B, and 2E-8C) being totally dominated by calcareous species, and others (2E-1C, 2E-7E, 2E-9B) are fully one-quarter occupied by arenaceous species indicates considerable variation in test type distribution. It might be expected, if interpretation 1) were the case, that the arenaceous forms would be more equitably distributed throughout the basin. If, on the other hand, the arenaceous forms were replacing a previously existing fauna, the distribution would be expected to show a gradient, as seems to be indicated from core percentages. This would support interpretation 2). Numerous species of *Reophax scorpiurus* and *Sacammina atlantica* can be seen engulfing whole and fragmented calcareous tests and incorporating them into their own tests. Several arenaceous forms have been observed to contain recognizable fragments of *Bolivina* and *Elphidium*. This behaviour of arenaceous species has been recognized previously and does not, by itself, constitute conclusive evidence for the second interpretation. However, the condition of many of the calcareous tests incorporated into the arenaceous test, seems to point toward that conclusion. It is hoped that an extensive sampling program, coupled with an effective use of Rose Bengal protoplasm stain, will clarify this situation during the summer of 1971.

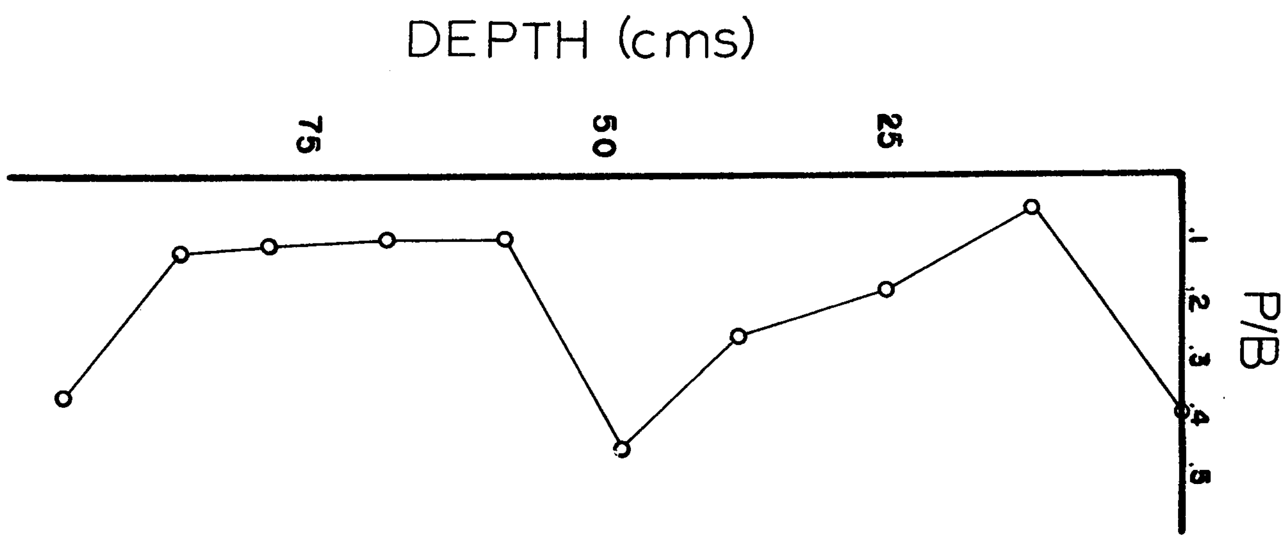

Figure 2: Plot of Plankton/Benthonic Ratio for Core WB-42-

Planktonic/Benthonic Ratios

The core from the central portion of the Wilkinson Basin was carefully analyzed for its foraminiferal content including nature and type of benthonic species, their changing percentages and planktonic/benthonic ratios. Figure 2 shows the changes in the latter parameter. The ratio remained at about 0.1 to approximately 58 cm in the core. Above this level it increased rapidly, indicating a doubling of planktonic organisms per total volume of sediment. Such a change is generally regarded as an increase in "marineness" generated by a rise in sea level, usually associated with Pleistocene deglaciation.

However, it appears that the change in planktonic/benthonic ratios may also support Ruddiman, et. al. (1969) who suggested that a change of 1.5 to 2°C temperature occurred in the last 1,000 to 4,000 years. It is thought possible that the warmer temperatures may have encouraged a greater abundance of planktonic forms, perhaps responding to a possible increase in organic matter production in the shallow Gulf waters. The planktonic/benthonic ratios found from this core are interpreted as supporting this hypothesis. Further support will be sought during the summer of 1971 as more cores are analyzed. In particular, the faunal composition of the planktonic foraminifera will be examined as it may be expected to show species changes that would relate to the warming trend.

Summary

The preliminary work performed to date has shown that, within a highly diverse and densely populated continental shelf, the deeper portions of the shelf basins contain both lower foraminiferal density and reduced diversity.

The continental shelf is viewed as a time-stratigraphic surface on which exist "patches" of restricted fauna corresponding to the distribution of the deep basins.

Future work will be directed at specifying foraminiferal diversity patterns throughout the Wilkinson Basin. Work also is directed at analyzing the organic components of the basinal sediments so as to possibly determine whether nutrient deficiencies are responsible for the lowered populations within the basins.

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