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Vertical Distribution of Foraminifera in the Lower Chalk Member of the Austin Formation, Southern Dallas County, Texas

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ABSTRACT

The Austin formation (Upper Cretaceous) in Dallas County is divisible into three members: a lower chalk, a middle marl, and an upper chalk. Because of the gentle dip of the Austin formation and the low surface relief of the area, stratigraphic sections of as much as 30 feet are rare, thus no complete surface section exists for any of the members. A composite stratigraphic section of the lower chalk member, 155 feet thick, was constructed from exposures in the upper reaches of Ten Mile Creek. Individual sections in excess of 10 feet were carefully measured and correlated by insoluble residues, in conjunction with bed thicknesses and weathering profiles, to obtain the composite section. The microfaunal content was examined at five foot intervals and points of significant lithologic change.

Approximately 50 species of Foraminifera, representing 26 genera and 9 families, are present in the lower chalk member. The dominant species are *Globigerina cretacea* d'Orbigny, *Globotruncana canaliculata* (Reuss), *G. marginata* (Reuss), *G. fornicata* Plummer, *Gümbelina striata* (Ehrenberg), and *Planulina* sp.; cf. *P. austinana* Cushman. *Globigerina cretacea* d'Orbigny is the most common and persistent. All of the above are planktonic except *Planulina.*

The only indications of limited vertical distribution within the lower chalk member were restricted occurrences of *Rectogumbelina hispidula* Cushman and *Pleurostomella watersi* Cushman. The former was observed only in a single sample taken approximately 8 feet above the Eagle Ford—Austin contact; the latter was found in samples of the uppermost 12 feet of the lower chalk section as one of the most common species; it probably, however, ranges upward into the middle and upper Austin.

INTRODUCTION

The purpose of this study was to obtain a clear, concise picture of the vertical distribution and frequency of occurrence of foraminiferal species in the lower chalk member of the Austin formation. Close stratigraphic control was prerequisite to such a study. I obtained this by the construction of a composite measured section, through lithologic correlation of a series of separate but overlapping stratigraphic sections from along Ten Mile Creek in southern Dallas County (see Figure 1 and Plate 1).

Little work has been published concerning the stratigraphic distribution of Forminifera in the Austin formation. The earlier studies

(Carsey, 1926; Plummer, 1931) are entirely taxonomic and based primarily on single exposures and isolated samples, with no indication of the exact distribution and abundance of species. Cushman's (1946) more recent publication is likewise largely a taxonomic study, and offers only a general picture of species abundance and distribution. C. L. McNulty, Jr. (1955; unpublished manuscript) prepared the most comprehensive analysis of Austin Foraminifera, but intra-member zonation was handicapped by lack of adequate stratigraphic control.

GEOLOGIC SETTING

The Austin formation is within the Upper Cretaceous Gulf Series, and in Texas forms an arcuate outcrop belt extending from the Rio Grande to the Texas-Oklahoma-Arkansas border. In Dallas County the Austin dips east-southeast at about 50 feet per mile toward the

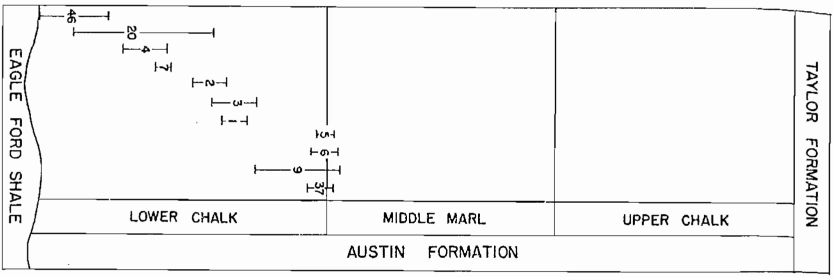

FIG. 1. Stratigraphic Position of Measured Sections of the Lower Chalk Member.

East Texas Basin. It is underlain disconformably (Stephenson, 1929, p. 1328; Adkins, 1932, p. 424) by the Eagle Ford shale and is overlain, probably conformably (McNulty, 1955, p. 6; 131), by the Taylor formation.

In Dallas County the Austin formation is approximately 600 feet thick and can be differentiated (in ascending order) into three lithologically distinctive members: a lower chalk (155 feet), a middle marl (229 feet), and an upper chalk (200 feet); thicknesses of middle and upper units given are from Dallas Petroleum Geologists (1941, p. 43). Although type sections have never been designated, these members are mappable units and have been treated as such (Bryan, 1953; Overmyer, 1953; Watkins, 1954; Cheatham, 1955; Reaser, 1957; Ingels, 1959). It is proposed that the upper reaches of Ten Mile Creek and the White Rock Escarpment immediately west be considered the type area of the lower chalk member, and the composite section contained herein (Plate I) serves as the type section.

LOWER CHALK MEMBER

This member rests disconformably on the Eagle Ford shale and is in gradational contact with the overlying middle marl member. Transition between the two members occurs through a zone of approximately 15 feet (Williams, 1957, p. 39).

The lower chalk member of the Austin formation is basically a white, massive, chalky limestone, intercalated occasionally with beds of marl and calcareous shale. The horizontal relief on these beds is the result of differential weathering which accentuates the variation in argillaceous content noted in individual layers and produces a strongly indented profile.

Most of the beds have an insoluble content ranging from 15 to 25 per cent and a thickness of from 1 to 4 feet, averaging about 2 feet. Beds of less than 15 per cent insoluble content are relatively rare within this member. These two groupings of beds are relatively resistant to weathering and tend to form the more prominent ledges in outcrop.

Beds with an insoluble content of 25 to 35 per cent are common in the lower member, but are only about one-sixth as frequent as those with a lower insoluble content. The former are usually thinner, seldom exceeding 1 foot, and are usually recessed due to more rapid weathering, although occasionally when situated between more resistant layers, are less conspicuously recessed.

Beds exceeding 35 percent insoluble are relatively uncommon, and their insoluble content generally ranges between 40 and 50 percent. These beds are very thin, from 2 to 4 inches, and form the most recessed portions of the weathering profile of each outcrop section.

PROCEDURE

Because of the gentle dip of the Austin formation and the low surface relief in southern Dallas County, sections in the lower member exposing as much as 30 feet stratigraphically are rare. Consequently every section in excess of 10 feet along the upper reaches of Ten Mile Creek was sampled and measured. Seven stratigraphic sections were measured with tape, hand level, and Jacob's staff. Each bed was sampled, measured to the nearest tenth of a foot, and its weathering profile noted. These sections were then correlated, primarily by insoluble residues, in conjunction with bed thicknesses and weathering profiles, and combined with the pertinent sections of Williams (1957) to produce a composite stratigraphic section for the lower chalk member (see Plate I).

Samples were crushed, and a 50-gram portion was further pulverized in a mortar until reduced to less than a 200-mesh sieve-size. The amount of calcium carbonate in each sample was determined by a rapid volumetric analysis method devised by Herrin *et al.* (1958). In these measurements it was assumed that the carbonate radical was completely in association with calcium. The solubility percentage of 10 random samples was determined by this method and compared with the results obtained for the same 10 samples by Williams (1957), who used the popular leaching method. The percentage of carbonate as determined by the rapid volumetric analysis method and the leaching method differed from 3 to 6 percent, always being higher in the leaching method. The difference is due to the ability of the solvent (HCl) used in the leaching method to dissolve compounds which are unaffected by the solvent (H_2SO_4) used in the rapid volumetric-analysis method. The percent insoluble was plotted on the stratigraphic sections to enhance comparison with Williams' sections.

The composite section I have constructed does not attain the 200 feet given by the Dallas Petroleum Geologists (1941, p. 43) as the thickness of the lower chalk member in Dallas County. The discrepancy may be partially explained by: (1) their figure is based on data from wells immediately east of the outcrop area and is approximate, and (2) the transitional nature of the lower chalk-middle marl contact precludes uniformity in choice of the top of the lower chalk. I am unable further to explain the apparent thinning, since my work did not include a study of the lateral relations within the lower chalk member. Nevertheless, I believe the composite section is essentially complete. The correlation of sections 1, 2, and 3 with Williams' Section 20 appears quite certain, as does the correlation of sections 5 and 6 with his Section 9. Due to a lack of sufficient overlap, the correlation between section 3 and Williams' Section 9 is less certain. It is consistent, however, with the relation between geographic position, topography, and regional dip.

From the composite section, samples from beds at 5-foot intervals and points of significant lithologic change were prepared for examination of their microfaunal content; forty-four samples were processed. Fifty grams of each sample was crushed to chips with an average width of one-quarter of an inch. Samples of more than 30 percent insoluble content broke down readily upon boiling in a sodium bicarbonate solution for about 2 hours. Those of less than 30 percent were not affected by the boiling process; for these, the Campbell sample washer (Hussey and Campbell, 1951) was necessary to disintegrate the material sufficiently. Each sample was then washed free of silt and clay in a 325-mesh sieve, and the residue slowly dried in an oven. The sample concentrate was split 5 times, giving an amount proportional to 1.6 grams of the original 50 grams, from which the Foraminifera were picked and identified. Samples tumbled in the Campbell sample washer were split fewer times since they were found to break down only partially.

FORAMINIFERA

The following 26 genera, representing 9 families, were observed in the lower chalk member:

Family	*Genus*
Valvulinidae	*Dorothia*
Lagenidae	*Lenticulina*
	Planularia
	Palmula
	Kyphopyxa
	Frondicularia
	Marginulina
	Saracenaria
	Dentalina
	Nodosaria
Heterohelicidae	*Gumbelina*
	Bolivinita
	Rectogumbelina
	Eouvigerina
Buliminidae	*Bulimina*
	Neobulimina
Ellipsoidinidae	*Pleurostomella*
Rotaliidae	*Valvulineria*
	Cyroidina
Globigerinidae	*Globigerina*
	Globigerinella
	Hastingerinella
Globorotaliidae	*Globotruncana*
	Globorotalites
Anomalinidae	*Anomalina*
	Planulina

Of these genera, the presence of *Bolivinita, Hastingerinella* and *Nodosaria* is questionable because of the rarity and poor preservation of forms having affinity with these genera. The classification of Foraminifera employed in this report follows that of Cushman (1955). A complete suite of specimens is on deposit at the Southern Methodist University Museum of Paleontology.

The foraminiferal fauna of the lower member is strikingly dominated by representatives of *Globigerina, Globotruncana, Gumbelina*, and *Planulina*—all planktonic with the exception of *Planulina*. The dominant species are: *Globigerina cretacea* d'Orbigny, *Globotruncana canaliculata* (Reuss), *G. fornicata* Plummer, *G. marginata* (Reuss), *Gumbelina striata* (Ehrenberg), and *Planulina* sp. cf. *P. austinana* Cushman. They constitute, in varying proportions, from 75 to 95 percent of the foraminiferal population in each sample. *Globigerina cretacea* d'Orbigny is the most common and persistent of the above species; it was found in every sample studied and constituted more than 25 percent of the total population in each sample, occasionally even exceeding 75 percent (see Table 1).

The following species contribute to the faunules in varying proportions and are fairly persistent throughout the lower chalk member, but seldom constitute more than 15 percent of a population: *Globigerinella aspera* (Ehrenberg), *Gumbelina plummerae* Loetterle, *G. pseudotessera* Cushman, *Globotruncana* sp. aff. *G. arca* (Cushman), and *G.* sp. aff. *G. globigerinoides* Brotzen.

The fauna is fairly uniform throughout and does not change significantly with changing lithology. Marls and calcareous shales have essentially the same species in the same relative abundance as do the chalky limestones. It was noted, however, that the state of preservation of Foraminifera is proportional to the percent of insoluble material in the samples from which they were derived; the best preserved specimens came from beds of high insoluble content. This is of course related to the procedure employed in washing the sample which in turn is a function of percent of calcium carbonate present or degree of cementation. I would recommend, therefore, that in future investigations of this sort, samples for examination of microfaunal content be limited to beds of high insoluble content, provided such beds occur reasonably close to 5-foot intervals.

Three striking features were noticed in reference to the vertical

TABLE 1

RELATIVE ABUNDANCE OF FORAMINIFERA

Dominant(D), 75-100%; Abundant(A), 50-75%; Common(C), 25-50%; Scarce(S), 5-25%; Rare(R), <5%
Unidentifiable samples(*)

Section	46										20																				3						9							
Bed (sample)	1	8	10	16	20	21	25	31	37	42	24	27	28	33	35	37	41	45	48	50	51	54	58	59	61	62	64	65	68*	72	10	15	16*	18	22	23	9	15	19	25*	32	40	47	52
Per cent insoluble residue	30.5	17.0	47.0	17.0	17.0	37.0	15.0	16.0	16.5	16.5	18.0	94.5	76.5	45.5	26.0	56.0	28.0	26.0	22.0	58.0	18.5	16.5	32.0	12.0	18.5	38.0	20.5	38.5	13.0	17.5	19.4	63.4	16.3	20.5	41.2	19.2	24.0	50.5	19.5	16.5	15.5	28.5	22.0	26.0
Anomalina sp. cf. A. ammonoides																																				R								
Bolivinita? sp. aff. B. costifera											R																																	
Bulimina sp.			R																																									
Dentalina sp.			R														R																											
Dorothia sp.														R						R	R	R	R					S															R	
Bouvigerina sp. cf. E. americana			R																																									
Bouvigerina sp.																																					R							
Frondicularia sp.										R										R																			R					
Globigerina cretacea	C	A	C	A	A	D	A	A	C	D	C	A	A	A	C	A	C	C	C	A	C	C	C	C	C	C	C	A		S	C	C		C	C	C	C	A	S		C	C	C	C
Globigerina? sp.	C		R												S		S																											
Globigerinella aspera	R	R	R	R	R	R	R				R	S		R	R	R		S	R	R	R	R				R				R	R			R	R		R	R	S				R	R
Globorotalites micheliniana		R	R																																									
G. subconicus			R																																									
G. umbilicatus				R		S	R	R	R																		R							R	S		R	R						
G. sp. aff. G. umbilicatus					S			R		R																																		
Globotruncana sp. aff. G. arca									R					R			R		R	R		R	R	R	R		R	R						R	R		R		R					
G. canaliculata		R	R				R	R	R				R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R		R	R	R		R	S		S		S		S	S	S	R
G. sp. aff. G. cretacea						R	R		R		R			R	R							R		R																				
G. fornicata							R				R	R	R	R	R	R	S	S	S	S	S	S	S	S	S	S		S		C	S	S		S	S	S	S	R	R		S	S	S	S
G. sp. aff. G. globigerinoides		R	R				R	R	R		R			R	S	R	R		R	R	S	S			S	R				S	R	R		R		R							R	R
G. marginata			R	R	S		R	R	R	R	S	R	S	S	R	S	S	S	S	R	S	S	S		S	C	S	S		S	S	S		S	R	R	S	S	S		S	S	S	S
G. sp. cf. G. rosetta																					R	R		R			R			R									R				R	
G. ventricosa												R	R												R	S		S		R												R		
G. sp. cf. G. ventricosa				R		S	R						R	R	R	R	R	R					R									R					R						R	
Gümbelina sp. aff. G. moremani															R	R	R	R										R																
G. sp. aff. G. planata													R		R		R																											
G. plummerae	R	R	S				R	R	R		R	R	R	R	R	R	S	R	R	R	R	R								R		R		R	R								R	R
G. pseudotessera							R	S	R		R			R	R	R	R	R	R	R	S	R			R		R			R	R			S	R				R		S	R	S	
G. striata	S	S	C	C	S		S	A	C	S	C	S		C	C	S	S	S	C	R	R	S			R	S	R	S		S	S	R		S	S	R		R	S		R	S	C	S
Gyroidina globosa				R			R	R						R											R		R																	
Hastingerinella? sp. aff. H. simplex				R							R				R			R	R		R													R										
Kyphopyxa christneri																																			R									
"Lenticulina rotulata"														R																														
"Lenticulina" pondi	R																					R																						
Lenticulina sublaevis	R	R	R				R																																					
L. sp.	R		R		R		R																R		R		S				R			R	R		R	R					R	
Marginulina sp.																							R																					
Neobulimina sp. aff. N. canadensis		R	R												R																							R						
N. irregularis	R	R	R											R			R														R	R										S		
Nodosaria? sp.								R																																				
Palmula suturalis																				R																	R	R						
Planularia sp.													R																															
P. sp. aff. P. umbonata																																						R						
Planulina austinana																				R																			R			S	S	C
P. sp. cf. P. austinana	R	R	R	R		R	R		R	S	S	S	S	S	R	S	R	S	C	C	C	C	C	C	C	C	C	S		R	S	C		C	S	C	S	S	S		R	R		
P. sp. cf. P. texana																			S		R						R				R			R			R							
Pleurostomella watersi																																												C
P. sp. cf. P. watersi																																										S	R	
Rectogümbelina hispidula			S																																									
Saracenaria sp.											R																																	
Valvulineria infrequens																			R	R																								
V. plummerae	R			R	R		R	R		R	R											R			R		R				R						R							

distribution of species in the lower member. The ranges of *Rectogumbelina hispidula* Cushman and *Pleurostomella watersi* Cushman are restricted to only a short portion of the composite section. *Rectogumbelina hispidula* Cushman was found only in bed 10 of section 46, approximately 8 feet above the base of the Austin, and made up about 10 percent of the faunule. The first definite appearance of *Pleurostomella watersi* Cushman occurs 153 feet above the base of the Austin (bed 52, section 9); it constituted 25 percent of the faunule. Badly deformed and compressed specimens identified as *Pleurostomella* sp. cf. *P. watersi* Cushman are found at the 144.5-foot and 149-foot levels (beds 40 and 47, section 9).

Accompanying these forms in the last 3 sampled beds of the lower chalk member are specimens of typical *Planulina austinana* Cushman which compose from 20 to 40 percent of the faunules in these beds. Lower in the section typical *Planulina austinana* Cushman are very rare; but forms having affinity with this species (identified as *Planulina* sp. cf. *P. austinana* Cushman) are common throughout the section. The vertical distribution of *Pleurostomella watersi* Cushman and *Planulina austinana* Cushman is primarily restricted to that portion of the section referred to as the transition zone; they may however persist up into the middle marl member; and examination of McNulty's (1955) faunal lists suggests that such is the case.

Faunal and lithological evidence of the environment under which the lower chalk member was deposited may appear somewhat contradictory to some. The lithology seems to indicate a relatively shallow-water milieau, whereas the striking domination of the foraminiferal fauna by pelagic forms, and the small percentage of benthonic forms would suggest deeper water conditions. I am forced to the conclusion that the environment was basically that of shallow water, which apparently was not conducive to supporting a prolific benthonic fauna. To state further what conditions existed would be pure speculation.

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