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PETROLOGY OF A CARBONATE CORE FROM THE MISSISSIPPIAN PENNINGTON FORMATION: SAND MOUNTAIN, ALABAMA

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ABSTRACT

Ninety two feet of carbonate core from the Mississippian Pennington Formation near the western erosional edge of Sand Mountain, Alabama, was examined for small-scale sedimentary structures, parts of large-scale bed forms, texture and composition with the view of developing a sedimentational model.

Ferm and Ehrlich (1967) provided a stratigraphic framework in which Mississippian and Pennsylvanian rocks are, in part, temporal equivalents. The Pennsylvanian consists of a deltaic-quartz sand barrier system with Mississippian carbonates situated seaward. Bergenback, Horne and Inden (1972) have suggested that the Pennington Formation is probably a tidal flat complex.

Eleven facies have been recognized. Five are interpreted as back barrier, one as a tidal channel, one as an algal mat, one as pellet mounds, one as a tidal flat, and two as barriers.

INTRODUCTION

In the summer of 1970, the Arch Mineral Company of Fabius, Alabama, located atop Sand Mountain, drilled Pennsylvanian and Mississippian rocks in search of water (Fig. 1). They drilled to a depth of 305 feet

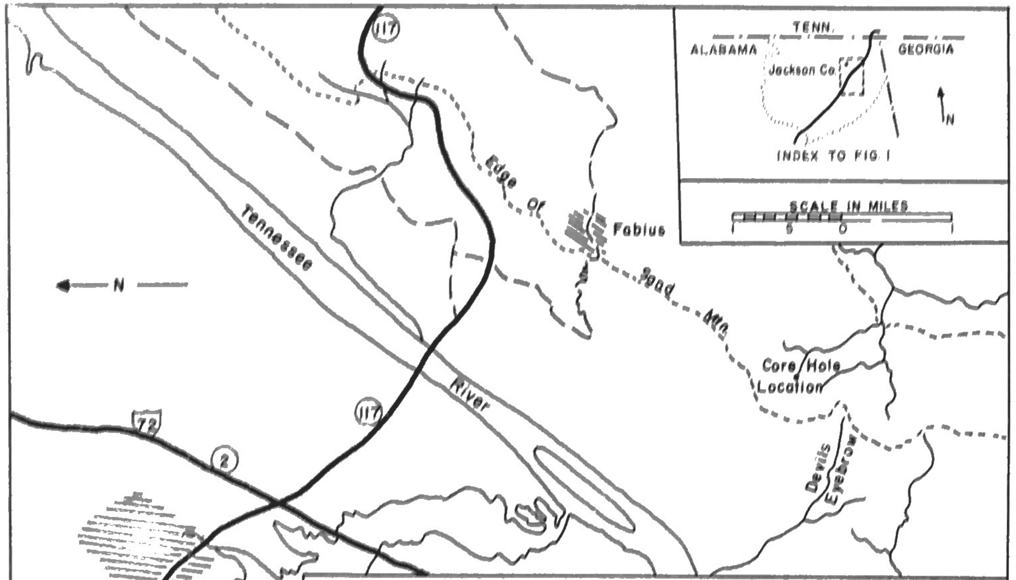


Figure 1, Core Hole Location Along Western Erosional Edge Of Sand Mountain, Alabama

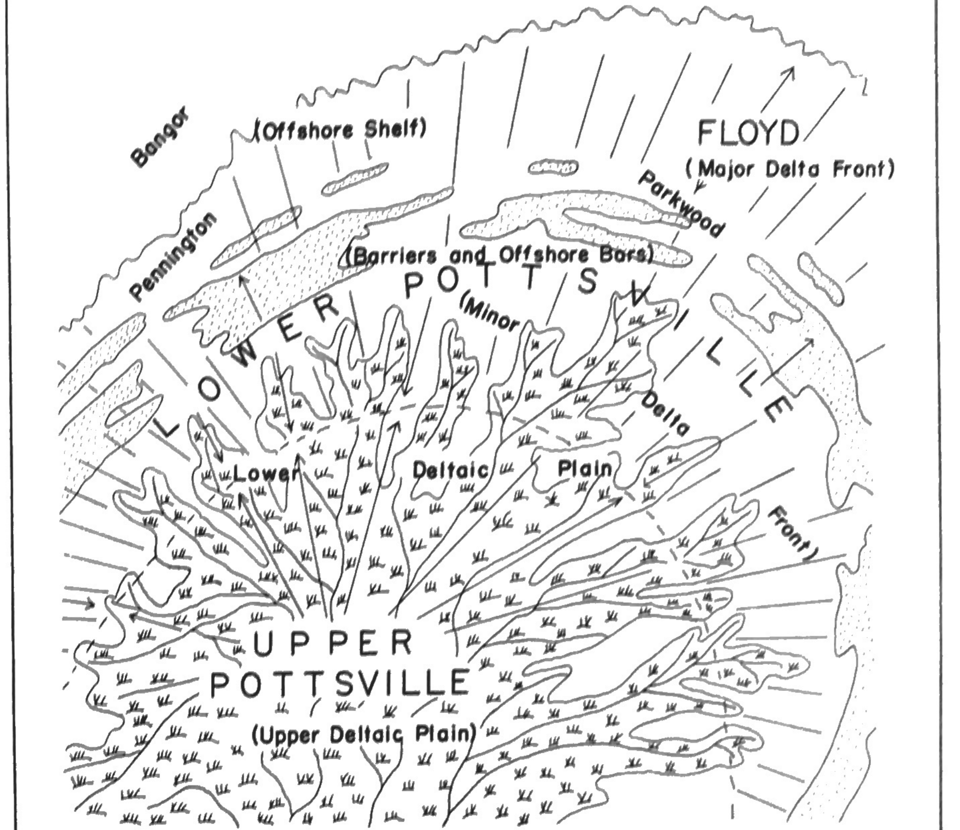


Figure 2, Interpretive Diagram Of Ferm And Ehrlich (1967) Showing Generalized Carboniferous Sedimentational Patterns In Northern Alabama and cored an additional 92 feet of Pennington carbonate rocks for a total hole depth of 397 feet.

Because exposures of the Mississippian Pennington Formation are rare in northeastern Alabama, it is believed that the stratigraphic and petrologic information obtained in this core study will make a unique contribution to knowledge of the Pennington in this area.

Ferm and Ehrlich (1967) considered Pennsylvanian and Mississippian rocks in Alabama to be, in part, temporal equivalents. Figure 2 shows their interpretation of the Pennsylvanian system as a northward prograding deltaic complex with offshore quartz sand barriers. A number of Mississippian carbonate environments existed seaward of the Pennsylvania clastic complex.

Hobday (1969) suggested that there are two Carboniferous prograding sequences which overlap in the vicinity of Cullman, Alabama. One sequence was reported by Ferm and Ehrlich (1967) as a northward prograding deltaic complex in Alabama. The other is much larger, progrades generally westward and covers part of the states of Alabama, Georgia, Tennessee, Kentucky, Virginia, West Virginia, Ohio and Pennsylvania. The Pennington core, studied in this report, is from northeastern Alabama near the southwestern edge of the larger detrital complex.

Work by Horne and Inden (1970) in northeastern Kentucky and by Bergenback, Horne and Inden (1972) near Monteagle, in southeastern Tennessee, suggests that the Pennington formed as a huge tidal flat complex composed of red, green and gray shales, green sandstones with locally abundant carbonates.

The purpose of this study is to develop a sedimentational model for the Pennington core based on examination of vertical changes in bed forms, small-scale sedimentary structures, texture, and composition.

STRATIGRAPHY

Figure 3 shows Wilson's (1965) classification of Carboniferous rocks of Sand Mountain, Alabama. Culbertson (1963) subdivided the Carboniferous sediments of northwest Georgia in a similar manner (Fig. 4).

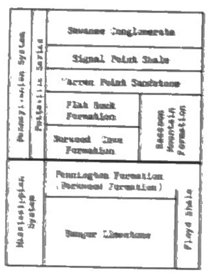


Figure 3, General Stratigraphic Nomenclature for Lower Pennsylvanian Section of Northeast Alabama after Wilson (1965)

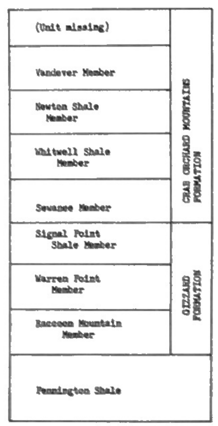


FIGURE 4, STRATIGRAPHIC NOMENCLATURE OF LOWER POTTSVILLE STRATA IN NORTHWEST GEORGIA (CULBERTSON, 1963)

Thomas (1967) studied subsurface Mississippian rocks in northern Alabama and suggested a stratigraphic classification based on the premise that Mississippian carbonates accumulated on a shallow marine platform which gave way laterally to fine clastics in an adjacent basin (Figs. 5 and 6). Presumably these rocks formed in the westernmost portion of the aforementioned westward-prograding detrital complex.

McLemore (1971) worked with surface exposures of the Mississippian system in northern Georgia and developed a similar stratigraphic classification and sedimentational model

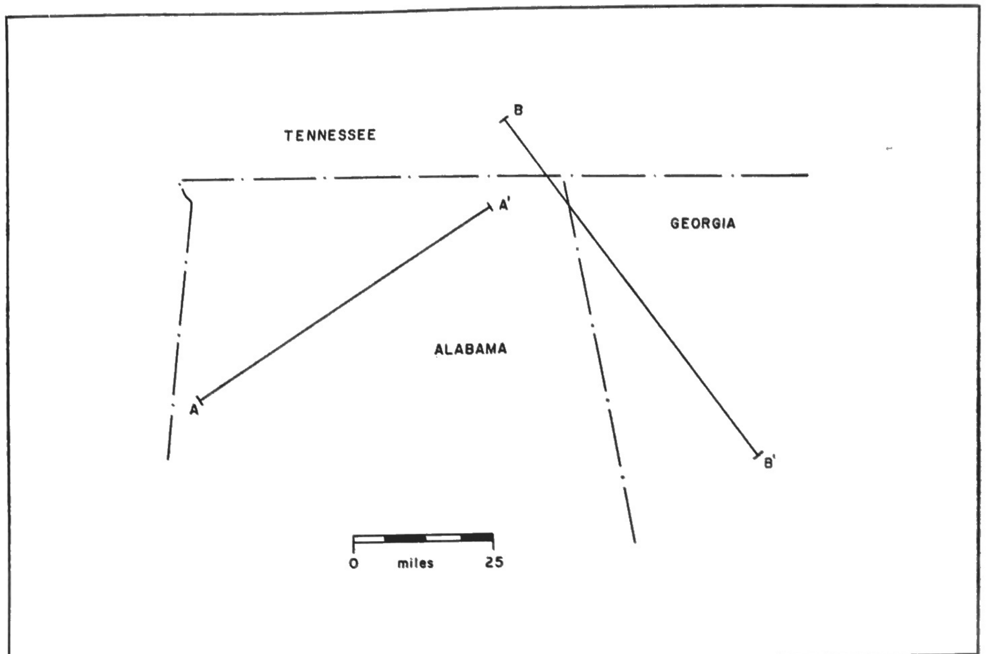


FIGURE 5, LOCATION OF STRATIGRAPHIC CROSS-SECTIONS, THOMAS (1967) AND MCLEMORE (1971)

MATERIALS AND METHODS

Slabs of core were examined for parts of large-scale bed forms, small-scale sedimentary structures, texture and composition.

Thin section samples of selected facies were point-counted in order to estimate proportions of constituents. Point-count data are in the Appendix of this report.

Insoluble residue analyses were prepared and are summarized in Table 1.

DISCUSSION

Eleven facies have been recognized in a core of the Pennington Formation from Sand Mountain, Alabama (Fig. 7). Obviously, deposit geometry and large-scale sedimentary structures cannot be ascertained with certainty from single core samples.

Table 1 shows the results of an insoluble residue study on ten of eleven facies. Residues consist largely of terrestrial clays with sand, silt and chertified fossil debris in minor amounts. These data may be used, in a general way, to aid petrologic interpretation.

Facies 1 is approximately 6 feet thick and consists of laminated, burrowed, dolomitized, fine- to coarse-grained biomicrite with certain of the more micritic laminae containing numerous small dolomite euhedra. Insoluble residues average 23%. Echinoderm and bryozoan debris predominate with echinoid and brachiopod fragments constituting 1% or less. The laminated and dolomitized biomicrite, plus a relatively large amount of suspension sedimentation (clays), suggest deposition in a back barrier area such as a shallow bay or lagoon.

Facies 2 grades upward into Facies 1 and is in sharp contact with underlying Facies 3. This unit is 6.5 feet thick, contains fine-pebble-sized micrite rip-up clasts at its base and grades upward to laminated, cross-bedded, sand-sized oolites and fossil debris. This rock is classified as a bio-oosparite because fossil debris is more abundant than oolites. Insoluble residues average 2.5% in the upper portion and 12.5% in the lower portion. Echinoderm, bryozoan and gastropod grains are the dominant fossil fragments with lesser brachiopod, echinoid and ostracod debris. Tests of endothyra are present in the upper part. The sharp basal contact, the higher clay content at the base, the upward decrease in grain size, the winnowed, laminated, cross-bedded nature of the sediments suggest deposition in a scoured, subtidal tidal channel. The oolite grains may have been swept in from distant oolite shoals, but recent work by Friedman, *et al.* (1973) in the Gulf of Aqaba indicates that oolites may have formed on nearby algal mats. Presumably the endothyra tests were swept into this tidal channel from a shallow marine environment.

Facies 3 is approximately 5.5 feet thick, but its

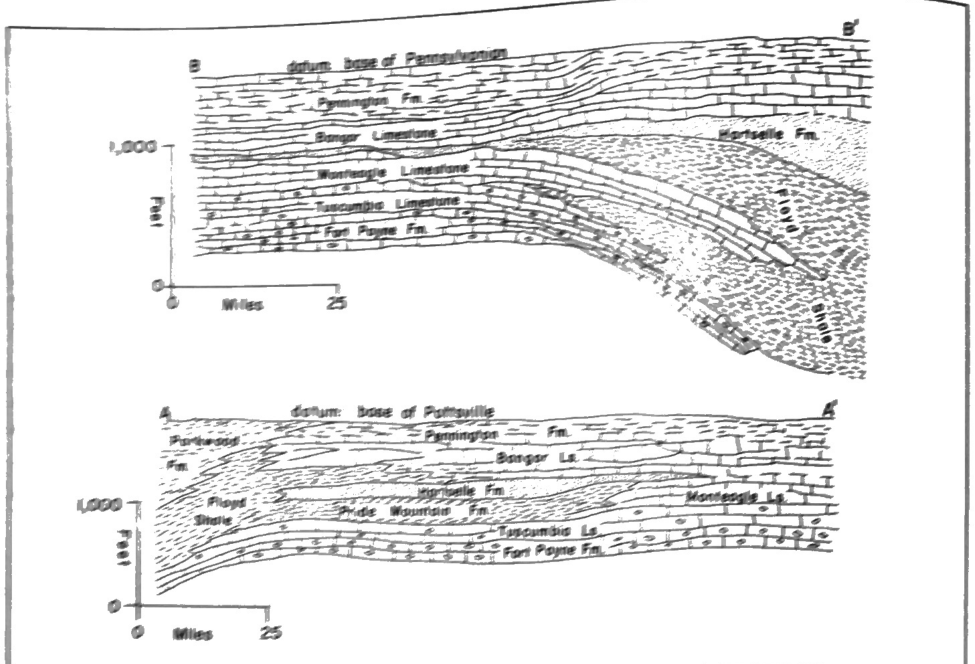


FIGURE 6, STRATIGRAPHIC CROSS-SECTIONS A-A' AFTER THOMAS (1967); B-B' AFTER MCLEMORE (1971)

lower contact with Facies 4 is indeterminate because of missing core. This rock is a non-fossiliferous, dessicated micrite with green shale filling mud cracks and forming clastic dikes. Insoluble residues average 27%. Dessicated, non-dolomitized micrite with associated suspension sedimentation (green clay) suggests a tidal flat origin.

The lower and upper contacts of Facies 4 are indeterminate because of missing core. This unit is approximately 15.75 feet thick. Numerous linear, or horizontal, and fewer globular birdseye structures characterize this rock. Thin red and green shale laminae are present throughout and locally, the limestone is tinted with red and green clay. The rock consists largely of micrite with scattered pellets, and tiny bits of of unidentifiable fossil debris. The micrite appears to have been extensively mud-cracked, and the voids filled with spar, many of them forming linear birdseye structures. Insoluble residue samples were taken from areas of the core where thin shale laminae are not present. Residues average 10% at the top and 4% at the bottom of this unit. Red and green clay probably represents alternating oxidizing and reducing conditions. Birdseye structure, that may be the result of dessication, likely indicates a high intertidal or supratidal environment. It is suggested that these rocks are of high intertidal origin and may represent a much-dessicated algal mat.

Facies 5 is represented by only a few inches out of approximately 4 feet of core. The dazzling white appearance of this core caused the driller to regard the core as a curiosity and so he removed large sections to take home as playthings for his children. The bleached-white nature of this rock would, at first sight, lead one to think of it as an evaporite, but it is a pelmicrite. Insoluble residues average 12%. The lack of organic matter and abundance of pellets suggests an oxidizing environment where pellets accumulated. Perhaps these deposits represent heaped-up, supratidal pellet mounds.

Facies 6 is approximately 20 feet thick and consists largely of laminated, argillaceous, burrowed, fine-grained biomicrite that rests sharply on underlying Facies 7. Echinoderm grains predominate with lesser bryozoan and echinoid debris. Insoluble residues average 18.5% at the top and 24.5% at the bottom. These sediments may have accumulated in a back barrier zone.

The upper and lower contacts of Facies 7 are sharp. This 6 foot thick unit is composed of laminated, cross-bedded, coarse-grained oo-biosparite. Oolites are the most abundant grains. Echinoderm, gastropod, and bryozoan debris are the dominant fossil fragments with

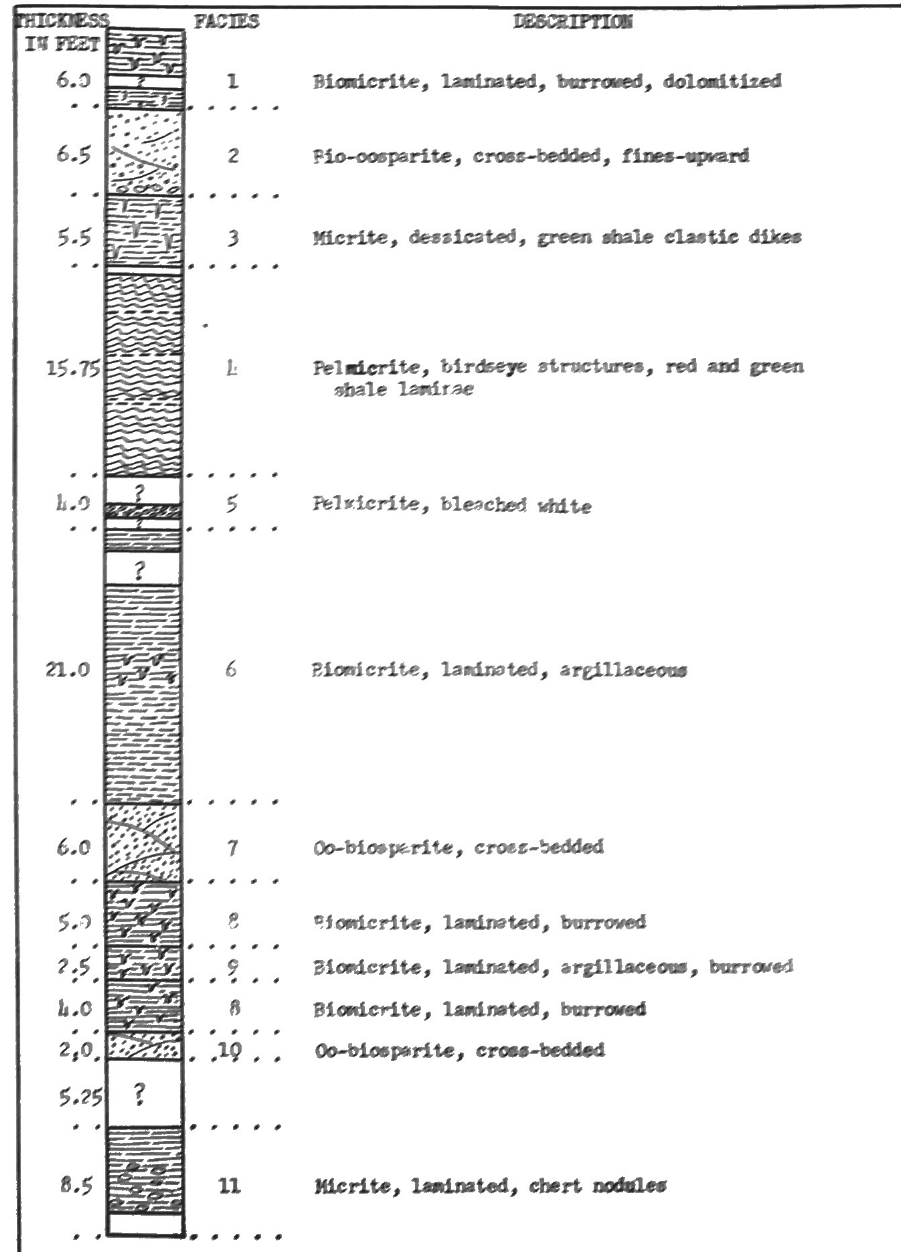


Figure 7, Descriptive Log Of Pennington Fm. Core

TABLE I, SUMMARY OF INSOLUBLE RESIDUE ANALYSES

Facies	Sample Location	Replicate Sample Numbers	Sample Weight	Weight Insoluble Residue	Average Insoluble Residue	Experimental Error
1	1 ft.	1	2.0 g.	0.45 g.	23.0%	0.5%
		1	2.0 g.	0.46 g.		
2	7 ft.	2	2.0 g.	0.06 g.	2.5%	1.0%
		2	2.0 g.	0.04 g.		
	12 ft.	3	2.0 g.	0.24 g.	12.5%	0.5%
		3	2.0 g.	0.25 g.		
3	14.5 ft.	4	2.0 g.	0.48 g.	27.0%	5.5%
		4	2.0 g.	0.59 g.		
4	20 ft.	5	2.0 g.	0.19 g.	10.0%	0.5%
		5	2.0 g.	0.20 g.		
	25 ft.	6	2.0 g.	0.09 g.	4.0%	0.5%
		6	2.0 g.	0.07 g.		
5	36 ft.	7	2.0 g.	0.23 g.	12.0%	0.5%
		7	2.0 g.	0.24 g.		
6	42 ft.	8	2.0 g.	0.36 g.	18.5%	0.5%
		8	2.0 g.	0.37 g.		
	48 ft.	9	2.0 g.	0.50 g.	24.5%	1.0%
		9	2.0 g.	0.48 g.		
7	59 ft.	10	2.0 g.	0.20 g.	10.0%	0.5%
		10	2.0 g.	0.19 g.		
	64 ft.	11	2.0 g.	0.14 g.	6.5%	1.0%
		11	2.0 g.	0.12 g.		
8	69 ft.	12	2.0 g.	0.32 g.	16.0%	0.5%
		12	2.0 g.	0.31 g.		
	74 ft.	13	2.0 g.	0.18 g.	9.0%	0.0%
		13	2.0 g.	0.18 g.		
9	71 ft.	14	2.0 g.	1.18 g.	60.0%	2.0%
		14	2.0 g.	1.22 g.		
10	77 ft.	15	2.0 g.	0.12 g.	7.0%	1.5%
		15	2.0 g.	0.15 g.		

lesser brachiopod shell pieces. Insoluble residues average 10% at the top and 6.5% at the bottom. The winnowed and pore-filled, cross-bedded oolite and fossil grains suggest a mound or ridge-like deposit, possibly an oolite shoal or barrier.

Facies 8 embraces Facies 9 in transitional contact. Rocks of Facies 8 consist of laminated, burrowed, medium-grained biomicrite with numerous echinoderm grains and lesser amounts of bryozoan and echinoid spine fragments. Insoluble residues average 16% at the top and 9% at the base. These characteristics probably indicate a back barrier environment.

Facies 9 is composed of laminated, burrowed, argillaceous, medium-grained biomicrite with echinoderm grains dominant. Insoluble residues average 60%. The high clay content plus the burrowed nature of these sediments suggests that they accumulated in localized settling basins, or ponds, within a back barrier bay or lagoon.

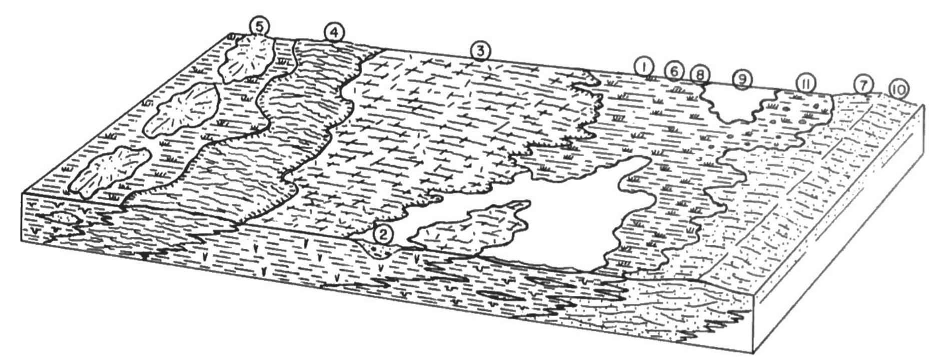
Facies 10 is in sharp contact with overlying Facies 8, but its lower contact is indeterminate because of core loss. Two feet of core represent 7.25 feet of section. Cross-bedded, laminated, coarse-grained oo-biosparite compose Facies 10. Echinoderm fragments are dominant with lesser bryozoan and echinoid spine debris. Insoluble residues average 7%. Presumably this is an oolitic barrier, similar to Facies 7.

Facies 11 is over 8.5 feet thick and is made up of laminated, silicified micrite that contains gray chert nodules which range up to 1½ inches in long dimension. No insoluble residues were prepared on these silicia-rich sediments. Certain of the micrite laminae appear to have been sedimented over a blob of silica, however, this may be a compactional phenomena, but it would seem to suggest that a silica gel mass was present during sedimentation. Thus it is likely that blobs of silica gel (that form chert) randomly accumulated in a high subtidal, back barrier area.

SUMMARY AND CONCLUSION

Ninety-two feet of carbonate core from the Pennington Formation, located near the western erosional edge of Sand Mountain, Alabama, were examined for parts of large-scale bed forms, small-scale sedimentary structures, texture and composition. These data were fitted into regional Carboniferous depositional models developed by Ferm and Ehrlich (1967), Thomas (1967), McLemore (1971) and Ferm *et al.* (1972).

Eleven facies were recognized and a tidal flat com-



NUMBERS INDICATE FACIES SHOWN IN FIGURE 7

Figure 8, Tidal Flat Complex Model Of Pennington Fm. Core plex sedimentational model was prepared (Fig. 8). Facies 1, 6, 8, 9 and 11 are interpreted as back barrier deposits. Facies 2 probably accumulated in a tidal channel. Winnowed, oolite-rich Facies 7 and 10 may have formed as bars or barriers, and Facies 3 likely was deposited on a lower tidal flat. The birdseye structures in Facies 4 presumably were formed in a massive ancient algal mat. The white, bleached pellet-rich deposits of Facies 5 may have accumulated as pellet mounds.

APPENDIX

Point-count data of selected facies

Facies	Sample Number (Depth in Feet)	Dolomitized Micrite Matrix	Micrite Matrix	Spar Pore Filling	Fossils: Echinoderms	Fossils: Bryozoans	Fossils: Brachiopods	Fossils: Ostracods	Fossils: Echinoid Spines	Fossils: Gastropods	Fossils: Endothyra	Fossils: Spines?	Algae: Oncolites	Algae: Encrusting Algae	Algae: Algal Structures	Algae: Calcispheres	Oolites: Mature	Oolites: Superficial	Pellets	Micrite Clasts	Micrite Coating	Clay Minerals	Unidentified Allochems	Total
	0.5	86	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	100
	1.0	97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	100
	1.3	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100
	1.5	47	-	-	33	11	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	100
1	1.8	42	-	9	33	6	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	8	100
	2.0	63	-	1	21	6	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	7	100
	2.4	30	-	18	28	6	2	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	6	100
	3.4	77	-	9	10	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100
	3.7	81	-	-	15	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	100
	4.3	-	-	20	16	25	3	4	1	-	3	-	-	-	-	-	4	-	-	7	-	-	17	100
	5.6	-	-	26	25	7	3	1	2	-	-	-	3	-	-	-	8	6	-	9	-	-	8	100
	6.4	-	-	28	21	-	-	-	-	8	-	-	-	-	-	-	19	12	-	6	-	-	6	100
	7.5	-	-	25	27	2	1	-	-	14	-	-	-	-	-	-	5	13	-	7	-	-	6	100
	8.3	-	-	13	25	6	3	-	1	2	-	-	-	10	19	-	-	-	1	6	3	-	11	100
2	8.8	-	-	17	41	3	-	1	-	7	1	-	-	-	1	-	7	7	-	8	5	-	2	100
	9.8	-	-	17	25	5	2	1	-	3	-	-	-	-	-	-	9	18	-	12	2	-	6	100
	10.5	-	-	16	29	1	-	-	-	4	-	-	-	-	-	-	9	26	-	7	1	-	7	100
	11.2	-	-	17	14	5	-	-	-	4	-	-	-	-	-	-	19	31	-	7	2	-	1	100
	12.0	-	-	11	35	3	-	-	-	5	1	-	-	-	-	-	11	15	-	11	5	-	3	100
	12.3	-	-	28	18	1	1	-	-	8	-	-	-	-	-	-	13	11	-	15	3	-	2	100
	12.5	-	-	12	10	3	-	-	-	-	-	-	-	-	-	-	7	11	-	42	-	10	5	100
3	13.0	-	85	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	100
4	20.5	-	49	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-	-	-	-	100
	23.3	-	75	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	100

Facies	Sample Number (Depth in Feet)	Dolomitized Micrite Matrix	Micrite Matrix	Spar Pore Filling	Microspar	Fossils: Echinoderms	Fossils: Bryozoans	Fossils: Brachiopods	Fossils: Ostracods	Fossils: Echinoid Spines	Fossils: Gastropods	Fossils: Endothyrids	Fossils: Spines?	Algae: Oncolites	Algae: Encrusting Algae	Algae: Algal Structures	Algae: Calcispheres	Oolites: Mature	Oolites: Superficial	Pellets	Micrite Clasts	Micrite Coating	Clay Minerals	Unidentified Allochems	Total
	26.7	-	73	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	100
4	29.4	-	67	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	100
	31.0	-	81	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	-	100
	32.5	-	82	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	100
5	35.75	-	35	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55	-	-	-	-	100
	43.45	-	19	-	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100
	44.0	-	79	7	-	-	8	-	-	-	-	2	-	-	-	-	2	-	-	-	-	-	-	2	100
	47.8	-	99	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100
6	49.8	-	81	11	-	3	-	-	-	-	-	-	-	-	2	-	3	-	-	-	-	-	-	-	100
	52.6	-	79	-	-	13	4	-	-	2	-	-	-	-	-	-	1	-	-	-	-	-	-	1	100
	58.6	-	84	4	-	8	-	-	1	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	100
	59.0	-	81	4	-	17	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100
	61.6	-	81	2	-	8	4	-	-	-	-	2	-	-	-	-	-	2	1	-	-	-	-	-	100
7	62.9	-	-	28	-	50	7	-	-	-	2	-	-	-	-	-	-	11	2	-	-	-	-	-	100
	64.0	-	-	29	-	-	11	-	-	1	2	1	-	-	-	-	-	13	35	-	3	-	-	5	100
	64.9	-	-	30	-	13	2	-	-	1	-	-	-	-	-	-	-	25	23	-	4	-	-	2	100
	66.0	-	-	46	-	-	-	-	-	-	-	2	-	-	-	-	1	-	-	-	23	-	-	28	100
	66.8	-	-	59	-	-	3	-	-	-	-	5	-	-	-	-	2	-	-	-	13	-	-	18	100
	67.5	-	-	56	-	8	-	-	1	-	-	3	-	-	-	-	-	-	-	-	15	-	-	17	100
8	67.8	-	35	-	43	7	-	-	-	-	-	2	-	-	-	-	-	-	-	-	11	-	-	-	100
	68.1	-	46	-	-	22	26	-	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-	3	100
	68.6	-	51	-	-	31	12	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	5	100
	69.1	-	21	-	65	10	-	-	1	-	-	1	-	-	-	-	1	-	-	-	-	-	-	1	100

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1973 SURVEY REPORT EXPLORES U.S. CONVERSION TO METRICATION

During March and April 1973, the Management Research Group of American Management Associations (135 West 50th St., New York, N.Y. 10020) conducted a nation-wide survey of approximately 5,500 U.S. business firms and other organizations in an effort to measure the mood of the business community with respect to going metric. The questionnaire, mailed to vice presidents of either administration or manufacturing and chief engineers of companies selected for the survey, received more than 1,000 responses. In general, responses strongly suggest that U.S. commerce and industry are both willing and able to begin an effective conversion program on short notice. Some of the report's findings include:

1. More than 75% of the respondents favored a national conversion.
2. More than 80% estimated that a 10 year transition period would be ample.
3. More than 50% now purchase abroad. Of these, most were not worried aboutt he possibility that metric conversion by the U.S. would lead to a flood of imports from nations already familiar with metric.
4. Less than 25% expect problems in sales, marketing, clerical work, executive management, packaging, finance, distribution and legal affairs.
5. About 50% wanted subsidies or tax relief during conversion. 25% thought legal standards, such as building codes, should be temporarily relaxed.
6. 80% of the companies felt that their costs of doing business would either decrease (7%) or remain about the same (73%). Eleven per cent were uncertain.

In light of the recent refusal of the House to allow the Metric Conversion Bill (HR 11035) to come before the floor, it may be that the general public may not be as favorable towards conversion as American business firms.

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