

**STATE OF FLORIDA
DEPARTMENT OF CONSERVATION**

R. L. DOWLING, Supervisor

GEOLOGICAL BULLETIN No. 16

**STRATIGRAPHY AND MICROPALEONTOLOGY
OF TWO DEEP WELLS IN FLORIDA**

**By
W. STORRS COLE
Ohio State University**

TALLAHASSEE, FLORIDA

1938

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LETTER OF TRANSMITTAL

HONORABLE R. L. DOWLING,
Supervisor of Conservation.

SIR:

I have the honor to transmit a report on the Stratigraphy and Micropaleontology of Two Deep Wells in Florida by Dr. W. Storrs Cole of the Ohio State University, Columbus, to be published as Geological Bulletin No. 16.

In the drilling of deep wells in Florida much information of permanent value is obtained and this is especially true when samples of the cuttings and cores of the material penetrated are saved and studied. The two wells here reported upon have yielded fundamental data about the character, thickness and age of the deposits encountered and will add to our knowledge of the structure and stratigraphy of that portion of Florida in which they are located.

I want to take this opportunity of expressing my appreciation of the interest you have shown in the work of the Geological Department and the support you have so generously given it.

Very respectfully,

HERMAN GUNTER,
*Assistant Supervisor,
State Board of Conservation,
Geological Department.*

Tallahassee, Florida,
August 7, 1938.

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STRATIGRAPHY AND MICROPALAEONTOLOGY OF TWO DEEP WELLS IN FLORIDA

W. STORRS COLE

Ohio State University

INTRODUCTION

The Florida Geological Survey has collected for many years information and samples from numerous wells drilled within the state of Florida in the search for possible oil horizons or water-bearing zones. Through the kindness of Mr. Herman Gunter, State Geologist, samples from two of these wells were sent to the writer on October 28, 1936 for preliminary study. The results of the investigation were so gratifying in the amount of information which was obtained concerning the stratigraphy and micro-faunas of the areas involved that Mr. Gunter decided to publish the results of this study, if permission to do so could be obtained from the owners of the wells. The owners very generously granted this permission.

ACKNOWLEDGMENTS

The preparation of the final report was made possible through the assistance and kindness of numerous persons. My thanks are due to Mr. Herman Gunter for his kindness and never failing interest during the progress of this study. I am obligated to Dr. T. Wayland Vaughan for comments on the large foraminifera and to Drs. L. W. Stephenson and C. Wythe Cooke for reading the manuscript. Mrs. Helen Jeanne Plummer examined many of the smaller foraminifera. Her comments were particularly helpful as well as the specimens which she kindly furnished for comparison. Mrs. Elizabeth Burckmyer made the drawings of the small foraminifera and my thanks are offered for her care in accurately illustrating the various species.

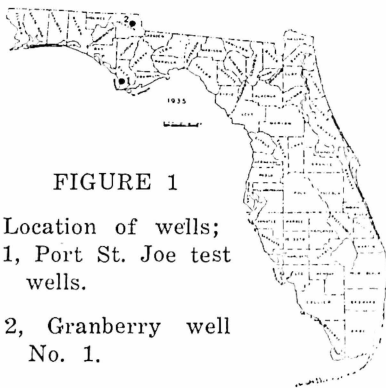


FIGURE 1

Location of wells;
1, Port St. Joe test
wells.
2, Granberry well
No. 1.

All the specimens mentioned in this bulletin are filed in the Florida Geological Survey Museum at Tallahassee, with the exception of a few specimens used for comparison. Notation of the depository of these will be found on the explanation of the plates.

PORT ST. JOE TEST WELLS 3 AND 4

These wells were drilled by the Layne-Central Company of Memphis, Tennessee for the city of Port St. Joe, Gulf County, Florida, in search of water-bearing zones. The elevation of the well mouth of each well is about 5 feet above the water in the bay. All the samples are cuttings as cores were not taken. Mr. Ray Hudson, field superintendent, and Mr. W. R. Galt, city manager, furnished the samples and the data concerning the wells.

Five samples were submitted from test well 4, starting at the surface and extending to a depth of 104 feet. The total depth penetrated by the well was 114 feet (W-289).

Test well 3 was drilled to a depth of 1037 feet. Brackish water was encountered and this well will not be used. The samples represent the interval from 83 to 1035 feet, except for a short section between 911 to 975 feet from which samples were not available (W-288).

STRATIGRAPHY

The formations penetrated by test wells 3 and 4 and their lithologic character are shown on Figure 2. The combined sections present a picture of the stratigraphic succession to a depth of 1035 feet.

RECENT AND PLEISTOCENE

The Recent and Pleistocene epochs could not be separated with the information obtained from these wells. Although broken fragments of shells are present, foraminifera were not encountered until the sample at 130-145 feet was examined.

The bottom sample (83-104 feet) of test well 4 has the same lithologic character as the first sample (83-114 feet) in test well 3. The base of the Pleistocene occurs at a depth of approximately 114 feet. This point was selected because of the lithologic change.

LOGS OF
PORT ST. JOE TEST WELLS
PORT ST. JOE, GULF CO., FLORIDA

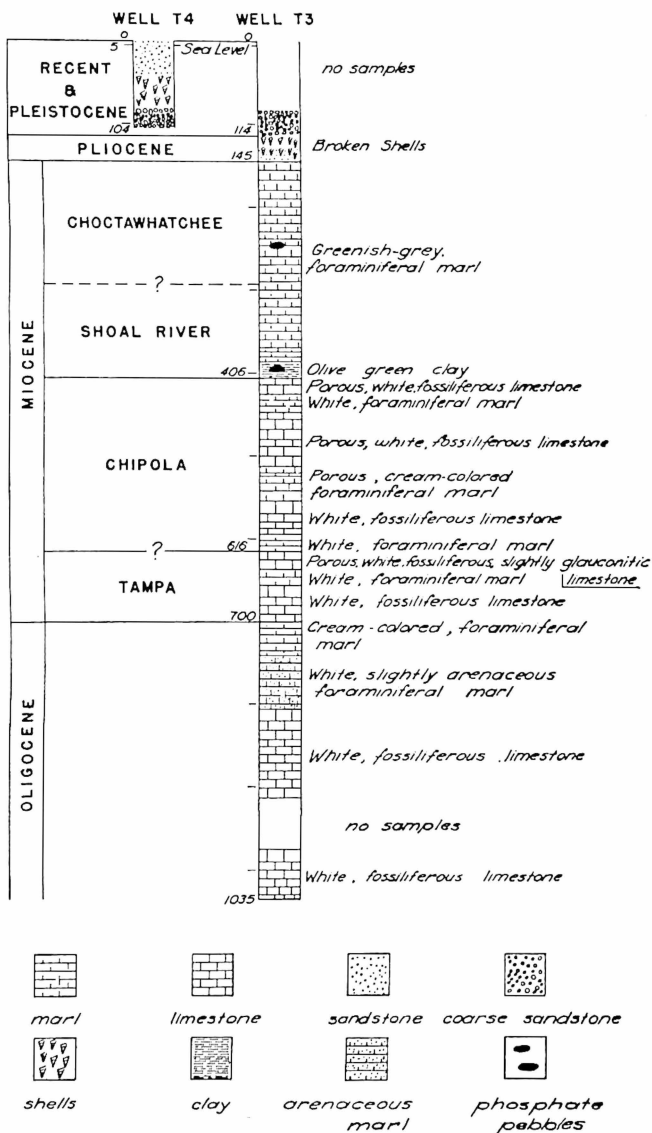


FIGURE 2

PLIOCENE

The Pliocene is represented by only two samples, covering the interval from 114 to 145 feet. The first of these samples (114-130 feet) contains numerous broken shell fragments and a considerable number of Bryozoa. A number of the Bryozoa were submitted to Dr. R. S. Bassler of the United States National Museum. The following is a quotation from his letter: "I will first report that this assemblage of species (*Cupularia doma* d'Orbigny, *C. denticulata* Conrad and *C. umbellata* De-france) is unfortunately found in all of the rocks from Miocene to Recent times. These species commence growth usually around a sand grain so they indicate that sort of a sea bottom, but for stratigraphic purposes they are only useful in recognizing the Miocene or younger rocks."¹

The second sample (130-145 feet) contained a number of foraminifera. The fauna suggests the one described from the Waccamaw formation² rather than that of the Caloosahatchee marl.³

MIOCENE

Choctawhatchee formation. — The contrast in lithologic character between the material from the first Miocene sample (145-171 feet) and that from the samples representing younger epochs is most striking. The Miocene to the top of the Tampa formation is dominantly composed of greenish-grey, foraminiferal marls with some beds of olive-green clay. Occasional phosphate pebbles are encountered.

Foraminifera are scarce in the upper samples representing the Choctawhatchee. However, sufficient number of foraminifera occur at the depth of 145-171 feet to assign definitely this sample to the Miocene, especially when the lithologic change is considered. *Textulariella barrettii* (Jones and Parker) was found in this sample in some abundance. As far as the writer knows, this species has not been recorded from Florida, except as a Recent species. However, it is found in the Bowden marl (Miocene) of Jamaica at Bowden, and also one-half mile east

¹ Letter to writer, dated March 1, 1938.

² W. Storrs Cole, "The Pliocene and Pleistocene Foraminifera of Florida," Florida Geol. Survey, Bull. 6, table 1, station 14-16, 1931.

³ *Ibid.*, table 1, stations 17-23.

of Buff Bay, Jamaica. It occurs in the Miocene of the Dominican Republic, Mexico and probably in the Miocene of Venezuela.⁴

It is interesting to note that this species occurs in Recent samples from the coast of Florida in depths of water from 40-100 fathoms. The largest specimens are all from 100 fathoms or less, although specimens have been found to 350 fathoms or more.⁵ This suggests the maximum and minimum depths of water in which Choctawhatchee deposition took place.

Foraminifera increase in abundance in the succeeding samples, but the first large fauna is not encountered until the depth of 235-257 feet.

Mansfield and Ponton⁵ have divided the Choctawhatchee into five zones. Cushman and Ponton⁶ have listed and described the foraminifera found in these zones. In the present study an attempt was made to recognize these zones.

Inasmuch as the sample at 235-257 feet had the first abundant fauna, a definite decision could be made concerning the probable zone represented. Though the range of the various species is different from that reported by a study of outcrop samples and many of the species are apparently so rare that they do not appear in large samples of cuttings, it is evident that the well had penetrated the *Arca* zone of the Choctawhatchee between 235 and 257 feet.

This conclusion was strengthened by finding in the sample at 278-300 feet *Plectofrondicularia floridana* Cushman and *Siphogenerina lamellata* Cushman, two striking and easily recognized species confined to the *Arca* zone. In this same sample was found *Operculinoides tuxpanensis* (Thalmann).⁷ Although this species has been reported to date only from its type locality in the Tuxpan formation (Miocene) and adjacent areas in Mexico, it should make a valuable index fossil in the Miocene of Florida.

Associated with the above was *Textularia warreni* Cushman and Ellisor. Cushman and Ponton report that this species

⁴ J. A. Cushman, "A Monograph of the Foraminiferal Family Valvulinidae," Cushman Lab. Foram. Res., Spec. Publ. No. 8, p. 66, 1937.

⁵ Wendell C. Mansfield and Gerald M. Ponton, "Faunal Zones in the Miocene Choctawatchee Formation of Florida," Jour. Washington Acad. of Sci., vol. 22, No. 4, pp. 84-88, 1932.

⁶ Joseph A. Cushman and Gerald M. Ponton, "Foraminifera of the Upper, Middle and Part of the Lower Miocene of Florida," Florida Geol. Survey Bull. 9, pp. 1-147, pls. 1-17, 1932.

⁷ Hans E. Thalmann, "Liste der Foraminiferen von der Typus-Lokalität der miozänen Tuxpan-Stufe (Ciudad de Tuxpan, Veracruz, Mexico)," Eclogae geol. Helvetiae, vol. 28 No. 2, pp. 603-605, 2 text-figs, 1935.

is confined to the Shoal River formation. Though it is dangerous to base a decision on a single species, the probability is that the top of the Shoal River was penetrated by the drill just above 300 feet.

Mansfield and Ponton^s give the thickness of the Choctawhatchee from surface outcrops as 135 to 150 feet of which 55 feet is occupied by the *Arca* zone. The thickness of the Choctawhatchee in the well under discussion is approximately that given for surface measurements.

Shoal River Formation.—The lithologic character of the section assigned to the Shoal River is similar to that of the overlying Choctawhatchee. Foraminifera are present throughout this portion of the section, but more abundant in certain samples than in others.

The Oak Grove sand was not recognized in this well. If present, it may be represented by the sample from 384 to 406 feet, at which depth there is a lithologic change. This sample was dominantly clay. Though it yielded a considerable number of foraminifera, diagnostic Oak Grove species could not be found.

Chipola Formation.—At 406 feet, the drill encountered a white, porous limestone, in which the fossils are very poorly preserved and are hard to obtain. However, rather numerous specimens of *Amphistegina* were recovered which are thought to be *Amphistegina chipolensis* Cushman and Ponton. The presence of this species and the change in lithologic character is sufficient indication to warrant the statement that the well penetrated the Chipola formation at this depth. At 469-490 feet, fragments of *Sorites* sp. were found. *Sorites* sp. has been found in the Chipola and Tampa.

Tampa Formation.—At 616-637 feet, a few specimens were recovered which are referred to *Archaias floridanus* (Conrad). As this form characterizes the Tampa in outcrop, the well must have penetrated this formation at this depth. There is a slight lithologic change which substantiates the paleontological evidence.

OLIGOCENE

The drill penetrated the Oligocene at 700 feet. The lithologic break is not striking, although there is a distinct change

^s *Op. cit.*, p. 86.

with the introduction of a cream-colored marl at this depth. The faunal change, however, is unique.

Abundant specimens of *Miogypsina* were found associated with a species of *Operculinoides*. These have been identified as *O. forresti* Vaughan and Cole, *M. hawkinsi* Hodson and *M. venezuelana* Hodson. The *Miogypsina* were described from the Oligocene-Miocene of Venezuela⁹ while the *Operculinoides* was described from the Oligocene of Antigua.¹⁰ Gravell¹¹ reports *M. hawkinsi* from many localities of Venezuela associated with a fauna of *Lepidocyclina* of middle Oligocene age. Inasmuch as the exact range of *M. hawkinsi* is still in doubt, the indications are that this species is confined to the Oligocene, although it may range upward to the Miocene contact.

At 859 to 870 feet, specimens of a *Heterostegina* were found which resemble *H. texana* Gravell and Hanna.

At 890 to 911 feet, another species of *Miogypsina* was found. This species is the same as that referred to *Miogypsina* cf. *irregularis* (Mich.) by Barker and Grimsdale.¹² Hanna and Gravell¹³ figure a specimen from a core from the Gulf Refining Company No. 2 Pascagoula well, located in Section 15, T. 3S., R. 7W., George County, Mississippi, which is identical with the specimens found in this well. As will be pointed out under the description of species, this form represents a new species to which the name *M. gunteri* is given.

Again at 975 to 1017 feet, specimens were found which could be assigned to *M. gunteri*, n. sp., but associated with a *Heterostegina* which seems to be identical with *H. texana* Gravell and Hanna. As these *Miogypsina* have an entirely different type of preservation from that of those found at 890 to 911 feet, they do not represent cavings from that depth.

The last sample (1017-1035 feet) furnished a few specimens of *Lepidocyclina*. One species is definitely *L. parvula*

⁹ Helen Hodson, "Foraminifera from Venezuela and Trinidad," Bull. Amer. Pal., vol. 12, No. 47, pp. 28-30, 1926.

¹⁰ T. Wayland Vaughan and W. Storrs Cole, "New Tertiary Foraminifera of the Genera *Operculina* and *Operculinoides* from North America and the West Indies," Proc. U. S. Nat. Mus., vol. 83, No. 2996, pp. 493-494, pl. 37, figs. 1-3, 1936.

¹¹ Donald W. Gravell, "Tertiary Larger Foraminifera of Venezuela," Smithsonian Miscell. Coll., vol. 89, No. 11, pp. 8, 34, 1933.

¹² R. Wright Barker and Thomas F. Grimsdale, "Studies of Mexican Fossil Foraminifera," Ann. and Mag. Nat. Hist., vol. 19, Ser. 10, pp. 163-166, pl. 5, figs. 4, 5, 7-10; pl. 7, figs. 2, 3, 1937.

¹³ Guidebook of the Eleventh Annual Field Trip of the Shreveport Geological Society, pl. 6, fig. 3, 1934.

Cushman as both microspheric and megalospheric individuals were found. The other is undoubtedly *L. undosa* Cushman although only two broken specimens were found from which it was difficult to make satisfactory preparations.

The paleontological evidence from 700 feet to the bottom of the well (1035 feet) is such that this portion may be referred to the Oligocene without question, but the division of this into various formations is not practicable at the present time with the information at hand. It is probable, however, that the major portion of this section represents the Suwannee limestone.¹⁴

After studying the mollusks found in the Suwannee limestone, Mansfield¹⁵ states: "The fauna of the Suwannee limestone, as a whole, lived during the latter part of the time represented by the Flint River formation."

Cooke¹⁶ correlates the Flint River formation with the Chickasawhay marl member of the Byram marl, the Antigua formation (Leeward Islands) and the Meson formation (Mexico).

The upper portion of the Oligocene section in this well is apparently equivalent to the *Heterostegina-Miogypsina* zone as charted by Hanna and Gravelle.¹⁷ In a recent article, the same authors¹⁸ state: "If the terms Miocene and Oligocene must be used in the Gulf Coast, we believe it more logical to consider the *Heterostegina* zone and associated beds, the Chickasawhay and associated beds; and the Vicksburg and associated beds as Oligocene, rather than part Oligocene and part Miocene."

The writer agrees with the views expressed by Mansfield, Cooke and Gravelle and Hanna with the exception of the correlation of the Flint River formation and associated beds with the Meson formation of Mexico, as shown by the correlation table presented by Cooke.¹⁹ The Meson contains abundant specimens

¹⁴ C. Wythe Cooke and Wendell C. Mansfield, "Suwannee Limestone of Florida" (Abstract), Geol. Soc. Amer., Proc. for 1935, p. 71, 1936.

¹⁵ Wendell C. Mansfield, "Mollusks of the Tampa and Suwannee Limestones of Florida," Florida Geol. Survey, Bull. 15, p. 61, 1937.

¹⁶ C. Wythe Cooke, "Notes on the Vicksburg Group," Bull. Amer. Assoc. Petrol. Geol., vol. 19, No. 8, pp. 1170-1171, 1935.

¹⁷ Guidebook of the Eleventh Annual Field Trip of the Shreveport Geological Society, chart opposite p. 30.

¹⁸ Donald W. Gravelle and Marcus A. Hanna, "The *Lepidocyclina texana* Horizon in the *Heterostegina* Zone, Upper Oligocene of Texas and Louisiana," Jour. Pal., vol. 11, No. 6, p. 522, 1937.

¹⁹ *Ibid.*, p. 1171.

of *Lepidocyclina parvula* which has been considered to date to be confined to the middle Oligocene.

The information obtained from this well in conjunction with the available known ranges of the larger foraminifera suggests that the Meson is older than the *Heterostegina-Miogypsina* zone. The writer believes that the last sample of the well represents the top of a formation which will eventually be found to be the equivalent of the Meson formation.

The writer²⁰ described a fauna of larger foraminifera from near Duncan Church, Washington County, Florida, and assigned the beds which contained this fauna to the Glendon. Cooke, in a personal communication to the writer, states that at present he correlates these beds with the Suwannee limestone. As this fauna contains *Lepidocyclina supera* which is characteristic of the Byram marl, Cooke is undoubtedly correct. Although the present well was studied in great detail, none of the species reported from near Duncan Church were found, except *L. undosa* Cushman. The relationship of the Duncan Church fauna to those in the present well cannot be stated with the information at hand.

COMPARISON WITH OTHER FLORIDA WELLS

The nearest well to the Port St. Joe wells on which a detailed study has been made is the one drilled by the Calhoun Gas and Oil Company, about half a mile northwest of Clarks-ville, Calhoun County. The record is not entirely satisfactory and this well should be restudied (W-7).

Mossom²¹ in interpreting the stratigraphy of this well gives the following: 0-20 feet, Pliocene and Pleistocene; 30-100 feet, upper Miocene; 100-180 feet, Alum Bluff group; 180-600, all the formations between the base of the Chipola and top of the Ocala.

It is interesting to note that *Lepidocyclina cf. undosa* Cushman and *L. cf. crassata* Cushman are reported from this well at 450 feet. Without restudying these specimens, positive statements should not be made. However, the suggestion may be given that this may be the same horizon as the one represented by the last sample in the Port St. Joe test well.

²⁰ W. Storrs Cole, "Oligocene Orbitoids from near Duncan Church, Washington County, Florida," Jour. Pal., vol. 8, No. 1, pp. 21-28, pl. 3-4, 1934.

²¹ Stuart Mossom, "A Review of the Structure and Stratigraphy of Florida," Florida Geol. Survey, 17th. Ann. Rept., pp. 207-208, 1926.

Another interesting paleontological record needs checking. Cushman²² reports the occurrence of a *Miogypsina* as *M. cf. panamensis* Cushman from a depth of 852 feet in the well drilled at Marathon on the Florida Keys. As a description or figures were not presented, the specific identification must remain in doubt. It is entirely possible that these specimens from the Marathon well represent one of the species found in the present well.

Besides the present record, the Marathon well is the only other to-date from which *Miogypsina* has been reported. Detailed study would undoubtedly show that this genus is present in many of the wells which have penetrated the Oligocene.

PALEONTOLOGICAL RECORD

Port St. Joe Test Well 3

130-145 feet

- Textularia gramen* d'Orbigny
 mayori Cushman
- Quinqueloculina fusca* H. B. Brady
 lamarchiana d'Orbigny
- Globulina gibba* d'Orbigny
- Elphidium incertum* (Williamson)
 fimbriatulum (Cushman)
- poeyanum* (d'Orbigny)
- Rectobolivina* sp.
- Reussella spinulosa* (Reuss)
- Rotalia beccaria* (Linné) var *tepida* Cushman.
- Asterigerina carinata* d'Orbigny
- Amphistegina gibbosa* d'Orbigny
- Globigerina triloba* Reuss
- Anomalina edwardsiana* (d'Orbigny)
- Planulina ariminensis* d'Orbigny
- Cibicides concentricus* (Cushman)
 lobatulus (Walker and Jacob)
- Planorbulina mediterraneensis* d'Orbigny

145-171 feet

- Textulariella barrettii* (Jones and Parker)
- Discorbis consobrina* (d'Orbigny)
 orbicularis (Terquem)
- Planulina depressa* (d'Orbigny)
- Globorotalia menardii* (d'Orbigny)
- Cibicides concentricus* (Cushman)

²² Joseph A. Cushman, "Foraminifera from the Deep Wells of Florida," Florida Geol. Survey, 13th. Ann. Rept., pp. 59-60, 1921.

171-192 feet

- Textulariella barrettii* (Jones and Parker)
Nonion pizarrensis Berry
Elphidium fimbriatulum (Cushman)
Planulina depressa (d'Orbigny)
Globorotalia menardii (d'Orbigny)
Cibicides concentricus (Cushman)

192-213 feet

Identical with 171-192 feet

213-235 feet

- Pseudarcella arenata* Cushman
Reusella spinulosa (Reuss)
Siphonina pulchra Cushman
Cibicides floridanus (Cushman)
Dyocibicides biserialis Cushman and Valentine

235-257 feet

- Robulus americanus* (Cushman)
americanus (Cushman) var. *spinosus* (Cushman)
Lagena clavata d'Orbigny
Nonion grateloupi (d'Orbigny)
Nonion pizarrensis Berry
Nonionella auris (d'Orbigny)
Elphidium fimbriatum (Cushman)
Virgulina punctata d'Orbigny
Reussella spinulosa (Reuss)
Uvigerina peregrina Cushman
Angulogerina occidentalis (Cushman)
Discorbis candeiana (d'Orbigny) var. *bullata* Cushman
and Ponton
Eponides antillarum (d'Orbigny)
Canceris sagra (d'Orbigny)
Cassidulina crassa d'Orbigny
laevigata d'Orbigny, var. *carinata* Cushman
Orbulina universa d'Orbigny
Globorotalia menardii (d'Orbigny)
Cibicides concentricus (Cushman)
floridanus (Cushman)

257-278 feet

- Textularia foliacea* Heron-Allen and Earland, var.
occidentalis Cushman
warreni Cushman and Ellisor
Virgulina (*Virgulinella*) *gunteri* Cushman
Discorbis candeiana (d'Orbigny), var. *bullata* Cush-
man and Ponton
Planulina depressa (d'Orbigny)
Dyocibicides biserialis Cushman and Valentine

278-300 feet

- Spiroplectammina gracilis* (von Muenster)
Gaudryina (*Pseudogaudryina*) *atlantica* (Bailey)
Robulus americanus (Cushman)
 americanus (Cushman), var. *spinosus* (Cushman)
 vaughani (Cushman)
Fronicularia sagittula Vanden Broeck
Nonion pizarrensis Berry
Operculinoides tuxpanensis (Thalmann)
Plectofronicularia floridana Cushman
Buliminella elegantissima (d'Orbigny)
Bulimina buchiana d'Orbigny
Virgulina punctata d'Orbigny
Loxostoma gunteri Cushman
Siphogenerina lamellata Cushman (Plate 1, figure 1)
Discorbis floridana Cushman
Eponides antillarum (d'Orbigny)
 lateralis (Terquem)
Canceris sagra (d'Orbigny)
Cassidulina laevigata d'Orbigny, var. *carinata* Cushman
Orbulina universa d'Orbigny
Globorotalia menardii (d'Orbigny)
Cibicides concentricus (Cushman)
 floridanus (Cushman)

300-342 feet

Nothing diagnostic

342-364 feet

- Textularia foliacea* Heron-Allen and Earland, var.
 occidentalis Cushman
Gaudryina (*Pseudogaudryina*) *atlantica* (Bailey)
Robulus americanus (Cushman)
 americanus (Cushman), var. *spinosus* (Cushman)
 vaughani (Cushman)
Guttulina irregularis (d'Orbigny)
Globulina gibba d'Orbigny
Nonion grateloupi (d'Orbigny)
 pizarrensis Berry
Virgulina pontoni Cushman
Bolivina marginata Cushman
Uvigerina peregrina Cushman
Discorbis floridana Cushman
Eponides antillarum (d'Orbigny)
 repandus (Fichtel and Moll)
Canceris sagra (d'Orbigny)
Siphonina jacksonensis Cushman and Applin, var.
 limbosa Cushman

- Amphistegina lessonii* d'Orbigny
Cassidulina crassa d'Orbigny
Orbulina universa d'Orbigny
Cibicides concentricus (Cushman)
 floridanus (Cushman)
- 406-425 feet
 Amphistegina chipolensis Cushman and Ponton
- 469-490 feet
 Sorites sp.
- 490-512 feet
 Sorites sp. (very abundant)
- 616-637 feet
 Archaias floridanus (Conrad)
- 700-721 feet
 Operculinoides forresti Vaughan and Cole
 Miogypsina hawkinsi Hodson
 venezuelana Hodson
- 807-828 feet
 Amphisorus sp.
- 859-870 feet
 Heterostegina texana Gravell and Hanna
- 870-890 feet
 Heterostegina texana Gravell and Hanna
- 890-911 feet
 Miogypsina gunteri Cole, n. sp.
- 975-996 feet
 Amphisorus sp. (very abundant)
- 996-1017 feet
 Heterostegina texana Gravell and Hanna.
 Miogypsina gunteri Cole, n. sp.
- 1017-1035 feet
 Heterostegina texana Gravell and Hanna.
 Lepidocyclina (*Lepidocyclina*) *parvula* Cushman
 (*Eulepidina*) *undosa* Cushman

GRANBERRY WELL 1

The Granberry well was drilled by the Modisett Drilling Company of Eldorado, Arkansas in the south-east corner of the SW $\frac{1}{4}$ of the NE $\frac{1}{4}$ of Section 15, Township 5 N., Range 9 W., Jackson County, Florida. Samples and the driller's log were received from Mr. G. Scott Hammonds, through Mr. B. W. Blanpied. The elevation of the derrick floor was 124 feet.

LOG OF GRANBERRY WELL NO. 1

S.E. COR. S.W. 1/4 NE. 1/4 SEC. 15, T.5N., R.9W.

JACKSON CO., FLORIDA

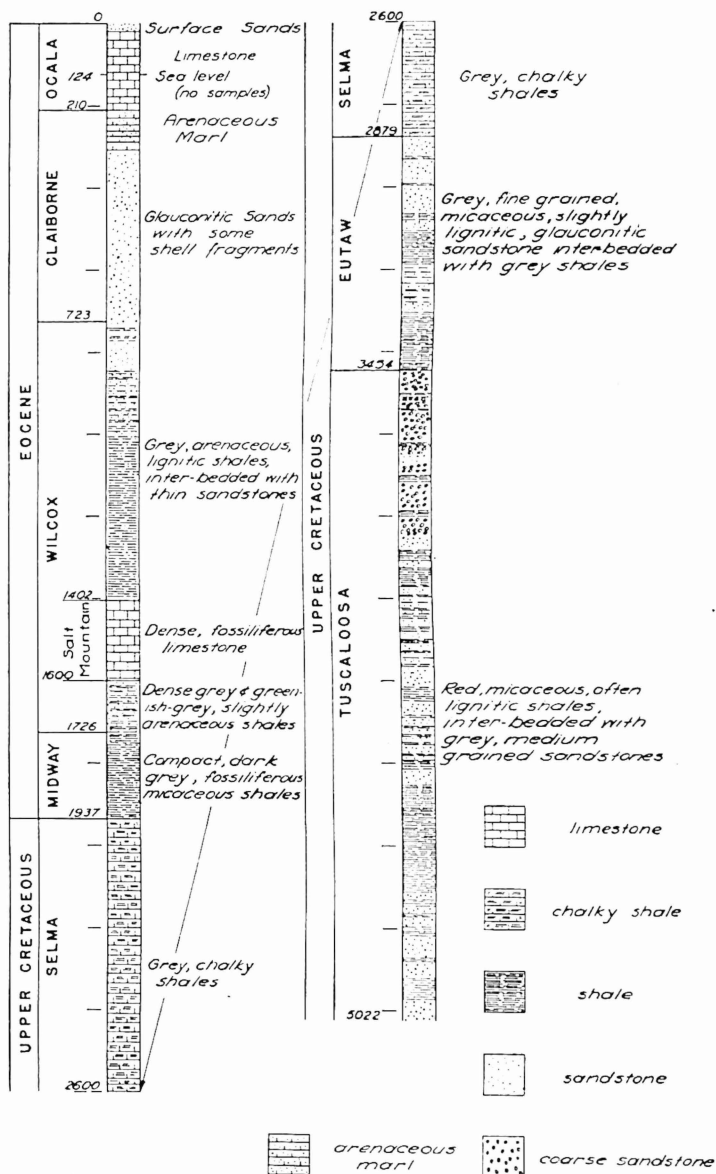


FIGURE 3

The set of samples is complete from 210 feet to 5022 feet at which depth the well was abandoned on July 14, 1936. While most of the samples are cuttings, 32 cores were submitted. These cores furnished an excellent check on the cutting samples (W-285).

STRATIGRAPHY

The groups and formations encountered with their lithologic characteristics are shown on Figure 3. The four main divisions of the Eocene are represented, but the data do not warrant the separation of certain of these groups into formations. The Upper Cretaceous is represented by the Selma, Eutaw and Tuscaloosa formations in which the well ends.

EOCENE

Ocala limestone.—Although samples were not submitted for the first 200 feet of this well, there is little question that this portion should be assigned to the Ocala limestone; reference to the geologic map of Florida,²³ indicates that the township in which the well was drilled is underlain by the Ocala except in the extreme southern portion.

Below 20 feet of surface sand, the driller's log records "hard and soft cavernous lime" to a depth of 210 feet. This section is assigned to the Ocala limestone.

The first sample from 200 to 220 feet is composed of soft limestone fragments and subangular quartz grains, but is without diagnostic fossils.

CLAIBORNE GROUP

The succeeding sample from 220 to 240 feet is composed almost entirely of large foraminifera. These represent three genera. The most abundant is *Operculinoides sabinensis* (Cole), but numerous specimens of *Lepidocyclina* (*Polylepidina*) *gardnerae* Cole were also found. Associated with these, there are a few specimens of a *Discocyclina* referred to *Discocyclina flintensis* (Cushman). The latter species represents cavings from the overlying Ocala limestone.

The horizon of *L. gardnerae* was given in the original description as St. Maurice.²⁴ Though there is still insufficient in-

²³ C. Wythe Cooke and Stuart Mossom, "Geology of Florida," Florida Geol. Survey, 20th. Ann. Rept., map in pocket, 1927-28.

²⁴ W. Storrs Cole, "Three New Claiborne Fossils," Bull. Amer. Pal., vol. 15, No. 56, p. 6, 1929.

formation concerning the age of the type locality of this species, it is probably Crockett formation of the Cook Mountain.

Below 310 feet the samples are composed of medium coarse, sub-angular quartz grains, rather large grains of dark green glauconite and broken shell fragments. Foraminifera were not present. This characteristic lithology changes at 708-730 feet.

WILCOX GROUP

The driller's log indicates that a marked lithologic change was encountered at 723 feet. At this point sandy shale and shale was penetrated by the drill. Examination of the sample (708-730 feet) indicates that the shale is strongly lignitic.

From 776 to 1406 feet, the samples contain fragments of lignitic shales with varying amounts of sand without fossils so far as could be observed. This section is apparently non-marine.

Salt Mountain Limestone.—At 1406 feet a limestone was encountered. Examination of the sample from this depth revealed that certain fragments were extremely fossiliferous limestone while others were dense, non-fossiliferous limestone. Certain of these fragments of limestone had grains of glauconite scattered through them. Of extreme interest was the discovery of broken specimens of the genus *Discocyclus* in some of the fragments. Unfortunately, the state of preservation was such that entirely satisfactory thin sections could not be prepared.

In the thin sections which were prepared, several vertical sections of *Discocyclus* were encountered. Though the specific identification of this *Discocyclus* is practically impossible with the material at hand, various features suggest that certain of the specimens are *D. cookei* Vaughan.²⁵

However, the presence of *Discocyclus* in a limestone below the top of the Wilcox suggests immediately that this limestone is the Salt Mountain limestone, previously placed at the top of the Vicksburg group and but recently assigned to its correct position in the Wilcox group. Cooke²⁶ in a recently published article states: "Such critical study has since been given by B. W. Blanpied, who, from study of well logs, finds that the

²⁵ T. Wayland Vaughan, "New Species of Orbitoidal Foraminifera of the Genus *Discocyclus* from the Lower Eocene of Alabama," Jour. Pal., vol. 10, No. 4, pp. 256-259, pl. 42, figs. 1-6, 1936.

²⁶ C. Wythe Cooke, "Notes on the Vicksburg Group," Bull. Amer. Assoc. Petrol. Geol., vol. 19, No. 8, p. 1163, 1935.

Salt Mountain limestone occupies a place within the Wilcox group between the Tuscahoma sand and the Nanafalia formation."

The base of the Salt Mountain limestone is encountered at 1600 feet. Although the section between 1406 and 1600 feet may be definitely assigned to the Salt Mountain limestone, the data at hand do not warrant the separation of the interval from 723 to 1406 feet into definite formations.

Nanafalia Formation.—Immediately below the Salt Mountain limestone, the cutting samples carry small foraminifera, although they are not abundant. A core taken at 1672-79 feet does not yield much paleontological information. This core represented a greenish-grey, fine-grained, compact slightly arenaceous shale with minute grains of glauconite and small flakes of mica. It was very refractory and did not break down satisfactorily. The washed portion contained a few calcareous foraminifera and ostracods of the type encountered in the cuttings immediately above and below.

A core taken at 1761-68 feet, however, contained an excellent fauna of undoubted upper Midway age. The lithologic and paleontologic evidence from these cores indicates that the base of the Nanafalia formation and the top of the Midway occurs between 1679 feet and 1761 feet.

Inasmuch as the driller's log indicates a change of lithology at 1726 feet, this depth has been chosen as the base of the Nanafalia formation.

MIDWAY GROUP

Though the determination of the top of the Midway is unsatisfactory, it is the best estimate which can be given with the information at hand. Without more cores and more information concerning the distribution of the foraminiferal faunas from surface outcrops from the basal Nanafalia and upper Midway, the boundary cannot be satisfactorily determined in a well of this type.

In addition to the fauna from the core at 1761-1768 feet, a number of species were found in a core taken at 1878-1883 feet. Additional Midway species were found in cutting samples.

Two interesting species were found in the Midway cores. *Rzehakina epigona* (Rzehak) has been reported to date only from Cretaceous strata in America. Cushman in his text-book on the foraminifera states the range of the genus: "Upper Cretaceous, lowest Eocene (?) of Europe."²⁷ The range of this genus may now be definitely established as high as from the lowest Eocene in North America.

Associated with the Midway species in both the cores was *Globorotalia membranacea* (Ehrenberg). This species is one of the characteristic species of the Velasco shale of Mexico. Muir²⁸ has recently stated that the name Velasco shale should be abandoned in favor of the Tamesí formation, apparently without reason and in opposition to the rules of priority. Although the exposures around Velasco on the Mexican National Railway may not be as satisfactory as the beds designated by Muir, that fact cannot be considered as sufficient reason for abandoning the name Velasco which not only has priority but is also well understood by all workers in Mexican geology.

Another species which should be mentioned is *Globigerina triloculinoides* Plummer. The writer compared this species with *G. velascoensis* Cushman. As these two seemed identical the slides were sent to Mrs. Plummer, who reports as follows:

"*G. velascoensis* and *G. triloculinoides* are very close and perhaps could without argument be combined. However, for those who depend on species as such for correlations without much regard for other aspects in problems of correlation, it might introduce a hazard in that some might automatically believe that here is another strong plea for synchronicity of Velasco and Midway. Such a conclusion may be right, but I am not inclined yet to agree.

Certain consistent differences seem to mark *G. velascoensis* from *G. triloculinoides*, even though they may fall within the legal range of variation within a species, according to how one views a species. *G. velascoensis* is somewhat more compact, with chambers compressed slightly peripherally instead of being perfectly globular, its sutures are less depressed, and most important perhaps is that the final whorl consists of only three and a slight fraction of a fourth chamber. In some tests

²⁷ "Foraminifera, Their Classification and Economic Use," Cushman Lab. Foram. Res., Special Publ., No. 4, p. 144, 1933.

²⁸ John M. Muir, "Geology of the Tampico Region, Mexico," Amer. Assoc. Petrol. Geol., p. 77, 1936.

the peripheral outline shows a faint lobation due to a minute arc of the fourth chamber, but many tests fail to show such a curve. The whorl of *G. triloculinoides* has fully three and one-half chambers to even a little more on frequent tests.

I believe for the present it will be wise to retain the two names."

Thalmann²⁹ has stated that the Velasco foraminifera are more closely connected with forms occurring in the Eocene than in the Cretaceous. His opinion is that the Velasco should be regarded as being of lower Tertiary age.

Muir considers the tentative age of the Velasco as Danian rather than Palaeocene. He quotes the opinions of various micro-paleontologists to support this view.³⁰ These opinions need not be repeated here.

Though the evidence from the well under discussion is slight, the writer is inclined to regard Thalmann's stand as the more logical.

UPPER CRETACEOUS

The first Cretaceous foraminifera appear in the cuttings at 1934-1956 feet. A core taken at 1940-1943 feet contains a typical Cretaceous fauna. The top of the Cretaceous is thus defined by the samples between 1934 and 1940 feet. A change in lithologic character was observed by the driller at 1937 feet. This depth, without doubt, marks the top of the Cretaceous. In addition to the core mentioned above, splendid faunas were recovered from two additional cores at 2014-2017 feet and 2047-2050 feet.

Selma Formation.—The faunas from these cores are characteristic of the Taylor formation of Texas. Inasmuch as diagnostic Navarro foraminifera are not present, it is assumed that the Midway of this area rests directly on a formation which is the age equivalent of the Taylor of Texas.

Inasmuch as the lithologic character of this portion of the well is a grey, chalky shale, the name Selma is used rather than Ripley-Selma which is commonly reported.

²⁹ Hans E. Thalmann, "Age of the Velasco Formation in Eastern Mexico," abstract, Geol. Soc. Amer. Proc., p. 371, 1935.

³⁰ *Op. cit.*, pp. 90-91.

Much additional study is needed on the foraminifera from known outcrops of Ripley and Selma as well as from cores. Foraminiferal zones which are well established in Texas will, without doubt, be recognized in the Ripley and Selma. Thus, more exact correlations between the eastern and western Gulf will result through detailed studies of this type. Cushman³¹ and Sandidge³² have made preliminary studies but much more detailed work needs to be accomplished before certainty is attained in the use of micro-faunas.

Eutaw Formation.—The well penetrated fine-grained, micaceous, slightly carbonaceous sandstones with some grains of glauconite at 2879 feet. These sandstones mark the top of the Eutaw.

After passing through these sandstones which undoubtedly represent in part the Tombigbee sand member, the drill encountered a series of shales and sandy shales.

Tuscaloosa Formation.—Even with a rather complete set of cores, it is difficult to decide on the position of the top of the Tuscaloosa. The most logical place appears to be at 3454 feet at the bottom of the shales and sandy shales which were assigned to the Eutaw and above a zone of conglomeratic sandstone. The break between these indicates a marked change in conditions of deposition. The Tuscaloosa extends from this depth to the bottom of the well.

Though this section is assigned to the Tuscaloosa, a reservation must be made. Monroe and Toler³³ in their description of the State Fee No. 2 deep test well drilled in Hinds County, Mississippi, assigned certain of the beds encountered by that well below the Selma to the Trinity (Early Cretaceous). This correlation was made solely on the basis of lithologic character.

The lithologic character of certain portions of the section encountered in the Granberry well below the Eutaw corresponds rather closely to the Trinity described in the Mississippi well.

³¹ J. A. Cushman, "A Preliminary Report on the Foraminifera of Tennessee," Tenn. Geological Survey, Bull. 41, pp. 1-112, 13 pls., 1931.

³² J. R. Sandidge, "Foraminifera from the Ripley formation of Western Alabama," Jour. Pal., vol. 6, No. 3, pp. 265-287, pls. 41-44, 1932; "Significant Foraminifera from the Ripley Formation of Alabama," Amer. Midland Nat., vol. 13, pp. 190-202, pl. 19, 1932; "Fossil Foraminifera from the Cretaceous, Ripley formation, of Alabama," *ibid.*, pp. 312-318, 9 figs.; "Additional Foraminifera from the Ripley formation in Alabama," *ibid.*, pp. 333-377, pls. 31-33.

³³ Watson H. Monroe and Henry N. Toler, "The Jackson Gas Field and the State Deep Test Well," Miss. Geol. Sur., Bull. 36, pp. 12-13, 28-32, 1937.

Until more evidence is obtained it is futile to speculate regarding the possibility that the well under discussion actually penetrated the Lower Cretaceous. However, this fact must be kept clearly in mind with the hope that additional data in the future will solve the problem.

COMPARISON OF THE GRANBERRY WELL WITH THE CHIPLEY WELL

A well drilled by the Chipley Oil Company at Falling Water Sink in NW $\frac{1}{4}$ of the NW $\frac{1}{4}$ of Section 27, Township 4 N., Range 13 W., Washington County, Florida is the nearest well to the one under discussion for which there is published information. The log of this well was published by Mossom³⁴ with the comments of a number of paleontologists and stratigraphers who had the opportunity of examining the samples (W-1).

The most recent interpretation of the section penetrated by this well has been given by Semmes,³⁵ who gives the following interpretation:

FORMATIONS IN THE CHIPLEY WELL

<i>Formation</i>	<i>Thickness</i>	<i>Depth</i>
Alum Bluff	25'	0- 25'
Glendon		
Marianna limestone	160'	25- 185'
Ocala limestone	190'	185- 375'
Jackson or Claiborne	225'	375- 600'
Claiborne	370'	600- 970'
Wilcox	650'	970-1620'
Wilcox or Midway	440'	1620-2060'
Midway (?)	350'	2060-2410'
Ripley (?)		
Selma	1060'	2410-3470'
Eutaw	220'	3470-3690'
Eutaw or Tuscaloosa	465'	3690-4155'
Tuscaloosa (?)	857'	4155-4912'

³⁴ Stuart Mossom, "A Review of the Structure and Stratigraphy of Florida," Florida Geol. Survey, 17th. Ann. Rept., pp. 195-206, 1926.

³⁵ Douglas R. Semmes, "Oil and Gas in Alabama," Ala. Geological Survey, Special Report 15, pp. 314-317, 1929.

In addition Semmes³⁶ republished a section studied in detail by Langdon³⁷ along the Chattahoochee river from Columbus, Georgia to Alum Bluff, Florida. Though the thickness of the formations encountered in the Chipley and Granberry wells vary considerably from those obtained on the surface outcrop, a summarized table is presented below to illustrate the similarities and differences.

THICKNESSES ON THE OUTCROP AND IN THE WELLS

		<i>Langdon's Chattahoochee Section</i>	<i>Chipley Well</i>	<i>Granberry Well</i>
<i>EOCENE</i>	Ocala	?	190'	210'
	Jackson	30'	225'	
	Claiborne	224'	370'	513'
	Wilcox	402'	1090'	1003'
	Midway	218'	350'	210'
<i>CRETACEOUS</i>	Ripley-Selma	1071'	1060'	942'
	Eutaw	345'	655'	575'
	Tuscaloosa	65'	857'+	1568'+

NOTE:—In the Granberry Well, the Ocala apparently rests directly on the Claiborne. If the interval which is called Jackson in the Chipley Well is considered Claiborne, it will be observed that the thickness of the Claiborne in the two wells compares very closely.

³⁶ *Ibid.*, pp. 309-314.

³⁷ E. A. Smith and others, "Report on the Geology of the Coastal Plain of Alabama," Ala. Geological Survey, pp. 439-445, 1894.

DESCRIPTION OF CORES FROM THE GRANBERRY WELL 1.

Depths	Washed	Unwashed
1672-79'	This core was very refractory. The washed residue consisted mainly of large fragments. A few foraminifera and ostracoda were recovered.	Greenish-grey, fine grained, compact, slightly sandy shale with some very small grains of glauconite and flakes of mica.
1761-67'	Foraminifera and some ostracoda.	Hard, dark grey, micaceous shale.
1878'-	Small shale fragments; considerable number of foraminifera.	Grey, brittle, slightly micaceous shale.
1940-43'	Small shale fragments, some rounded quartz grains, abundant foraminifera.	Grey, slightly sandy, chalky shale.
2014-17'	Foraminifera; few subangular quartz grains.	Dark grey, waxy, slightly micaceous, fossiliferous shale.
2047-50'	Abundant foraminifera; considerable fine quartz; <i>Inoceramus</i> prisms.	Dark grey, fossiliferous shale.
2885-88'	Small, subangular grains of quartz, some mica, glauconite and carbonaceous material.	Light grey, fine grained, micaceous, carbonaceous sandstone with some grains of glauconite.
2971-74'	Fine to medium sized subangular quartz, shell fragments, carbonaceous material.	Light grey, fine grained, shaly sandstone with small amounts of glauconite, carbonaceous material and a few shell fragment.
2995-98'	Fine subangular quartz grains; few grains of glauconite; some carbonaceous material, very few shell fragments.	Light grey, fine grained, shaly micaceous sandstone.
3065-68'	Fine subangular quartz; abundant flakes of muscovite; considerable quantity of lignite; some shell fragments.	Greyish green, slightly glauconitic, strongly micaceous, lignitic, fossiliferous sandstone.
3193-97'	Fine subangular quartz; abundant flakes of mica and carbonaceous material.	Light grey, fine grained, strongly lignitic, shaly sandstone.
3291-94'	Small shale flakes; some quartz; a few foraminifera.	Dark grey, slightly sandy shale.
3472-77'	Fine to large, angular and subangular quartz; some flakes of carbonaceous material.	Coarse grained sandstone, containing pebbles up to $\frac{1}{4}$ inch in diameter and showing some carbonaceous material.

Depths	Washed	Unwashed
3488-92'	Similar to 3872-77.	Similar to 3872-77.
3868-71'	Medium sized quartz with some larger grains of quartz; few flakes of lignite.	Medium grained, grey sandstone with some white ash as cementing material.
3902-05'	Poorly sorted, subangular grey and clear quartz.	Coarse, grey sandstone with streaks of brown, slightly micaceous clay.
3967-70'	Fine subangular quartz; red shale flakes; abundant mica: (muscovite and biotite.)	Red to brown, micaceous, slightly carbonaceous, sandy shale.
4044-48'	Medium grained, subangular quartz; some mica and lignite fragments.	Grey, medium grained, micaceous, shaly sandstone.
4082-85'	Fine to medium coarse, poorly sorted, subangular quartz.	Grey, slightly micaceous sandstone with grey ash cement.
4123-26'	Fine, subangular quartz; flakes of mica.	Dark grey, micaceous, carbonaceous, sandy shale.
4179-82'	Medium grained subangular quartz.	Grey, medium grained, slightly micaceous, ash cemented sandstone.
4262-65'	Fine, subangular, clear and brown stained quartz; flakes of mica.	Mottled, reddish brown, micaceous, slightly sandy shale.
4344-46'	Similar to 4262-65.	Similar to 4262-65.
4357-60'	Grey, subangular, medium-sized quartz; flakes of mica.	Grey, medium grained, micaceous, ash cemented sandstone.
4387-92'	Fine, subangular; clear and brown stained quartz; mica.	Reddish, micaceous, sandy shale.
4424-27'	Subangular, medium sized quartz; some mica.	Grey, medium grained, micaceous ashy sandstone.
4701-04'	Poorly sorted, subangular quartz; some of the individual pebbles reaching a size of $\frac{1}{2}$ inch.	Grey, poorly cemented, coarse grained sandstone.
4752-55'	Poorly sorted, subangular quartz; some of the pebbles are $\frac{1}{4}$ inch in diameter; flakes of reddish shale.	Grey, coarse, poorly cemented sandstone with some red shale streaks.
4824-27'	Poorly sorted, grey, subangular quartz; few flakes of mica.	Grey, soft, coarse grained sandstone.
4883-86'	Medium sized, subangular, grey quartz.	Light grey, medium grained sandstone with streaks of brownish colored sandy shale.
4989-92'	Poorly sorted, grey quartz.	Grey and brown streaked, medium grained sandstone.
5019-22'	Medium to coarse grains of grey quartz.	Grey, coarse, poorly cemented sandstone.

PALEONTOLOGICAL RECORD

Granberry Well No. 1

Certain small foraminifera were selected for illustration in order that a representative picture of the important markers used in determining the various formations might be given. As most of these are well known, descriptions and synonymies are not given.

Notation is made in the paleontological lists of the plate and figure, if the species is illustrated.

220-240 feet and 240-260 feet. Cuttings.

Operculinoides sabinensis (Cole) (Plate 5, figures 1-7)
Lepidocyclina (*Polylepidina*) *gardnerae* (Cole) (Plate 9, figures 1, 6-8)

Discocyclina (*Discocyclina*) *flintensis* (Cushman) (Plate 12, figures 1-3). These specimens are from the Ocala and represent cavings.

1390-1412 feet. Cuttings.

Discocyclina cf. *D. cookei* Vaughan (Plate 12, figures 4, 5)

1605-1759 feet. Cuttings.

The base of the Salt Mountain limestone is encountered at 1600 feet. The sample from 1605 to 1627 feet contains small foraminifera. The table on page 33 gives the various small foraminifera encountered in the cuttings between 1605 and 1759 feet.

A core taken at 1672-79 feet in the interval covered by the table (p. 33) does not yield much paleontological information. This sample was a greenish-grey fine grained, compact, slightly sandy shale with minute grains of glauconite and small flakes of mica. It was very indurated and did not break up satisfactorily. It contained a few calcareous foraminifera and ostracoda of the type encountered in the cuttings.

1761-67 feet. Core.

Bathysiphon sp.

Ammobaculites expansus Plummer (Plate 1, figure 13)
midwayensis Plummer (Plate 1, figure 6)

Spiroplectammina mexiaensis Lalicker

Clavulina sp.

Lenticulina degolyeri (Plummer) (Plate 1, figure 12)

Hemicristellaria longiforma (Plummer)

Dentalina pauperata (d'Orbigny)

Nodosaria affinis d'Orbigny
radicula (Linné)

Saracenaria sp.

Ramulina sp.

Nonionella turgida (Williamson) (Plate 1, figure 9)
welleri (Plummer) (Plate 1, figures 7, 8)

Bulimina arkadelphiana, var. *midwayensis* Cushman
 and Parker (Plate 1, figure 14)

Bulimina sp.

Valvulineria sp. (similar to one in Texas Midway)

Gyroidina subangulata (Plummer)

Coleites reticulosus (Plummer)

Siphonina prima Plummer

Pulvinulinella culter (Parker and Jones) (Plate 1, figures 2, 3)

exigua (H. B. Brady)

Allomorphina trigona Reuss

velascoensis Cushman

Globigerina pseudobulloides Plummer

triloculinoïdes Plummer (*G. velascoensis*

Cushman)

Globorotalia membranacea (Ehrenberg) (Plate 1, figures 4, 5)

wilcoxensis Cushman and Ponton

Cibicides allenii (Plummer) (Plate 1, figures 10, 11)

1878 feet. Core.

eggerella trochoïdes (Reuss) (Plate 2, figure 6)

Dorothia sp.

Rzehakina epigona (Rzehak) (Plate 2, figure 15)

Quinqueloculina sp.

Hemicristellaria longiforma (Plummer) (Plate 2, figure 5)

Nodosaria longiscata d'Orbigny

radicula (Linné) (Plate 2, figure 7)

Flabellina oldhami (Plummer) (Plate 2, figure 8)

Frondicularia sp.

Spiroplectoides clotho (Grzybowski) (Plate 2, figure 4)

Nonionella welleri (Plummer)

Bulimina arkadelphiana, var. *midwayensis* Cushman
 and Parker

Valvulineria allomorphinoïdes (Reuss)

Bifarina eleganta (Plummer) (Plate 2, figure 3)

Pulvinulinella exigua (H. B. Brady)

Globigerina triloculinoïdes Plummer (*Globigerina*
velascoensis Cushman)

Globorotalia membranacea (Ehrenberg)

wilcoxensis Cushman and Ponton (Plate 2
 figures 1, 2)

Besides the forms listed from the two cores, the cuttings yielded the following additional species:

DISTRIBUTION OF SPECIES BETWEEN 1605 AND 1759 FEET

	1605- 1627'	1627- 1649'	1649- 1672'	1672- 1694'	1715- 1737'	1737- 1759'
<i>Bathysiphon</i> sp.				X	X	
<i>Lenticulina turbinata</i> (Plummer)				X		
<i>Hemicristellaria longiforma</i> (Plummer)	X	X	X	X		X
<i>Nodosaria radícula</i> (Linné)	X		X		X	X
<i>Nonionella welleri</i> (Plummer)			X	X	X	X
<i>Bulimina</i> sp.				X		
<i>Bifarina eleganta</i> (Plummer)					X	
<i>Gyroidina subangulata</i> (Plummer)		X				
<i>Pulvinulinella exigua</i> (H. B. Brady)	X	X	X		X	
<i>Allomorphina trigona</i> Reuss				X		
<i>Chilostomella cylindroides</i> Reuss		X				
<i>Globigerina pseudobulloides</i> Plummer			X		X	X
<i>triloculinoides</i> Plummer	X	X		X		
<i>Globorotalia wilcoxensis</i> Cushman and Ponton	X	X	X	X	X	
<i>Globorotalia membranacea</i> (Ehrenberg)				X	X	
<i>Cibicides</i> sp.		X	X		X	X

Vaginulina legumen (Linnaeus)
Glandulina comata (Batsch)
Neobulimina quadrata (Plummer)
Eponides tenera (H. B. Brady)
Epistomina elegans (d'Orbigny)
Anomalina vulgaris (Plummer)
Cibicides alleni (Plummer)

1940-43 feet. Core.

Protonina diffflugiformis (H. B. Brady)
Heterostomella americana Cushman
Eggerella trochoides (Reuss)
Nodosaria radicula (Linné)
Nonionella cretacea Cushman
Gümbelina excolata Cushman
Ventilabrella carseyae Plummer
**Buliminella cushmani* Sandidge (Plate 2, figure 14)
Bulimina kickapooensis Cole, n. sp.
Uvigerina seligi Cushman (Plate 2, figure 12)
Gyroidina depressa (Alth)
Gyroidina alabamensis Sandidge
Pullenia americana Cushman
Globotruncana arca (Cushman)
Anomalina henbesti Plummer (Plate 2, figures 9, 10)

2014-17 feet. Core.

Ammobaculites agglutinans (d'Orbigny)
stephensoni Cushman
Textularia sp.
Heterostomella americana Cushman (Plate 3, figures 11, 12)
Clavulina trilatera Cushman (Plate 3, figure 15)
Arenobulimina americana Cushman
eggerella trochoides (Reuss)
Dorothyia bulletha (Carsey)
Lenticulina sp.
Astacolus sp.
Dentalina aculeata d'Orbigny
 cf. *consobrina* d'Orbigny
Flabellina rugosa d'Orbigny (Plate 3, figure 6)
Fronidicularia archiaciana d'Orbigny
 clarki Bagg (Plate 2, figure 11)
Lagena orbignyana Sequenza
Pyrulina cylindroides (Roemer)
Gümbelina plummerae Loetterle (Plate 3, figure 9)
 excolata Cushman (Plate 3, figure 4)
 globulosa (Ehrenberg) (Plate 3, figure 10)
Ventilabrella carseyae Plummer (Plate 3, figures 7, 8)

²⁵ *B. cushmani* Sandidge will undoubtedly prove to be a synonym of *B. carseyae* Plummer. There are very slight differences in the two species.

- Bolivinoïdes decorata* (Jones)
Pseudouvierina cretacea Cushman (Plate 4, figure 3)
 plummerae Cushman
Buliminella carseyae Plummer (Plate 4, figure 2)
Bulimina reussi Morrow
 triangularis Cushman and Parker (Plate 4,
 figure 1)
 kickapoensis Cole, n. sp (Plate 3, figure 5)
Bolivina incrassata Reuss (Plate 3, figure 1)
Loxostoma plaitum (Carsey)
Valvulineria allomorphinoides (Reuss)
Gyroidina depressa (Alth)
 girardana (Reuss) (Plate 2, figure 13)
 globosa (v. Hagenow)
 nitida (Reuss)
 subconica (Morrow)
Pullenia coryelli White
Globigerina cretacea d'Orbigny (Plate 4, figure 4)
Globigerinella aspera (Ehrenberg) (Plate 4, figure 5)
Globotruncana arca (Cushman)
Stensiöina excolata (Cushman) (Plate 3, figures 2, 3)
Anomalina taylorensis Carsey (Plate 3, figures 13, 14)
Karrerina fallax Rzehak

2047-50 feet. Core.

- Ammobaculites agglutinans* (d'Orbigny)
Textularia sp.
Gaudryina (*Pseudogaudryina*) *ellisorae* Cushman
Heterostomella americana Cushman
Clavulina trilatera Cushman
Marginulina bullata Reuss (Plate 4, figure 10)
Nodosaria radícula (Linné)
Flabellina rugosa d'Orbigny
Lagena orbignyana Sequenza
Gümbelina excolata Cushman
 plummerae Loetterle
 pseudotessera Cushman
Ventilabrella carseyae Plummer
Bolivinoïdes decorata (Jones) (Plate 4, figure 9)
Pseudouvierina plummerae Cushman (Plate 4, figure 8)
Buliminella carseyae Plummer
Bulimina sp.
Bolivina incrassata Reuss
Pleurostomella subnodosa Reuss (Plate 4, figure 7)
Valvulineria allomorphinoides (Reuss)
Gyroidina depressa (Alth)
 globosa (v. Hagenow)
 nitida (Reuss)
Pullenia coryelli White

Globigerina cretacea d'Orbigny
lacera (Ehrenberg)

Globotruncana arca (Cushman) (Plate 4, figures 11,12)

Stensiöina excolata (Cushman)

Anomalina taylorensis Carsey

3291-3294 feet. Core.

Gümbelina sp.

Globigerina cretacea d'Orbigny

Globotruncana arca (Cushman)

DESCRIPTIONS OF SPECIES

Family CAMERINIDAE

Subfamily Camerininae

Genus OPERCULINOIDES Hanzawa, 1935

Operculinoides forresti Vaughan and Cole

Plate 5, figures 8-13

Operculinoides forresti Vaughan and Cole, Proc. U. S. Nat. Mus., vol. 83, No. 2996, pp. 493-94, pl. 37, figs. 1-3, 1936.

Test small, completely involute, thin, compressed, without ornamentation except for a small umbo and the trace of the septal lines. Diameter from outer edge of aperture through center ranges from 1.5 to 1.7 mm., diameter at right angles to apertural plane ranges from 1.7 to 2.1 mm.; thickness through the center is about 0.5 mm. The diameter of the central umbo is about 0.25 mm.

A section of a specimen about 1.9 mm. in diameter has 3 coils, with 18 chambers in the final volution. Another specimen of approximately the same diameter has 3 coils, with 20 chambers in the final whorl. The initial chamber is circular with a diameter of about 80 μ . The second chamber is kidney-shaped with dimensions of 40 μ by 80 μ .

The chamber walls are but slightly curved for most of their length, radiating out at 90° from the inner wall. As they approach the periphery, they are sharply and strongly recurved, so that the point of attachment of the chamber wall to the periphery is directly above the point that the preceding chamber wall starts its recurvature.

The height of the chambers slowly and regularly increases as the chambers are added. The final chamber has a height of about 0.6 mm.

Port St. Joe well T. 3, first appearance at depths of 700-721 feet.

Horizon: Suwannee limestone, upper Oligocene.

This species is characterized by its thin, fragile test externally and by the strong recurvature of the sutures in their distal portions internally.

Operculinoides sabinensis (Cole)

Plate 5, figures 1-7

Operculinella sabinensis Cole, Bull. Amer. Pal., vol. 15, No. 56, p. 6, pl. 2, figs. 5, 6, 1929.

Test small, completely involute, compressed, thickest in the center, gradually thinning to a bluntly rounded periphery, without ornamentation except for traces of the septal lines. Diameter from the outer edge of aperture through the center of average sized specimens is about 2.1 mm.; diameter at right angles to line through aperture of average sized specimens, about 2.4 mm. The thickness of average sized specimens is about 0.7 mm.

A specimen with diameters of 2.25 mm. by 2.46 mm. has $3\frac{1}{2}$ whorls with 19 chambers in the final coil; another 2.9 mm. by 3.3 mm. has 4 whorls with 23 chambers in the final whorl. The initial chamber is circular, about 100 μ in diameter. The second chamber is kidney-shaped with diameters of about 80 μ by 120 μ .

The chamber walls are thin and slightly but evenly recurved throughout their length. There is a very gradual increase in height of the chambers as they are added.

Granberry well No. 1, first appearance at depths of 220-240 feet.

Horizon: Claiborne, middle Eocene.

The specimens from this well are identical to the ones described from Cooper's Mill, one and one-half miles south of Sabinetown, Texas, except for size. The type specimens have a diameter of 3.6 mm. The largest specimen in the present collection has a diameter of about 3.3 mm.

Operculinoides tuxpanensis (Thalmann)

Plate 5, figures 14-17

Operculina tuxpanensis Thalmann, Eclogae geol. Helvetiae, vol. 28, No. 2, pp. 603-605, 2 text-figs., 1935.

Operculinoides tuxpanicus Vaughan and Cole, Proc. U. S. Nat. Mus., vol. 83, No. 2996, p. 494, pl. 37, figs. 4-9, 1936.

Test small, fragile, compressed, completely involute, without ornamentation except for traces of the septal lines. The

test is slightly thicker in the center and slopes gradually to the rather narrow, but rounded periphery. The smallest specimen in this collection has a diameter from the outer edge of the aperture through the center of 1.5 mm. and a diameter at right angles to apertural plane of 1.7 mm.; the largest specimen has a diameter from the outer edge of the aperture through the center of 2.3 mm. and a diameter at right angles to apertural plane of 2.6 mm. The thickness through the center of a specimen about 2.6 mm. in diameter is 0.4 mm.

A section of a specimen about 2.0 mm. in diameter has $3\frac{1}{2}$ coils with 17 chambers in the final volution. Another specimen about 2.5 mm. in diameter has $3\frac{3}{4}$ coils with 21 chambers in the final whorl. The initial chamber is small, nearly circular with a diameter varying from 40 to 60 μ .

The chamber walls are gently recurved except near the periphery where they are sharply recurved. As some of the chamber walls are more strongly recurved than others, the chambers have an irregular appearance.

Port St. Joe well T. 3, first appearance at depths of 278-300 feet.

Horizon: Choctawhatchee, upper Miocene.

These specimens are identical to those described by Vaughan and Cole from the Tuxpan formation of Miocene age of Mexico. However, the name proposed by Vaughan and Cole must be placed in synonymy under *O. tuxpanensis* (Thalmann) as Thalmann's article appeared while the one of Vaughan and Cole was in press.

Although Thalmann describes and figures only a microspheric specimen, there is no doubt but that the megalospheric specimens described by Vaughan and Cole represent the same species. The features are similar and the two suites of specimens were from the same locality.

Genus HETEROSTEGINA d'Orbigny, 1826

Four species of *Heterostegina* have been described from the Oligocene of America. The following table lists the important features of these species as recorded by various writers. Included in this table are measurements of the specimens encountered in the Port St. Joe test well 3 and from specimens in

the Meson of Mexico. Figures are given of certain specimens as follows:

Heterostegina texana Gravell and Hanna (from Meson formation) (Plate 6, figures 3-8.)

Heterostegina texana Gravell and Hanna (from Port St. Joe test well 3.) (Plate 5, figures 18-21, Plate 6, figures 1-2.)

LOCALITIES FOR TABLE ON PAGE 41

1. Horizontal measurements from topotype specimens from Long Island, Antigua, B. W. I. Thickness measurements from a specimen from Man of War Island, Antigua, B. W. I. Thin sections are the property of the U. S. National Museum.

2. After Gravell. Specimens from about 1 kilometer northeast of Pecaya, District of Democracia, Venezuela.

3. After Gravell and Hanna. Specimens from Sun Oil Company's No. 1-A Hamilton well, located 1400 feet south and 1400 feet east of the northwest corner of the H. T. and B. Sec. No. 128, Chambers County, Texas at depths of 7336-7346 feet.

4. After Gravell and Hanna. Same locality as number 3, except from depths of 7356-7366 feet.

5. Specimens from the Meson formation between kilometer posts 17-18.5 on the Aguila Petroleum Company's narrow-gauge railroad between Potrero and Tanhuijo, Mexico.

6. Port St. Joe test well Number 3 at depths of 870-890 feet.

7. Same as number 6, except the depths are 1017-1935 feet.

SUMMARY OF CHARACTERISTICS OF OLIGOCENE SPECIES OF HETEROSTEGINA

	Length	Width	Thickness through embryonic apparatus	Thickness through flange	Portion of test oc- cupied by um- bonate area	Surface ornamenta- tion	Number of whorls	Diameter of initial chamber	Diameter of second chamber	Number of chambers not subdivided
1. <i>Heterostegina antillea</i> Cushman	4.2mm.	3.9mm.	0.7-0.9mm.	0.25-0.35mm.	1/3	raised sutures	3	100 μ	100 μ X 200 μ	3
2. <i>Heterostegina panamensis</i> Gravel	3.0mm.		0.75mm.		1/2	umbonal boss and raised costae	3 1/2	140 μ	70 μ X 140 μ	3
3. <i>Heterostegina israelskyi</i> Gravell and Hanna	4.25mm.	3.0mm.	0.35mm.	0.2mm.	1/4	sutures slightly raised	2 1/2	67 μ	48 μ X 110 μ	4
4. <i>Heterostegina texana</i> Gravell and Hanna	4.4mm.	3.1mm.	0.75mm.	0.25mm.	2/3	boss of clear shell mat- erial; raised sutures	3 1/2	140 μ	100 μ X 200 μ	3
5. <i>Heterostegina texana</i> Gravell and Hanna	4.2mm.	3.2mm.	0.6mm.	0.3mm.	1/3 to 1/2	boss of clear shell mat- erial; raised sutures	3	100 μ	70 μ X 180 μ	3
6. <i>Heterostegina texana</i> Gravell and Hanna	3.3mm.	2.5mm.	0.76mm.	0.2mm.	2/3	slightly raised sutures	3	100 μ	80 μ X 200 μ	3
7. <i>Heterostegina texana</i> Gravell and Hanna	3.9mm.	3.2mm.	0.76mm.	0.44mm.	1/3 to 1/2	raised sutures	2 1/2	100 μ	60 μ X 160 μ	3

Subfamily Miogypsininae Vaughan

Barker and Grimsdale³⁰ have recently demonstrated the presence of a canal-system in certain representatives of the genus *Miogypsina*. It is obvious that such a discovery automatically removes this group from the Orbitoididae. Barker and Grimsdale present evidence to show that the subfamily *Miogypsininae* should be transferred to the family *Rotaliidae*.

It seems more logical to the writer to place this subfamily under the family *Camerinidae*. This conclusion is based on a study of the relative forms of the tests.

Miogypsina is composed of a definite equatorial layer with the lateral chambers and pillars developed on either side of the equatorial layer. In general plan, the test of *Miogypsina* is not essentially different from that of *Spiroclypeus*. The subgenus *Miogypsinoides* resembles *Cycloclypeus* in having thick lateral walls.

Miogypsina (*Miogypsina*) *gunteri* Cole, n. sp.

Plate 6, figures 10-12, 14. Plate 8, figures 1-9

Miogypsina (*Miogypsina*) cf. *irregularis* Barker and Grimsdale (not Michelotti), Ann. and Mag. Nat. Hist., vol. 19, Ser. 10, pp. 163-166, pl. 5, figs. 4, 5, 7-10; pl. 7, figs. 2, 3, 1937.

Miogypsina sp. Hanna and Gravell, Guidebook of the Eleventh Annual Field Trip of the Shreveport Geological Society, pl. 6, figs. 3, 4, 1934.

Test compressed, ovate in plan, thickest over the embryonic apparatus and thinning regularly from this point to the periphery. The macrospheric form has a length of 1.44 to 1.6 mm. and a width of 1.27 to 1.5 mm.; thickness varies from 0.46 to 0.64 mm. Surface of the test is ornamented by a series of minute papillae which completely cover it. The average diameter of these is 60 μ .

The initial chamber is circular with an internal diameter of about 60 μ . The distance from the center of this chamber to the periphery of the test is about 0.2 mm. Following the initial, circular chamber there is a more or less rectangular chamber with diameters of 40 x 80 μ . These two chambers are succeeded by 10 to 12 wedge-shaped chambers, arranged so that they ex-

³⁰ R. Wright Barker and Thomas F. Grimsdale, "Studies of Mexican Fossil Foraminifera," Ann. and Mag. Nat. Hist., vol. 19, Ser. 10, pp. 161-178, pls. 5-9, 1937.

tend almost completely around the initial chambers in the form of a partial spire. These chambers gradually increase in length as added until the fifth to seventh chamber after which there is a progressive decrease in length. The distance across the embryonic apparatus is about 0.34 mm.

The equatorial chambers are of various sizes and types. Commonly they are either rudely diamond-shaped or with arcuate outer walls and pointed inner ends. Their length ranges from 80 to 120 μ and their width from 60 to 100 μ . The thickness of the equatorial layer is rather uniform, about 160 μ .

The lateral chambers are not in definite layers, but are imbricately laid down one above the other. There are from 3 to 4 layers on either side of the equatorial chambers. The lateral chambers have a length of about 80 μ and a height of about 20 μ . The roof of the lateral chambers is usually arcuate. Pillars are irregularly present.

Port St. Joe well T. 3, first appearance at depths of 890-911 feet.

Horizon: Suwannee limestone, upper Oligocene.

Cotypes: Fla. Geol. Surv. Cat. Nos. S2501-S2504.

M. gunteri differs from *M. irregularis* in possessing a more definite coil of chambers surrounding the initial embryonic chambers. *M. irregularis* has very strong pillars with the lateral chambers arranged in regular tiers between the pillars. The vertical sections of *M. gunteri* are considerably different in that the pillars are weak, irregularly developed and the lateral chambers tend to overlap.

Miogypsina (*Miogypsina*) *hawkinsi* Hodson
Plate 7, figures 5-7

Miogypsina hawkinsi Hodson, Bull. Amer. Pal., vol. 12, No. 47, pp. 28-29, pl. 7, fig. 9; pl. 8, figs. 1, 2, 1926.

Miogypsina hawkinsi Gravell, Smithsonian Miscell. Coll., vol. 89, No. 11, p. 34, pl. 6, figs. 11-14, 1933.

Test small, discoidal to wedge-shaped, papillate with a diameter of about 2.0 mm. and a thickness of about 0.7 mm.

There are two equal or subequal embryonic chambers. The initial chamber has a diameter of about 160 μ ; the second cham-

ber has diameters of about $160\ \mu \times 240\ \mu$. The distance across both chambers is about 0.4 mm. The distance of these chambers from the periphery is about 0.3 mm. There are a few intermediate chambers surrounding the embryonic chambers.

The equatorial chambers are normally diamond-shaped, but other types may be observed. Common diameters of the equatorial chambers are $140\ \mu$ by $80\ \mu$. The thickness of the equatorial layer including the roof and floor walls is $120\ \mu$.

The lateral chambers are open, distinct and arranged in rather regular tiers. The length of the lateral chambers varies from 60 to $100\ \mu$ with an average height of $30\ \mu$. There are about 4 chambers on either side of the equatorial layer. Pillars are present with a surface diameter of 60 to $80\ \mu$.

Port St. Joe well T. 3, first appearance at depths of 700-721 feet.

Horizon: Suwannee limestone, upper Oligocene.

These specimens are identical with those described by Mrs. Hodson.

Recently, Thiadens⁴⁰ has figured specimens from Cuba which he assigned to this species. The vertical sections which he published show characteristics of *M. staufferi* Koch rather than *M. hawkinsi*.

Miogypsina (*Miogypsina*) *venezuelana* Hodson
Plate 6, figures 9, 13. Plate 7, figures 1-4. Plate 11, figure 8

Miogypsina venezuelana Hodson, Bull. Amer. Pal., vol. 12, No. 47, pp. 29-30, pl. 8, figs. 3-6, 1926.

Test compressed, fragile, ovate to wedge-shaped in plan, surface ornamentated by small papillae, spaced relatively far apart. Most of the larger specimens recovered were broken; a fragment has a length of 5.1 mm. and a thickness of 0.51 mm. Smaller specimens have an average length of 2.5 mm. and an average width of 2.1 mm; the thickness is about 0.44 mm.

The embryonic apparatus consists of two subequal chambers, partially surrounded by a ring of intermediate chambers.

⁴⁰ A. A. Thiadens, "Cretaceous and Tertiary Foraminifera from Santa Clara Province, Cuba," Jour. Pal., vol. 11, No. 2, p. 107, pl. 17, fig. 4; pl. 18, fig. 3; pl. 19, figs. 2, 3, 6, 7, 1937.

The distance from the periphery of the test to large embryonic chambers is about 0.2 mm. The initial chamber is nearly circular with a diameter of about 180 μ . The second chamber is subspherical with diameters of about 120 μ by 180 μ . The distance across both chambers varies from 0.28 to 0.32 mm. Surrounding the embryonic chambers, there is a partial ring of intermediate chambers, composed of 4 small chambers and 4 or 5 larger chambers.

The equatorial chambers are rudely diamond-shaped, but some vary from this form. Average chambers have a length of 140 μ and a width of 80 μ . The thickness of the equatorial layer including the roof and floor walls is about 120 μ near the embryonic chambers. It becomes slightly thinner as the periphery is approached.

The vertical section shows 3 or 4 layers of lateral chambers on either side of the equatorial layer. The lateral chambers are in rather definite tiers with pillars equally spaced between the lateral chambers. The length of the lateral chambers varies from 100 to 120 μ . The height of the lateral chambers is about 20 μ . The pillars have a surface diameter of about 60 μ .

Port St. Joe well T. 3, first appearance at depths of 700-721 feet.

Horizon: Suwannee limestone, upper Oligocene.

The extremely compressed form of the test in relation to its size serves to separate this species from the other American species of *Miogypsina*.

Family BULIMINIDAE

Subfamily Bulimininae

Genus BULIMINA d'Orbigny, 1826

Bulimina kickapooensis Cole, n. sp.

Plate 3, figure 5

Bulimina quadrata Cushman and Parker (not Plummer), Cont. Cushman Lab. Foram. Res., vol. 11, pt. 4, pp. 100-101, pl. 15, figs. 13, 14, 16 (not 12, 15), 1935.

Cushman refers a number of Cretaceous forms from the Navarro and Taylor to *Neobulimina quadrata* (Plummer). Detailed comparison of specimens from the Granberry well 1 with topotype specimens of *Neobulimina quadrata* furnished by Mrs.

Plummer has convinced the writer that the specimens from the Granberry well 1 represent a new species, but that this species is identical with those figured by Cushman from the upper Taylor under the name *B. quadrata*. Therefore, the writer proposes the name *Bulimina kickapooensis*, n. sp., for this form, designating Cushman and Parker's specimens, the types. These specimens were collected from the branch of Kickapoo Creek, 1200 feet south of public road, 1.8 miles northwest of Annona, Red River County, Texas.

Family ORBITOIDIDAE

Subfamily Orbitoidinae

Genus LEPIDOCYCLINA Gümbel, 1868

Subgenus *Lepidocyclina* Gümbel, 1868

Lepidocyclina (*Lepidocyclina*) *parvula* Cushman

Plate 11, figures 2-5

Lepidocyclina parvula Cushman, Carnegie Inst. Washington, Publ. 291, p. 58, pl. 3, figs. 4-7, 1919.

Lepidocyclina (*Lepidocyclina*) *parvula* Vaughan, Smithsonian Miscell. Coll., vol. 89, No. 10, pp. 16-17, pl. 7, figs. 1-5; pl. 8, figs. 3-5; pl. 9, figs. 1-4; pl. 10, figs. 1-6, 1933.

This species has been so well described that additional comments are not needed here. Both megalospheric and microspheric individuals were found.

Port St. Joe well T. 3, first appearance at depths of 1017-1035 feet.

Horizon: middle Oligocene.

Subgenus *Polylepidina* Vaughan, 1924

Lepidocyclina (*Polylepidina*) *gardnerae* Cole

Plate 9, figures 1-10; Plate 10, figures 4-5

Lepidocyclina (*Polylepidina*) *gardnerae* Cole, Bull. Amer. Pal., vol. 15, No. 56, pp. 4-6, pl. 1, figs. 1-6; pl. 2, figs. 1, 2, 1929.

Inasmuch as Vaughan⁴¹ has considered that *L. gardnerae* and *L. antillea* Cushman may represent only one species, and van de Geyn and van der Vlerk⁴² have placed *L. gardnerae* in

⁴¹ T. Wayland Vaughan, "American Species of the Genus *Dictyoconus*," Jour. Pal., vol. 6, No. 1, p. 97, 1932.

⁴² W. A. E. van de Geyn, and I. M. van der Vlerk, "A monograph on the Orbitoididae occurring in the Tertiary of America," Leidsche Geol. Meded., vol. 7, No. 2, pp. 241, 259, figs. 73-81, 1935.

synonymy under *L. proteiformis* Vaughan, illustrations of thin sections made from topotype specimens of *L. antillea* (Pl. 10 figs. 1-3) *L. gardnerae* (Pl. 9, figs. 2, 4, 9, 10; Pl. 10, fig. 4) and *L. proteiformis* (Plate 10, figures 6-9) are presented here so that direct comparisons may be made. Besides these, specimens from the Granberry well and from a well drilled about 6 miles south of Brewton in Escambia County, Alabama, assigned to *L. gardnerae*, are illustrated.

Comparison of horizontal and vertical thin sections of *L. gardnerae* with those of *L. proteiformis* at once shows marked differences between these species. First, the embryonic apparatus of *L. gardnerae* is in the form of a distinct spiral, while that of *L. proteiformis* is an indistinct spiral composed of two large chambers with smaller accessory chambers, often only two in number, arranged at the sides of the larger initial chambers. Second, the two initial chambers of the embryonic apparatus of *L. gardnerae* are much smaller than those of *L. proteiformis*. Third, the vertical sections of *L. gardnerae* show very irregularly developed and arranged lateral chambers with very thick roofs and floors, while the lateral chambers of *L. proteiformis* are rather regularly arranged in tiers with comparatively thin roofs and floors. Fourth, *L. gardnerae* possesses more and heavier pillars. Fifth, megalospheric specimens are smaller and have a more inflated test than do average sized specimens of *L. proteiformis*.

L. gardnerae and *L. antillea* are closely related species, yet there seem to be sufficient characters to separate readily these forms into two distinct species. Equatorial sections are so nearly identical that the slight differences shown are not worthy of comment. However, the vertical sections show marked differences and these are of a magnitude which warrant specific distinction.

The general cross-section shape of the test is decidedly different. Normal specimens of *L. gardnerae* have an inflated central portion bordered by a slight rim, while all the specimens of *L. antillea*, which the writer has examined, possess an even lenticular-shaped test. Vertical thin sections exhibit the following differences. First, the lateral chambers of *L. gardnerae* are extremely irregular in size and distribution, while those of *L. antillea* are arranged in regular tiers. Second, the pillars

of *L. gardnerae* are relatively small and irregularly spaced even in the central portion of the test, while *L. antillea* possesses strong pillars regularly spaced. Third, there is a slight, but regular increase in the thickness of the equatorial layer as the periphery is approached in *L. gardnerae*, but a very rapid expansion of the equatorial layer in the peripheral zone is characteristic of *L. antillea*.

Granberry well, first appearance at depths of 220-240 feet; also a few specimens from a well drilled about 6 miles south of Brewton, Escambia County, Alabama, at depths of 766-786 feet (W-219).

Horizon: Claiborne, middle Eocene.

Subgenus Eulepidina H. Douvillé, 1911

Lepidocyclina (*Eulepidina*) *undosa* Cushman

Plate 11, figures 6-7

Lepidocyclina undosa Cushman, Carnegie Inst. Washington Publ. 291, p. 65, pl. 2, fig. 1a, 1919.

Lepidocyclina (*Eulepidina*) *undosa* Cole, Jour. Pal., vol. 8, No. 1. p. 26, pl. 4, figs. 4-5, 10-11, 13-14, 1934.

Although only two fragments of forms referred to this species were recovered, there is slight doubt but that they represent this species.

Port St. Joe well T. 3, first appearance at depths of 1017-1035 feet.

Horizon: middle Oligocene.

PLATES 1-12

PLATE 1

Miocene and Midway Foraminifera

Figure 1 of a specimen from Port St. Joe test well 3 at a depth of 270-300 feet.

Figures 2-14 of specimens from Granberry well 1 from a core at a depth of 1761-1767 feet.

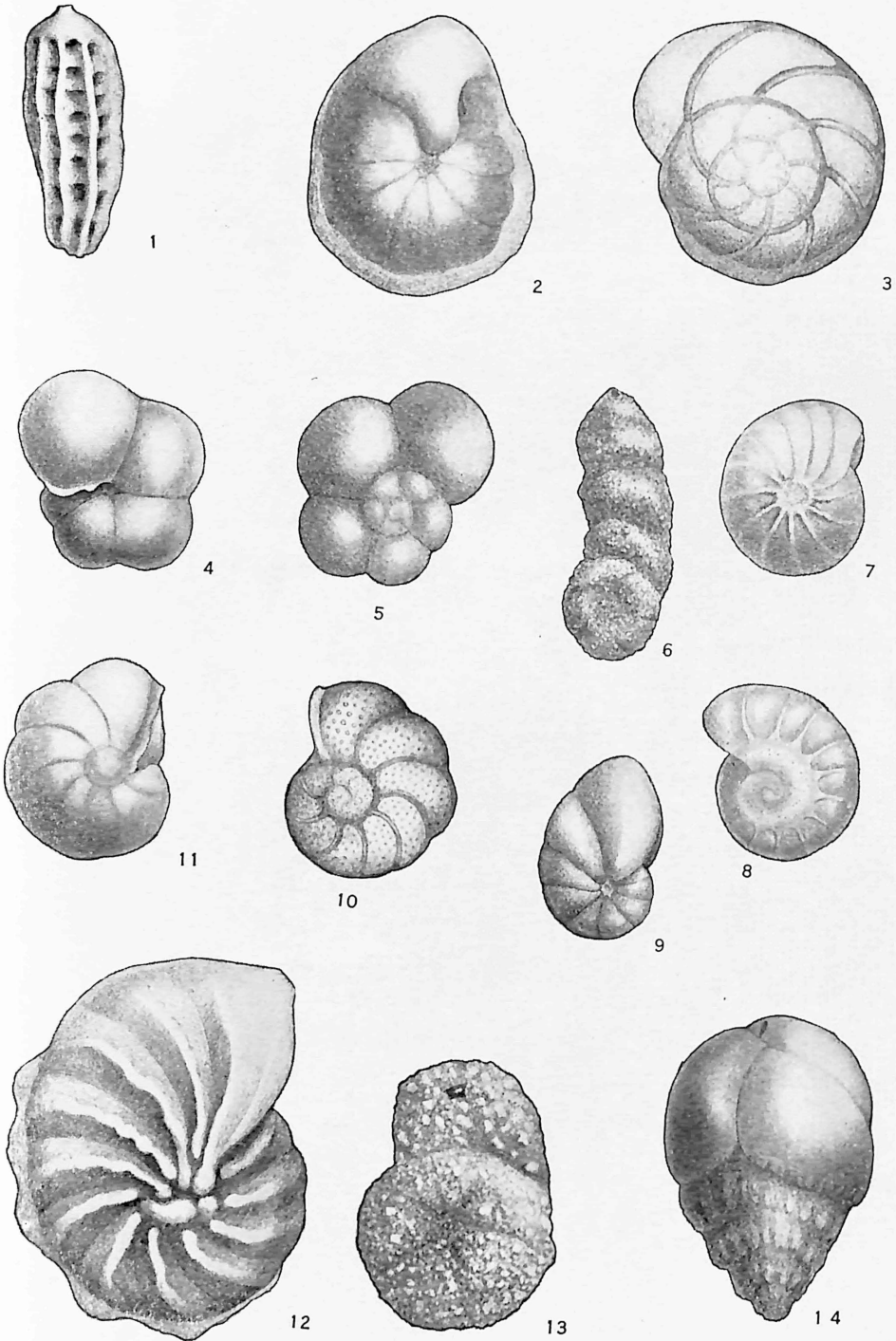
Figure 1, X 34; from the Miocene

Figures 2-13, X 75; from the Midway

Figure 14, X 125; from the Midway

FIGURE

1. *Siphogenerina lamellata* Cushman
2. *Pulvinulinella culter* (Parker and Jones); ventral view.
3. *Pulvinulinella culter* (Parker and Jones); dorsal view.
4. *Globorotalia membranacea* (Ehrenberg); ventral view.
5. *Globorotalia membranacea* (Ehrenberg); dorsal view.
6. *Ammobaculites midwayensis* Plummer.
7. *Nonionella welleri* (Plummer); side view.
8. *Nonionella welleri* (Plummer); opposite side of the same specimen.
9. *Nonionella turgida* (Williamson); side view.
10. *Cibicides alleni* (Plummer); dorsal view.
11. *Cidicites alleni* (Plummer); ventral view of the same specimen.
12. *Lenticulina degolyeri* (Plummer); side view.
13. *Ammobaculites expansus* Plummer
14. *Bulimina arkadelphiana* Cushman and Parker, var. *midwayensis* Cushman and Parker



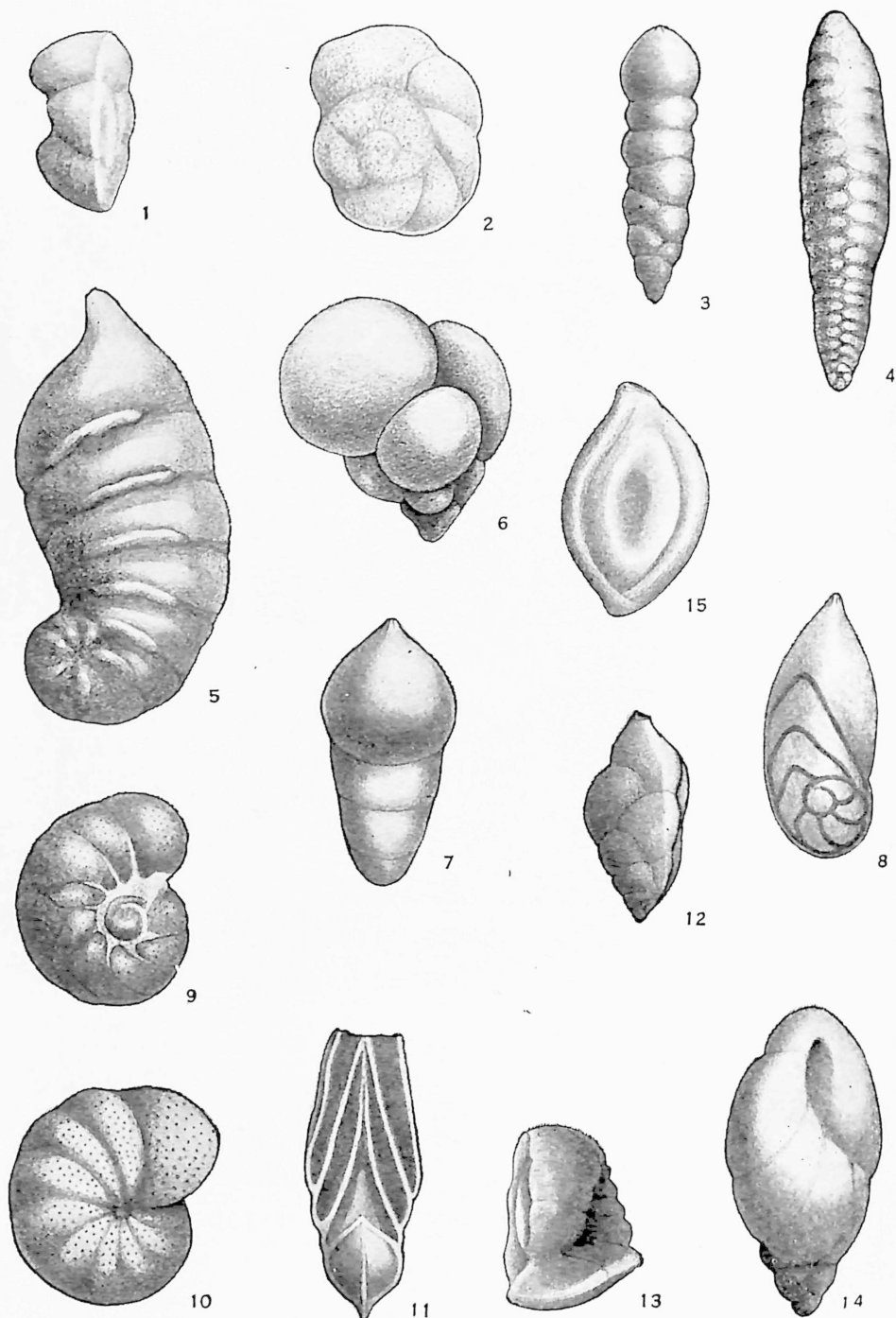


PLATE 2

Midway and Selma Foraminifera

All Specimens from the Granberry well 1.

Figures 1-8, 15 of specimens from a core in the Midway at a depth of 1878 feet.

Figures 9-10, 12, 14 of specimens from a core in the Selma at a depth of 1940-1943 feet.

Figures 11, 13 from a core in the Selma at a depth of 2014-2017 feet.

All figures, X 75, except figures 12, 14 which are X 125.

FIGURE

1. *Globorotalia wilcoxensis* Cushman and Ponton; side view.
2. *Globorotalia wilcoxensis* Cushman and Ponton; dorsal view of another specimen.
3. *Bifarina eleganta* (Plummer)
4. *Spiroplectoides clotho* (Grzybowski)
5. *Hemicristellaria longiforma* (Plummer)
6. *Eggerella trochoides* (Reuss)
7. *Nodosaria radricula* (Linnaeus)
8. *Flabellina oldhami* (Plummer)
9. *Anomalina henbesti* Plummer; dorsal view.
10. *Anomalina henbesti* Plummer; ventral view of another specimen.
11. *Fronicularia clarki* Bagg
12. *Uvigerina seligi* Cushman
13. *Gyroidina girardana* (Reuss); side view.
14. *Buliminella cushmani* Sandidge.
15. *Rzehakina epigona* (Rzehak)

PLATE 3

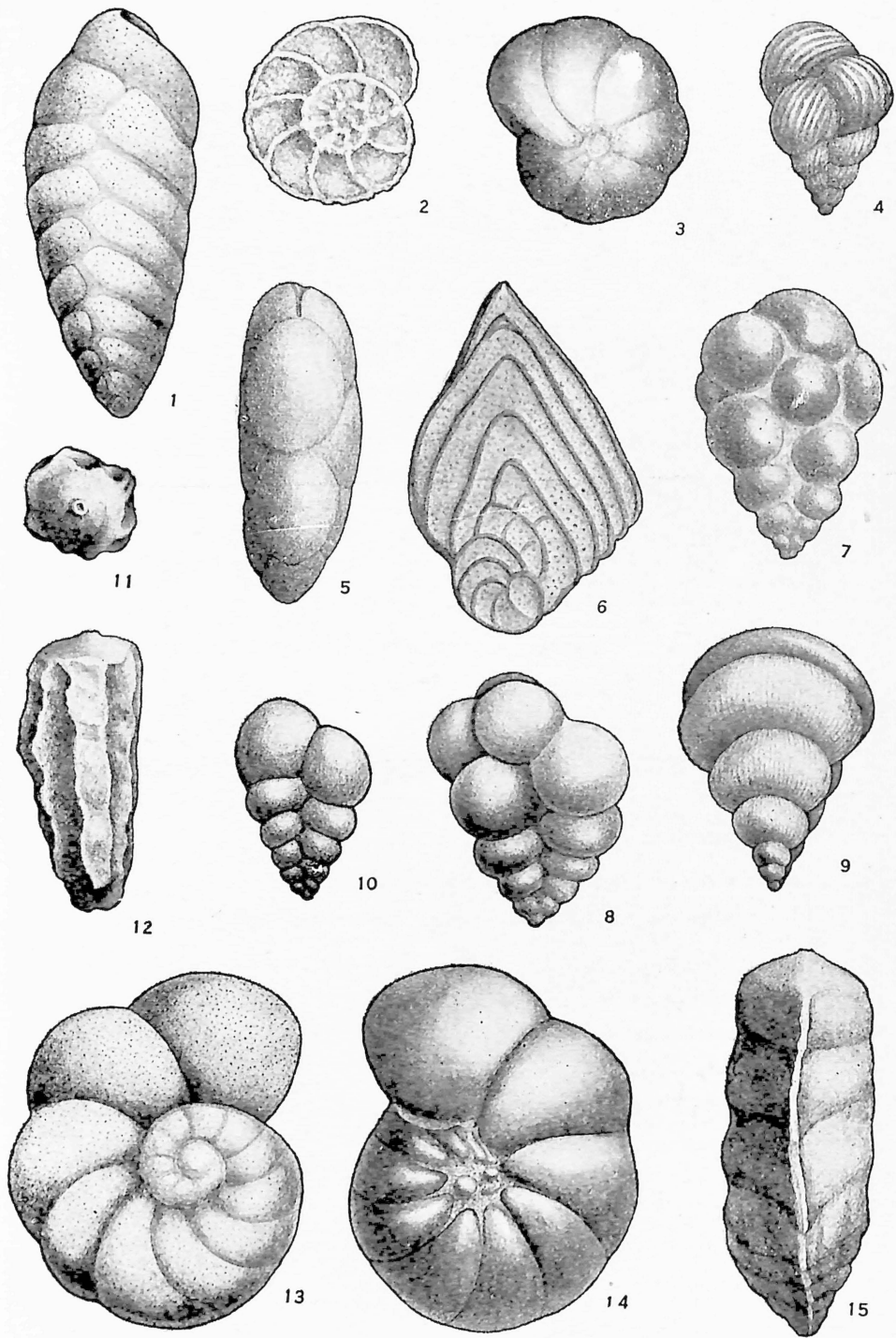
Selma Foraminifera

All specimens are from the Granberry well 1 at a depth of 2014-2017 feet.

All figures, X 75.

FIGURE

1. *Bolivina incrassata* Reuss.
2. *Stensiöina excolata* (Cushman); dorsal view.
3. *Stensiöina excolata* (Cushman); ventral view of the same specimen.
4. *Gümbelina excolata* Cushman; side view.
5. *Bulimina kickapooensis* Cole, n. sp.
6. *Flabellina rugosa* d'Orbigny.
- 7, 8. *Ventilabrella carseyae* Plummer; side view showing stages of development.
9. *Gümbelina plummerae* Loetterle.
10. *Gümbelina globulosa* (Ehrenberg).
11. *Heterostomella americana* Cushman; end view
12. *Heterostomella americana* Cushman; side view of another specimen.
13. *Anomalina taylorensis* Carsey; dorsal view.
14. *Anomalina taylorensis* Carsey; ventral view of the same specimen.
15. *Clavulina trilatera* Cushman.



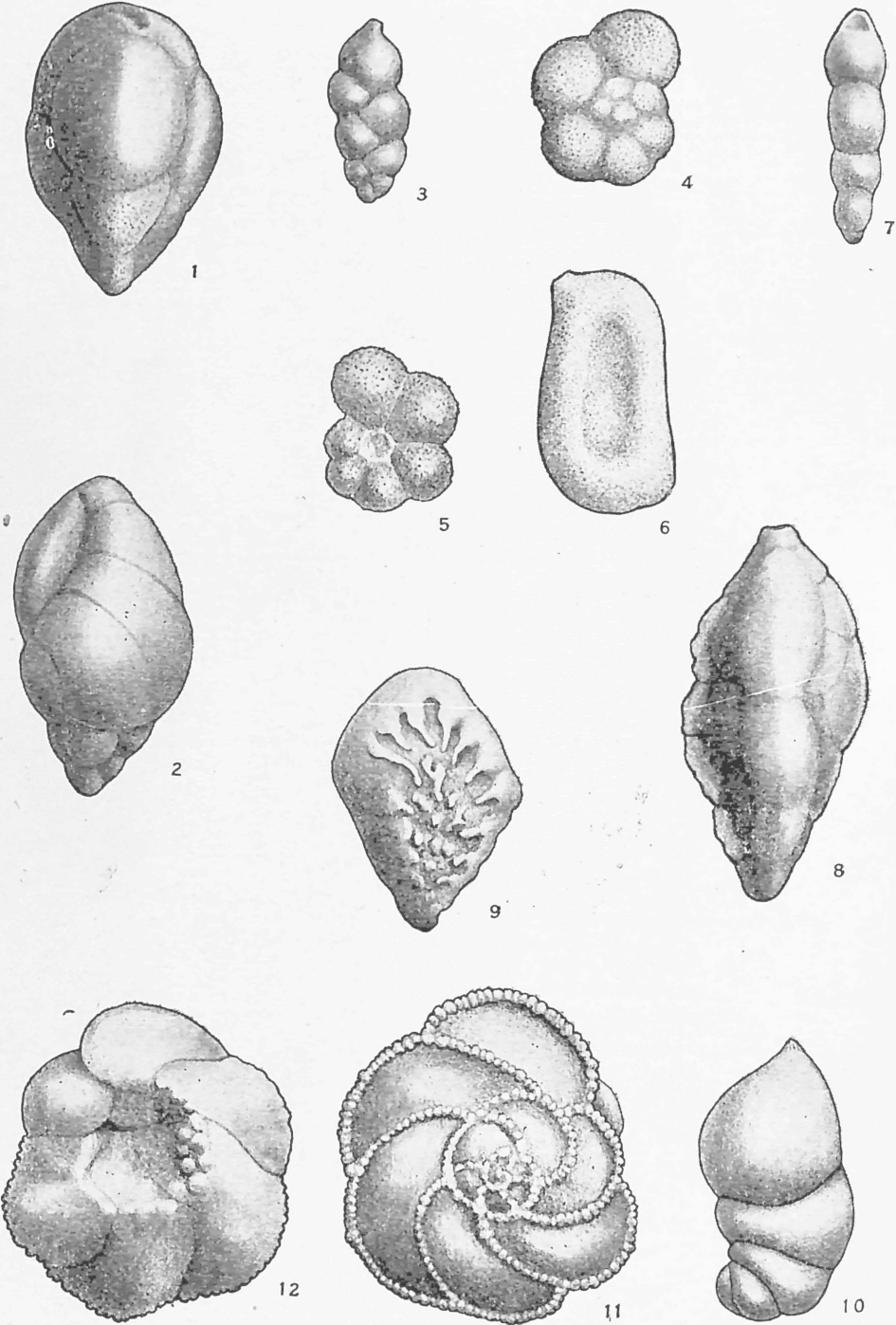


PLATE 4

Selma Foraminifera

All specimens are from the Granberry well 1.

Figures 1-5 of specimens from a core at a depth of 2014-2017 feet.

Figures 6-12 of specimens from a core at a depth of 2047-2050 feet.

All figures, X 75, except figures 1-3, 8 which are X 125.

FIGURE

1. *Bulimina triangularis* Cushman and Parker.
2. *Buliminella carseyae* Plummer
3. *Pseudouvigerina cretacea* Cushman
4. *Globigerina cretacea* d'Orbigny
5. *Globigerinella aspera* (Ehrenberg)
6. *Rzehakina* sp.
7. *Pleurostomella subnodosa* Reuss
8. *Pseudouvigerina plummerae* Cushman
9. *Bolivinoidea decorata* (Jones)
10. *Marginulina bullata* Reuss
11. *Globotruncana arca* (Cushman) ; dorsal view.
12. *Globotruncana arca* (Cushman) ; ventral view.

PLATE 5

Figures 1-7 of specimens from the Granberry well 1 at a depth of 220-240 feet.

Figures 8-21 of specimens from the Port St. Joe test well 3; 8-13, at a depth of 700-721 feet; 14-17, at a depth of 342-364 feet; 18, 19, at a depth of 1017-1035 feet; 20-21, at a depth of 870-890 feet.

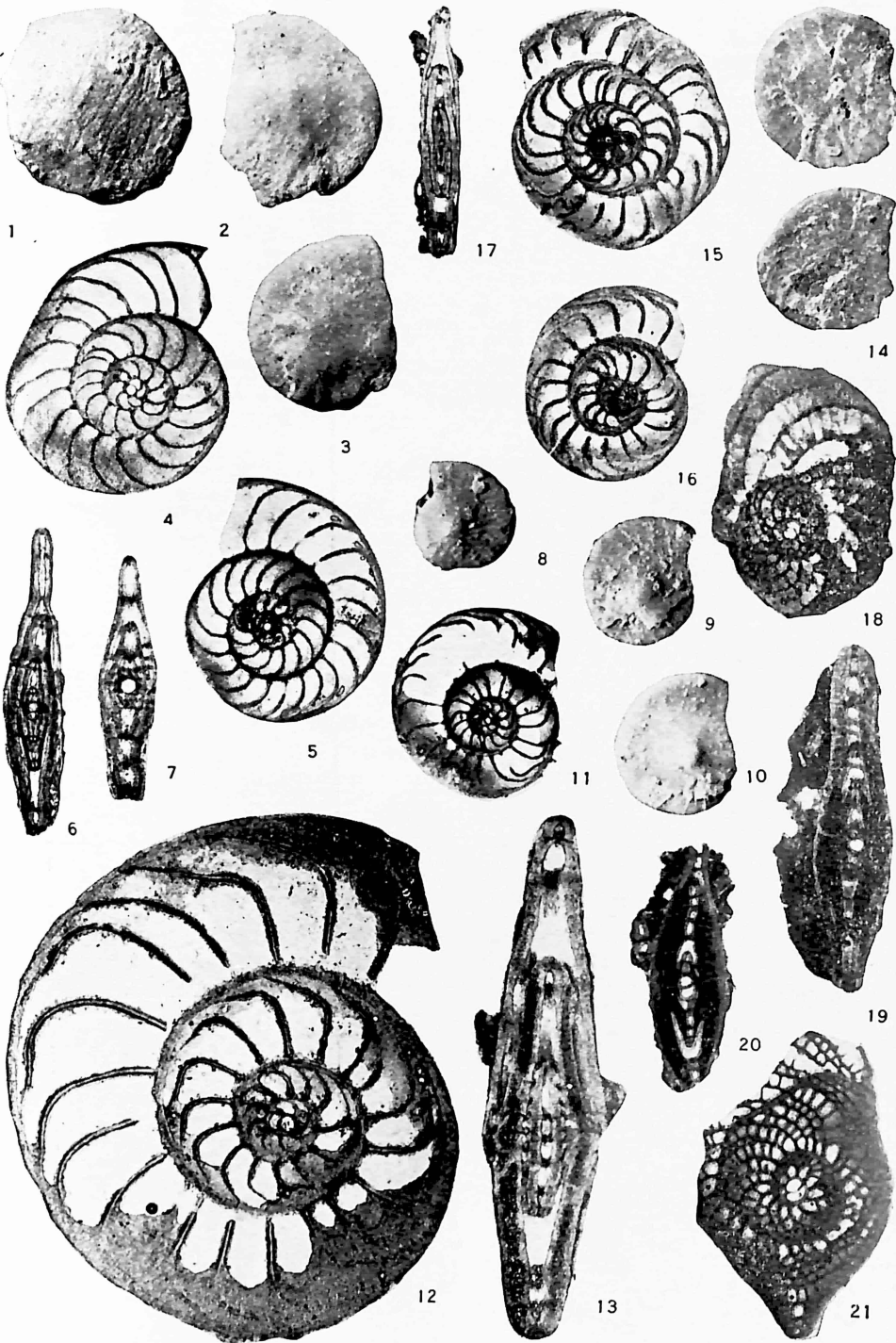
Figures 1-3, 8-10, 14, X 10.

Figures 4-7, 11, 15-21, X 13.5.

Figures 12, 13, X 36.5.

FIGURE

- 1-7. *Operculinoides sabinensis* (Cole); 1-3, external view of three specimens; 4, 5, median sections; 6, 7, transverse sections.
- 8-13. *Operculinoides forresti* Vaughan and Cole; 8-10, external view of three specimens; 11, 12, median sections; 13, transverse section.
- 14-17. *Operculinoides tuxpanensis* (Thalmann); 14, external view of two specimens; 15, 16, median sections; 17, transverse section.
- 18-21. *Heterostegina texana* Gravell and Hanna; 18, 21, median sections; 19, 20, transverse sections.



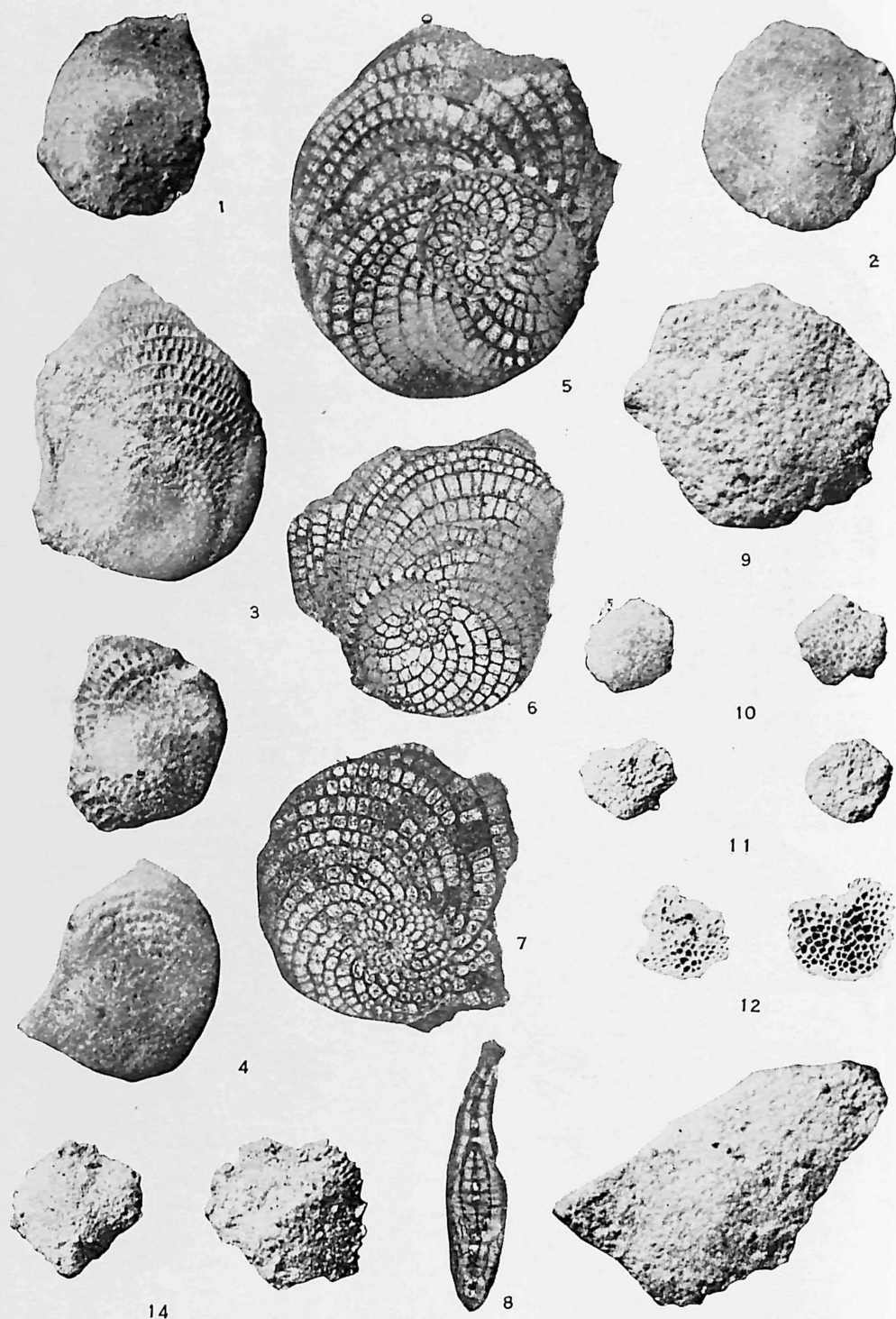


PLATE 6

Figures 1, 2, 9-14 of specimens from the Port St. Joe test well 3; 1, at a depth of 870-890 feet; 2, at depth of 996-1017 feet; 9, 13, at a depth of 700-721 feet; 10, at a depth of 890-911 feet; 11, 12, 14, at a depth of 996-1017 feet.

Figures 3-8 of specimens from the Meson formation between kilometer posts 17-18.5 on the Aguila Petroleum Company's narrow-gauge railroad between Potrero and Tanhuijo, Mexico; collection of W. S. Cole.

Figures 1-4, 9-14, X 10.

Figures 5-8, X 13.5.

FIGURE

- 1-8. *Heterostegina texana* Gravell and Hanna; 1-4, external view of five specimens to illustrate surface ornamentation; 5-7, median sections; 5, 6, megaspheric individuals; 7, microspheric individual; 8, transverse section; 3-8, figured for comparison with the specimens from the Port St. Joe test well 3.
- 9, 13. *Miogypsina* (*Miogypsina*) *venezuelana* Hodson; external view of two specimens.
- 10-12, 14. *Miogypsina* (*Miogypsina*) *gunteri* Cole, n. sp.; 10, 11, 14, external view of six specimens; 10, cotypes; 11, 12, 14, paratypes; 12, equatorial layer and embryonic chambers of two specimens viewed by reflected light.

PLATE 7

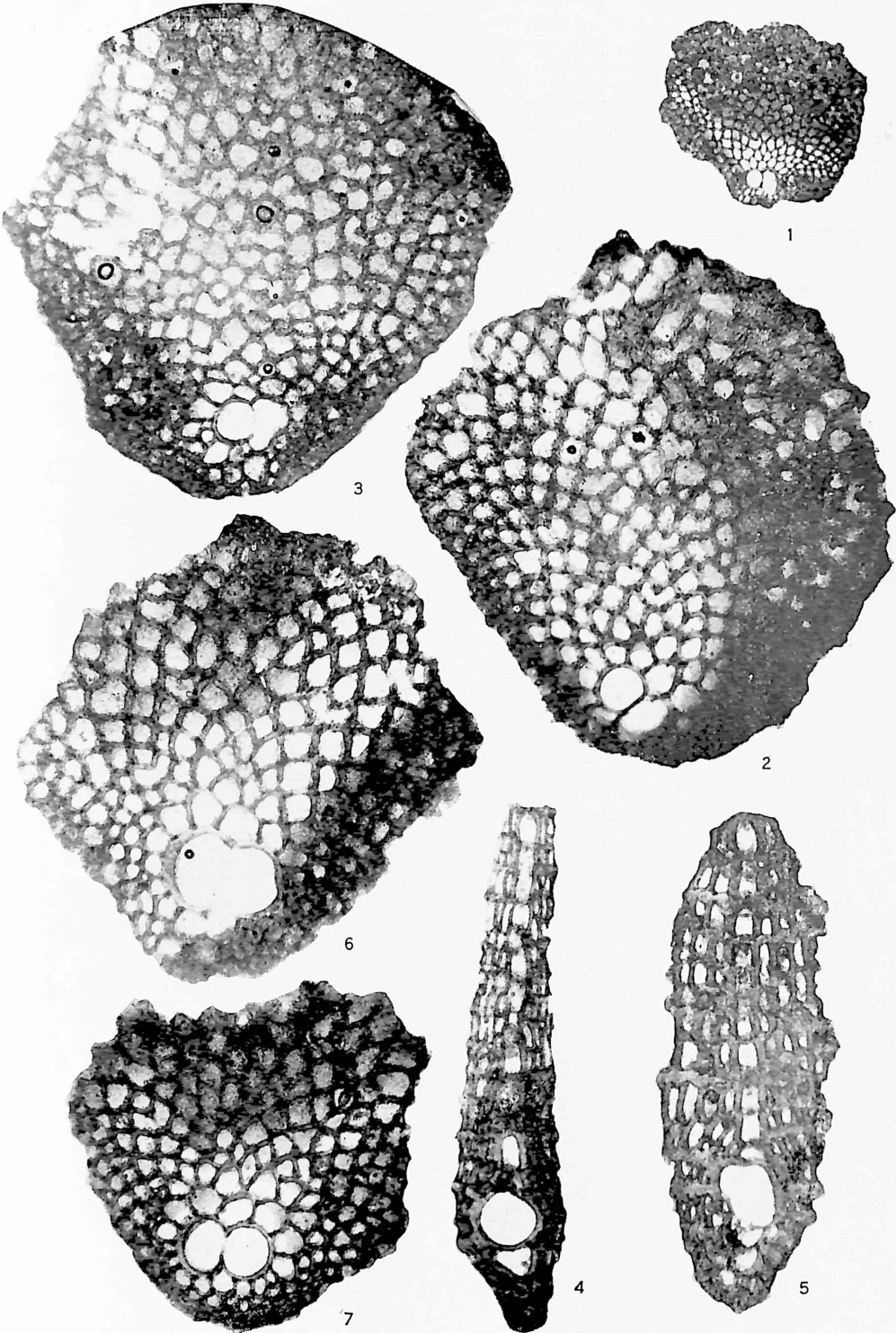
All specimens from the Port St. Joe test well 3 at a depth of 700-721 feet.

Figure 1, X 13.5.

Figures 2-7, X 36.5.

FIGURE

- 1-4. *Miogypsina* (*Miogypsina*) *venezuelana* Hodson; 1-3, equatorial sections, showing embryonic apparatus and equatorial chambers; 4, vertical section of a megalospheric individual.
- 5-7. *Miogypsina* (*Miogypsina*) *hawkinsi* Hodson; 5, vertical section of a megalospheric individual; 6, 7, equatorial sections, showing embryonic apparatus and equatorial chambers.



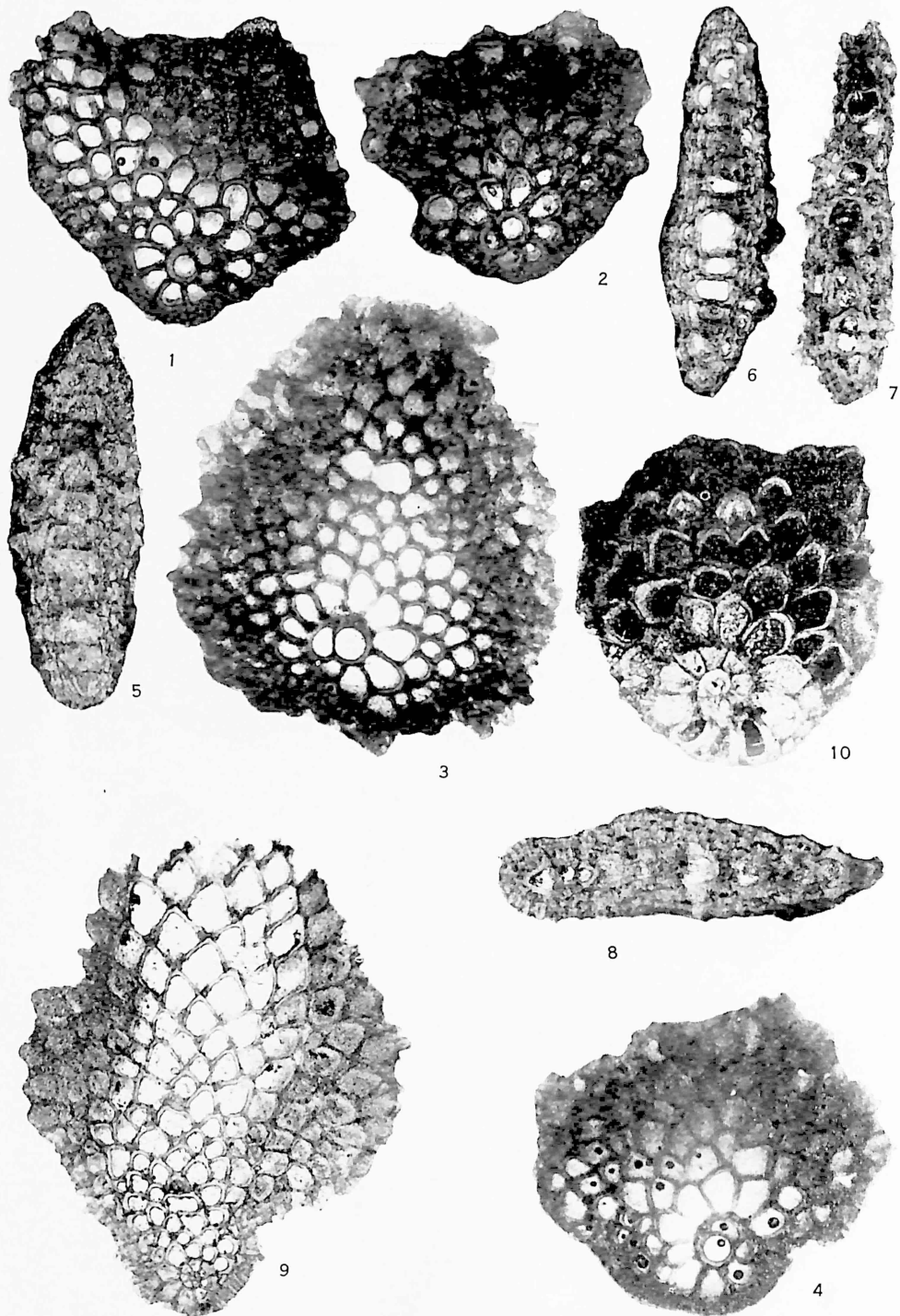


PLATE 8

Figures 1-9 of specimens from the Port St. Joe test well 3; 1, 2, 5, 6, at a depth of 890-911 feet; 3, 4, 7-9, at a depth of 996-1017 feet.

Figure 10 of a specimen from Rancho Abajo, Mexico; collection of W. S. Cole.

All figures X 36.5.

FIGURE

- 1-9 *Miogypsina* (*Miogypsina*) *gunteri* Cole, n. sp.; 1, 2, 5, 6, cotypes; 3, 4, 7-9, paratypes; 1-4, 9, equatorial sections; 1-4, megalospheric individuals; 9, microspheric individual; 5-8, vertical sections.
- 10. *Miogypsina* (*Miogypsinoides*) *complanata* Schlumberger, t. Barker and Grimsdale; equatorial section introduced for comparison.

PLATE 9.

Figures 1, 6-8 specimens from the Granberry well 1, at a depth of 220-240 feet.

Figures 2, 4, 9, 10 of specimens from Cooper's Mill, 1.5 miles south of Sabinetown, Texas. Topotypes; collection of W. S. Cole.

Figures 3, 7 of specimens from a well drilled 6 miles south of Brewton, Escambia County, Alabama, at a depth of 766-786 feet.

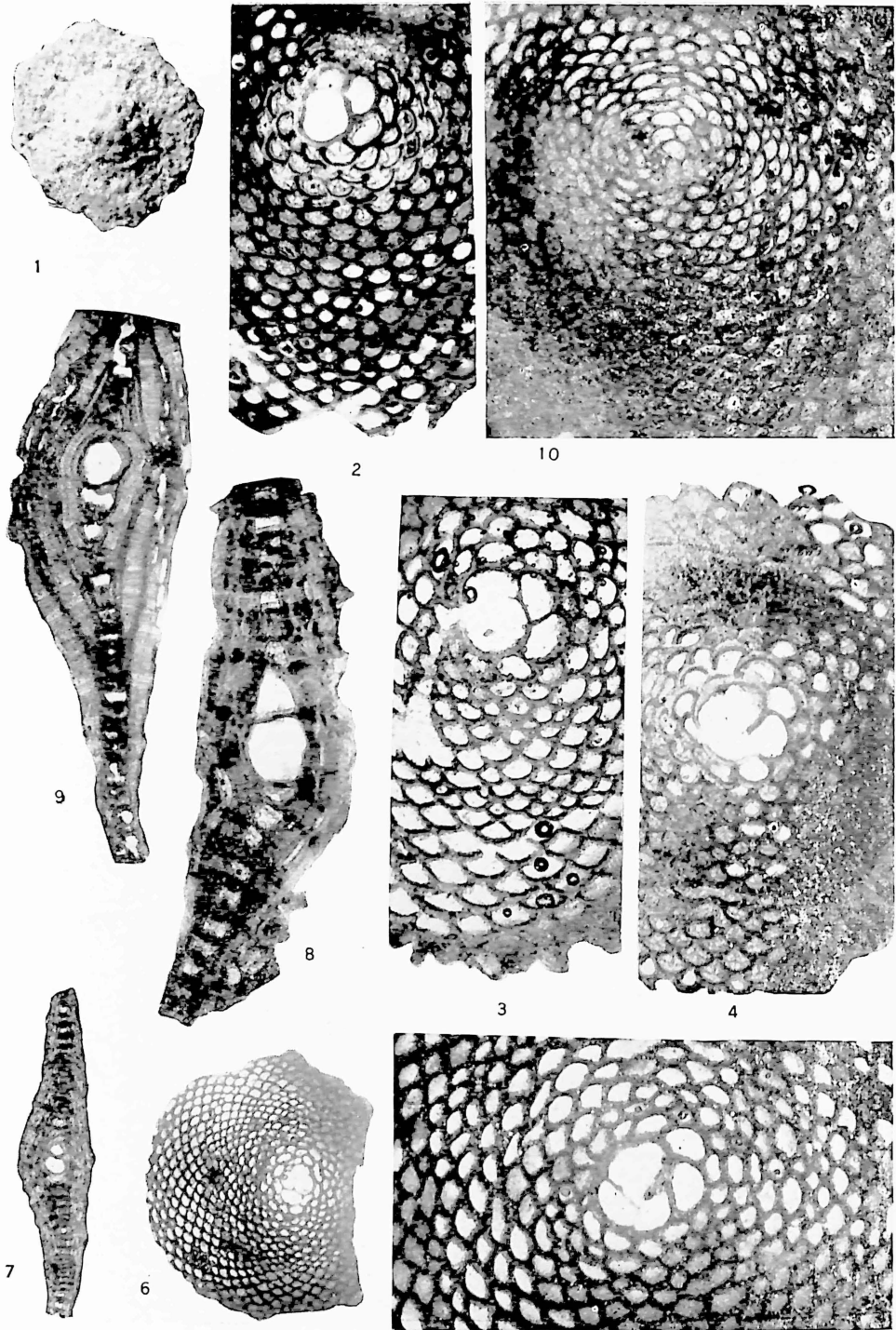
Figure 1, X 10.

Figures 2-5, 8-9, X 36.5.

Figures 6, 7, X 13.5.

FIGURE

- 1-10 *Lepidocyclina* (*Polylepidina*) *gardnerae* Cole; 1, external view; 2-6, equatorial sections of megalospheric individuals, showing embryonic apparatus and equatorial chambers; 7-9, vertical sections of megalospheric individuals; 10, equatorial section of microspheric individual.



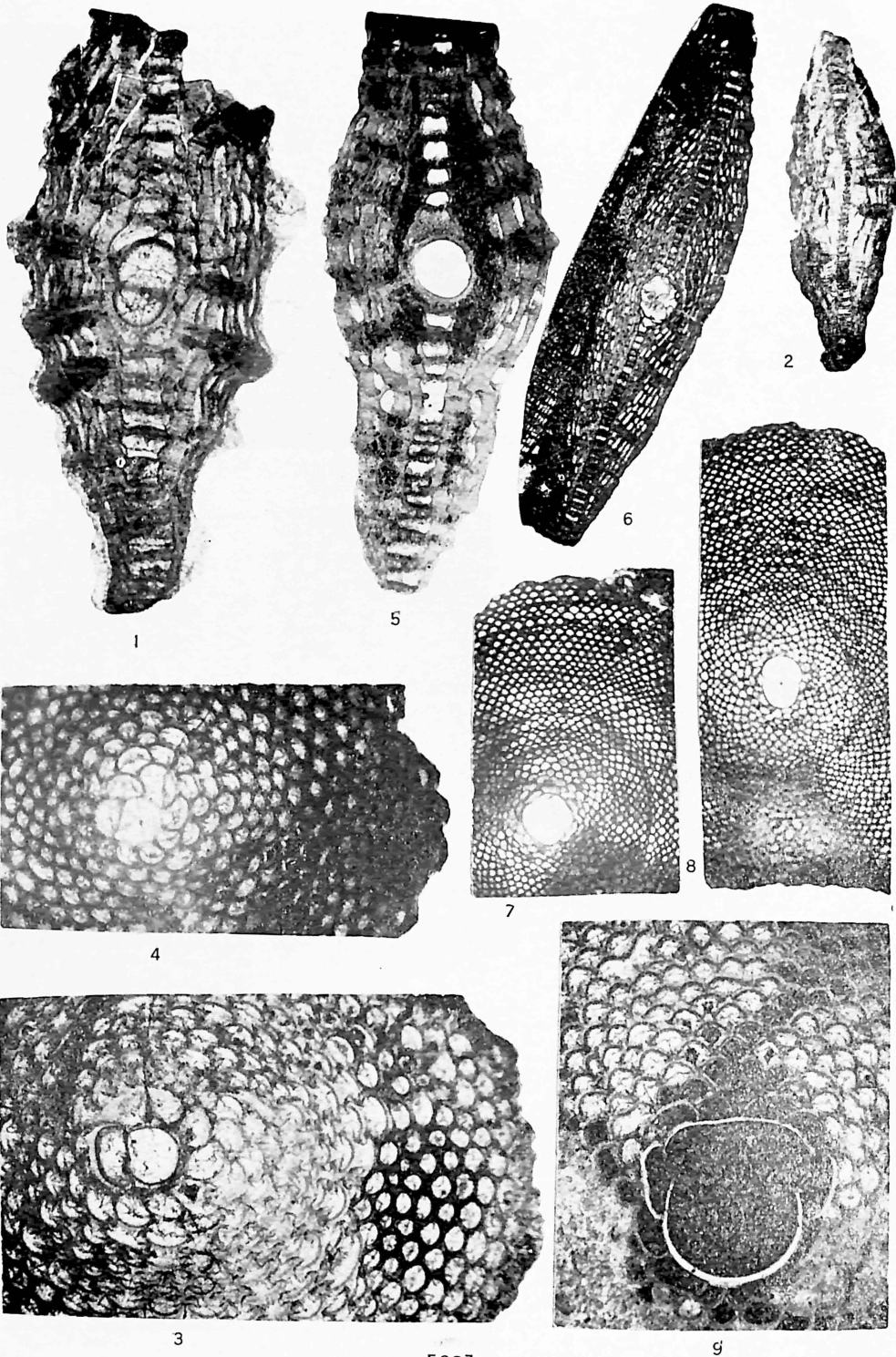


PLATE 10.

Figures 1-3 of specimens from U. S. Geol. Survey Loc. 6897, St. Bartholomew. Topotypes; collection of U. S. National Museum: 1, U. S. National Museum Cat. No. 497951; 2, U. S. National Museum Cat. No. 497949; 3, U. S. National Museum Cat. No. 497950.

Figure 4 of a specimen from Cooper's Mill, 1.5 miles south of Sabinetown, Texas. Topotype; collection of W. S. Cole.

Figure 5 of a specimen from a well drilled 6 miles south of Brewton, Escambia County, Alabama, at a depth of 766-786 feet.

Figures 5-9 of specimens from 0.5 kilometers southwest of Palma Sola, Vera Cruz, Mexico. Topotypes, presented to the writer by Dr. T. Wayland Vaughan; collection of W. S. Cole.

Figures 1, 3-5, 9, X 36.5.

Figures 2, 6-8, X 13.5.

FIGURE

- 1-3. *Lepidocyclina* (*Polylepidina*) *antillea* Cushman; 1, 2, vertical sections; 1, megalospheric individual; 2, microspheric individual; 3, equatorial section of a megalospheric individual.
- 4-5. *Lepidocyclina* (*Polylepidina*) *gardnerae* Cole; 4, equatorial section of a calcite-filled specimen, which resembles the state of preservation encountered in *L. antillea*; 5, vertical section, showing the irregular distribution of lateral chambers, the thick roofs and floors of the lateral chambers, and the weak development of pillars.
- 6-9. *Lepidocyclina* (*Polylepidina*) *proteiformis* Vaughan; 6, vertical section; 7-9, equatorial sections to illustrate the embryonic apparatus which is very different from that of *L. gardnerae* or *L. antillea*.

PLATE 11.

Figure 1 of a specimen from 0.5 kilometers southwest of Palma Sola, Vera Cruz, Mexico. Topotype, presented to the writer by Dr. T. Wayland Vaughan; collection of W. S. Cole.

Figures 2-8 of specimens from the Port St. Joe test well 3; 2-7, at a depth of 1017-1035 feet; 8, at a depth of 700-721 feet.

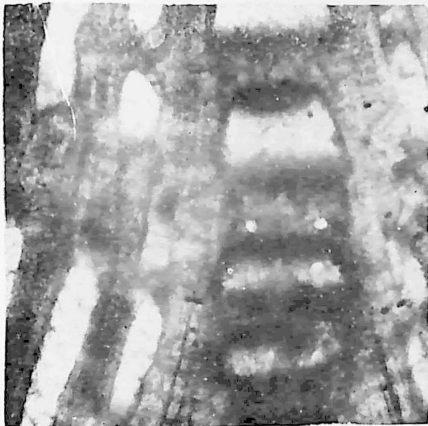
Figure 1, X 170.

Figures 2, 3, 5-8, X 36.5.

Figure 4, X 13.5.

FIGURE

1. *Lepidocyclina* (*Polylepidina*) *proteiformis* Vaughan; portion of the vertical section, illustrated on pl. 10, fig. 6, greatly enlarged to show the stoloniferous apertures.
- 2-5. *Lepidocyclina* (*Lepidocyclina*) *parvula* Cushman; 2, 4, 5, vertical sections; 2, megalospheric individual; 4, 5, microspheric individuals; 3, equatorial section of a megalospheric individual.
- 6-7. *Lepidocyclina* (*Eulepidina*) *undosa* Cushman; 6, portion of equatorial section illustrating equatorial chambers; 7, vertical section.
8. *Miogypsina* (*Miogypsina*) *venezuelana* Hodson; equatorial section of a microspheric individual.



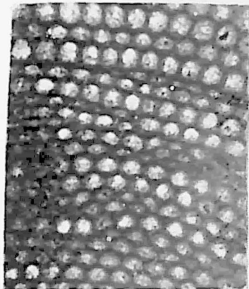
1



2



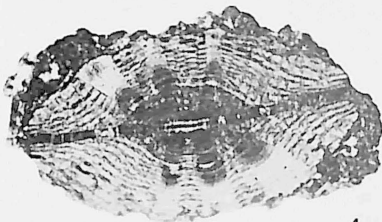
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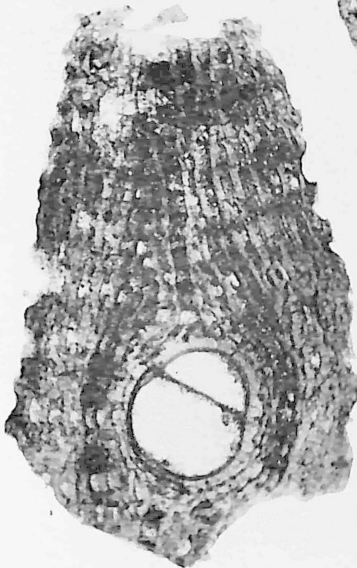
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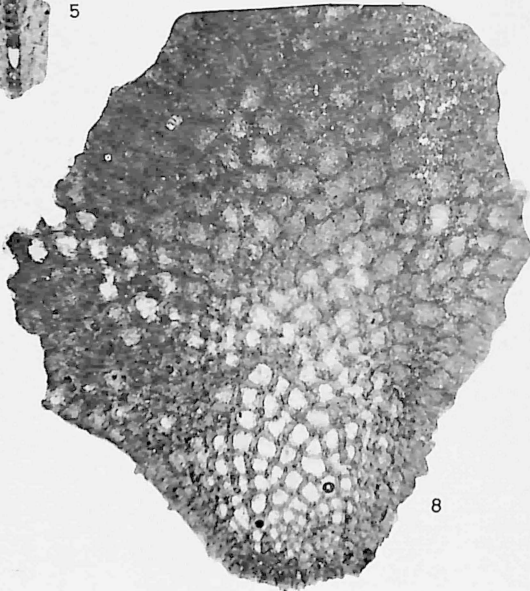
5



4



7



8



PLATE 12.

Figures 1-5 of specimens from the Granberry well 1; 1-3, at a depth of 240-260 feet; 4-5, at a depth of 1390-1412 feet.

Figure 6 of a specimen from the Port St. Joe test well 3 at a depth of 342-364 feet.

Figure 1, X 10.

Figures 2, 3, 5, X 36.5.

Figures 4, 6, X 13.5.

FIGURE

- 1-3. *Discocyclina* (*Discocyclina*) *flintensis* (Cushman); 1, external view; 2, equatorial section; 3, vertical section.
- 4-5. Portions of a thin section showing *Discocyclina* cf. *D. cookei* Vaughan; 5, an enlargement of the largest specimen in fig. 4.
6. *Textulariella barrettii* (Jones and Parker).

