

WILLISTON MEMBER

Definition: The Williston is the upper member of the Moodys Branch formation, the lower Jackson of peninsular and possibly western Florida. The bed crops out over a wide area west of Williston, Florida, and almost the entire thickness is exposed in a series of sinks and limestone pits. The limestone exposed at locality L-37 in a pit in the southeast quarter, northeast quarter, Section 27, Township 12 South, Range 18 East, is typical of the member.

Physiography and Outcrop Pattern: The Williston crops out in annular bands surrounding the Inglis member, except where these have been interrupted by small normal faults, forming horst-graben structures. The bed is thin and must be essentially horizontal in western and northeastern Levy County where the outcrop is exceedingly broad. The hardness of the limestone and its resistance to erosion is variable but in general the bed is harder and more resistant than the overlying Ocala limestone and is softer and less resistant than the Inglis member. The limestone is part of the floor of the coastal and river hammocks in western Levy and northwestern Citrus counties; composes a portion of the bedrock of the Williston Limestone Plain and the Tsala Apopka Lake; and extends along the Recent submarine limestone shelf.

The limestone is thinly veneered by sand, marl and limestone of the Pamlico and Wicomico formations and more thickly covered in the outcrop areas of the Coharie-Okefenokee deposits and the Alachua formation. Sink holes characterize the outcrop and solution pipes, filled with red argillaceous sand and clay, are exceedingly common in most exposures.

General Lithology: Two types of marine limestone predominate in the Williston member, one being essentially a cream-colored coquina of camerinids and miliolids loosely held in calcite paste, and the other, a cream to tan-colored, detrital limestone composed of quantities of small foraminifers with minor percentages of echinoids, large foraminifers, Comatulid brachials, and mollusks loosely held by secondary calcite and calcite paste. In the vicinity of Crystal River, Florida, and south of the outcrop area the limestone is a granular to sub-chalky mass of poorly preserved miliolids and other small foraminifers and almost devoid of identifiable fossils other than these. This relatively barren, equigranular, detrital, soft, porous facies is represented in the canal wells W-1228 to W-1235, figure 14.

Silicified limestone, particularly large masses showing irregular exfoliation plates, are common in outcrops, and are generally found near

the contact with the Inglis member. The top of the Williston is a transition zone, having faunal similarities with the Ocala limestone, but generally differing in lithology, being harder, more granular, and containing fewer specimens of large foraminifers.

Thickness: In the core holes, on which exact controls have been established, the Williston is about 30 feet thick. This agrees well with the samples taken from water wells, where exact sampling and controls are not possible, and with the thicknesses exposed in the outcrop. The thickest sections of the Williston are exposed at localities C-3, L-8 and L-52 where sinks have penetrated 32, 27 and 30 feet of the bed.

Fauna and Age: Miliolids are the most abundant fauna in the Williston member outranking the camerinids in numbers of individuals but being less by volume. The miliolids are largely undescribed and are generally so poorly preserved that specific identification is prevented. Specimens of the Camerinidae were identified by the writer and checked by Madame Marie de Cizancourt, Paleontologist, Paris, France; and Donald W. Gravell, Cabon Gref Oil Company, Havana, Cuba. The most common species and greatest number of specimens in the bed is *Camerina vanderstoki* (Rutten and Vermunt) with minor percentages of *C. guaya-balensis* Barker, *C. sp. cf. C. moodybranchensis* Gravell and Hanna, *Operculinoides floridensis* (Heilprin), *O. vughani* (Cushman) var. (noded septae). *Lepidocyclina ocalana* Cushman and *Heterostegina ocalana* Cushman are rare throughout the bed and more common at the top than at the base.

Some of the more common small foraminifers of the Williston member are given in Table 10, a checklist of the Moodys Branch formation fauna. *Amphistegina pinarensis cosdeni* Applin and Jordan, *Nonion advenum* (Cushman) occur in both members as does *Camagueyia perplexa* Cole and Bermudez, not identified in the Williston member on the checklist, and these species appear to be confined to the Moodys Branch formation. *Camerina vanderstoki* (Rutten and Vermunt), *Rotalia cushmani* Applin and Jordan range from the upper Inglis member into the basal Ocala limestone but flood the Williston member.

In the miliolid-rich facies of the Williston member, small plates believed to be Comatulid brachials are common. Echinoids are not a dominant percentage of the fauna as they are in the Inglis member. Of 21 species of irregular echinoids listed by Cooke (1942, pp. 1-4) as occurring in the Ocala limestone, *Fabularia vughani* (Twitchell), *Oligopygus haldemani* (Conrad), *Laganum floridanum* Twitchell, *L. ocalanum* Cooke, *Peronella crustuloides* (Morton), *P. cubae* Weisbord, *P. arch-*

erensis (Twitchell), *Schizaster armiger* Clark, *Agassizia floridana* de Loriol, and *Eupatagus dixie* Cooke have been identified from the Williston member.

The mollusks are preserved as molds and some of these have been described in the literature covering the Ocala limestone. These molds have not been studied since other fossils are better preserved and more useful in stratigraphic determinations. Shells of *Vulsella ocalensis* McNeil occur in some outcrops.

The Williston member is a transition bed of limestone that is closer lithologically to the Inglis member than to the Ocala limestone. The fauna consists of a few species that are confined to it and to the Inglis member and a larger number that range up into the Ocala limestone. Probably as much argument could be presented that the bed is a member of the Ocala (restricted) as could be cited in support of placing it in the Moodys Branch formation, but because it is a transition bed, deposited in water only slightly deeper than the Inglis member, the bed is believed to represent the upper part of the lower Jackson group.

Stratigraphic Relations: The Williston member lies conformably between the Inglis member and the Ocala limestone (restricted). The contact with the underlying Inglis member is marked by a sharp lithologic change, the Williston being more granular and softer, and by faunal differences. Both the fauna and lithology of the Williston grades into the Ocala limestone and an exact contact can rarely be placed. In some exposures a well-developed nodular, spongiform-concretion bed, a change from a granular-miliolid limestone containing *Amphistegina pinarensis cosdeni* below the concretions to a coquina of large foraminifers above, mark the contact. In other sections the concretions apparently have no stratigraphic significance, occurring in beds that can be definitely assigned on other characteristics to either the Ocala limestone or the Williston member. In the outcrop area the Williston and Ocala have been separated wherever possible by lithologic differences and elsewhere according to the percentage of large foraminifers common to the Ocala limestone in relation to the percentage of such distinct foraminifers as the noded *Operculinoides vughani*, *Amphistegina pinarensis cosdeni*, *Nonion advenum* and *Camerina vanderstoki*, placing those exposures that contain the latter to the exclusion of abundant species of *Lepidocyclina* and *Heterostegina* in the Williston member. The outcrop distribution, Plate 1, indicated that this division can be mapped and is a distinct and logical unit.

Subsurface Characteristics: In well penetrations the Ocala limestone is

typically a coquina of large foraminifers and the Williston is granular and slightly harder. The Inglis member is very hard and can be identified by increased drilling time, fauna and more indurated matrix. Eastward and northeastward of the outcrop area the Williston member is composed of abundant specimens of *Camerina vanderstoki* and *Amphistegina pinarensis cosdeni* contained in a fragmental, miliolid-rich limestone. The lower portion commonly has silicia incrustations in voids, and the limestone is sometimes completely silicified. It has a red to deep yellow color, is very porous, uniformly granular and contains almost no fossils except miliolids. The concentrations of specimens of *Camerina vanderstoki* in some wells of the proposed ship canal occurs relatively near the base of the Williston and in others they occur higher.

The increased thickness of the Moodys Branch formation toward Baker, Duval, and adjacent counties to about 150 feet appears to have occurred in the Inglis member, but in a few wells no definite Inglis member was present. The first occurrence of *Amphistegina pinarensis cosdeni*, usually small in size, appears very high in the section but in a distinct lithology, characteristic of the Williston member. A marked increase in the percentage of echinoid fragments and an increased granularity about 40 to 60 feet below the first appearance of *Amphistegina* may represent the Inglis member, but other diagnostic characteristics of the member are lacking.

In Orange and Osceola counties the base of the Williston member frequently is a very porous, loose, cream-colored collection of detrital grains composed of Comatulid brachials, echinoid spines and fragments and foraminifers, all of which are beautifully preserved and apparently entirely uncemented. The upper part of the bed is similar in lithology to the limestone in the outcrop area.

In Pasco, Pinellas, Hillsborough and Polk counties the Williston member is a normal miliolid-rich limestone containing abundant specimens of *Camerina vanderstoki* and *Amphistegina pinarensis cosdeni*. Some wells penetrate a coquina limestone, similar to the Ocala limestone (restricted) lithologically, that contains numerous specimens of *Camerina moodybranchensis* Gravell and Hanna and this probably represents the member. Where the Williston member contains *Camerina moodybranchensis* the contact with the Ocala limestone is gradational and is not sharply marked.

Detailed Geologic Exposures in Levy County: The Williston member is typically developed west of Williston, Florida, the limestone composing a portion of a broad, flat, sand-covered plain made irregular by solution

and cavity collapse. The following section measured June 5, 1951, on the southeast side of a limestone quarry in the southeast quarter, northeast quarter, Section 27, Township 12 South, Range 18 East is selected as the type locality, see figure 26.

Locality L-37

Feet

Upper Eocene series

Moodys Branch formation

Williston member

- 4) Cream to tan, soft, detrital limestone containing numerous hard crystalline nodules, many *Pecten* sp., rare *Amusium* sp., *Lepidocyclina ocalana*, *Operculinoides floridensis*, *Amphistegina pinarensis cosdeni* and abundant *Camerina vanderstoki*..... 0.6
- 3) Cream-colored, massive, somewhat nodular, pasty foraminiferal coquina limestone with numerous spongiform concretions. Foraminifers of bed 4, *Operculinoides floridensis*, *Nonion advenum*, *Rotalia cushmani* and *Eponides jacksonensis* are very abundant..... 6.8
- 2) Cream-colored, very hard ledge, porous, somewhat crystalline, very fossiliferous limestone containing numerous mollusks, molds, echinoid plates, abundant miliolids and other rare foraminifers 0.45
- 1) Cream-colored, granular, detrital, soft, porous, miliolid limestone containing the fossils above. Somewhat more

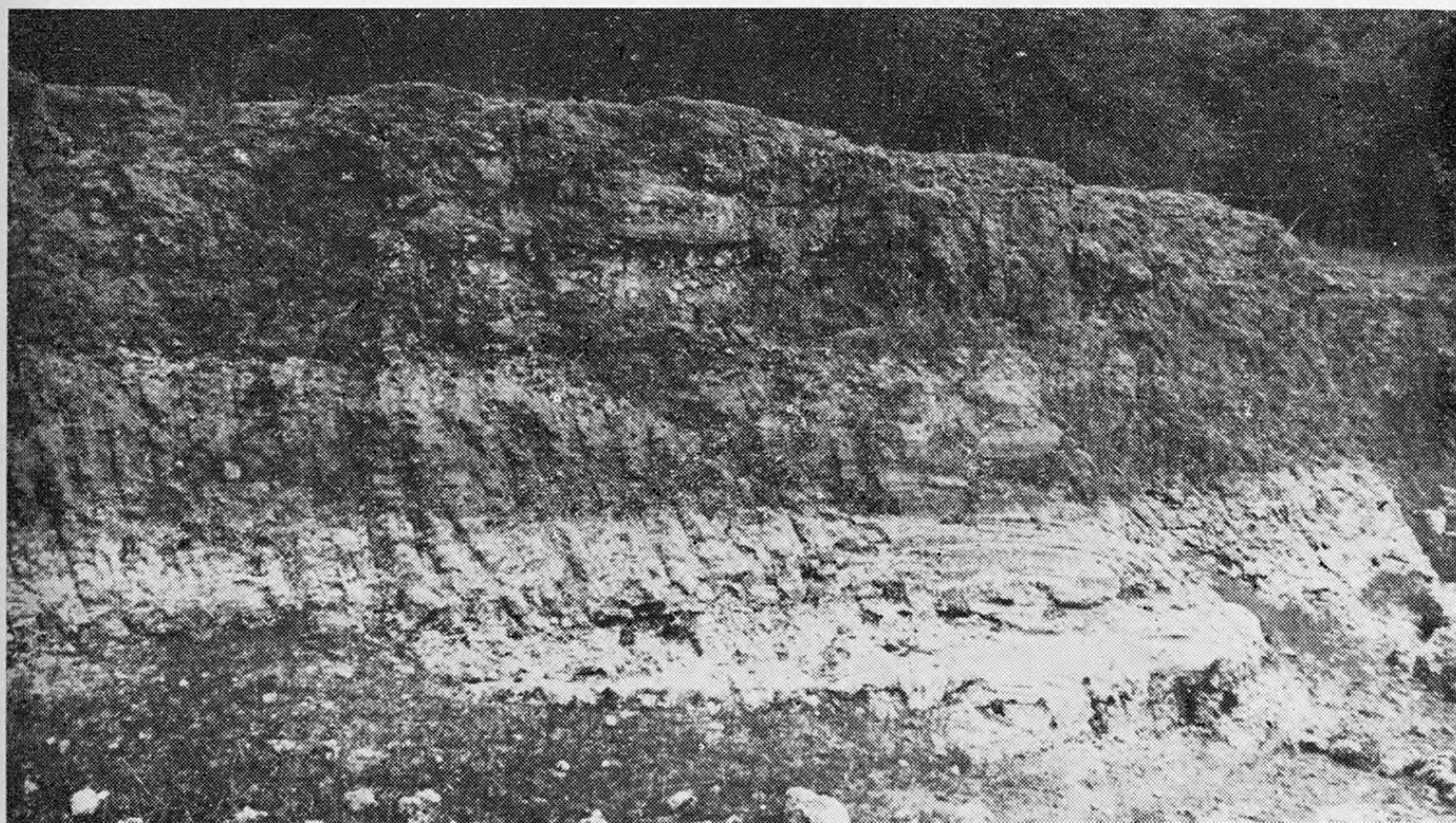


Figure 26. Locality L-37, the type locality of the Williston member, Moodys Branch formation.

resistant to weathering and more massive than beds
above 9.3

Thickness of exposure 17.15

On the northwest side of the pit an additional 3.6 feet of bed 4 is exposed in the face of the quarry and an additional 2 feet, fifty feet back of the rim.

Numerous sinks and holes in sections 4 and 5, Township 12 South, Range 18 East, expose the Williston member and a sink in the northeast quarter southeast quarter, Section 5, locality L-27, penetrated 11 feet of nodular, spongiform-concretion limestone. This limestone is a typical detrital mass of small and large foraminifers with a smaller percentage of echinoid fragments, brachials and mollusks loosely held in calcite paste and the rock is somewhat more pasty at the top. Rare specimens of *Heterostegina ocalana*, *Lepidocyclina ocalana* and more abundant *Operculinoides vauhani* (noded), brachials, *Amphistegina pinarensis cosdeni* are present. The Williston member may also be seen at the localities listed below:

- 1) Locality L-33: In south side of phosphate pit in the SE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 18, T. 12 S., R. 18 E. — two pinnacles 4 feet high.
- 2) Locality L-28: Along U. S. 19 and in small sink southwest of the road in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 34, T. 12 S., R. 18 E. — 4 feet in road cut top of hill, 4 feet in sink.
- 3) Locality L-42: In sink west of timber road on section line in the NE^c NW $\frac{1}{4}$ Sec. 10, T. 13 S., R. 18 E. — 9.3 feet thick.
- 4) Locality L-64: In small sink on east bank of Lake Stafford in the NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 35, T. 13 S., R. 18 E. — 4 feet thick.
- 5) Locality L-71: A road metal pit in the SE^c Sec. 4, T. 14 S., R. 19 E. — 10.5 feet thick.

The limited outcrop in Township 11 South, Range 17 East, Plate 1, was identified by the presence at locality L-4 of a 4-foot pinnacle of the Williston member exposed in the phosphate pit in the northeast quarter, southeast quarter, Section 17, at an elevation of 65 feet, and a similar pinnacle exposed in a pit in the northwest quarter, southeast quarter, Section 21. A prospect pit 1/2-mile west of the last mentioned pit exposes a ledge of Ocala limestone.

South of Double Sink, Florida, the Williston member is exposed in numerous sinks and road metal pits. Several sinks formed late in 1949 following a period of extended rainfall in this area, and three of these located on the Spillane farm in the northeast quarter, northeast quarter, Section 22, Township 11 South, Range 15 East, expose almost the complete section of the Williston member, ranging from the transition beds at the top down 29 feet into beds more typical of the Williston member.

The following section was measured January 17, 1950, in a sink located approximately in the center of the farm.

Locality L-8	Feet
Pleistocene series	
Wicomico formation?	
7) Cream argillaceous quartz sand and soil.....	2.0
Unconformity	
Upper Eocene series	
Moodys Branch formation	
Williston member	
6) Cream, slightly pasty limestone containing <i>Operculinoides vaughani</i> (noded), <i>Heterostegina ocalana</i> , <i>Lepidocyclina ocalana</i> , rare <i>Amphistegina pinarensis cosdeni</i> , and <i>Camerina</i> sp. cf. <i>C. moodybranchensis</i> , miliolids and small foraminifers.....	8.0
5) Limestone of bed 6, specimens of <i>Lepidocyclina</i> and <i>Heterostegina</i> rare	2.8
4) Cream-colored, detrital grains of calcite, brachials, miliolids, small foraminifers and rare <i>Camerina vanderstoki</i> , <i>C.</i> sp. cf. <i>C. moodybranchensis</i> and <i>Amphistegina pinarensis cosdeni</i> loosely cemented in calcite paste. Fragments of one regular echinoid noted.....	7.2
3) Cream-colored coquina of foraminifers of bed 4 loosely held in calcite paste.....	2.7
2) Limestone and fauna of bed 4.....	1.6
1) The coquina of bed 3.....	4.7
Thickness of exposure	29.0

Other excellent exposures in the vicinity are located as follows:

- 1) Locality L-9: In road metal pit east of section road in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 23, T. 11 S., R. 15 E. — 13 feet of coquina.
- 2) Locality L-39: In sink north of section road, just west of a turn around a house, in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 23, T. 11 S., R. 15 E. — 24 feet of coquina.
- 3) Locality L-52: In a series of sinks on Ethel G. Wood's land in the SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 28, T. 11 S., R. 15 E. — 27 to 30 feet of detrital and coquina limestone, the top of which is transitional.
- 4) Locality L-137: In road metal pit on F. B. Marshburn land in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 34, T. 11 S., R. 15 E. — 3 feet of coquina covered by 10 feet of transitional limestone.

The contact of the Inglis and Williston members is exposed at locality L-20, page 128, and the contact of the Williston with the Ocala limestone is exposed in a road metal pit located in the northwest quarter, northwest quarter, Section 23, Township 11 South, Range 14 East; in a sink in the northeast corner, Section 30, Township 11 South, Range 15

East; in a solution pipe in the southeast quarter, Section 32, Township 11 South, Range 15 East; and at locality L-21, a road metal pit in the southeast quarter, southeast quarter, Section 31, Township 11 South, Range 16 East, on the C. C. Tillis' land. Each of these exposures has a definite lithology and fauna of the Williston member at the base and definite Ocala limestone (restricted) at the top. The exposure at the Tillis' pit is typical and is described as follows:

Locality L-21	Feet
Pleistocene series	
Wicomico formation?	
4) Light gray to brown, very fine quartz sand	3.0
Unconformity	
Middle Eocene series	
Ocala Limestone (restricted)	
3) White, soft, massive, miliolid, pasty limestone. Numerous specimens of <i>Camerina</i> sp., <i>Operculina</i> sp., <i>Lepidocyclina ocalana</i> , <i>Heterostegina ocalana</i> , <i>Amusium ocalanum</i> Dall, <i>Ostrea</i> sp. cf. <i>O. podagrina</i> Dall	2.8
2) A concentration of <i>Ostrea</i> sp. cf. <i>O. podagrina</i> Dall, <i>Operculinoides vaughani</i> and fossils of bed 3 loosely held in a miliolid-rich calcite paste	0.6
Moodys Branch formation	
Williston member	
1) Cream-colored, porous, miliolid limestone, more granular than beds 2 and 3 and containing <i>Amphistegina pinarensis cosdeni</i> , <i>Camerina</i> sp. cf. <i>C. moodybranchensis</i> , <i>Rotalia cushmani</i> , <i>Nonion advenum</i>	2.9
Thickness of exposure	9.3

Undoubtedly, many other sinks within the Ocala outcrop penetrate the contact but because of cover, poor preservation and water it was identified in only the exposures listed above and in a few other exposures, pages 160 to 161. The Ocala limestone is thin over the fault block extending from Chiefland northwest to Fanning Springs, since most of the pits and sinks expose the base of the Ocala limestone and the Williston member outcrops along the Suwannee River in the west edge of Townships 10 and 11 South, Range 14 East, about 6 feet of typical detrital limestone with characteristic fauna being exposed in the river banks.

The Williston member crops out in an irregular u-shaped band extending from Chiefland southwest to Sumner and northwest over a broad band that surrounds an inlier of the Inglis member. The outcrop

is extended over the western portion of Levy County on the basis of three wells, Plate 1, that penetrated the member below a thin veneer of sand. Excellent exposures are present in the outcrop as follows:

- 1) Locality L-13: In a small road metal pit, north of graded road in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 27, T. 11 S., R. 14 E. — 3.5 feet of transitional bed.
- 2) Locality L-17: In a sink east of timber road in the SE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 34, T. 11 S., R. 14 E. — 14.1 feet of detrital limestone and transition, see figure 27.
- 3) Locality L-31: See page 127.
- 4) Locality L-34: Two road metal pits in the SE $\frac{1}{4}$ Sec. 15, T. 12 S., R. 14 E. — 11 feet of detrital limestone.
- 5) Locality L-36: In a road metal pit in the NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 30, T. 12 S., R. 15 E. — 12 feet of *Camerina coquina*.
- 6) Locality L-44: In a road metal pit south of graded road in the center of Sec. 12, T. 13 S., R. 14 E., on B. J. Collier's land. — 7.3 feet of detrital and coquina limestone.
- 7) Locality L-48: Two pits in the SW $\frac{1}{4}$ Sec. 14, and SE $\frac{1}{4}$ Sec. 15, T. 13 S., R. 14 E., on opposite sides of State Road 345. — 3 to 5 feet of typical *Camerina coquina*.
- 8) Locality L-85: Small pits northwest of State Road 24 in the NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 30, T. 14 S., R. 14 E. — one foot detrital limestone.
- 9) Locality L-84: In a barrow ditch on C. C. C. road in the NW $\frac{1}{4}$ Sec. 27, T. 14 S., R. 13 E. — 10 inches of coquina.
- 10) Locality L-72: In a natural well at a hunter's camp west of the Cummer grade in the NW $\frac{1}{4}$ Sec. 9, T. 14 S., R. 13 E. — 2.8 feet of *Camerina coquina*.
- 11) Locality L-51: In a small sink southwest of a timber road in the SE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 21, T. 13 S., R. 13 E. — 3.9 feet of detrital limestone.
- 12) Locality L-38: On Fowlers Island at Smokehouse hole, a sink in the NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 33, T. 12 S., R. 13 E. — 3 feet of typical *Camerina coquina*.
- 13) Locality L-29: In a ditch at the base of a sand hill southwest of a country road in the SE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 11, T. 12 S., R. 13 E. — a pinnacle of *Camerina coquina*.

The outcrop of the Williston member extends almost due south of Sumner and forms part of a submarine limestone shelf from which two samples were taken, about 1-1/2 miles offshore, see Plate 1 for approximate locations. The bed extends along the Gulf floor into Citrus County and was penetrated by core holes W-1228 to W-1235, see figure 14, and it crops out on South Mangrove Point, sections 18 and 19, Township 16 South, Range 15 East.

The broad outcrop in southeastern Levy County, surrounding Acme Mines, is covered by sediments of the Coharie-Okefenokee Sand Ridge

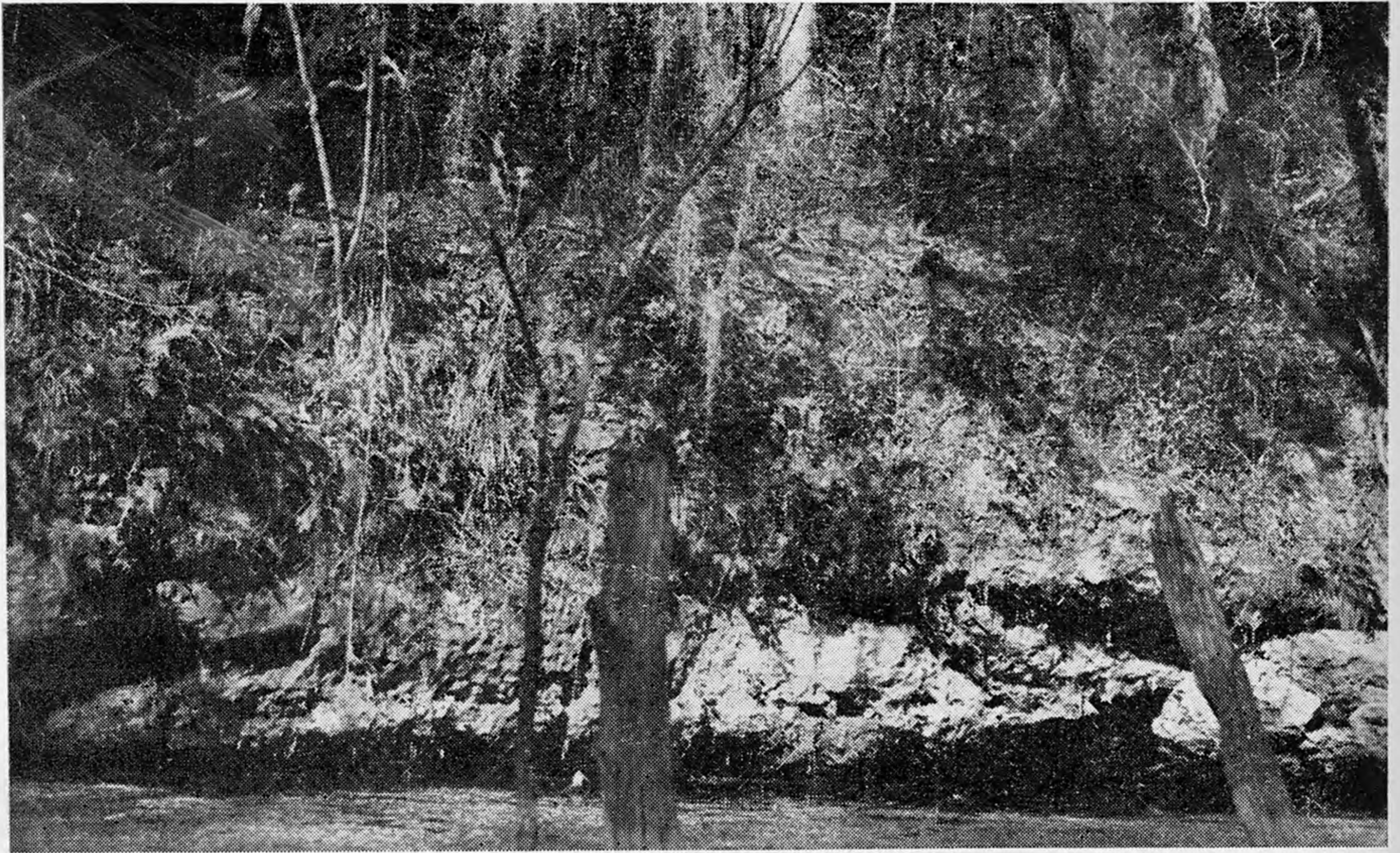


Figure 27. Exposure of the Williston member, Moodys Branch formation, at locality L-17, in the north side of a sink east of the county road in the SE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 34, T. 11 S., R. 14 E., Levy County.

and is mapped on structural projections, the presence of a few fragments of the bed in the samples of well W-214, Section 27, Township 13 South, Range 17 East, and an exposure at locality L-88 in the Acme Mines (abandoned) in the northwest quarter, Section 27, Township 14 South, Range 18 East, where pinnacles of the Williston member extend into sediments of the Alachua formation.

Detailed Geologic Exposures in Citrus County: The outcrop of the Williston member that extends south of Sumner from Levy County along the submarine shelf again rises on the land in Citrus County along Crystal River. It is folded and eroded over several small structures near the towns of Crystal River and Homosassa Springs, and extends northeast toward the outcrops in eastern Levy County, being interrupted and extended southeastward along small normal faults, see figure 14 and Plate 1.

- 1) Locality C-22: At the mouth of Crystal River, north of Shell Point, in a small island in the NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 9, T. 18 S., R. 16 E. — one foot of detrital limestone.
- 2) Locality C-40: On an island in Salt River in the SW^c SE $\frac{1}{4}$ Sec. 24, T. 18 S., R. 16 E. — 2.5 feet of detrital limestone.
- 3) Locality C-46: On an island in the north end of Dixie Bay, in the NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 25, T. 18 S., R. 16 E. — a 2-foot ledge of detrital limestone.

- 4) Locality C-67: In a road metal pit in the NW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 7, T. 19 S., R. 17 E. — pinnacles of detrital limestone.
- 5) Locality C-72: In pit at an old sugar mill in Homosassa, SE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 32, T. 19 S., R. 17 E. — 2 feet of detrital limestone.
- 6) Locality C-69: On a dirt road in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 10, T. 19 S., R. 17 E. — a 1.5-foot ledge of detrital limestone.
- 7) Locality C-79: On the land of G. A. Haxby in the NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 33, T. 18 S., R. 17 E. — 1.5 feet of detrital limestone.
- 8) Locality C-34: Pit of the Ocala Road Base Materials Company in the SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 17, T. 18 S., R. 17 E. — About 5.8 feet of the cream to white, soft, massive, granular, pasty, miliolid, detrital limestone of bed 2, Locality C-24, page 134, is exposed on the north side of the pit. Spongi-form-concretions, cup corals, *Laganum floridanum*, *L. ocalanum*, *Peronella cubae*, *P. archerensis*, *Vulsella ocalensis*, *Globulina gibba*, *Reussella eocena*, *Amhistegina pinarensis cosdeni*, *Gypsina globula*, *Camagueyia perplexa*, *Bolivinella alata* and other foraminifers are present. If dip is considered an additional thickness is exposed on the south side of the pit where the fossils above and *Lepidocyclina ocalana* and *Camerina* sp. were identified. The base of the pit may penetrate the Inglis member, but water prevented study of this section.
- 9) Locality C-27: Road metal pits on opposite sides of graded road in the SW $\frac{1}{4}$ Sec. 9, T. 18 S., R. 17 E. — 3 feet of transitional limestone.
- 10) Locality C-36: Ledges crossing dirt road in the NW $\frac{1}{4}$ Sec. 22, T. 17 S., R. 17 E. — 2 feet of transitional limestone.

The elongate outcrops of the Williston member east of the Inverness fault are based on surface elevations; geologic interpolation; the structural section, figure 14; locality C-3, pages 137-138; and locality C-4, pages 203-204.

Several good exposures of the member are present along the Withlacoochee River in northeastern Citrus County above and below Stokes Ferry (bridge on State Road 200). Two feet of detrital limestone is present in an exposure, locality C-15, on the left bank of Withlacoochee River, about three miles above Stokes Ferry in the northeast quarter, northwest quarter, Section 32, Township 17 South, Range 20 East. The following section was measured June 25, 1948, on the right bank in Marion County, about one-half mile below Stokes Ferry in the southeast quarter, Section 24, Township 17 South, Range 19 East:

Locality M-1

Feet

Upper Eocene series

Moodys Branch formation

Williston member

- 2) Cream-colored, hard, granular, cavernous, detrital, very fossiliferous limestone. Numerous *Camerina vanderstoki*, echinoid fragments, *Amhistegina pinarensis cos-*

deni, *Operculinoides vaughani* (noded), Comatulid brachials and spongiform concretions are present.....2.1

- 1) Light-gray, purple-tinted, soft, pasty, dense limestone with fossils above. Extends at least 10 feet below water...0.9

Thickness of exposure

3.0

The most southerly exposures of the Williston member are in the vicinity of Floral City in southeastern Citrus County. Well W-874 located at Floral City penetrated the member below 40 feet of Pleistocene(?) sand and 25 feet of sediments of the Alachua formation. The better exposures are listed below:

- 1) Locality C-92: Abandoned phosphate pit in the SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 9, T. 20 S., R. 20 E. — pinnacles up to 3 feet high of *Camerina coquina* in base of pit.
- 2) Locality C-99: In abandoned phosphate pit in the NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 16, T. 20 S., R. 20 E. — pinnacles, the highest being 27.3 feet above water level and an estimated 40.0 feet above the base of the quarry, of detrital limestone, showing phosphatic replacement along vertical and horizontal fractures, see figure 28.



Figure 28. Pinnacles of limestone of the Williston member extending up to 40 feet above the quarry floor through the Alachua formation. Locality C-99, an abandoned phosphate pit in the NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 16. T. 20 S., R. 20 E.

TABLE 11.—Formations, Avon Park limestone and younger, penetrated by wells in Citrus and Levy counties, Florida. Tops referred to sea level to nearest foot. Coreholes along the proposed "Ship Canal," locations shown on Plate 1 and geologic sections on Figure 14, are excluded.

CITRUS COUNTY								
Well Number	Location	Ground Elevation	F O R M A T I O N S					
			Pleistocene	Alachua formation	Ocala limestone	Moody's Branch formation		Avon Park limestone
						Williston member	Inglis member	
W-720	NW 1/4 SW 1/4, Sec. 6, T 19 S, R 18 E....	170.04	170.0	130.0	90.0	0.0	—30.0	—90.0
W-874	SE 1/4 NW 1/4, Sec. 15, T 20 S, R 20 E....	63.59	64.0	24.0	Abs.	Abs.	— 1.0	—36.0
W-1763	SE 1/4 SW 1/4 Sec. 22, T 19 S, R 17 E.....	4.61	Abs.	Abs.	Abs.	Abs.	5.0	—35.0
W-1767	NW 1/4 NW 1/4 Sec. 4, T 18 S, R 18 E....	113.55	114.0	54.0	Abs.	44.0	29.0	—21.0
W-1791	NE ^c Sec. 32, T 17 S, R 18 E.	107.95	108.0	18.0	Abs.	Abs.	Abs.	—12.0
W-1847	SW 1/4 SW 1/4 Sec. 1, T 17 S, R 17 E.....	29.61	30.0	0.0	Abs.	Abs.	Abs.	—10.0
W-1848	SE 1/4 SW 1/4 Sec. 11, T 17 S, R 17 E.....	41.65	42.0	22.0	Abs.	Abs.	15.0	2.0(?)
LEVY COUNTY								
W-166	NE 1/4 NW 1/4 Sec. 16, T 15 S, R 13 E....	17.8	← No Samples →				In at	—122.0
W-170	SW 1/4 NW 1/4 Sec. 30, T 12 S, R 19 E....	83.9	84.0	Abs.	64.0	34.0	4.0	.....
W-171	SE 1/4 SW 1/4 Sec. 35, T 12 S, R 18 E....	73.63	74.0	Abs.	44.0	34.0	4.0	.....
W-172	SW 1/4 NE 1/4 Sec. 8, T 13 S, R 18 E....	89.5	90.0	Abs.	Abs.	45.0	10.0	.....
W-211	NW 1/4 SW 1/4 Sec. 31, T 13 S, R 17 E....	39.77	40.0	Abs.	Abs.	Abs.	15.0	.....
W-212	SE 1/4 NE 1/4 Sec. 20, T 14 S, R 16 E....	11.9	12.0	Abs.	Abs.	Abs.	7.0	.....
W-214	NE 1/4 NW 1/4 Sec. 27, T 13 S, R 17 E....	72.5	Abs.	73.0 to	.....	(?)	.....	.....
W-330	SW 1/4 SE 1/4 Sec. 29, T 14 S, R 16 E....	29.73	30.0	Abs.	Abs.	Abs.	27.0	15.0

TABLE 11.—Continued.
LEVY COUNTY

Well Number	Location	Ground Elevation	F O R M A T I O N S					
			Pleistocene	Alachua formation	Ocala limestone	Moody's Branch formation		Avon Park limestone
						Williston member	Inglis member	
W-331	NW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 1, T 15 S, R 15 E.....	22.93	23.0	Abs.	Abs.	Abs.	20.0	3.0
W-333	NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 28, T 14 S, R 16 E....	28.6	29.0	Abs.	Abs.	Abs.	Abs.	27.0
W-355	SE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 16, T 15 S, R 13 E....	8.9	←	— No Samples —		→	—31.0	—81.0
W-379	SE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 20, T 14 S, R 16 E....	27.75	28.0	Abs.	Abs.	Abs.	18.0	— 7.0
W-380*	SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 8, T 14 S, R 16 E....	33.02	33.0	Abs.	Abs.	Abs.	25.0	23.0
W-501	NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 20, T 14 S, R 16 E....	17.5	18.0	Abs.	Abs.	Abs.	Abs.	3.0
W-511	SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 15, T 14 S, R 17 E....	65.7	←	No Samples		→	—11.0 to —61.0?	above —111.0
W-652	NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 11, T 13 S, R 18 E....	69.5	Abs.	Abs.	in at 68.0	35.0	5.0	.....
W-653	SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 11, T 13 S, R 18 E....	69.7	Abs.	Abs.	in at 68.0	20.0	— 10.0	.....
W-664	NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 5, T 14 S, R 15 E....	19.5	Abs.	Abs.	Abs.	Abs.	20.0	.....
W-814	NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 16, T 15 S, R 13 E....	8.7	9.0	Abs.	—16.0	—41.0	—76.0	—126.0
W-866	NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 26, T 13 S, R 15 E....	27.8	28.0	Abs.	Abs.	Abs.	0.0	—46.0
W-871	SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 15, T 13 S, R 16 E....	34.1	34.0	Abs.	Abs.	Abs.	28.0	— 6.0
W-1007	NW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 31, T 14 S, R 17 E....	28.8	29.0	Abs.	Abs.	Abs.	—16.0	—46.0
W-1093	NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 29, T 10 S, R 14 E....	10.5	Abs.	Abs.	11.0	0.0	—30.0 Est.	.....
W-1094	NW ^c Sec. 7, T 13 S, R 13 E.....	3.7	4.0	Abs.	Abs.	—19.0	—39.0	.....
W-1095	NW ^c Sec. 33, T 13 S, R 12 E.....	0.9	1.0	Abs.	Abs.	—24.0	.....	.....
W-1240	Cen. Sec. 14, T 17 S, R 15 E.....	2.0	2.0	Abs.	Abs.	Abs.	— 1.0	.....
W-1241	NW ^c Sec. 21, T 15 S, R 15 E.....	4.5	5.0	Abs.	Abs.	Abs.	0.0	.....
W-1242	Cen. Sec. 22, T 15 S, R 14 E.....	2.0	2.0	Abs.	Abs.	Abs.	— 1.0	.....

TABLE 11.—Continued.
LEVY COUNTY

Well Number	Location	Ground Elevation	FORMATIONS					
			Pleistocene	Alachua formation	Ocala limestone	Moody's Branch formation		Avon Park limestone
						Williston member	Inglis member	
W-1243	SEC Sec. 17, T 15 S, R 13 E.....	4.0	4.0	Abs.	—5.0	.....	.....	.....
W-1244*	SE ¼ Sec. 2, T 15 S, R 12 E.....	3.5	4.0	Abs.	—3.0	.....	.....	.....
W-1245	NW ¼ NE ¼ Sec. 14, T 14 S, R 12 E....	4.0	4.0	Abs.	Abs.	—6.0	.....	.....
W-1449	SE ¼ Sec. 16, T 13 S, R 16 E.....	34.1±	34.0	Abs.	Abs.	Abs.	10.0	— 2.0
W-1537	SE ¼ SW ¼ Sec. 16, T 15 S, R 13 E.....	5.0	5.0	Abs.	—15.0	—65.0	—95.0	—145.0
								Est.
W-1564	NE ¼ SW ¼ Sec. 28, T 11 S, R 14 E....	30.1	←		No Samples		→	—112.0
W-1633	NW ¼ NE ¼ Sec. 31, T 12 S, R 18 E....	100.37	100.0	50.0	Abs.	40.0	20.0	.....
W-1699	NW ¼ NE ¼ Sec. 6, T 13 S, R 19 E.....	71.22	Abs.	Abs.	71.0	16.0	— 7.0	—49.0
W-1841	NW ¼ SW ¼ Sec. 25, T 15 S, R 17 E....	81.0±	81.0	—59.0	Abs.	Abs.	Abs.	—169.0
W-1843	SE ¼ SE ¼ Sec. 24, T 13 S, R 15 E.....	25.19	25.0	Abs.	Abs.	Abs.	Abs.	10.0
W-1844	SW ¼ SE ¼ Sec. 24, T 12 S, R 14 E.....	31.47	Abs.	Abs.	Abs.	31.0	1.0	—59.0
W-1845	SW ¼ SW ¼ Sec. 22, T 13 S, R 13 E....	10.0±	Abs.	Abs.	Abs.	Abs.	10.0	—26.0
W-1846	SW ¼ NE ¼ Sec. 23, T 13 , R 13 E....	10.0±	Abs.	Abs.	10.0	—30.0	—60.0	—110.0
W-1849	SW ¼ NW ¼ Sec. 4, T 14 S, R 15 E.....	20.38	Abs.	Abs.	Abs.	Abs.	20.0	— 7.0
W-1850	NW ¼ NE ¼ Sec. 34, T 13 S, R 15 E....	26.06	26.0	Abs.	Abs.	Abs.	— 4.0	—13.0
W-1870	NW ¼ NW ¼ Sec. 17, T 12 S, R 17 E....	67.37	Abs.	67.0	42.0	.....	.....	.....
W-2009	NE ¼ SW ¼ Sec. 25, T 13 S, R 15 E.....	25.95	26.0	Abs.	Abs.	Abs.	Abs.	—14.0
W-2010	NE ¼ NW ¼ Sec. 5, T 14 S, R 16 E.....	17.0±	17.0	Abs.	Abs.	Abs.	Abs.	7.0
W-2012	NE ¼ NE ¼ Sec. 19, T 16 S, R 17 E.....	58.0±	←		No Samples		→	in at
								—67.0
W-2135	NE ¼ NE ¼ Sec. 36, T 11 S, R 14 E....	45.0±	Abs.	Abs.	45.0	30.0	0.0	.....
W-2166	NW ¼ SE ¼ Sec. 34, T 13 S, R 16 E....	18.0±	←		No Samples		→	in at
								—57.0

* Not plotted on Plate 1.

OCALA LIMESTONE (restricted)

Introduction and Definition: If a complete bibliography of the Ocala limestone were compiled it would include several hundred references dealing with rocks of this age. The history of the name and the major publications covering the formation have been summarized by Vernon (1942, pp. 40-41) and Cooke (1945, p. 53), and the term is fully understood and requires no further discussion except that the Ocala limestone has been restricted in this paper by the separation of a thickness of about 80 feet from the base, which is the Moodys Branch formation.

The type locality is at Ocala, Marion County, where the formation is well-exposed in numerous pits dug for road base material, and is a massive coquina composed of specimens of miliolids, other small foraminifers and numerous large foraminifers, principally *Lepidocyclina* and *Camerina*, set in a pasty calcite matrix. Wells at Ocala indicate that the limestone of the type locality lies on the Moodys Branch formation at shallow depths and only the base of the Ocala limestone is represented in the type section. The well data for Ocala and vicinity is tabulated as follows:

TABLE 12

<i>Florida Geological Survey Well Number</i>	<i>Elevation of top of Ocala limestone</i>	<i>Elevation of top of Moodys Branch fm.</i>	<i>Location, nearest town</i>
W-1975.....	+112	+12	Fellowship
W-742.....	Absent	+38	Reddick
W-891.....	+83	+18	Reddick
W-892.....	+92	+17	Reddick
W-1766.....	Absent	+ 7	Reddick
W-1965.....	Absent	+57	Anthony
W-1967.....	Absent	+55	Silver Springs
W-888.....	-14	-44	Ocala
W-1934.....	+102	+25	Ocala

The series of core holes, figure 14, crossing southern Marion County, penetrated a thin veneer of the Ocala limestone (restricted) lying upon the Moodys Branch formation, the top of which has elevations of plus 38 feet and above. No exposures of the Moodys Branch formation have been found in the pits at Ocala, but the base of the deeper ones should lie close to the top of the formation.

The term Ocala limestone is restricted in this report to include the marine limestones of peninsular Florida of upper Jackson age that contain a high percentage of specimens of the larger foraminifers, *Lepidocyclina*, *Heterostegina*, and various camerinids, as developed in Polk and

adjacent counties in well penetrations. The base of this interval is exposed at the type locality, Ocala, Florida.

Physiography and Outcrop Pattern: The Ocala limestone forms broad, rolling plains upon which a karst topography is well-developed. Caverns and solution pipes are quite common within the outcrop. The formation covers limited outcrops in southwestern, northwestern, northern and eastern Levy County, and most of western and central Citrus County, see Plate 1. In general the formation forms a broad band that circles the outcrop of the Williston member, and extends along the submarine shelf, being penetrated by the core holes along the northwestern Citrus County coast as shown in figure 14. The normal outcrop pattern circling older beds is interrupted by breached shallow structures and small normal faults, in particular the formation being preserved along the Bronson graben in northeastern Levy County, a shallow basin in western Levy County and a shallow basin in the vicinity of Crystal River, Citrus County.

General Lithology: The formation is known from many hundreds of well samples as well as from a broad outcrop area. It is typically a white to cream, soft, very massive, friable coquina composed of the remains of large foraminifers set in a pasty calcite matrix. Fossil concentrations sometimes provide some bedding, oysters in particular providing definite horizons that are useful in mapping. Thin beds of pasty, miliolid limestone containing relatively few specimens of the large foraminifers occur irregularly throughout the formation and the base is a transitional bed of very porous, soft, pasty limestone containing nodular and spongi-form concretions and numerous detrital grains of calcite, echinoid plates, miliolids, and rare large foraminifers. It grades down into the Williston member of the Moodys Branch formation, which is separated on the basis of fauna and a more granular texture. This basal transition bed of the Ocala limestone is well represented in the canal core holes, figure 14, where *Rotalia cushmani*, *Gypsina* sp. and miliolids are common. The Williston member was penetrated in these core holes in wells W-1228 to W-1235 inclusive and the gradual change to limestone more typical of the Ocala limestone is illustrated in samples from core holes W-1234 to W-1239.

In Polk County, where the thickest section of the Ocala in northern peninsular Florida is penetrated by water wells, the top is marked by a worm case, *Spirolaea vernoni* Richards and *Gypsina* sp. The base is commonly marked by abundant specimens of *Camerina moodybranchensis* Gravell and Hanna which range downward into the Williston member of the Moodys Branch formation.

Thickness: The Ocala limestone in peninsular Florida is the erosional remnant of sediments deposited during the upper Jackson epoch, the bed having been extensively eroded during three separate periods: Prior to the deposition of the Suwannee limestone; prior to the deposition of the Hawthorn formation; and throughout the time interval extending from the Miocene into the Recent in some areas. The top of the formation, as penetrated in wells, is highly irregular and the thickness is variable. In general the formation is thickest along the plunge of the crest of the Ocala uplift, and has been thinned or reworked from the flanks and apex of the folds, see figure 13. This thinning along the flanks indicates late structural movements, probably lower Miocene in age.

In well penetrations available for most of the counties of the northern and central Peninsula, the Ocala limestone (restricted) is thin to absent in Brevard, Columbia, Dixie, Gilchrist, Lake, Marion, Orange, Osceola, Putnam, St. Johns, Seminole, Sumter, Taylor and Volusia; about 100 feet thick in Baker, Clay, Hernando and Madison; variable up to 150 feet in Alachua, Hillsborough, Pasco and Pinellas; variable up to 250 feet in Bradford; 100 to 285 feet in Duval, Hamilton and Nassau; and absent to 300 feet thick but normally between 100 and 200 feet in Polk County. The thickest section was present in well W-632, located at the Army Airport, Lakeland, Polk County.

In Citrus and Levy counties the Ocala limestone is absent over much of the area and wells within the outcrop penetrate a thickness ranging from less than ten feet along the core holes, figure 14, to a maximum of 129 feet in well W-1870, located at Bronson, Levy County, which bottomed in the Ocala at a depth of 154 feet.

The thickest exposure of the Ocala limestone is present at locality C-64, Crystal River Rock Company quarry in the southwest quarter, Section 6, Township 19 South, Range 18 East, where a minimum of 107.9 feet of the bed is exposed. Well W-720, located on the back side of the quarry, penetrated an additional 17 feet of the limestone before entering the Moodys Branch formation at sea level, indicating a total thickness of 124.9 feet for the Ocala limestone, an interval extending from the base of the Suwannee limestone to the top of the Moodys Branch formation.

Fauna and Age: The most abundant and prominent of the Ocala fauna in Citrus and Levy counties are numerous specimens of *Lepidocyclina ocalana* Cushman and varieties, *Camerina jacksonensis* Gravel and Hanna, *C. vanderstoki* (Rutten and Vermunt), *C. moodybranchensis* Gravel and Hanna, *Operculinoides vaughani* (Cushman), *O. willcoxii* (Heil-

prin), *Heterostegina ocalana* Cushman. Combined with these large foraminifers are numerous small foraminifers, the most abundant of which are various miliolids. These fossils have been adequately described in papers published by Cushman (1917, 1920, 1921, 1935, 1945, 1946) Gravell and Hanna (1935, 1938) Vaughan (1928, 1933) and Applin and Jordan (1945).

The most prominent mollusks noted in Citrus and Levy counties are *Amusium ocalanum* Dall which are most prolific in some exposures, *Pecten ocalanus* Dall, *P. suwanneensis* Dall, *P. sp. cf. P. "perplanus"* Morton and *Ostrea podagrina* Dall. Other mollusks are preserved as molds and have been identified only as to genus. Dall (1890-1903), in a series of papers, described over 30 species of macrofossils from the type locality, but few of these were specifically identified in these counties.

Echinoids and bryozoa are abundant in some exposures. The Ocala bryozoan fauna was described by Canu and Bassler (1920) and the echinoids by Cooke (1941, 1942). Fischer²² revised the distribution of the echinoids and recorded 22 species in the Ocala limestone (restricted) of which *Fibularia vauhani* (Twitchell), *Laganum floridanum* Twitchell, *L. ocalanum* Cooke, *Peronella crustuloides* (Morton), *P. cubae* Weisbord, *P. archerensis* (Twitchell) and *Agassizia floridana* de Loriol are most common.

Unfortunately, the descriptions of most of the fossils of the Ocala limestone (restricted) were included with those that are now known to be characteristic of the Moodys Branch formation and considerable work on type localities and the segregation of the fossils in each formation remains to be done. Complete check lists of the fauna of the Jackson group cannot be completed until detailed stratigraphic studies in Marion County have been completed and fossil types have been checked with these studies.

Cooke (1915) correlated the Ocala limestone with the Jackson formation of Alabama and Mississippi, both formations being the equivalent of the entire Jackson group. The term Ocala limestone is now restricted to the upper Jackson in southern Alabama (MacNeil, 1947) and the base of the Jackson group is the Moodys Branch formation. In this study the Ocala limestone as originally defined is restricted by the separation of about 80 feet of distinctive limestone from the base, to which the name Moodys Branch formation is applied. As thus restricted, the Ocala limestone is upper Jackson age.

²²Manuscript for Florida Geological Survey Bull. 34.

Stratigraphic Relations: The Ocala limestone (restricted) lies conformably upon the Williston member of the Moodys Branch formation and unconformably beneath sediments ranging in age from Recent to Oligocene. In these counties the contact with the Suwannee limestone of Oligocene age is marked by a thin green clay, the thinning of the Ocala limestone, and by an irregular surface.

Detailed Geologic Exposures in Levy County: The Ocala limestone was penetrated by a series of wells in Section 16, Township 15 South, Range 13 East, beneath a thin veneer of sand of the Pamlico formation, and three feet of the limestone is exposed at locality L-95, a barrow pit, northwest of the State Road 24 in the southwest quarter, northwest quarter, Section 2, of the same Township and Range.

The formation is preserved in a shallow basin on the upthrown block of the Long Pond fault in western Levy County and exposures are numerous in sinks, road cuts and road metal pits. The following exposures are distributed throughout this outcrop and can be located easily:

- 1) Locality L-46: Road metal pit on section line, Secs. 4 and 5, T. 14 S., R. 14 E. — one foot of basal Ocala limestone.
- 2) Locality L-58: In barrow pits on both sides of State Road 345 in the SE $\frac{1}{4}$ Sec. 28, T. 13 S., R. 14 E. — 2 feet of basal Ocala limestone.
- 3) Locality L-43: Sink and pit in the SW^c Sec. 11, T. 13 S., R. 14 E. — 3.8 feet of transitional Ocala limestone.
- 4) Locality L-41: "Rock Hole" in the SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 1, T. 13 S., R. 14 E. — 5.75 feet above and 3 feet below water level — basal Ocala limestone.
- 5) Locality L-35: A small outlier in two road metal pits on opposite sides of the graded road in the S $\frac{1}{2}$ NE $\frac{1}{4}$ Sec. 24, T. 12 S., R. 14 E. — 8 feet basal Ocala limestone.
- 6) Locality L-24: Road metal pit south of graded road in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 19, T. 12 S., R. 14 E. — 9.75 feet of typical Ocala limestone.
- 7) Locality L-22: In Willow Sink in the SE $\frac{1}{4}$ Sec. 34, T. 11 S., R. 14 E. — Sink 30-40 feet deep — 5.75 feet typical Ocala limestone above water level.
- 8) Locality L-10: At Manatee Spring in the SW^c Sec. 25, T. 11 S., R. 13 E. — 7 feet typical Ocala limestone.

The transitional contact of the Williston member of the Moodys Branch formation with the Ocala limestone (restricted) is exposed in western Levy County at the following locations, which are in addition to those listed on pages 147 to 148: Large sink in the northwest quarter southwest quarter Section 31, Township 12 South, Range 15 East—basal 4 feet of 8 exposed is Williston. Pit in the southwest quarter northwest quarter Section 19, Township 12 South, Range 14 East—basal foot of 3 exposed is Williston. In road metal pit on State Road 345 in the northwest

corner of Section 11, Township 12 South, Range 14 East—base questionably Williston. Pit in the southwest quarter northwest quarter Section 27, Township 11 South, Range 14 East—upper few inches typical Ocala limestone (restricted).

In the Chiefland-Double Sink area, located on the downthrown block of the Long Pond fault, the Ocala limestone crops out throughout a broad plain that is extensively farmed, and the outcrop pattern is sharply separated by the fault from that developed to the southwest—see figure 5. Exposures of the basal part of the formation are common and an excellent one is present at locality L-1, Fanning Springs in the northwest quarter Section 29, Township 10 South, Range 14 East, where 22 feet of Ocala limestone is exposed in the main spring and 17.2 feet in a road metal pit 200 yards southwest. The basal four feet is a pasty detrital limestone composed of miliolids and other small foraminifers with rare specimens of *Lepidocyclina*, *Heterostegina* and *Camerina*. There is a gradual increase in the percentage of larger foraminifers from the base to the top of the exposure that culminate in a coquina of foraminifers at the top. The lower few feet of the exposure are typical of the basal Ocala limestone (restricted) and the Williston member of the Moodys Branch formation is probably exposed along the base of the spring and in the spring run.

A list of some other localities in the Chiefland-Double Sink area follows:

- 1) Locality L-2: Road metal pit in the SW^c Sec. 28, T. 10 S., R. 14 E. — 11.1 feet of typical Ocala limestone.
- 2) Locality L-3: In deep sink on graded road in the SE^c NE $\frac{1}{4}$ Sec. 5, T. 11 S., R. 14 E. — 15.3 feet of typical Ocala limestone.
- 3) Locality L-14: Road metal pit north of graded road in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 26, T. 11 S., R. 14 S. — 9-1 feet of typical nodular Ocala limestone.
- 4) Locality L-7: In road metal pit in SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 23, T. 11 S., R. 14 E. — 13.25 feet of typical Ocala foraminiferal coquina.
- 5) Locality L-11: Road metal pit north of timber road in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 32, T. 10 S., R. 15 E. — 13.2 feet of nodular Ocala limestone.
- 6) Locality L-15: Sink south of graded road in the NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 36, T. 11 S., R. 15 E. — 8 feet of basal Ocala limestone.
- 7) See also locality L-21, page 148.

A long outcrop of the Ocala limestone is mapped diagonally across eastern Levy County, extending northwest and southeast, and is believed to be a small graben named the Bronson graben. Evidence for this structure is present at Bronson, where well W-1870 was bottomed in the Ocala limestone at a depth of 154 feet whereas wells to the west pene-

trate only the Inglis member of the Moodys Branch formation, and structure sections indicate that this member is present almost to Bronson. To the north 5 to 8 feet of typical coquina of the Ocala limestone is exposed in a number of sinks located in the southeast quarter Section 18, and the northwest quarter northeast quarter Section 19, Township 16 South, Range 16 East, see Plate 1. The Williston member is exposed in sinks to the west.

The graben is obscured by a thin veneer of the Alachua formation at its northwest and southeast ends, and over the center the Coharie-Okefenokee Sand Ridge covers it. However, the Ocala is exposed in the graben at locality L-83, a road cut on U. S. Highways 19 and 41 in the southeast quarter Section 19, Township 14 South, Range 19 East, although the Williston member is exposed over a wide area to the northeast and at Acme Mines to the southwest. The limited evidence supports the structure as mapped.

The outcrop in the vicinity of Meredith is covered by early Pleistocene sands and sediments of the Alachua formation, from which phosphate was mined in the past. The abandoned phosphate pits, see Plate 1, expose pinnacles of Ocala limestone in place and boulders are common in the overburden waste. One pit, easily reached, is located in the southwest quarter Section 34, Township 11 South, Range 17 East and contains a 4-foot pinnacle of the basal Ocala limestone (restricted), that extends into the phosphate clays and phosphate ore of the Alachua formation. Four feet of typical Ocala limestone was also penetrated by a prospect pit located just west of the abandoned phosphate pit in the northwest quarter southeast quarter Section 21, Township 11 South, Range 17 East, in which pinnacles of the Williston member are present.

The broad outcrop of the limestones of Jackson age in the vicinity of Williston is the second largest center of the road base materials industry in the State, Marion County being first, and large tonnages are shipped from Williston where numerous pits are and have been operated to maintain production. These pits provide excellent exposures of limestone of Jackson age, and in particular of the Ocala limestone which is the best road base material. Exposures in sinks, and road cuts are shown by exposure symbols (+) on Plate 1, and a tabulation of some of the pits is presented in Table 13.

The Ocala limestone as exposed in these pits is a massive, very soft, friable coquina of specimens of *Lepidocyclina*, camerinids, *Heterostegina*, numerous *Amusium ocalanum*, *Pecten ocalanus*, *Pecten* sp., and scatter-

TABLE 13.—Ocala limestone exposed in limestone pits in the vicinity of Williston, Florida

Location	Overburden (in feet)	Thickness of Ocala (in feet)
Township 12 South, Range 18 East		
NE ¼ SE ¼ Sec. 13.....	1 to 5	17 to water
NE ¼ NE ¼ Upper Sec. 24.....	1 to 2	7
SEC lower Sec. 24, at Gunnels.....	0 to 3	30
NE ¼ SW ¼ Sec. 25.....	2 to 4	18 to water
NEC Sec. 35, see figure 29	1 to 2	23 to water
Township 12 South, Range 19 East		
SE ¼ SW ¼ Sec. 19.....	1 to 3	35
NE ¼ NW ¼ Sec. 30.....	1 to 5	30
Township 13 South, Range 18 East		
SE ¼ NE ¼ Sec. 12.....	1 to 3	27
Township 13 South, Range 19 East		
NWC Sec. 4.....	1 to 3	22

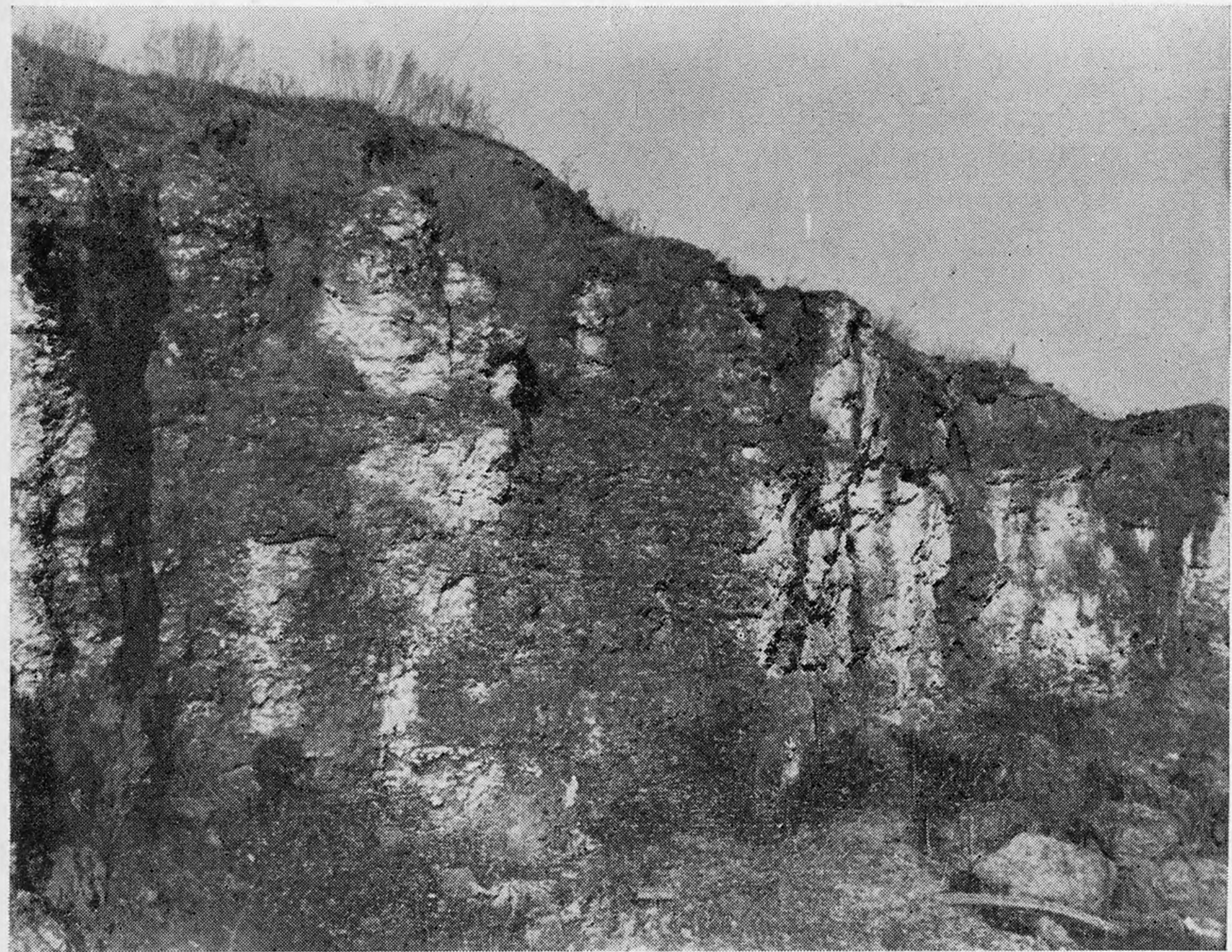


Figure 29. Twenty-three feet of Ocala limestone (restricted) exposed in the face of the Connell Shultz pit in the NE^c Sec. 35, T. 12 S., R. 18 E., Levy County.

ed echinoids and other mollusks set in a pasty to granular miliolid matrix. A pit, being operated currently by Connell and Shultz, in the northwest quarter southeast quarter Section 31, Township 12 South, Range 19 East, locality L-47, is the highest quarry in the county, see figure 38. The limestone exposed in this thick section is typical of the Ocala limestone (restricted) and has been studied in some detail. A total of 45 feet of white, soft, friable, porous coquina made up of large numbers of specimens of *Lepidocyclina ocalana*, *Heterostegina ocalana*, *Operculinoides vaughani*, *O. Willcoxii*, *O. ocalanus*, *Camerina* sp., *Amusium ocalanum*, *Pecten* sp. cf. *P. "perplanus"*, *Pecten suwanneensis*, *Oligopygus haldemani*, *Fibularia vaughani*, *Laganum floridanum*, *Peronella archerensis*, *Eupatagus ocalanus* and bryozoa in a pasty, miliolid, calcite matrix. Almost no bedding, other than fossil concentrations, is present and the whole section is cut by solution pipes filled by Pleistocene to Recent red sandy clay.

Detailed Geologic Exposures in Citrus County: The Ocala limestone underlies central and southern Citrus County which is covered irregularly by the Suwannee limestone, the Alachua formation and clastics of the Pleistocene epoch. A thin section of the formation is preserved in a shallow basin at the town of Crystal River, and the springs that combine to form the river rise from this limestone. A number of samples were collected from ledges beneath the water and along the banks, the following localities being typical:

- 1) Locality C-49: At the J. T. Staley docks in the SE^c NW $\frac{1}{4}$ Sec. 28, T. 18 S., R. 17 E. — ledges of cream to white, soft, porous, granular to pasty limestone with specimens of *Lepidocyclina* crop out four feet below water level.
- 2) Locality C-44: In Spring run 100 feet south of concrete pier, NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 21, T. 18 S., R. 17 E. — ledges of limestone as locality C-49 but with more specimens of fossils, crop out five feet below water level.
- 3) Locality C-41: Series of pinnacles in ditch along dirt road in NE $\frac{1}{4}$ Sec. 19, T. 18 S., R. 17 E. — 1.5 feet of hard, cream-colored, miliolid limestone, more laminated than massive and containing specimens of *Lepidocyclina*, *Heterostegina*, *Camerina* and small foraminifers of the basal Ocala limestone (restricted) in some abundance.

Limestone assigned to the Ocala and ranging from a typical coquina of large foraminifers, mollusks and echinoids to a more granular and pasty matrix containing only a few specimens of larger foraminifers, is present along the coast from Crystal River south to Chassahowitzka River and east to Homosassa Springs. Exposures are almost continuous along Salt River, a tidal stream paralleling the coast, and along all the coastal streams. The following localities are typical:

- 1) Locality C-52: In "The Narrows" on Salt River, S $\frac{1}{2}$ Sec. 36, T. 18 S., R. 16 E. — 3 feet of pasty limestone with specimens of *Lepidocyclina*.
- 2) Locality C-73: On the left bank of St. Martins River in the NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 15, T. 19 S., R. 16 E. — 1.6 feet of soft, cream-colored limestone with specimens of *Lepidocyclina*.
- 3) Locality C-75: On the right bank at the mouth of St. Martins River back of peninsula in sump pond — 2 feet of limestone of locality C-73, exposed at low tide.
- 4) Locality C-78: Two small pits on dirt road in the NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 15, T. 19 S., R. 17 E. — 3 feet of limestone of locality C-73.
- 5) Locality C-84: Shallow pit and fissure on east side of U. S. 19 in the SE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 22, T. 19 S., R. 17 E. — 4.8 feet of white to cream, fairly soft, pasty, miliolid limestone containing *Lepidocyclina ocalana*, *Heterostegina ocalana*, *Gypsina* sp., *Nonion advenum*, *Rotalia cushmani*, *Camerina* sp., *Operculinoides vauhani*, Comatulid brachials and echinoid fragments.
- 6) Locality C-86: Exposed in railroad cut of abandoned Atlantic Coast Line Railroad and also along the graded road running west, NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 28, T. 19 S., R. 17 E. — 1.5 feet of limestone of locality C-84.
- 7) Locality C-105: Chassahowitzka Springs in the NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 25, T. 20 S., R. 17 E. — pinnacles of pasty coquina limestone exposed about the springhead.

Inland, a thick cover of Pleistocene sands and sediments of the Alachua formation make exposures less common than along the coast but two excellent exposures are present as follows:

- 1) Locality C-37: A rock pit on John Newell's land in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 15, T. 18 S., R. 18 E. — 17 feet of typical coquina limestone with specimens of camerinids, *Lepidocyclina*, *Pecten* and *Amusium* being common.
- 2) Locality C-57: Series of sinks and caves on H. E. Maynard's place in the E $\frac{1}{2}$ NE $\frac{1}{4}$ Sec. 32, T. 18 S., R. 18 E. In one room in the the largest sink — 45 feet of limestone is exposed. The upper 35 feet is a coquina with *Lepidocyclina* and *Amusium ocalanum* being prominent. The lower 10 feet is cream, dense, pasty and granular limestone with few specimens of *Lepidocyclina* and abundant *Operculinoides vauhani* and *Camerina* sp.

One of the better known exposures in Florida is located in the northwest quarter southwest quarter Section 6, Township 19 South, Range 18 East, at the Crystal River Rock Company quarry. This is the thickest rock exposure in the State and almost the entire thickness of the Ocala limestone is penetrated by the quarry. The contact of the Ocala limestone is exposed here along a long section, see figures 30 and 31. The complete section, from the highest pinnacle of rock on the rim to the base of the quarry, is 131.25 feet. The following section was measured July 14, 1948, on the east side of the quarry.

Locality C-64

Feet

Oligocene series

Suwannee limestone

- 13) A cream-colored, porous, firmly cemented, detrital limestone composed of echinoid plates and spines, poorly preserved foraminifers and granular calcite. *Chlamys brooksvillensis*, *Chione* sp., *Clypeaster rogersi*, *Cassidulus gouldii*, *Kuphus incrassatus*, and numerous specimens of *Dictyoconus cookei*, *Coskinolina floridana* are present. The bed measured 9 feet from the top of the highest pinnacle east of the quarry to the rim and an additional 8 feet is exposed in the quarry face.....17.0
- 12) Cream to tan, hard, crystalline, nodular, very porous limestone with seams of the limestone of bed 13 and containing many poorly preserved mollusk molds, including *Chione* sp. cf. *C. bainbridgensis*, *Turritella martinensis*, *T. vicksburgensis*²³ and rare specimens of *Cassidulus gouldii* and *Lepidocyclina* sp.....1.6
- 11) White to light-gray, dense, thin-bedded, pasty to cryptocrystalline limestone containing rather numerous molds of *Turritella martinensis* and *T. vicksburgensis*. Weathered surfaces appear brecciated.....2.0
- 10) Layer of light-gray to cream-colored, weathered brown, cryptocrystalline, sub-lithographic, hard, dense, thin-bedded limestone with an occasional seam of light-green, waxy marl.....0.3
- 9) Light-gray, dense, thin-bedded, hard, lithographic limestone with rare molds of *Turritella*1.65
- 8) Brown to light-gray, dense, hard, cryptocrystalline limestone with porous detrital limestone seams.....1.0
- 7) Light greenish-gray clay with fibrous, crystalline, light greenish-gray calcite growths lying along a very irregular surface developed upon bed 6, see figures 30 to 31.....0.5
(variable)

Unconformity

Upper Eocene series

Ocala Limestone (restricted) Elevation: 124.65 feet

- 6) Cream-colored, detrital, porous, firmly cemented limestone with seams of dense, crystalline limestone and numerous poorly preserved molds of mollusks and rare specimens of *Gypsina* sp. cf. *G. globula*. The upper few inches are very indurated and the top of the limestone is very irregular.....1.9
- 5) Cream to white, massive, bedded, pasty, soft coquina composed of mollusks, bryozoa, corals and large fora-

²³Comparisons made with molds identified by Mr. F. Stearns MacNeil, December 5, 1947, on the Southeastern Geological Society's Fifth Field Trip.

minifers in a pasty calcite matrix. Specimens of <i>Cam- erina vanderstoki</i> are common in the lower 25 feet, but decrease upward and are replaced by <i>Operculinoides ocalana</i> . <i>Turritella</i> sp., <i>Pecten</i> sp., corals, <i>Lepidocyclina ocalana</i> , <i>Gypsina globula</i> , <i>Eponides jacksonensis</i> , <i>Gau- dryina jacksonensis</i> were identified ²⁴	43.25
4) Cream to white limestone of bed 5, but containing ir- regular crystalline nodular concretions and <i>Ostrea podagrina</i> , <i>Amusium ocalanum</i> , <i>Pecten</i> sp., <i>Gypsina globula</i> , <i>Lepidocyclina ocalana</i> , <i>Reussella eocena</i> , <i>Dis- cocyclina flintensis</i> , <i>Nonion preadvenum</i> , <i>Cibicides mis- sissippiensis ocalanus</i>	9.5
3) Cream-colored, coquina limestone composed of fora- minifers, bryozoa, echinoid plates and spines, corals, <i>Pecten</i> sp. cf. <i>P. "perplanus"</i> , <i>Agassizia floridana</i> , <i>Oli- gopygus haldemani</i> , <i>Fibularia vughani</i> , <i>Laganum flor- idanum</i> , <i>L. ocalanum</i> , <i>Peronella cubae</i> , <i>Schizaster oca- lanus</i> , and some of the foraminifers above.....	7.0
2) Cream-colored, pasty, massive, coquina limestone with numerous irregular and spongiform-concretions, and <i>Amusium ocalanum</i> , <i>Ostrea podagrina</i> , <i>Pecten</i> sp. <i>P. "perplanus"</i> , <i>Fibularia vughani</i> , <i>Peronella cubae</i> , <i>La- gena laevis</i> and foraminifers of bed 4.....	38.0
1) Cream-colored, very pasty, porous, soft limestone con- taining <i>Lepidocyclina ocalana</i> , <i>Heterostegina ocalana</i> , <i>Operculinoides floridensis</i> , <i>Operculinoides</i> sp., <i>Gypsina globula</i> , <i>Cibicides mississippiensis</i> , <i>Rotalia cushmani</i> and other poorly preserved foraminifers.....	8.25
Thickness of exposure	131.25

On the northeast side of the quarry the overburden has been stripped to expose along a deep gully large slump-blocks of both Ocala and Suwannee limestones, with dips up to 30 degrees, see frontispiece. These blocks end abruptly in breccia at the quarry side of the gully, and the opposite side exposes up to 40 feet of bedded, red, yellow to gray, mottled sand; sandy clay and greenish-gray, waxy clay that is fractured, collapsed and contains numerous slickensides. These beds are assigned to the Alachua formation. The greenish-gray, waxy clay fills fissures and solution irregularities in the Suwannee limestone and in some cases appears to be bedded with the limestone, and may be in part Oligocene in age.

A small normal fault is present along the back side of the quarry, with the quarry being located on the upthrown block, and with the

²⁴Foraminifera have been compared with specimens identified by Dr. Hans G. Naegeli.

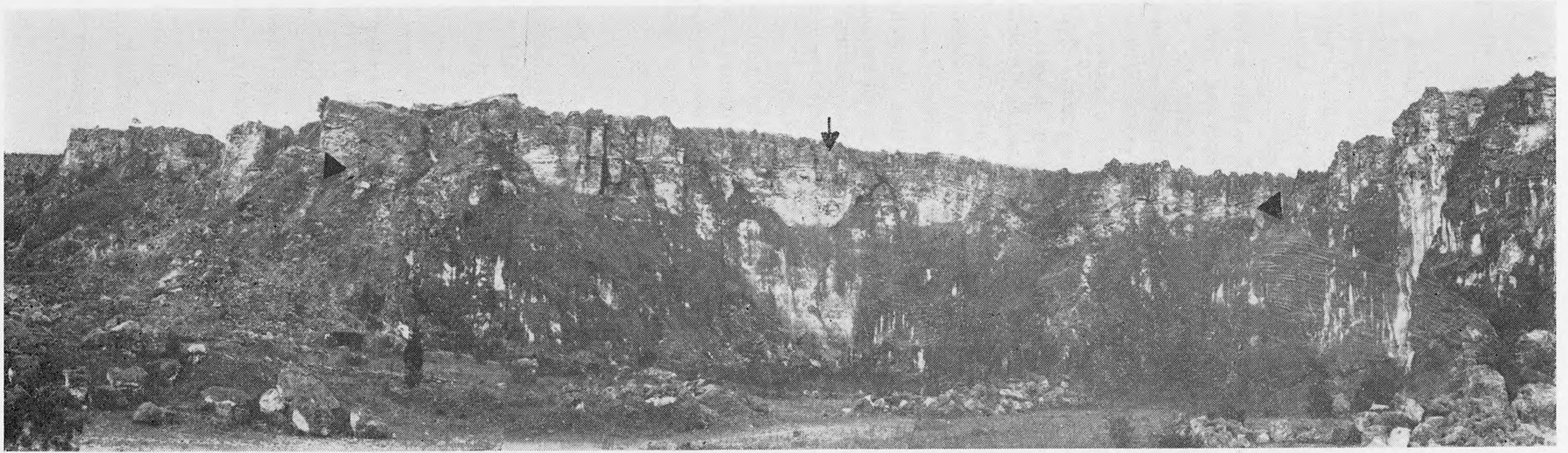


Figure 30. Panorama at locality C-64 showing the eastern face of the Crystal River Rock Company quarry in which the Suwannee limestone is exposed lying unconformably upon the Ocala limestone (restricted). The contact is shown by triangles and the arrow marks the position of the described section.



Figure 31. Unconformable contact of the Suwannee limestone upon the Ocala limestone as exposed at locality C-64 along the southeast margin of the Crystal River Rock Company quarry, from which the overburden has been removed.

downthrown block being covered by limestone breccia and deposits of the Alachua formation, see figure 36. The fault has caused considerable slumping and small local structures in the quarry face, see figure 30.

In the vicinity of Lecanto the Ocala limestone is well-exposed in numerous sinks, road cuts, and a few road metal pits.

- 1) Locality C-74: Road metal pit at "Rocky Sink" in the NW $\frac{1}{4}$ Sec. 2, T. 19 S., R. 18 E. — 34.8 feet of pasty coquina limestone.
- 2) Locality C-70: In road metal pit west of graded road running south of Lecanto in the SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 9, T. 19 S., R. 18 E. — 28.55 feet of pasty coquina limestone.

Numerous sinks and caves in the vicinity of locality C-70 exposed up to 15 feet of the Ocala limestone and the following section where the Ocala and Suwannee limestones are in contact was made in a sink located north of an abandoned road in the southwest quarter southwest quarter Section 15, and extending southeast along the road to an abandoned house in the northeast quarter northwest quarter Section 22, Township 19 South, Range 18 East.

Locality C-80

Feet

Oligocene series

Suwannee limestone

- 4) Cream to light greenish-gray, dense, blocky, thin-bedded, hard, detrital, crystalline limestone containing *Cassidulus gouldii*, *Dictyoconus cookei* and *Coskinolina floridana*. Hill crest covered by boulders of the limestone containing specimens of *Cassidulus* 5.0 to 10.0

Upper Eocene series

Ocala limestone (restricted)

- 3) Section covered with soil through which boulders of chalky, crystalline limestone containing *Lepidocyclina ocalana* extend. Exposures in hurricane roots show the same limestone filled with lepidocyclinas and mollusk molds 25.2
- 2) Cream, soft, miliolid, porous limestone composed of large foraminifers in a pasty, calcite matrix 13.4
- 1) Covered 5.8

Maximum thickness of section

54.4

The central Citrus County outcrop is in a rugged terrain of moderate relief. The higher hills are capped by the Suwannee limestone which is covered by early Pleistocene sands, and sediments of the Alachua formation lap up on the hills to fill irregularities in the limestone bedrock.

- 1) Locality C-90: At "The Rocks", approximately in the NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 25, T. 19 S., R. 18 E. — 17.4 feet of hard and soft ledges of cream to white, pasty, miliolid limestone covered by indurated boulders of limestone, both containing numerous specimens of lepidocyclinas. Rare boulders of Suwannee limestone are present.
- 2) Locality C-101: Along road to J. H. Cason farm along the common line between sections 23 and 26, and exposed in a cave on the farm in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 24, T. 20 S., R. 18 E. — more than 30 feet of white, porous, pasty Ocala limestone covered by boulders of Suwannee limestone in soil covering the hill.
- 3) Locality C-108: Limestone pit on J. R. Thomas' farm in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 36, T. 20 S., R. 18 E., where the following section was measured along a walk cut in the west side of the pit, see figure 32.

Locality C-108

Feet

Oligocene series

Suwannee limestone Elevation: 114.2

- 7) Cream-colored to tan, indurated, detrital, hard, dense, thin-bedded limestone containing no identifiable fossils. Resembles bed 12, locality C-64 in lithology. An additional 3 feet of similar limestone is exposed on the east side of the quarry where rare specimens of *Cassidulus*

gouldii and *Dictyoconus cookei* were found. The hill upon which the quarry is located rises 19 feet above the quarry rim..... 3.4

6) Greenish-gray, waxy, sandy clay seam 0.1

Unconformity — irregular contact

Upper Eocene series

Ocala limestone (restricted) Elevation: 110.7 feet.

5) White, finely granular to pasty, soft, porous limestone containing numerous mollusk molds, echinoid fragments and fairly abundant specimens of *Lepidocyclina ocalana* and small foraminifers. The upper few inches is a very hard, indurated, white, pasty, weathered limestone, the top of which is very irregular..... 16.5

4) White, fairly well indurated, pasty limestone containing rare specimens of *Spirolaea vernoni*, *Ostrea* sp. cf. *O. podagrina*, *Operculinoides* sp. and *Lepidocyclina ocalana*. Two thin beds of white, very finely granular to pasty, soft, porous limestone containing almost no recognizable fossils are located in the center of the bed and weather out to make dark streaks extending around most of the quarry face..... 15.0

3) Cream to white, porous, sub-granular, coquina limestone. *Lepidocyclina ocalana*, *Camerina striatoreticulata* (L. Rutten), *Operculinoides* sp. "A" common..... 5.0

2) White to cream, pasty, porous, soft limestone containing the fossils of bed 3 and *Heterostegina ocalana* 10.0

1) Covered 3.0

Thickness of exposure

53.0

Several other exposures, scattered over southern Citrus County, are plotted on Plate 1, and the most easily accessible are listed as follows:

1) Locality C-100: In a sink circled by the graded road in the SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 16, T. 20 S., R. 19 E. — 22.2 feet of pasty, coquina limestone.

2) Locality C-14: In abandoned pit of the Franklin Phosphate Company, north of paved road, on south side of pit, in the NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 21, T. 20 S., R. 20 E. — 7 feet of pasty, coquina limestone.

3) Locality C-107: In small sink between railroad and graded road in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 26, T. 20 S., R. 20 E. — 15.4 feet of pasty, coquina limestone.

4) Locality C-104: In northernmost part of limestone pits north of graded road (State Road 48) in the SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 19, T. 20 S., R. 21 E. — 17.8 feet of pasty limestone, irregularly jointed and with rare bedding lines across the quarry face. Irregular seams and areas of a *Lepidocyclina-Camerina* coquina.

5) Locality C-110: In road metal pit in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 2, T. 21 S., R. 20 E. — 21.8 feet of pasty, coquina limestone.