

STATE OF FLORIDA
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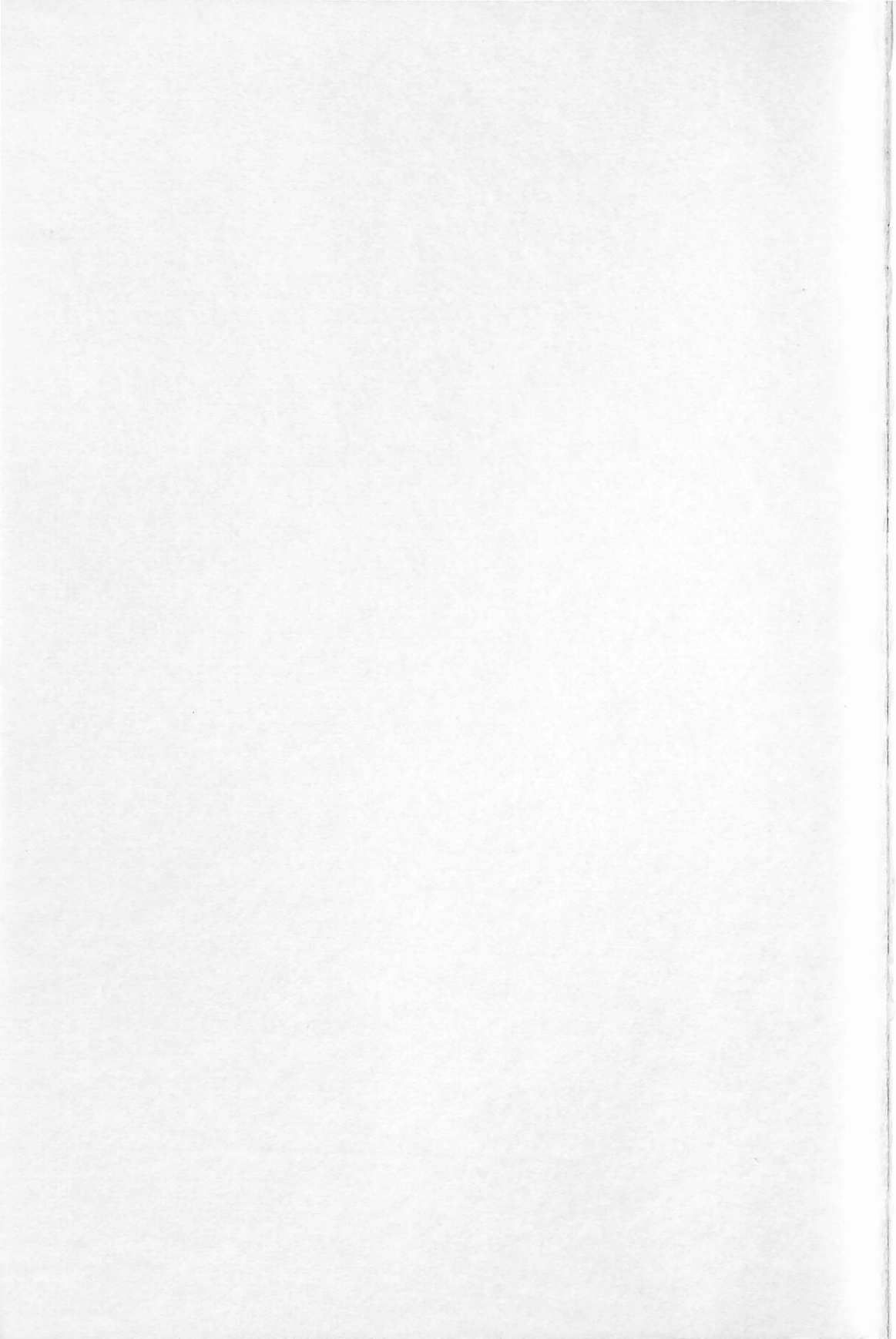
BULLETIN NO. 55

**IGNEOUS AND METAMORPHIC
BASEMENT ROCKS OF FLORIDA**

By
Charles Milton

Prepared by the
GEORGE WASHINGTON UNIVERSITY
and the
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
BUREAU OF GEOLOGY
FLORIDA DEPARTMENT OF NATURAL RESOURCES

TALLAHASSEE
1972



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**DEPARTMENT
OF
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LETTER OF TRANSMITTAL



Bureau of Geology
Tallahassee
October 5, 1972

Honorable Reubin O'D. Askew, Chairman
Department of Natural Resources
Tallahassee, Florida

Dear Governor Askew:

The Department of Natural Resources, Bureau of Geology, is publishing Bulletin No. 55 entitled "Igneous and Metamorphic Basement Rocks of Florida" by Charles Milton, U.S. Geological Survey.

This report describes the basement rocks that have been penetrated by wells in the State of Florida. These deep-seated igneous and metamorphic rocks form the structural backbone of the peninsula and can be invaluable in the determination of the structural history of the State.

Respectfully yours,

Charles W. Hendry, Jr., Chief,
Bureau of Geology

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ACKNOWLEDGMENTS

This work was begun in 1949, with study of the petrography of the cores and cuttings from Florida, Georgia, and Alabama reported on by Paul L. Applin (1951) in "Preliminary Report on Buried pre-Mesozoic Rocks in Florida and Adjacent States" (U.S. Geol. Survey Circular 91). This was the basic compendium of data then available. For Florida, the present report may be considered as final or comprehensive summary report on these igneous rocks, with inclusion of much data accumulated during the two decades following the 1951 circular. Mr. Applin and the Bureau of Geology have continued their helpful interest in this study, and furnished part of these additional data. George V. Cohee gave valuable counsel and assistance, and Miss Jean Berdan also of the U. S. Geological Survey contributed paleontologic-stratigraphic data, besides critically reviewing this report. I am indebted to Dr. A. A. Meyerhoff, Publication Manager of the American Association of Petroleum Geologists for permission to use material from a brief account of these rocks published in the Bulletin (Milton and Grasty, 1969). A grant from the National Science Foundation provided facilities which were used in the preparation of this report.

PREVIOUS STUDIES

The basic reference work on the petrology of the igneous-metamorphic rocks beneath the coastal plain of Florida, Georgia, and Alabama is by Applin (1951), who gave data on 100 wells drilled in those three states. Sixty-five wells were drilled in Florida (of which 3 were reported to have reached granite or diorite, 8 to have reached rhyolitic or other volcanic rock, and 10 to have reached basalt or diabase). Applin suggested a Precambrian age for the granite-diorite rocks, as well as for the Piedmont metamorphic rocks in Georgia and Alabama not far south of the Fall Line. This report indicates no ages greater than Paleozoic, and most of them are much younger.

Data of fossiliferous Mesozoic strata underlying the Florida coastal plain have been summarized by Applin and Applin (1965, 1967). As only a few wells have penetrated igneous rocks since Applin's (1951) publication, comparatively little is added to previous knowledge of Florida igneous-metamorphic petrology, and most of their discussion is of previously published data. They describe the coastal plain floor in northern and central Florida as a truncated surface of igneous and sedimentary rocks of "mostly Precambrian(?) and early Paleozoic" age, and in northern Florida as "late Triassic(?)" igneous rocks. Additional data on Florida wells, in part unpublished, have been given to us by P. L. Applin (written commun., 1967).

Milton and Hurst (1965) described samples from 13 wells in Georgia which were drilled into Paleozoic or older granite and crystalline schist, and from another 26 wells which were drilled beneath the coastal plain formations into volcanic or sedimentary rock more or less metamorphosed by igneous contact.

Grasty and Wilson (1967) discussed the Florida igneous rocks with reference to continental drift. Several of the age determinations given here were made for their study.

Bass (1969) reported on the petrography of nine Florida basement rocks and gave three age determinations, cited here in Table 1.

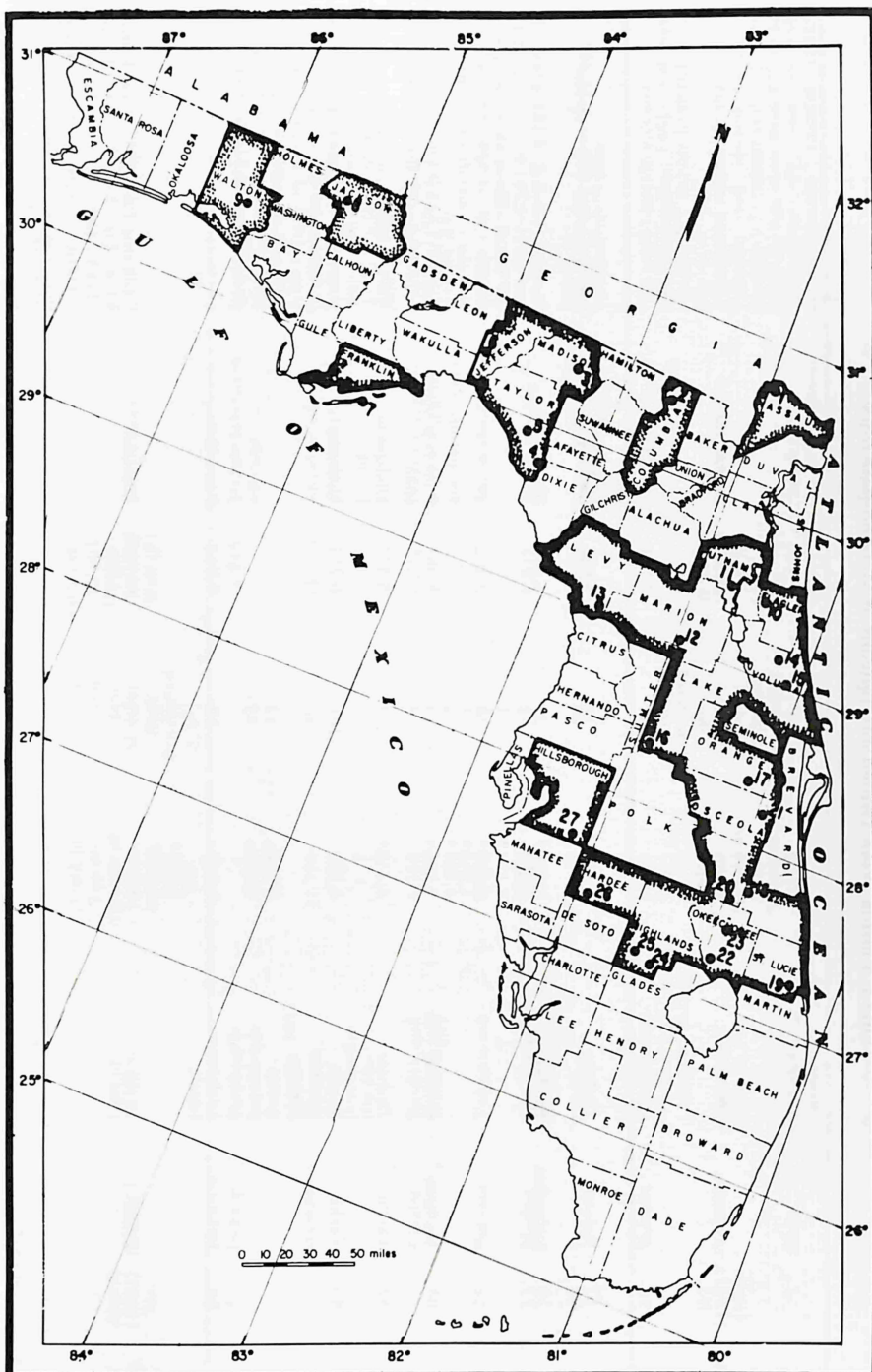


Table 1a. The numbers are those designating the wells in Table I, and are the order in which the wells are discussed in the text.

Table 1. Florida Wells Drilled into Igneous or Metamorphic Rocks

ix	Well Locality Fig. 1	Applin (1951) No.	County	Type of Rock	Depth to Top of Igneous or Meta- morphie Rock (ft)	Thickness Of Igneous or Meta- Morphic Rock Penetrated (ft)	Total Depth of Well (ft)	Bottom Rock	Remarks
	1	67	Nassau	Diabase	4,808	16	4,824	Diabase	Intrudes lower Paleozoic black shale.
	2	42	Columbia	Diabase	3,529° 3,564° 4,191° 4,193° 4,248° 4,267° 4,589°	33 1 1 2 3 3 39	4,444	Black shale	Samples labeled 4,181-4,206 ft and 4,231-4,281 ft are amygdaloidal basalt. Black shale overlying diabase at 3,529 ft contains abundant sericitized andalusite (?) (Fig. 2a)
	3	62	Madison	Diabase			5,385	Paleozoic black shale	Samples labeled 5,200-5,201 ft are hydrothermally altered diabase.
	4	82	Taylor	Diabase	5,438°	79	5,517	Diabase or basalt	Altered diabase or basalt.
	5	83	Taylor	Basalt "gabbro" diabase	6,153	101	6,254	Diabase	Upper 12 ft is basalt; lower 89 ft is diabase gabbro (Applin, 1951). Upper 10 ft of basalt highly calcitic and strongly brecciated. Analysis 5: diabase, 6,162 ft. Analysis 6: diabase, 6,216-6,219 ft.
	6	54	Jefferson	Diabase or basalt	7,690 7,763° 7,850°	10 9 10	7,913	Sandstone	—
	7	—	Franklin	Diabase	10,460°	10	10,566 (Driller) 10,507 (elec. log)	Diabase	California Co. and Coastal Petroleum Co. No. 2 State Lease 221A. Data from P. L. Applin (written commun., 1967) Location: Lat. 29° 47' 03" N long. 84° 22' 51" W. about 13 mi offshore from Carrabelle, Florida.

Table 1. (Continued)

ix	Well Locality Fig. 1	Applin (1951) No.	County	Type of Rock	Depth to Top of Igneous or Meta- morphie Rock (ft)	Thickness Of Igneous or Meta- Morphic Rock Penetrated (ft)	Total Depth of Well (ft)	Bottom Rock	Remarks
	8	53	Jackson	Porphyritic hornblende Basalt (Applin, 1951)	8,890° 8,970°	42 13	9,245	Middle Devonian siltstone	Basalt is amygdaloidal.
	9	—	Walton	Strongly altered porphyritic rhyolite	11,910	38	11,948	Rhyolite ash or porphyry	Pan American No. 1 J. E. Sealey. Data from Applin (written com- mun., 1967), cited in letter from R. T. Violette to P. L. Applin, June 3, 1960.
	10	19	Flagler	Basaltic and rhyolitic tuff	4,588	44	4,632	Volcanic agglom- erate of rhyolitic and basaltic debris	Analysis 8: volcanic agglomerate, 4,624 3/4 - 4,626 ft.
	11	25	Putnam	Volcanic ash	3,873	19	3,982	Ash or rhyolite	Fossils (?). Analysis 9: ash or rhyolite, 3,879-3,881 ft.
	12	23	Marion	Rhyolite or rhyolitic ash	4,615	22	4,637	Ash or rhyolite	—
	13	60	Levy	Diabase	4,317	60	4,609	Lower Paleozoic quartzite and shale	Top of igneous rock is clayey, bottom fresh diabase.
	14	26	Volusia	"Rhyolitic(?) volcanic rock" (Applin, 1951)	5,403	21	5,424	Rhyolite	"No cores taken in volcanic rock." (Applin, 1951) cuttings (5,424 1/2 T.D.) are fresh rhyo- lite.
	15	7	Volusia	Metabasalt	5,910 5,951- 5,952	12	5,958	Metabasalt, etc.	Also altered calcareous shale (?). Volcanic rock altered to clay. Analysis 7: metabasalt, 5,919- 5,922 ft. Age more than 480 m.y. Meta-arkose (?) "not studied petrographically" (Applin, 1951) (Fig. 2b).
	16	5	Lake	"Alaskite" or "granite"	6,103	26	6,129	"Alaskite" (H. L. Tomlinson, unpub. data) "Granite" (Applin, 1951)	

Table 1. (Continued)

Well Locality Fig. 1	Applin (1951) No.	County	Type of Rock	Depth to	Thickness	Total Depth of Well (ft)	Bottom Rock	Remarks
				Top of Igneous or Meta- morphie Rock (ft)	Of Igneous or Meta- Morphic Rock Penetrated (ft)			
17	—	Orange	"Granite"	6,550	39	6,589	"Granite"	Warner Petroleum Co. No. 1 George Terry. Data from Applin (written commun., 1967). Well 61 of Applin and Applin (1965). C. SW ¹ ₄ SE ¹ ₄ . Sec. 21, T23S, R31E. No samples available.
18	—	Indian River	"Andesite"	9,410	78	9,488	Diabase	Amerada Petroleum Corp. No. 1 Frondren Mitchell. Data from Applin (written commun., 1967). Sec. 28, T31S, R35E.
19	—	St. Lucie	Basalt Granite Diorite	12,725 12,744 12,748	23	12,748	"Diorite"	Amerada Petroleum Corp. No. 2 Cowles Magazine. Well 68A of Applin and Applin (1965). Anal- ysis 2: basalt, 12,734 ft, age 89.3 ± 2.2 m.y. (Fig. 2d). Analysis 3: "granite," 12,744 ft, age 226 ± 6m. y. (Fig. 3a). Analysis 4: "dior- ite," 12,748 ft, age 308 ± 5 m.y. (530 ± m.y., Bass, 1969) (Fig. 3b).
20	24	Osceola	Rhyolite	8,740	58	8,798	Rhyolite	Age 173 ± 4 m.y.
21	6	Osceola	"Granite" Arkose(?)	8,035 8,035	14 7	8,049 8,042	"Granite" (Applin, 1951) Arkose (?)	Analysis 1: granite or arkose, 8,034-8,042 ft, age 530 m.y. (Bass, 1969) (Fig. 2c).
22	—	Okeechobee	"Volcanic" rocks	10,750	88	10,838	Basalt	Amerada Petroleum Corp. No. 1 Marie Swenson. Data from Ap- plin (written commun., 1967). Well 60 of Applin and Applin (1965). Sec. 5, T36S, R34E.

Table 1. (Continued)

Well Locality Fig. 1	Applin (1951) No.	County	Type of Rock	Depth to Top of Igneous or Meta- morphitic Rock (ft)	Thickness Of Igneous or Meta- Morphic Rock Penetrated (ft)	Total Depth of Well (ft)	Bottom Rock	Remarks
23	—	Okeechobee	Rhyolite porphyry	9,682	158	9,840		Sun Oil Co.—Amerada Petroleum Corp. No. 1 Harris Holmes. Data from Applin (written commun., 1967). No samples available. Sec. 8, T33S, R34E.
24	21	Highlands	Amygdaloidal basalt, rhyolite, porphyry, <i>etc.</i> (Applin, 1951)	12,618	367	12,985	Basalt	Basalt, 12,664 ft, age 183 ± 10 m.y.
AX 25	—	Highlands	“Volcanic rock”	12,601	39	12,630	Diabase	Continental Oil Co. No. 1 G. C. Carlton <i>et al.</i> Data from Applin (written commun., 1967). Well 45 of Applin and Applin (1965).
26	20	Hardee	Basalt “lava and pyroclastic rocks” (Applin, 1951)	11,828	106	11,934	Basalt	Basalt, in part hydrothermally altered and brecciated, also ash (?). Altered basalt, 11,853 ft., age 143 ± 3 m.y.
27	22	Hillsborough	Rhyolite tuffs and flows (Fig. 3c), and meta- basalt (?)	10,010	119	10,129	Metabasalt (?)	Rhyolite and welded tuff overlies metabasaltic (?) agglomerate (Fig. 3d). Analysis 10: metabasaltic agglomerate, 10,115-10,125 ft. Analysis 11: rhyolite, 10,019-10,022 ft.

*Depth reported by Applin (1951).

INTRODUCTION

This report describes in detail all the cores and cuttings available from a large collection of wells which were drilled in the Florida Coastal Plain, which penetrated rocks older than the Late Cretaceous, Tuscaloosa Formation. It summarizes the literature concerned with these rocks. A similar account of the corresponding rocks in Georgia was given by Milton and Hurst (1965). The Florida rocks have recently been listed and briefly described by Milton and Grasty (1969).

The specimens described number several hundred, from 27 drill holes in 21 counties over most of Florida north of Lake Okeechobee, and include nearly all of the deep tests that have penetrated igneous rocks of the basement during a half century of drilling. To the south of Lake Okeechobee, wells have been drilled to greater depths, but only two have reached rock of pre-Mesozoic age, or of igneous-metamorphic character.*

Although many wells have been drilled into the Florida pre-Cretaceous basement, and Paleozoic strata have been recognized widely in the northern part of the state, the nature of the truly metamorphic basement underlying Paleozoic sedimentary rocks still may be considered virtually unknown. Twenty-seven wells have penetrated igneous or metamorphic rocks which appear mostly to be either Mesozoic or Paleozoic intrusive and related volcanic sedimentary rocks, or contact-metamorphic rocks affected by such volcanic activity. Because drilling generally was terminated when such rocks were penetrated, little or nothing is known of what may underlie them, or the extent and thickness of the basement rocks themselves.

*Editor's Note: Those are Humble O & R Co. No. 1 Lehigh, the discovery well of Lehigh Acres Field in Lee County, which bottomed in diabase, and Mobil Oil Co. No. 1 224-B F.S.L., a dry hole drilled about 6 miles SW of Englewood in the Gulf of Mexico. This well bottomed in rhyolite. Age determinations by potassium-origin percentages indicate late Triassic or early Jurassic intrusives for both diabase and rhyolite recovered in cores from the wells.

The petrography of basement^{*} rock from 27 Florida wells is described (Table 1); also some 14 isotopic datings from 6 wells in Florida and 3 in Georgia (Table 2); and chemical analyses of rocks from 7 Florida wells are given.

Figure A is a map of Florida showing the locations of the 27 wells and the counties in which they were drilled. Eight wells in Table 1 not listed by Applin (1951) are named and located under "Remarks," where the source of information also is indicated.

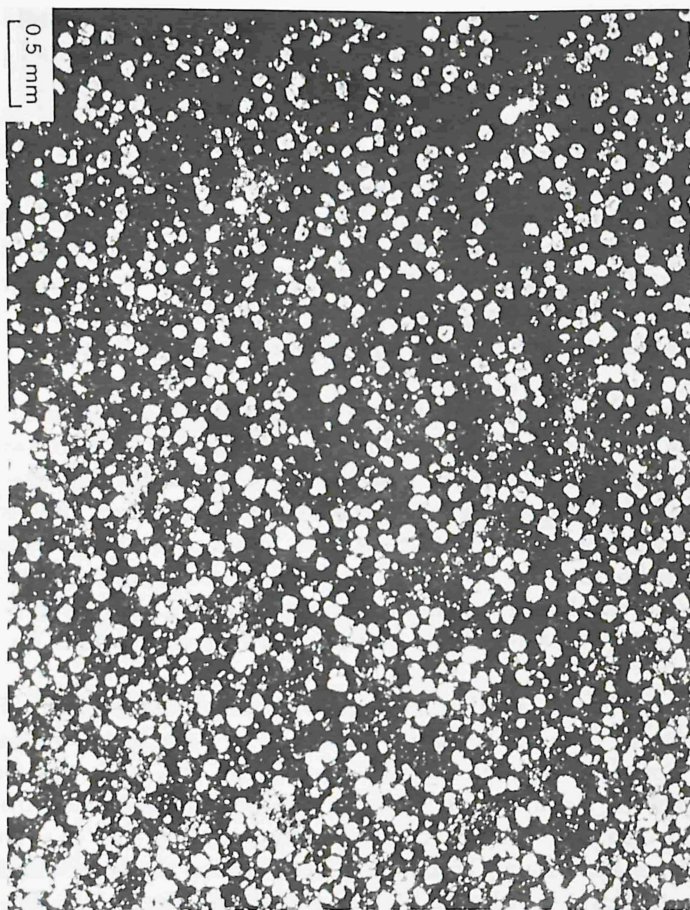
The collection of specimens described in this report, together with 125 thin sections, have been deposited with the Florida State Bureau of Geology in Tallahassee.

PETROGRAPHY OF FLORIDA IGNEOUS-METAMORPHIC ROCKS

The igneous rocks of Florida and southern Georgia include a (probably) time-related group of diabbases, basalts, and rhyolites that are present from the state line south as far as Lake Okeechobee. Their K-Ar dating—from 89.3 ± 2.2 to 183 ± 10 m.y.—indicate a Mesozoic age, and the volcanism is presumably correlative with the widespread Mesozoic volcanism of the North American Atlantic seaboard and the Gulf Coast.

These Florida igneous rocks appear to be a southward continuation of the rocks penetrated in southern Georgia (Milton and Hurst, 1965). In Glynn County, Georgia, just north of well No. 1 (Table 1; Fig. 1), which was drilled into diabase, the Humble Oil and Refining Co. No. 1 W. C. McDonald penetrated granophyre from 4,732 to 4,737 ft. Granophyre commonly is found as a border phase, normally at the top, of large bodies of diabase. In Clinch County, Georgia, Timber Products Co. No. 1 Wiley P. Ballard, Jr., penetrated amygdaloidal basalt from 4,210 to 4,232 ft; Brady Belcher et al. No. 1 Lem Griffis penetrated rhyolite and welded tuff from 4,348 to 4,588 ft. In contiguous Echols County, Georgia, in Hunt Oil Co. No. 1 Superior Pines, diabase intrudes Paleozoic black shale from 4,115 to 4,150 ft (approx.). Table 1 and Figure 1 show the presence of very similar rocks in the northern Florida counties.

^{*}The term "basement" is used variously by different writers; for the purposes of this report, we define it as crystalline, igneous, metamorphic and unmetamorphosed sedimentary rocks of early Paleozoic or older age, underlying unmetamorphosed (post-Paleozoic) sedimentary rocks that may contain oil or gas. Some Paleozoic and post-Paleozoic — pre-Cretaceous sedimentary rocks in Florida are intruded locally by igneous rocks, some of which have been dated by radiometric methods and are described in this report. Unquestioned regionally metamorphosed rocks (e.g., mica, garnet, staurolite, kyanite, sillimanite schists, or marbles) have not been found in Florida.



Baked shale

Figure 1. Columbia County, Florida, J. P. Cone No. 1, Humble Oil and Refining Company, 3520'-3529' Top 7 feet.

Carbonaceous shale, with disseminated andalusite (?) Ordinary light, X22.5.

The association of diabase or basalt, tuff, rhyolite, and granophyre is so characteristic of many regions of the world that it does not require emphasis here.

These rocks are found as far south as Lake Okeechobee (e.g., basalt in St. Lucie County on the east coast, basalt and rhyolite in Highlands County in southern central Florida, and rhyolite in Hillsborough County on the west coast). Evidently Mesozoic volcanism extended across most of the state.

Bass (1969) refers to "The two wells known to penetrate basalt, the

(Hardee County Humble) Keen and (Highlands County Humble) Carlton" as the southernmost . . . "and speculates as to a distinct province of mafic extrusive rocks in southern or southwestern Florida . . ." which "may be considerably younger than the rhyolitic rocks . . ." However, it may be noted that basaltic rocks exist in northern Florida (Milton and Grasty, 1969) not to mention Georgia (Milton and Hurst, 1965).

The terms "diabase" and "basalt" are used in this report with the understanding that they may in some cases refer to essentially the same rock, crystallized under varying conditions from the same body of magma. The chilled upper margin may have a basaltic aspect, whereas the more slowly cooling deeper magma may have the diabasic (ophitic) texture.

Similar considerations apply as to Gough's (1967) geophysically-based interpretation of a northeast-southwest "Appalachian" belt of volcanics, some two hundred kilometers wide, across Florida, through the Gulf of Mexico to the Campeche region; the northern boundary of this belt is held, following Applin (1951) to divide Silurian and Ordovician sedimentary rocks from rhyolitic lava, pyroclastic rocks, and granite-diorite. Bass cites the two basalts mentioned above as part of such a belt.

All this suggests the futility of basing broad conclusions on meager data.

In central Florida, another group, giving much earlier dates, includes metabasalts in Volusia County, "granites" or "alaskites" in Lake and Orange Counties, "granite" and "diorite" in St. Lucie County, and "metabasalt" in Hillsborough County. Age determinations on this group range from 226 ± 6 (or 224 ± 3) m.y. through 308 ± 5 m.y. to $480 \pm 100(?)$ m.y. or from Early Triassic or Late Permian through Middle Pennsylvanian to Early Cambrian. In two wells volcanic rock overlies metamorphic rock types—in St. Lucie County basalt overlies "granite" and "diorite," and in Hillsborough County rhyolite and welded tuff overlie metabasaltic agglomerate.

The relation of the basalt overlain by unaltered Upper Jurassic or Lower Cretaceous sediments (Applin and Applin, 1965) in St. Lucie County to the "granite" and "diorite" just below is an unsolved problem. Is the basalt a flow over a granite-diorite floor? The age of the basalt, which is similar in general appearance to other presumably Mesozoic southeastern basalts, has been determined (89.3 ± 2.2 m.y. = Late Cretaceous), but the underlying "granite" has been dated as Early Triassic and the "diorite" as Early-Middle Pennsylvanian (Table 2). These two disparate ages, however, may reflect decreasing thermal metamorphism downward from a basalt flow, with correspondingly diminished argon loss as demonstrated by Westcott (1966). Differential argon loss due to the degree of alteration of the dated specimens also could cause the variation in ages.

Table 2.—Isotope dating of Florida (and Georgia) rocks.

No. (Table 1)	Location Operator Well	Depth of Sample (ft)	K ₂ O %	Vol. of Radiogenic Argon-40 (mm ³ /g of sample)	% Atmos. Contam.	Age and Error (m.y.)	Remarks
24	Highlands County, Florida Humble Oil and Refining Co. No. 1 G. C. Carlton Estate	12,664	0.308 ± 0.007	1.96 × 10 ⁻³	19.0	183 ± 10	RG-1. Rock is very fined-grained, holocrystalline basalt, with rare phenocrysts of plagioclase. Contains 60 percent fresh feldspar, 25 percent cloudy clinopyroxene, and 15 percent olive-green-brown serpentine after olivine(?). Slightly altered. Whole rock. Grasty.
26	Hardee County, Florida Humble Oil and Refining Co. No. 1 B. T. Keen	11,853	3.49 ± 0.05	1.71 × 10 ⁻² 1.77 × 10 ⁻²	8.2 11.2	143 ± 7 147 ± 3	RG-2. Very fine-grained basalt which has suffered low-grade metamorphism with no fresh feldspar and all mafic minerals chloritized. Highly altered. Whole rock. Grasty.
19	St. Lucie County, Florida Amerada Petroleum Co. No. 2 Cowles Magazine	12,734	2.085 ± 0.048	3.59 × 10 ⁻²	39.4	89.3 ± 2.2	Basalt, dark-gray granular rock with calcite blebs up to several millimeters across. Diabasic texture; mostly plagioclase laths with large olivines completely replaced by bluish-green chlorite and ore grains. Some calcite replacing pyroxene(?). Whole rock. Grasty.
"	" " " "	12,744				399	Chloritized biotite K-Ar Bass
"	" " " "	"				148	Plagioclase " "
"	" " " "	12,744-8				530	Chloritized biotite Rb/Sr "
"	" " " "	12,748				470	Hornblende K-Ar "
"	" " " "	"				503	" "
"	" " " "	12,744	2.29 ± 0.01	1.79 × 10 ⁻² 1.80 × 10 ⁻²	13.5 10.3	226 ± 6 224 ± 3	RG-8. Rock has acid composition and granite texture with 10 percent quartz, 30 percent biotite, and 30 percent plagioclase of which 30-50 percent has been altered to sericite. Biotite shows slight alteration to chlorite. Quite altered. Whole rock. Grasty.
"	" " " "	12,748	1.24 ± 0.01	1.38 × 10 ⁻²	10.4	308 ± 5	RG-9. Diorite with 20 percent quartz, 30 percent brown-green hornblende, 10 percent pale brown biotite associated with hornblende, and 30 percent fresh plagioclase. Rock is fresh. Whole rock. Grasty.

Table 2. (Continued)

No. (Table 1)	Location Operator Well	Depth of Sample (ft)	K ₂ O %	Vol. of Radiogenic Argon-40 (mm ³ /g of sample)	% Atmos. Contam.	Age and Error (m.y.)	Remarks
20	Osceola County, Florida Humble Oil and Refining Co. No. 1 Hayman	8,781	5.32 ± 0.01	3.19 × 10 ⁻²	18.6	173 ± 4	RG-14. Rhyolitic tuff with very fine-grained matrix probably of quartz and feldspar. Contains rounded crystals, xenocrysts or fragments of (very common) quartz, (common) altered alkalic feldspar, and (rare) plagioclase and rock fragments of slightly altered basalt. Whole rock. Grasty.
21	Osceola County, Florida Humble Oil and Refining Co. Carroll No. 1	8,042-4				530	Feldspar Rb/Sr Bass
15	Volusia County, Florida Sun Oil Co. No. 1 Powell Land Co.	5,953-5,954					K ₂ O, 0.93 percent, K ⁴⁰ ppm 0.93, Ar ⁴⁰ ppm 0.0302, radiogenic Ar ⁴⁰ 92 percent, Ar ⁴⁰ /K ⁴⁰ 0.0325. Age 480 m.y. (Age may be low by 20 percent or more because of variable argon reactivity of K-bearing minerals of sample.) H. Thomas, R. Marvin, P. Elmore, and H. Smith, analysts, USGS.
"	" " " "	5,955.5-5,958				634	Hornfels biotite Rb/Sr Bass
"	" " " "	5,951-5,955				459	Hornblende indiorite K-Ar Bass
"	" " " "	" "				342	Plagioclase " " "
"	" " " "	5,955.5-5,958				524	Biotite indiorite hornfels K-Ar Bass
"	" " " "	" "				393	Hornblende indiorite hornfels K-Ar Bass
	Mitchell County, Georgia Stanolind Oil and Gas Co. No. 1. J. H. Pullen	7,375	0.558 ± 0.010	3.56 × 10 ⁻³	47.5	182 ± 5	RG-3. Diabase showing typical dark augitic pyroxene, and light plagioclase feldspar. Holocrystalline, free of alteration. Very fresh rock. Whole rock. Grasty.

Table 2. (Continued)

No. (Table 1)	Location Operator Well	Depth of Sample (ft)	K ₂ O %	Vol. of Radiogenic Argon-40 (mm ³ /g of sample)	% Atmos. Contam.	Age and Error (m.y.)	Remarks
	Echols County, Georgia Hunt Oil Co. No. 2 Superior Pines	4,130	0.813 ± 0.037	5.42 × 10 ⁻³	61.7	191 ± 15	RG-5. Rock chips from same rock type but with one fine-grained phase and one medium-grained phase. May be from chilled margin and coarser grained interior of either dike or flow or, more likely, a basalt and a diabase. Fine-grained phase has 20 percent plagioclase phenocrysts in matrix of very-fine grained opaques and pyroxene (?) with needles of plagioclase and some iddingsite after olivine (?). This phase is slightly altered. The medium-grained phase has a diabasic texture with 30 percent fresh plagioclase, 40 percent augite, and 10 percent interstitial iddingsite after olivine (?). Opaques occur as accessories. This rock is slightly altered, with 10-20 percent material which is probably devitrified glass. Whole rock. Grasty.
	Chattahoochee County, Georgia Cusseta (water well)	1,200-1,205	0.43 ± 0.007	4.69 × 10 ⁻³	67.5	303 ± 15	RG-6. Hornblende consisting essentially of blue-green hornblende, clear quartz, cloudy alkaline feldspar, brown biotite, and pale-green chlorite. Rock was run as hornblende separate of 70-120 mesh. Whole rock. Grasty.

Table 2a. Age determinations — Amerada Petroleum Corp. Cowles Magazine No. 1

Sample Depth	Material	Analyst	Method	Age
12734'	Basalt	Grasty	K-Ar	89.3 ± 2 m.y.
12744'	Granite	"	"	226 ± 6 m.y. 224 ± 3 m.y.
"	Chloritized biotite from schist and quartz diorite gneiss	Bass	Sr ⁸⁷ /Sr 86	530 m.y.
"	" " "	"	K-Ar	399 m.y.
"	Plagioclase from quartz diorite gneiss	"	"	148 m.y.
12748'	Diorite	Grasty	"	308 ± 5 m.y.
"	Hornblende in diorite (amphibolite)	Bass	"	470 m.y. 503 m.y.

Another question is whether the "granites" of Florida are really granites, or arkose altered by contact metamorphism. Altered sedimentary rocks are well known in regions of Triassic volcanism in many localities in the eastern United States; they are associated with major tectonic disturbances that exposed large volumes of granitic rocks both to rapid erosion, and, in places, to hydrothermal alteration. The "granite" in the Pierce County, Georgia, Adams McCaskill wells (Milton and Hurst, 1965) may have such a history. Further, granophyres of superficially granitic aspect and composition are well known as differentiates of large diabase bodies, and many of the so-called "basement granites" in Georgia strongly suggest a granophyric origin (e.g., Glynn County, Georgia, Humble Oil and Refining Co. No. 1 W. C. McDonald).

No unambiguously metamorphic rocks—such as mica schist, garnet schist, chlorite-kyanite-sillimanite schist, or marble—have been found in Florida. The rocks termed "granite" or "diorite" may be contact-metamorphosed sedimentary rocks, or thermally altered phases of igneous intrusives. Whether or not drilling in Florida has penetrated a truly metamorphic basement of Precambrian or even early Paleozoic age is, in our opinion, still an open question.

DATING OF FLORIDA AND GEORGIA IGNEOUS-METAMORPHIC ROCKS

The K-Ar dates in Table 2 were determined at the University of Toronto by Robert Grasty and M. N. Bass (1969), with the exception of that for the Volusia County, Florida, hornblende diorite or metabasalt, which was determined at the U. S. Geological Survey. For the rocks dated by Grasty, duplicate potassium determinations were made on each sample, with lithium as an internal standard and sodium as a buffer. Argon, extracted in a bakable glass fusion system, was mixed with "spike" argon-38 and analyzed by an MS 10 mass spectrometer, as described by Farrar et al. (1964). Six measurements of the argon-isotope ratios were made on each gas sample. The limits of error are standard deviations deduced from the errors in both the potassium and argon measurements. In the University of Toronto laboratory, the standard deviation of repeated measurements on the same sample is generally less than 2 percent and analyses of interlaboratory standard samples show that systematic errors are also less than 2 percent (Baksi et al., 1967, p. 6306). Repeat measurement on RG-2 and RG-8 confirmed this accuracy. Constants used in the calculations are $\lambda_B = 4.72 \times 10^{-10} \text{yr}^{-1}$, $\lambda_c = 0.584 \times 10^{-10} \text{yr}^{-1}$, $K^{40} = 1.19 \times 10^{-2}$ atom percent.

The K-Ar ages range from Late Cretaceous to Early Ordovician or Early(?) Cambrian. Except for the youngest and the three oldest, the ages

are within a range from Late Jurassic to Early Triassic. The two dates (middle Carboniferous) for hornblendite from Chattahoochee County, Georgia, and diorite from St. Lucie County, Florida, are similar to dates from late Paleozoic volcanic rocks recognized elsewhere in the Appalachians.

The youngest age whether or not valid, 89.3 ± 2.2 m.y., is by no means the youngest to be reported in the Appalachian region; Fullagar and Bottino (1968) give a Tertiary age (30 ± 15 m.y.) for felsite from Highland County, Virginia.

The oldest age, $480 \pm 100(?)$ m.y. (or 524 m.y.) from Volusia County, Florida, "metabasalt," is within the range of the Cambrian to Ordovician age of the North Carolina "Slate Belt" rhyolites determined by Hills and Butler (1968). Some workers have referred the Georgia-Florida volcanic rocks in part to the "Slate Belt" series. Three ages obtained by Bass (1969) on samples from Humble Oil and Refining Co., No. 1 Carroll, Osceola County, Sun Oil Co., No. 1 Powell Land Co., Volusia County, and Amerada Petroleum Corp. No. 2 Cowles Magazine Inc., St. Lucie County, are respectively, 530, 524, 530+ m.y. These determinations indicate a Middle Cambrian age.

The K-Ar and Rb/Sr dates of Bass (1969) cited in Table 2 are discussed in detail in his paper.

CHEMICAL ANALYSES OF FLORIDA IGNEOUS-METAMORPHIC ROCKS

Table 3 gives the chemical composition of 11 Florida igneous-metamorphic rocks. Because these results are from small and generally isolated specimens, their present value is limited; however, as more information on the Florida subsurface becomes available, comparative studies may be found useful.

The analyses have been computed in terms of normative minerals, in Table 3a. This often gives a somewhat clearer picture of what meaning the analyses may have, although it must be emphasized that the data presently available is altogether insufficient for any meaningful generalizations.

To illustrate this we may compare the analyses or rather the norms, 9 and 11, or volcanic ash and rhyolite, respectively, from Putnam County and Hillsborough County, 150 miles apart. The two norms are indeed similar — high normative quartz, substantial normative corundum orthoclase, and albite plagioclase; normative hematite and magnesite. It would appear that these two rocks are part of one body. Yet a second specimen of the Hillsborough County rock, analysis 10, unquestionably from the same body, shows neither normative quartz nor corundum, strongly calcic plagioclase, much, not little, mafic minerals, and neither hematite nor magnesite.

Again, the two very similar analyses of diabase, 5 and 6 from Taylor

Table 3. Chemical Analyses of Florida Igneous-Metamorphic Rocks^{1 3}

	1	2	3	4	5	6	7	8	9	10	11
SiO ₂	63.7	46.8	68.7	57.0	50.9	52.8	51.7	57.1	73.3	48.3	59.1
Al ₂ O ₃	15.1	17.1	15.4	16.8	16.6	15.3	17.3	13.9	13.8	14.0	13.0
Fe ₂ O ₃	3.3	3.5	.74	3.0	4.3	2.2	10.2	4.1	2.5	3.1	3.8
FeO	2.6	6.1	2.6	1.9	4.6	9.9	.72	3.4	.54	5.7	1.2
MgO	3.3	10.5	3.0	5.6	6.2	4.4	3.1	7.2	.93	9.2	3.0
CaO	1.1	3.2	3.7	6.8	6.3	8.9	.54	4.3	.02	8.3	4.1
Na ₂ O	3.0	1.2	1.9	1.6	3.3	2.5	1.4	2.7	2.1	1.5	4.3
K ₂ O	2.6	3.3	.95	.90	.57	.68	5.5	2.2	3.2	3.1	3.6
H ₂ O —	.32	.55	.14	.06	2.5	.46	3.5	.37	.43	1.1	.35
H ₂ O ⁺	2.9	5.4	2.1	1.9	1.9	1.1	3.6	2.1	1.7	2.9	.15
TiO ₂	.62	.83	.45	.75	1.2	1.1	1.2	.73	.32	.94	.32
P ₂ O ₅	.20	.12	.28	.28	.17	.17	.36	.22	.08	.16	.04
MnO	.11	.11	.07	.17	.08	.22	.07	.14	.03	.19	.23
CO ₂	.75	.52	<.05	<.05	.46	<.05	.15	.45	<.05	.95	6.1
Sum ²	100.	99.	100.	100.	100.	100.	99.	99.	99.	99.	99.
Powder density by sink float	2.72	2.72	2.72	2.80	2.60	2.95	2.52	2.80	2.72	2.80	2.70

¹ Analyses by Paul Elmore, L. Artis, S. Botts, G. Chloe, H. Smith, J. Kelsey, and J. Glenn, U. S. Geological Survey, using methods described by Shapiro and Brannock (1962), supplemented by atomic absorption techniques.

² Rounded to nearest whole number

³ For location, lab. no., and remarks see below.

Analysis No.	Well Locality (Fig. 1)	Lab. No.	Remarks
1	21	W168611	Osceola County, Florida; Humble Oil and Refining Co. No. 1 Ray Carroll; 8,034-8,042 ft. "Altered and veined biotite granite" (F. F. Grout in Applin, 1951). Possibly hydrothermally altered arkose (C. M.) (Fig. 2c).
2	19	W168612	St. Lucie County, Florida, Amerada Petroleum Co. No. 2 Cowles Magazine, amygdaloidal basalt, 12,734 ft. dated 89.3 ± 2.2 m.y. (Fig. 2d).
3	19	W168613	"Granite," 12,744 ft. dated 226 ± 6 m.y. 224 ± 3 m.y. (Fig. 3a).
4	19	W168614	"Diorite," 12,748 ft. dated 308 ± 5 m.y. (Fig. 3b).
5	5	W168615	Taylor County, Florida, Humble Oil and Refining Co. No. 1 G. H. Hodges, 6,162 ft. diabase.
6	5	W168616	Diabase, 6,216-6,219 ft.

Table 3. (Continued)

Analysis No.	Well Locality (Fig. 1)	Lab. No.	Remarks
7	15	W168617	Volusia County, Florida. Sun Oil Co. No. 1 Powell Land Co., 5,919-5,922 ft. "weathered" volcanic rock now clay.
8	10	W168618	Flagler County, Florida. Humble Oil and Refining Co. No. 1 J. W. Campbell, 4,624 ³ / ₄ -4,626 ft. Hydrothermally altered basalt and rhyolite tuff.
9	11	W168619	Putnam County, Florida. Sun Oil Co. No. 1 H. E. Westbury <i>et al.</i> 3,879-3,881 ft. Volcanic ash.
10	27	W168620	Hillsborough County Florida. Humble Oil and Refining Co. No. 1 T. S. Jameson, 10,019-10,022 ft. Rhyolite or welded tuff.
11	27	W168621	Rhyolite, 10,115-10,125 ft.

Table 3a. Florida igneous-metamorphic rock norms

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9**</u>	<u>10</u>	<u>11</u>
Quartz	39.949	3,189	40,923	19,709	7,124	6,901	18,022	14,009	45,776	—	19,832
Corundum	7,351	7,228	5,305	1,617	.573	—	9,044	.828	6,388	—	2,030
Orthoclase	15,364	19,501	5,614	5,318	3,368	4,018	32,501	13,000	18,910	18,319	21,273
Albite	25,385	10,154	16,077	13,539	27,924	21,154	11,846	22,847	20,308	12,693	36,385
Anorthite	—	11,804	16,210	31,589	27,236	28,517	—	17,050	—	22,312	—
Wollastonite	—	—	—	—	—	5,933	—	—	—	4,933	—
Enstatite	8,006	26,150	7,472	13,947	15,441	10,958	7,496	17,932	2,202	19,512	.802
Ferrosilite	1,229	7,144	3,550	5,597	3,062	11,955	—	1,911	—	5,711	—
Forsterite	—	—	—	—	—	—	—	—	—	2,383	—
Fayalite	—	—	—	—	—	—	—	—	—	.769	—
Magnetite	4,785	5,075	1,073	4,350	6,235	3,190	—	5,945	.911	4,495	3,691
Hematite	—	—	—	—	—	—	10,200	—	1,872	—	1,255
Ilmenite	1,178	1,576	.855	1,424	2,279	2,089	1,670	1,386	.608	1,785	.608
Rutile	—	—	—	—	—	—	.320	—	—	—	—
Apatite	.474	.284	.663	.663	.403	.403	.521	—	—	.379	.095
Calcite	1,493	1,183	.114	.114	1,046	.114	.118	1,023	—	2,161	7,224
Magnesite	.179	—	—	—	—	—	.188	—	.096	—	5,602
Salic	79,049	51,875	84,129	71,771	66,224	60,591	71,413	67,735	91,382	53,323	79,520
Femic	17,342	11,412	13,726	26,095	28,465	37,641	20,846	28,718	5,688	12,127	19,275
	96,392*	93,287	97,855	97,866	94,690	98,231	92,259	96,453	97,070	95,451	98,795

*This and other totals are computer figures.

**This norm has been computed with .08% P₂O₅ and .02% CaO, each reduced to .00%, to conform with the computer program.

County, referred to above (pages ■■■■■) do show definite difference from the St. Lucie County amygdaloidal basalt, some 250 miles distant; first being presumably Triassic-Jurassic, the second dated as much younger, namely upper Cretaceous (89.3 m.y., Table 2). However, comparing all three analyses of the St. Lucie County rocks, while the three analyses (2, 3, 4) are remarkably similar, their isotopic ages are widely disparate.

Thus we may conclude by observing that the value of these analyses is for the present limited to what they may contribute to the understanding of the individual rock specimen, and that attempts to use them for broad correlative purposes are futile.

DESCRIPTIONS OF FLORIDA "BASEMENT" ROCKS

NASSAU COUNTY

ST. MARY'S RIVER OIL CORP.

HILLIARD TURPENTINE CO. NO. 1 4824' T.D.

Completed 1940

Well locality 1

Applin (1951) No. 67

Triassic diabase in Paleozoic shale

Cole (1944) reports that this well was begun in 1936, and completed eight years later at a depth of 4817 feet. He briefly reviewed earlier accounts by Campbell, Schuchert, and Munyon, and discussed extensively the micropaleontology of the well. He also considered in detail the non-fossiliferous rocks, below the marine sediments (Upper Cretaceous Tuscaloosa).

Below the Tuscaloosa, which in this well consists of 380 feet of gray, hard, calcareous and glauconitic sandy shale, with shark's teeth, is 155 feet of dark gray, hard shale, devoid of fossils, followed by diabase to the bottom of the well. Applin (1951) states that the diabase underlies Paleozoic black shale, later confirmed by paleontologic studies by J. Bridge and J. Berdan.

Cole, after considering all the evidence, observed, "It is the opinion of the writer that the section from 4640 to 4795 (the 155 feet of unfossiliferous shale) represents a non-marine phase and that the age of the rocks is Triassic. The writer believes that they are equivalent to the Newark series." As for the diabase which intrudes the shale, a study by T. Osborn Fuller, cited at length by Cole, convinced him that it is of Newark (Triassic) age.

Nevertheless, Applin (1948) referred to the published data as "conflicting and inconclusive" but correctly included the well as among those which entered "Paleozoic black shale."

Berdan (written communication, May, 1970) states that "a sample of

rather large chips of dark gray shale from a depth of 4700-4800 feet contains a small fragment of eurypterid integument which shows the characteristic scales of the genus *Pterygotus*. This genus ranges from the Ordovician into the Devonian. However, a core of dark gray shale from Sun Oil Company J. H. Tillis No. 1 well in Suwannee County also contains *Pterygotus*, which was considered to be Silurian in age by Kjelleswig-Waering (Jour. Paleont., v. 24, no. 2, p. 229-231, 1950), who described it as *P. floridanus*. It seems probable that the shale in the Hilliard well is correlative with that in the Tillis well, and is also Silurian."

Two thin sections of the diabase, one from 4818'-4819', the other 4823' are both fresh unaltered diabase; the lower one is somewhat more fine grained.

COLUMBIA COUNTY
HUMBLE OIL AND REFINING CO.
J. P. CONE NO. 1 4444' T.D.

Completed 1949 Well locality 2 Applin (1951) No. 42
Diabase in Paleozoic shale

Applin (1951) lists six occurrences of diabase and amygdular basalt sills in black shale of Paleozoic age at

3529'-3562'	4193'-4195'
3564'-3565'	4248'-4251'
4191'-4192'	4267'-4270'

Cores are available from 3520' to 4281'.

Core 115 3520'-3529' recovery 8'

Top 7' is gray carbonaceous (burns white) shale, with pyrite and a little sphalerite along bedding planes. Microscopically the shale is seen to contain innumerable clear colorless sericitic grains, with rectangular or hexagonal cross section (Figure 1). Most show concentration of the dusty shaly matrix material in the interior of the grain, with clear borders; this suggests that the grains may be sericitized andalusite, in which such segregation is normal.

Bottom 1' is at the contact of black shale and underlying diabase. It is a light colored fine grained rock with calcite layers and numerous small rounded pyrite nodules. In thin section (Figure 2) the rock is seen to consist almost wholly of plagioclase laths and calcite (replacing augite?) and pyrite (replacing iron-titanium oxide?).

Core 119 3541'-3543' top part of core is hard fresh diabase.

Core 120 3543'-3555' top part of core.

This is a perfectly normal diabase, with typical mineralogy — calcic plagioclase laths and subhedral augite, with minor black ilmenite grains and greenish chlorite (Figure 3).



Altered diabase

Figure 2. Columbia County, Florida, Humble Oil and Refining Company J. P. Cone No. 1, 3520'-3529'. Bottom foot of core.

Shows (white) plagioclase feldspar. The dark areas represent mostly calcite (replacement of pyroxene?) and (most of large black aggregate left of center) pyrite, which may have replaced ilmenite-magnetite. Ordinary light, X28.5.

Core 121 3555'-3562' top and bottom of core, hard fresh fine grained diabase. No different from preceding.

Core 122 3562'-3589' Sample from second 10 ft. of core. Greenish gray shale with calcite-pyrite layers; also red heulandite(?). Orthoconic cephalopods occur in this shale (Roland Brown, J. M. Berdan, U.S.G.S.).

Core 149 4181'-4206' Sample from bottom of core, amygdaloidal basalt. This is a fine grained gray-green vesicular rock, with blebs of coarse white calcite up to an inch across; some of the smaller ones are reddish in part. There are also small pyritic segregations.



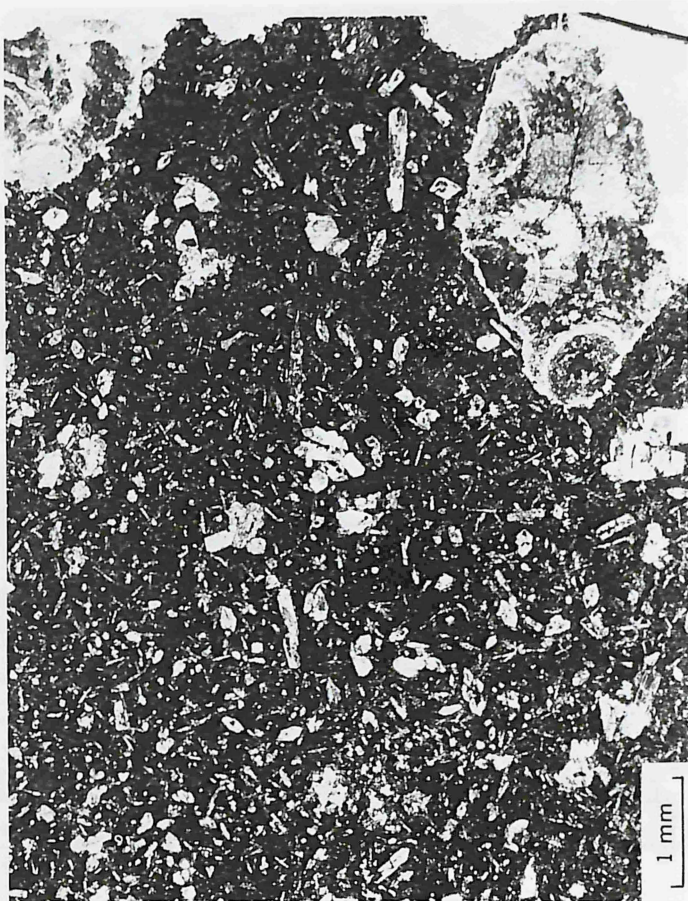
Diabase

Figure 3. Columbia County, Florida, Humble Oil and Refining Company J. P. Cone No. 1, 3543'-3555'. Top part of core.

Normal diabase, with typical laths of calcic plagioclase and euhedral augite between the feldspars. Ordinary light, X28.5.

In thin section, the rock shows a poorly crystallized dark turbid ground-mass, in which are strewn in abundance small colorless or faintly reddish augites. A few of these are larger than the others, and consist of interpenetrating twins of several individuals. Iddingsitized (?) euhedral olivines are small but numerous. The more definitely colored augites are reddish-violet, show axial dispersion and are probably titaniferous. The calcite segregations often show an irregular peripheral zone of brown substance, perhaps serpentine, and some have spherulitic development (Figures 4 and 5).

Core 151 4231'-4256' middle third, gray amygdular basaltic rock, with irregular calcitic amygdules.



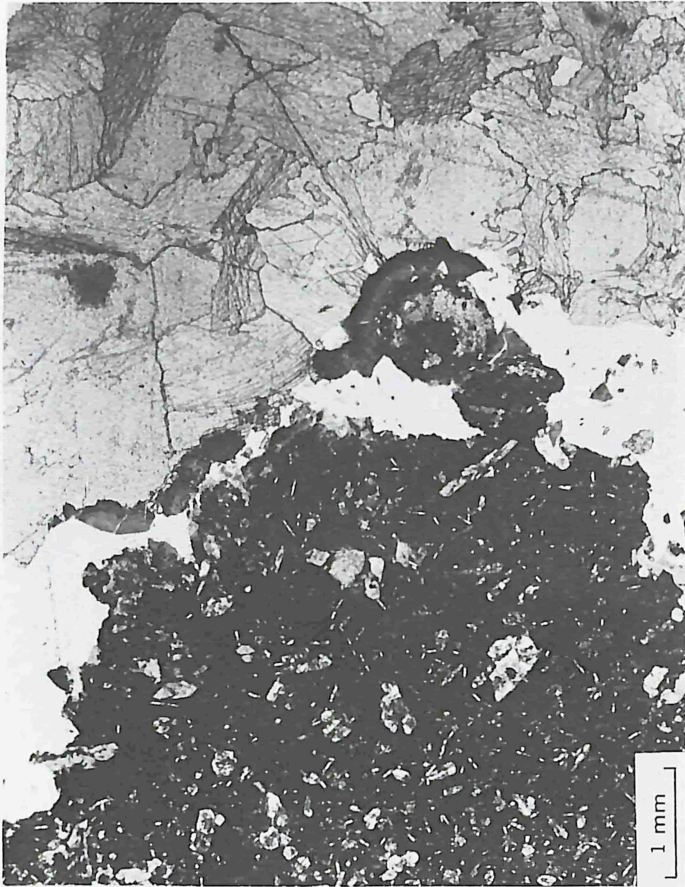
Amygdular basalt

Figure 4. Columbia County, Florida, Humble Oil and Refining Company J. P. Cone No. 1, 4181'-4206' Sample from bottom of core.

Amygdular basalt; at the lower right is a large amygdule of radially fibrous calcite, at the upper right, a similar amygdule with olive brown serpentine and calcite. The crystals in the basalt are mostly serpentinized olivine and unaltered augite. Ordinary light, X14.

Core 152 4256'-4281' Sample from middle of core. Recovery 24' "1 ft. of core is like material submitted, remainder is black shale" Louise Jordan (Sun Co. geologist, now deceased).

The sample of the 1' zone consists of two somewhat different rocks, one in contact with black slaty shale. The contact phase, about one inch wide, is light gray-green, markedly pyritic and vesicular; it grades into a darker more uniformly-textured rock, like the second specimen, which, however,

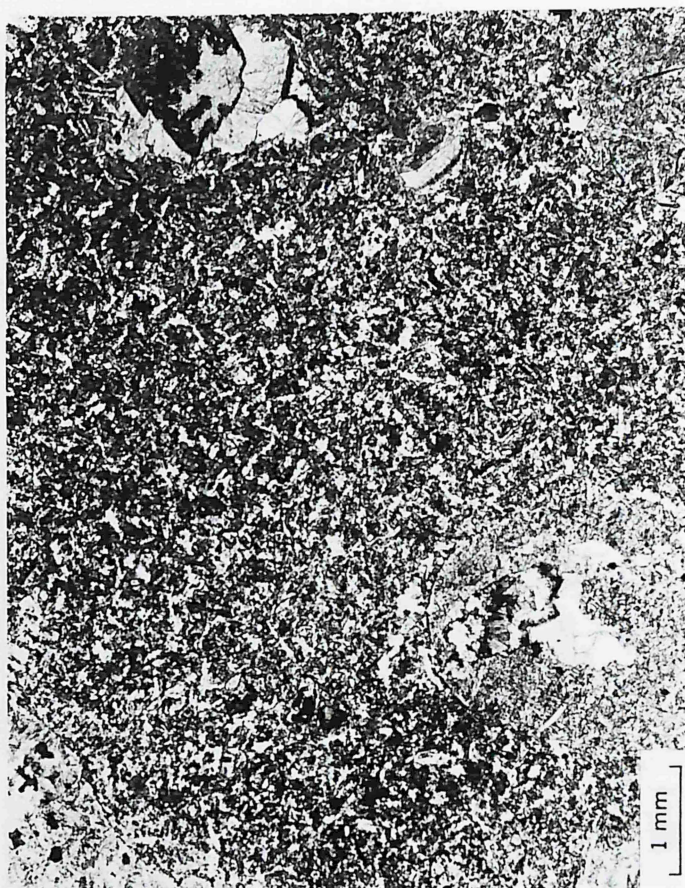


Basalt-calcite (hydrothermal) contact

Figure 5. Columbia County, Florida, Humble Oil and Refining Company J. P. Cone No. 1, 4181'-4206'. Sample from bottom part of core.

Shows contact of basalt and coarse (hydrothermal) calcite. Near the center is a mass of calcite partly enclosed by olive-brown serpentine. (The clear area is where the section broke apart during grinding.) Crossed nicols, X14.

also shows scattered pyritic-calcite amygdules. In thin section, the contact shows a poorly crystallized turbid aggregate, with small poorly-developed plagioclase crystals, and no well-developed augite. There are large ill-defined light colored areas, with skeletal magnetite and thin laths of brown hornblende. Often the middle of these areas is calcitic. (Figure 6). The darker rock, however, away from the contact, is well crystallized, and consists largely of reddish-violet tinted augite in stubby prisms, some larger than the others. There are also chloritized olivines, and inconspicuous poorly-developed feldspar in the groundmass. The few large calcite



Amygdular basalt

Figure 6. Columbia County, Florida, Humble Oil and Refining Company J. P. Cone No. 1, 4256'-4281'. Sample from middle of core. Ordinary light, X14.

vesicles contain euhedral pyrite and are associated with a colorless isotropic mineral, possibly analcite.

In this well basalt-diabase sills are found from 3529' to 4281', or through about 750 feet. The sills are intruded into 962 feet of fossiliferous black shale considered to be Late Silurian or Early Devonian in age (Berdan and Bridge, 1951, p. 69). The association of typical diabase with typical basalt suggests that the two rock types reflect differences of physical conditions under which these bodies crystallized, from a common magmatic source.

MADISON COUNTY
HUNT OIL COMPANY

J. W. GIBSON NO. 2 5385' T.D.

Completed 1945

Well locality 3

Applin (1951) No. 62

Diabase in Paleozoic shale

Igneous rock was not noted by Applin (1951) but cuttings from 5200'-5210' are greenish granular diabasic rock. It appears to be weathered, but microscopic examination indicates hydrothermal alteration rather than weathering. Calcite and bright green chlorite are abundant; very little feldspar remains, it being replaced by fine grained serpentinic or chloritic material. Black magnetite grains are numerous. Figure 7 shows the microscopic aspect of this rock.



Diabase (hydrothermally altered)

Figure 7. Hunt Oil Company J. W. Gibson No. 2, Madison County, Florida, 5200'-5210' (cuttings).

This is volcanic rock, still showing original texture though the constituent minerals have been altered considerably. Ordinary light, X28.

The rock is a hydrothermally altered diabase. A core above it, at the depth of 5154-5162 feet, is dark gray shale containing the trilobite *Colpocoryphe exsul* Whittington, 1953, which is considered late Early or early Middle Ordovician in age (Berdan, 1970, written communication).

TAYLOR COUNTY
GULF OIL COMPANY

BROOKS SCANLON BLK. 42, NO. 1 5517' T.D.

Completed 1949 Well locality 4 Applin (1951) No. 82
Diabase-basalt

"5438'-5517' T.D. is diabase, probably a lava flow. Underlies clastic rocks of Triassic (?) or Jurassic (?) ages." Applin (1951)

Specimens from Core 39 5448'-5453' (recovery 2 ft.) to Core 43 5512'-5517' T.D. (4 ft. recovered, top) were studied. All are of very similar rock, namely brown basalt with conspicuous green serpentinic material. Zeolitization (red heulandite?) is locally conspicuous.

In thin section Core 43, 5512'-5517' T.D. (sample from bottom of core), it is seen to have the characteristic texture of a basalt or diabase; the calcic plagioclase feldspars and augite remain little altered, but the larger crystals of olivine have been completely replaced by iron oxide and iddingsitic material (Figure 8).

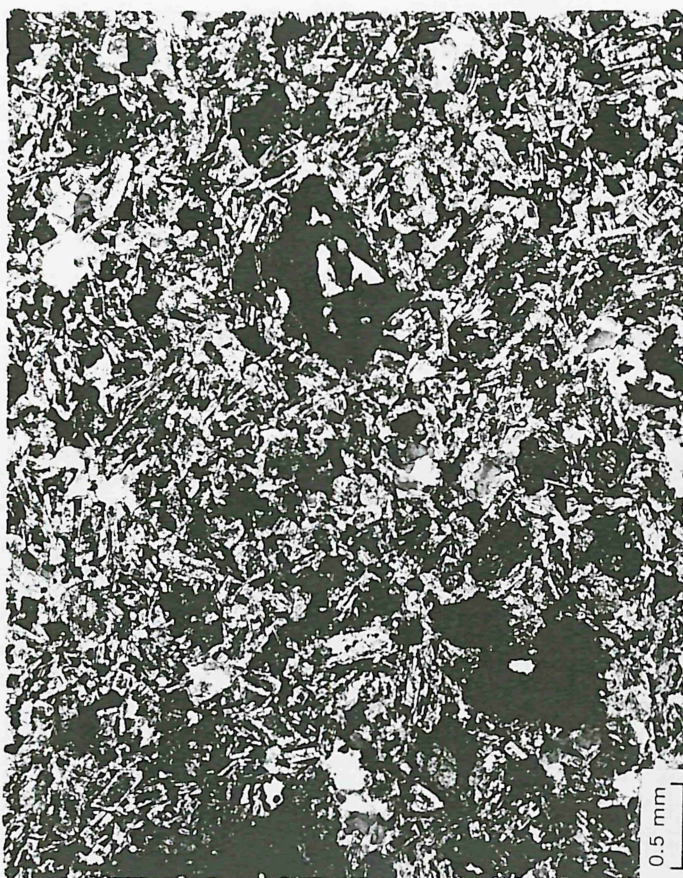


Figure 8. Gulf Oil Company Brooks-Scanlon Blk. 42, No. 1, Taylor County, Florida, 5512'-5517' (bottom of core).

Olivine (?) diabase. The black areas are limonitic replacements of olivine (?) which is also represented by olive-brown serpentinitic areas. Calcic plagioclase and augite are fairly unaltered. Ordinary light, X22.

TAYLOR COUNTY
HUMBLE OIL AND REFINING CO.
HODGES NO. 1 6254' T.D.

Completed 1948

Well locality 5

Applin (1951) No. 83

Diabase-basalt

Applin (1951) states that this "well terminated in diabase gabbro. Underlies early Mesozoic clastic rocks" and "6153'-6165' basaltic rocks; underlies clastic rocks of Triassic (?) or Jurassic (?) age. 6165'-6254' T.D. diabase gabbro."

Core samples are available representing some 96 feet of igneous rock, from 6153½' to 6249', all igneous rock.

The upper ten or twelve feet of the volcanic rock differs from the eighty-five feet of volcanic rock drilled below. The upper zone is highly calcitic, with abundant calcite veins, micro-breccia, and other evidence of possible contamination by ingested limestone. The lower zone is normal diabase. In detail:

Core 111 6151'-61' recovery 7¼', sample at 6153½'

This is a light gray granular volcanic rock, cut by a vertical vein of calcite, a quarter of an inch wide. (Fig. 9)

Gray or green volcanic rock, sample at 6155', and another core fragment, somewhat coarser, with abundant oligoclase-andesine, are almost completely chloritized and calcitized mafics. (Fig 10)

6156' calcitic agglomerate

6159'-60' gray green volcanic, with calcite veins

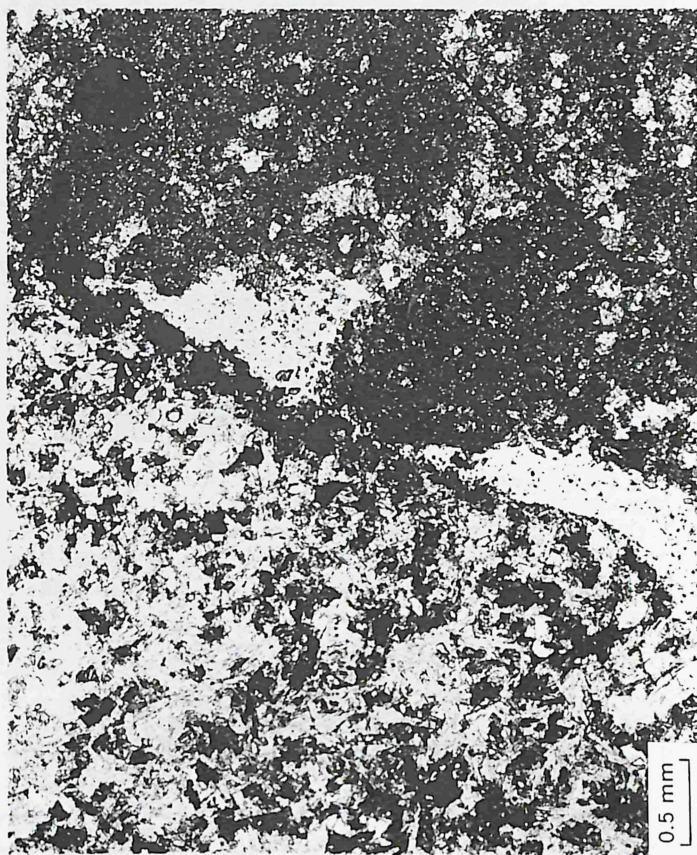


Figure 9. Humble Oil and Refining Co., Hodges No. 1, 6153½', Taylor County, Florida.

Basalt with calcite contact (?); somewhat calcitized basalt-diabase on left, fine grained calcite on right. Ordinary light, X22.

Core 112 6161'-62' recovery 1' sample at top gray green volcanic

Core 113 6162'-80' recovery 18', sample at 6162' top gray green volcanic agglomerate, with pyrite and calcite veins.

at 6162' bottom gray volcanic rock, chloritized mafics but feldspars (oligoclase-andesine) perfectly fresh. Some fresh brown biotite. Calcite veins. Texture rather coarse, grading into diabase.

This rock has been analyzed (Tables 3 and 3a, No. 5)

at 6165½' gray volcanic rock, highly calcareous, probably a volcanic breccia. (Fig. 11)

at 6167' coarse diabase

at 6175' coarse diabase

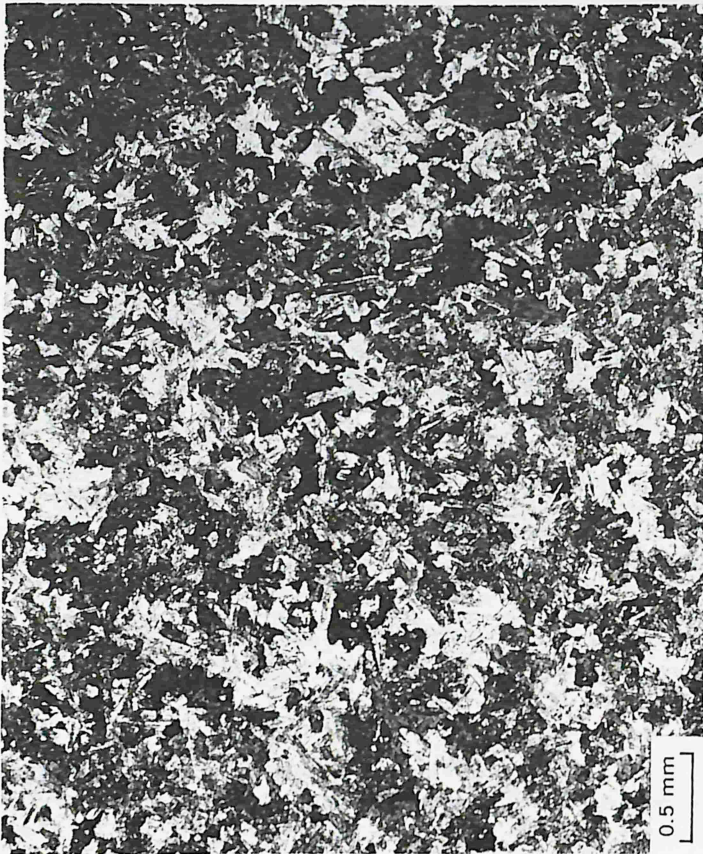


Figure 10. Humble Oil and Refining Co., Hodges No. 1, 6155', Taylor County, Florida. Basalt-diabase. The pyroxenes, etc. are completely calcitized, but the plagioclase feldspar is unaltered. Ordinary light, X22.5.



Figure 11. Humble Oil and Refining Co., Hodges No. 1, 6165½', Taylor County, Florida.

Calcitic explosion breccia? The rock consists of a calcite matrix with rounded fine grained ash (?) and chloritic debris, as well as coarse fresh angular particles of pyroxene, calcic plagioclase, highly altered biotite and micro-pegmatite. Most of the lighter area in the figure is calcite; several rounded ash (?) grains are shown. Ordinary light, X17.



Figure 12. Humble Oil and Refining Co., Hodges No. 1, 6216'-6219', Taylor County, Florida.

Coarse fresh normal diabase, completely unaltered. Ordinary light, X17.

Core 115 6204'-6219'

at 6216'-19' diabase, no chlorite or calcite in thin section; a perfectly fresh normal diabase. (Fig. 12) This rock has been analyzed (Tables 3 and 3a, No. 6)

Core 116 6229'-6254'

at 6246'-49' diabase, with pyrite along cracks.

The two rock analyses are in general quite similar, as might be expected, both being of diabase; however, the first shows both more oxidation of iron and considerably more water especially H_2O .

JEFFERSON COUNTY
COASTAL PETROLEUM CO.
E. P. LARSH NO. 1 7913' T.D.

Completed 1949 Well Locality 6 Applin (1951) No. 54

"Diabase and related kinds of volcanic rocks (7763'-7792' and 7850'-7890'). Sills or dikes in clastic rocks of Triassic (?) age."

Applin (1951)

Samples (cores and cuttings) were examined from 7650' to 7913', including the two igneous intrusives.

They are as follows:

7650'-7660' cuttings — mostly red sandstone; no igneous rock.

7680'-7690' cuttings — red and gray sandstone; no igneous rock.

7690'-7700' cuttings — much diabase with red and gray sandstone.

This indicates a third sill or dike, besides the two indicated above.

7720'-7730' cuttings — These are fresh unweathered diabase.

7760'-7770' cuttings — diabase

7789'-7791' core (1 ft. recovered). This is fresh unweathered diabase, similar to that from 7720'-7730', but somewhat finer grained. Figure 13 shows the typical diabasic micro-structure of this rock.

Another sample from this depth is cuttings, containing much diabase.



Diabase

Figure 13. Coastal Petroleum Company, E. P. Larsh No. 1, Jefferson County, Florida, 7789'-7791'.

This shows the characteristic texture ("ophitic") and mineralogy (essentially augite, calcic plagioclase and ilmenite). The rock is practically unaltered, the only replacement being of olivine (?) by chloritic or serpentinic material. Crossed nicols, X28.

7791'-7795' core (3 ft. recovered). Top foot — this is a very fine grained gray micro-porphyrific basaltic rock, showing some alteration — calcitization and chloritization. It is illustrated in Figure 14. This abrupt change in texture and composition within a few feet indicates that a given magma may crystallize either as basalt or diabase in response to very local conditions; and that correlations based on one or the other type of rock are likely to lead to error. Below this, only sedimentary rock was found.

middlefoot. This is a shaly sandstone.

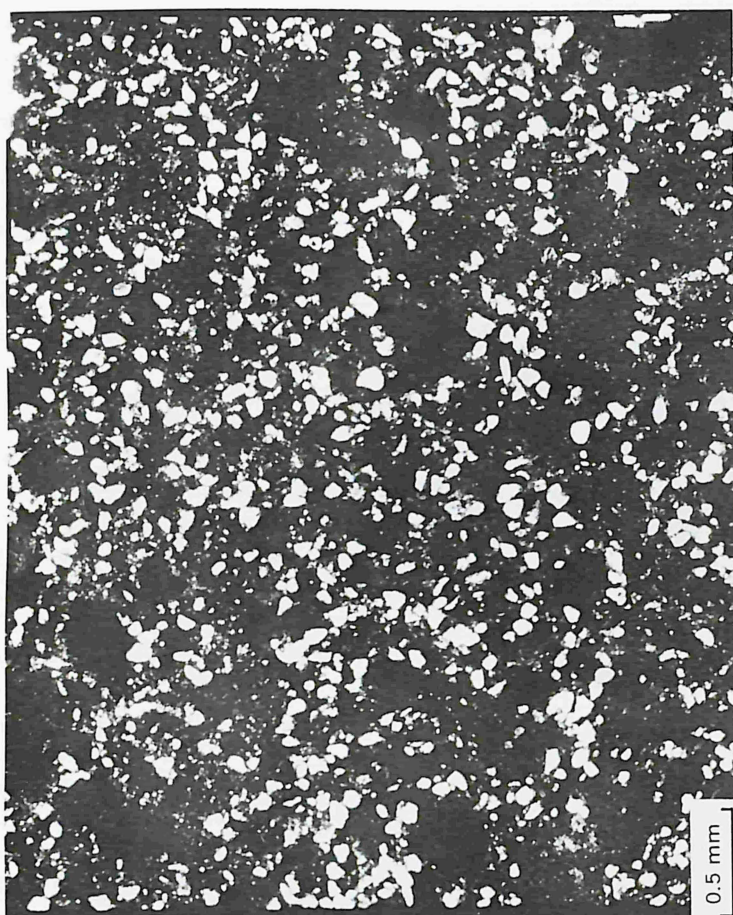
bottom foot. This is similar to the preceding, with less quartz. It may be baked shale (Fig. 15).



Calcitized basalt

Figure 14. Coastal Petroleum Company, E. P. Larsh No. 1, Jefferson County, Florida, 7791'-7795'.

Although the plagioclase feldspars are unaltered, the mafic minerals of the basalt are replaced by calcitic material. Ordinary light, X 28.



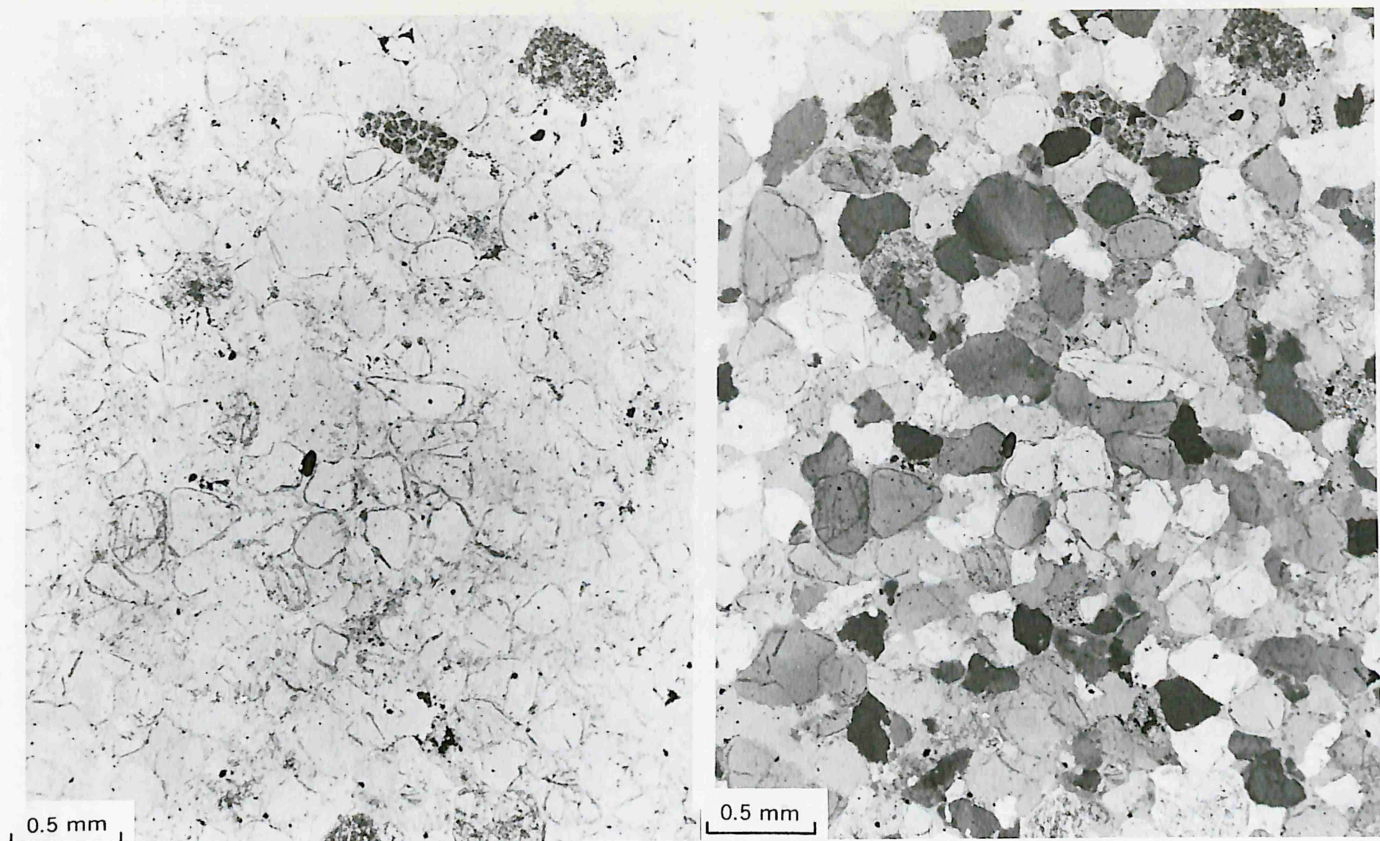
Baked shale (?)

Figure 15. Coastal Petroleum Company, E. P. Larsh No. 1, Jefferson County, Florida, 7791'-7795'.

Shows angular quartz particles in very fine grained dark crystalline matrix. Ordinary light, X 28.

7909'-7911' (1½' recovery) This is a whitish sandstone, almost wholly quartz, with strong evidence of recrystallization — almost all the quartz grains show peripheral secondary growth, and clay is recrystallized to sericite. There is also green tourmaline, in minute grains, also probably authigenic (Fig. 16 a, b).

7911'-7913' (1½ ft. recovery) Sample from bottom 1 ft. 10 in. of core. Two different specimens: One is hard rather coarse sandstone, light colored; the matrix of the quartz grains however is well recrystallized into pale green chlorite. The other specimen is rounded pebbles (1 cm. across) of red very fine grained shale, possibly volcanic ash.



Sandstone

Figures 16 a, b. Coastal Petroleum Company, E. P. Larsh No. 1, Jefferson County, Florida, 7909'-7911'.

This shows features which may perhaps be related to thermal metamorphism. Many of the quartz grains show secondary enlargement, the original detrital grains being outlined by the dark rims seen in the illustrations, with new quartz being deposited in optical continuity outside the rim. The two dark areas were chalcedonic silica, now recrystallized to quartz. The small black particles are hematite (?) associated with sericitic mica. Calcite is present, into which the quartz has grown with sharp crystal faces. Ordinary light and crossed nicols, X28.

In summary, a series of sandstones and shales was intruded by diabase or related rock at (or not far above) 7690', 7720'-7730', and again at 7789'-91', 7791'-95'. Below this to 7913' T.D. there are indications of volcanic activity, but no specimens of actual volcanic rock.

FRANKLIN COUNTY

CALIFORNIA CO. AND COASTAL PETROLEUM CO., NO. 2

Well locality 7

State Lease 224a. Latitude 29°47'03" N Longitude 84°22'51" W
South Shoal area about 13 miles offshore from Carrabelle, Florida T.D.
10566' (driller), 10507' (electric log). Completed 1961.

This well drilled into 10 feet of diabase at 10460 ft. (Data from P. L. Applin, written communication 1967).

Specimens are available as follows:

10318-19	10324-25
10320-21	°10325-26
10321-22	10326-27
10322-23	10327-28
10323-24	°10328-32½

These are all pinkish quartzitic sandstone (cored), well-indurated some with white clayey specks. Figure 17 illustrates 10325'-10326'. The Sandstone from 10328'-10332½' contains much calcite.

°10460-70	10510-20
10470-80	°10520-30 (Figure 18, basalt-diabase). Figure 19 baked shale.
10480-90	10530-40
10490-10500	10540-50
10500-10	10550-60

These all contain diabase fragments, admixed with sandstone.

°Thin sections

JACKSON COUNTY

HUMBLE OIL AND REFINING COMPANY

C. W. TINDEL NO. 1 T.D. 9245'

Completed 1949 Well locality 8 Applin (1951) No. 53

Applin (1951) refers to this as follows:

"8890'-8932' Porphyritic hornblende basalt. A small intrusive or flow in Paleozoic rocks," with a thickness of 42 feet. However, the overlying sandstone 8881'-8891' (top 5½ feet) is a fine grained reddish sandstone showing structures interpreted as being due to contact metamorphism, indicating an intrusion rather than a surface flow. A specimen from the bottom 6½ feet of this core is hard fresh fine grained basalt, showing marked calcitization.

Six specimens of the core from this well are:

Core 100 8521'-8526' (sic) fine grained red siltstone

Core 120 8737'-8742' fine grained gray siltstone

Both of these are similar to the siltstone specimens below the igneous rock.

Core 130 8881'-8891' (top 5¼ feet) fine grained light reddish brown siltstone. It shows disturbance and internal dislocation (fig. 20), and is interpreted as a mildly contact-metamorphosed siltstone overlying the intrusive rock, represented by the following specimen.

Core 130 8881'-8891' (bottom 1 ft. of 6½ ft. recovery) This is hard fresh fine grained basalt, strongly calcitized. Abundant calcic plagioclase is fairly fresh, as is also minor brown hornblende; but large areas in the



Figure 17. California Co. and Coastal Petroleum Co. No. 2, Franklin County, Florida 10325'-10326'.

Sandstone with rounded quartz grains showing secondary growth. Well crystallized calcite and dickite (?) aggregates occur interstitially. Ordinary light, X36.

thin section, formerly pyroxene or olivine, are now vague brownish aggregates of calcite, chlorite, and clayey material. Small brownish euhedral opaque ore grains, with somewhat large masses of pyrite, are fairly abundant; and quartz filled amygdules are present. Figures 21a, b illustrate this rock.

Core 136 8987'-8997' is fine grained red standstone.

Core 141 9232'-9237' is fine grained gray calcareous siltstone, uniform in thin section, unlike the siltstone overlying the basalt.

Core 142 9237'-9242' is similar.



Figure 18. California Co. and Coastal Petroleum Co. No. 2, Franklin County, Florida 10520'-10530'.

Calcitized Basalt. The basalt consists almost wholly of fresh plagioclase in an obscure matrix largely calcite; with some ilmenite. Ordinary light X29.

In summary, these four samples indicate that a 42 foot basaltic sill intruded a siltstone series in which the well bottomed 313 feet below the igneous rock, at 9245' T.D. The siltstone contains plant fragments identified by S. H. Mamay as *Psilophyton* s.l., indicative of an Early or Middle Devonian age (Berdan, written communication, May, 1970).



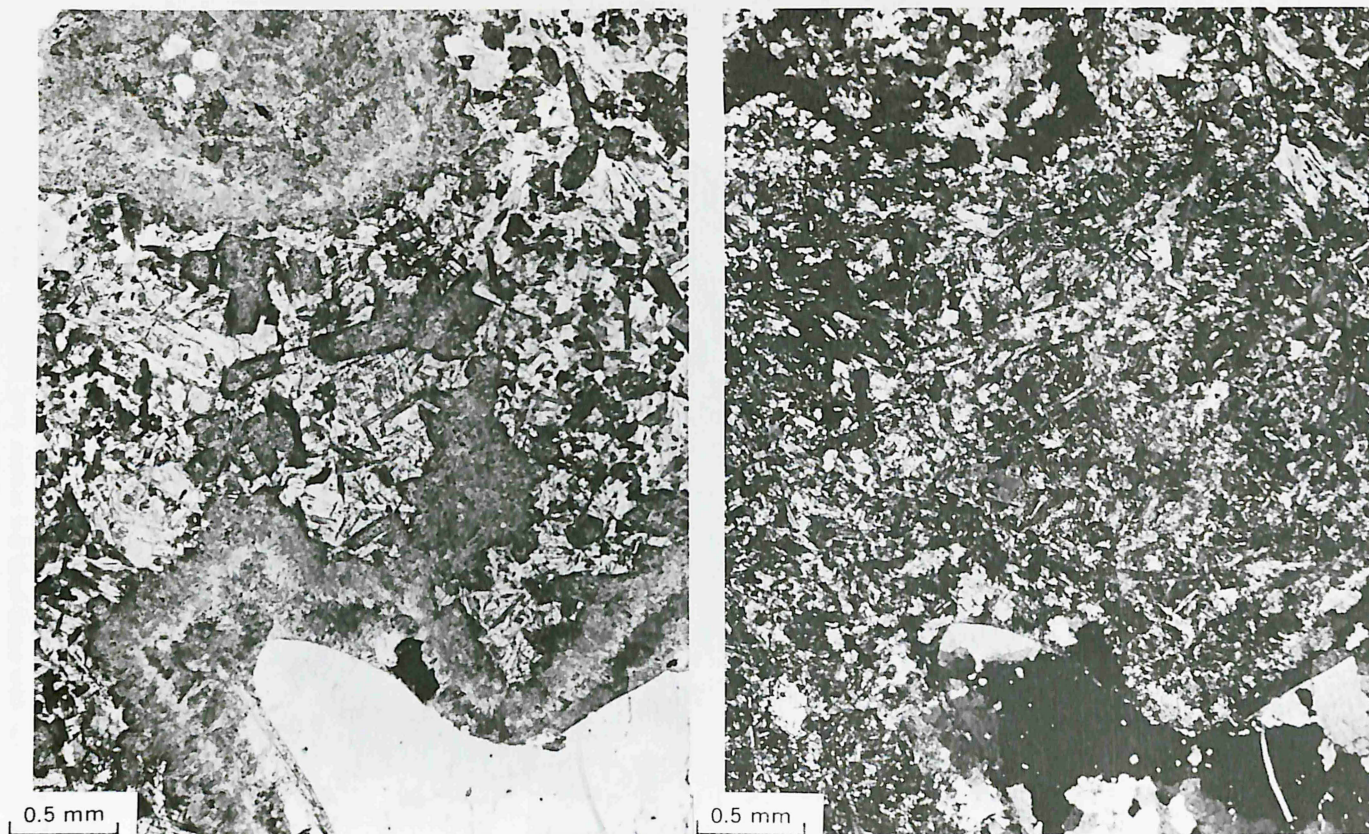
Figure 19. California Co. and Coastal Petroleum Co. No. 2, Franklin County, Florida 10520'-10530'.

Baked shale. The dark areas are calcareous, and appear to represent foraminifera. The gray matrix is a mud-stone with minute angular quartz particles. Ordinary light X17.



Figure 20. Humble Oil and Refining Company C. W. Tindel No. 1, Jackson County, Florida, 8881'-8891' (top 5%).

Fine grained siltstone overlying basalt and showing flowage and other metamorphic effects. Ordinary light, X13.



Amygdaloidal (quartz) Basalt

Figures 21 a, b. Humble Oil and Refining Company C. W. Tindel No. 1, Jackson County, Florida, 8881'-8891'.

Quartz amygdule (bottom) surrounded by highly calcitized zone in basalt. Another large calcitized area, with very minor quartz, is seen upper left. The slightly darker smaller areas are calcitized pyroxenes. Ordinary light and crossed nicols, X28.

WALTON COUNTY
PAN AMERICAN PETROLEUM CO.
J. R. SEALY NO. 1 T. D. 11948 FT.
Sec. 9 T1S R18W Center SE $\frac{1}{4}$ SE $\frac{1}{4}$.

Completed 1950.

Well locality No. 9.

Top of volcanic rocks 11910 ft. Fragments (cuttings) 11935'-11940' heavily altered porphyritic rhyolite.

Data from P. L. Applin (written communication 1967). Specimens were examined as follows:

11920'-11930' - Sandstone, arkose and felsite

11930'-11935' - Sandstone, arkose and felsite

11935'-11940' - Rhyolite porphyry ash with obscure shard structures in trix of plagioclase, phenocrysts. Also much sandstone, etc. Figures 22, 23.



Figure 22. Pan American Petroleum Sealey No. 1, 11935'-40'; Walton County, Florida.

Sericitized rhyolite porphyry or ash, with feldspar phenocrysts. Ordinary light X35.

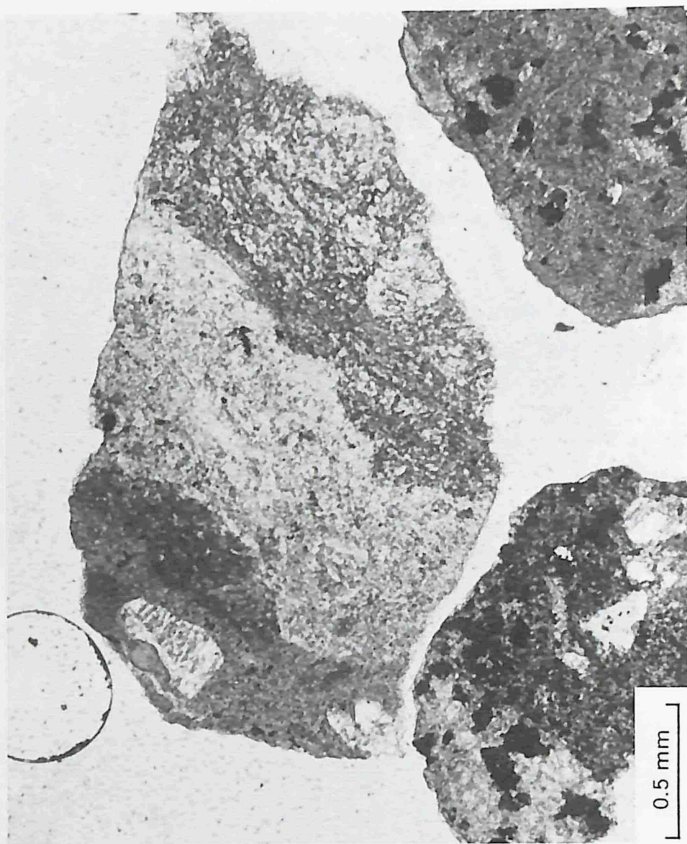


Figure 23. Pan American Petroleum Sealey No. 1, 11935'-40', Walton County, Florida. Sericitized rhyolite or ash. Ordinary light X35.

- 11940'-11945' - Rhyolite porphyry ash with obscure shard structures in matrix of plagioclase, phenocrysts. Also much sandstone, etc.
- 11945'-11950' - Rhyolite porphyry ash with obscure shard structures in matrix of plagioclase, phenocrysts. Also much sandstone, etc.

HUMBLE OIL AND REFINING COMPANY,
J. W. CAMPBELL NO. 1 FLAGLER CO., FLORIDA

Completed 1947 T. D. 4632' Well locality 10. Applin (1951) No. 19.

"Mixed tuff derived from an igneous complex. Origin, sedimentary or explosive igneous action." F. F. Grout. P. L. Applin (1951) Applin notes that the igneous rock was encountered at 4588' and drilling continued in such to 4632' T. D.

The samples available have two recorded depths, one of them "corrected" 12' less than the other. The depths cited above are "corrected."

Cores for the interval 4560' to 4575' were studied as follows:

Core 67 4560'-70' recovery 8½ feet top, middle and bottom, all friable white sandstone.

Core 68 4570'-75' top friable white sandstone; middle buff to red friable sandstone; bottom hard indurated red sandstone.

The top of the igneous rock in this well is at 4588'. Possibly the change noted in the last core 68 may be caused by the igneous rock found 13 feet lower down; but this interval is not represented by any sample.

Cores beginning at 4601' in the igneous section were studied as follows:

Core 69 (top) 4613'-18' recovery 3 ft. corrected measurement 4601'-06'

(bottom) 4613'-18' recovery 3 ft. corrected measurement 4601'-06'

Both samples are rather fine grained volcanic rock, the first reddish, the second darker. Whitish clayey material coats the surfaces and veins the core pieces.

Core 70 (top) 4618'-4624' recovery 3' corrected measurement 4606'-12'

(middle)

(about 6" above bottom)

These three samples are similar to preceding.

(bottom 6" approximately) This is dark gray fine grained rock, showing (in 1 inch fragments) no agglomerate structure or clay veining or coatings.

Core 71 4624'-4624¾" recovery 6" corrected measurement 4612'-4612¾" This is a fine grained dark gray rock.

Core 72 4624¾"-4626' corrected measurement 4612¾"-4614' This specimen is a fine grained gray rock, with white clayey patches. In thin section shows a heterogeneous agglomerate of heavily altered basaltic debris and quartzite particles, seamed with veinlets of calcite and, possibly, pumellyite. Figure 24 illustrates this rock. Without the thin section, the rock could be termed fine grained basalt, but this rock, and presumably the others above it, are almost certainly altered volcanic ash.

Core 73 No recovery

Core 74 4627'-29' recovery 6" corrected measurement 4615'-4617'

No thin section is available, but careful inspection under a binocular microscope suggests that it is like the preceding.

Core 75 4627'-29' recovery 1' corrected measurement 4615'-17'

Similar - dense dark gray fine grained.

Core 76 4630'-31' recovery 1' corrected measurement 4618'-19'

Similar

Core 77 4631'-32' recovery 1' corrected measurement 4619'-20'

Similar



Figure 24. Humble Oil and Refining Company, J. W. Campbell No. 1, Flagler County, Florida. 4624 $\frac{1}{2}$ '-4626'.

This is a volcanic agglomerate, perhaps hydrothermally altered ash. Calcite hornblende veinlets cut the rock. The two light colored areas at the left edge are aggregates of acicular pale green hornblende; the clear areas at the right are granular quartz. The dark areas are mostly aggregates of extremely fine black opaque material; a few are magnetite-ilmenite. Under high magnification, yellow epidote (?) and brown sphene in irregular grains are seen. Ordinary light, X22.

Core 78	4632'-33'	recovery 1'	corrected measurement 4620'-21'
Similar			
Core 79	4633'-34'	recovery 6"	corrected measurement 4621'-22'
Similar			
Core 80	4634'-35'	recovery 10"	corrected measurement 4622'-23'
Similar			
Core 81	4635'-36'	recovery 1'	corrected measurement 4623'-24'
Similar			

Core 82 4636'-37' recovery 1' corrected measurement 4624'-25'

Similar. Some of the preceding have white, greenish, or in this core, reddish veinlets. Some veinlets are mostly calcite; this one is a zeolite.

Core 83 4637'-38' recovery 8" corrected measurement 4625'-26'

Similar

Core 84 4638'-39' recovery 1' corrected measurement 4626'-27'

Similar; fine grained dark gray, with greenish veinlets one or two millimeters wide. In thin section, an aggregate of rhyolitic and other igneous fragments, including altered feldspars and pale green hornblende. Some of the rhyolite fragments have micro-pegmatitic structure. (Fig. 25)

Core 85 4639'-40' recovery 1' corrected measurement 4627'-28'

Similar

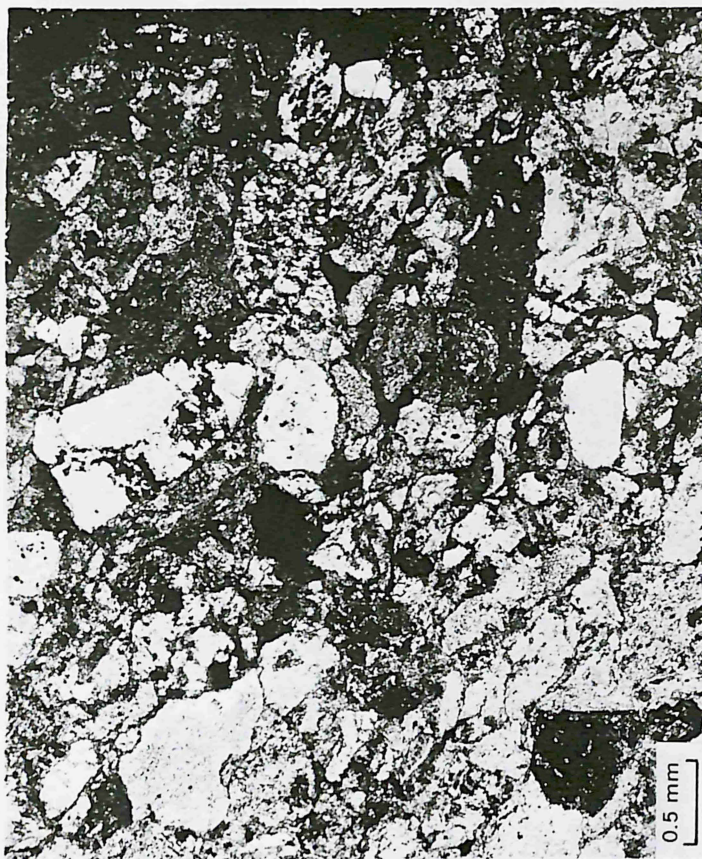


Figure 25. Humble Oil and Refining Company, J. W. Campbell No. 1, Flagler County, Florida. 4638'-4639'.

Volcanic agglomerate-ash. The clear areas are quartz; the finely dotted area, lower left, devitrified glass. Coarse feldspar grains, and greenish pyroxene (?), both heavily altered, can be seen. Ordinary light, X22.

Core 86 4640'-41' recovery 1' corrected measurement 4628'-29'
Similar

Core 87 4641'-42' recovery 1' corrected measurement 4629'-30'
Similar

Core 88 4642'-43' recovery 9" corrected measurement 4630'-31'
Similar, with fine salmon colored zeolite in veinlets.

Core 89 4643'-44' recovery corrected measurement 4631'-32' T.D.

Similar. In thin section an agglomerate of shattered quartz grains, basaltic fragments, altered feldspars and mafic minerals, and black opaque dust and iron oxide. (Figs. 26a, b)

Bass (1969) gives petrographic date for a sample designated as "4641-4642 ft. A sample of Core 87, from this depth, 1 ft. recovery is fine grained dark gray tuff."



Figures 26a. b. Humble Oil and Refining Company, J. W. Campbell No. 1, Flagler County, Florida. 4643'-4644'.

Volcanic agglomerate ash. The clear areas are mostly quartz, others are feldspathic. Large Carlsbad — twinned feldspars are seen in thin section, as large or even larger than the quartz aggregates, suggesting that the latter too are of volcanic origin (phenocrysts) and not fragments of engulfed sedimentary quartzite or sandstone. Ordinary light and crossed nicols, X22.

PUTNAM COUNTY
SUN OIL COMPANY

H. E. WESTBURY ET AL. 3892' T.D.

Completed 1949. Well locality 11 Applin (1951) No. 25

"Volcanic ash and tuff." Applin (1951).

Bass (1969) has described core specimens from this well, as noted below.

This well drilled into 19 feet of volcanic ash. Samples are available from 3872' to 3892' T. D.

Core 190 3872'-74' recovery 7" mid 3 inches (specimen).

Hard reddish clayey rock with rounded quartz grains. The clay swells and disintegrates in water, suggesting bentonitic volcanic ash.

bottom 3 inches: rather friable white clayey rock, no quartz grains.

Bass (1969) describes the material from 3871.5 to 3874 ft. as perhaps a silty mudstone or a thoroughly weathered tuff; from 3876 to 3878 ft. as microcrystalline welded tuff or pumice.

Core 193 3878'-3879' recovery 12" hard very fine grained reddish rock.

Bass (1969) describes this rock as laminated tuff.

Core 194 3879'-3881' recovery 20" like the preceding with ellipsoidal bleached areas a centimeter or two across. In thin section, it is seen to be volcanic ash (Figure 27). It contains a marine (?) fossil.

This sample has been analysed (Table 3).

Core 195 3881'-3883' recovery 24"

top 1 inch: similar to preceding.



Figure 27. Sun Oil Company, H. E. Westbury et al. No. 1. Putnam County, Florida. 3879'-3881'.

Ash with fossil, upper right. The other structures seem to be intensely altered fine-grained volcanic fragments. The dark areas are iron-stained. Ordinary light X22½.

Bass (1969) describes this core as lithic-crystal tuff with relict shard structure.

bottom 1 inch: similar to preceding, grading from reddish to white.

Core 196 3883'-3885' recovery 12" Similar to preceding. In thin section the reddish areas in the specimen are seen to be colored by reddish hematitic (?) dust, whereas the white areas are pale green, and chloritic. A few highly altered fragments of coarser volcanic rock are imbedded in an extremely fine grained clayey matrix.

Core 197 3885'-3887' recovery 17" This is more grayish in color, but otherwise like the preceding. In thin section it shows shard structures. Bass (1951) gives further details. (Fig. 28)



Pyroclastic

Figure 28. Sun Oil Company, H. E. Westbury et al. No. 1, Putnam County Florida, 3885'-3887'.

Fine-grained rock, with scattered sodic plagioclase feldspar crystals (white). The white streaks are minute fissures filled with quartz. Ordinary light X17½.

Core 198 3887'-3889' recovery 12" This is bluish gray ash, with numerous reddish grains a millimeter or two across. They are usually feldspar, either single large crystals, or granular aggregates, or highly feldspathic rhyolite. Some fragments consist of aggregates of almost colorless spherulitic chlorite.

Bass (1969) describes this core: Clastic vaguely laminated welded tuff. Core 199 3889'-3890' recovery 10" Similar to preceding with fairly large (several millimeters or more) fragments of well crystallized rhyolite and single unaltered plagioclase feldspars; also quartz grains.

Bass (1969) describes this core as clastic volcanic conglomerate or agglomerate. (Fig. 29)

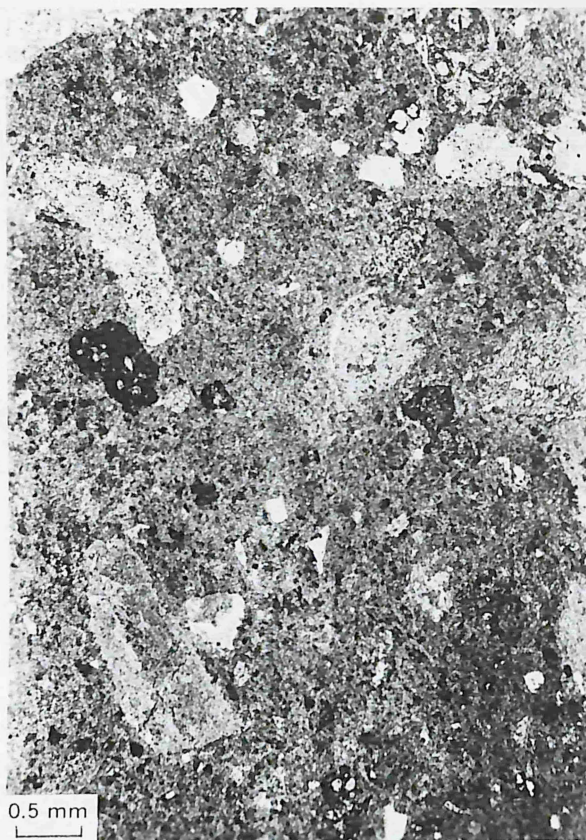


Figure 29. Sun Oil Company, H. E. Westbury et al. No. 1, Putnam County, Florida. 3887'-3891'.

Shows heterogeneous character. The large fragment (lower left) suggests either a shattered quartz crystal or a fine-grained sandstone. Ordinary light X17½.

Core 200 3890'-3892' T.D. recovery 24" Similar to preceding. (Fig. 30)

Bass (1969) describes this as similar to his preceding sample, with laminated welded tuff.



Figure 30. Sun Oil Company, H. E. Westbury et al. No. 1, Putnam County, Florida. 3890'-3892' T.D.

Shows variegated structure (fine and coarse). The coarse is largely quartz. Ordinary light X17½.

MARION COUNTY, FLORIDA

SUN OIL COMPANY

HENRY N. CAMP NO. 1 T.D. 4637'

Completed 1947 Well locality 12 Applin (1951) No. 23

"Vocanic agglomerate or tuff of rhyolitic composition. 'Mixed tuff derived from an igneous complex.' F. O. Grout." Applin (1951)

Applin gives 22 feet of volcanic rock beginning at 4615 ft.

Bass (1969) describes specimens from this well, as noted below. He describes cuttings from 4500 to 4610 ft. and core from 4574 to 4584 ft. as coarse grained conglomeratic sandstone loosely cemented by chlorite; about 1 percent or less of the sandstone is rhyolitic ash.

Only two samples are available:

Core 22 4574'-4584' (two different rock types)

a) fine grained ash?

b) coarse grained agglomerate or arkose fragments a milimeter or two in size. (Figure 31)

There is such a difference between these two specimens that it is possible that the coarse grained rock (b) is mislabeled. It shows definite indications of metamorphism by igneous contact, and contains fragments of rhyolitic rock (fig. 28) with coarse quartz and feldspar. The matrix has been recrystallized to micaceous aggregates.

Core 23 (bottom) 4623' Again there are two somewhat contrasting specimens, one a coarse volcanic agglomerate, the other rhyolitic welded tuff or rhyolite, with large quartzes and sodic feldspars. Both however, could well represent variant phases of a single ash fall, shifting winds and variations in explosive activity in the crater causing marked changes in material deposited at any one point.

Ross (1958) cited by Bass (1969) found 4618 to 4653 ft. to be welded tuff. Bass also found cuttings from 4610 to 4630 ft. to be rhyolitic welded tuff.

Dorothy Carroll (1963, p. All, Fig. 6) found her heavy mineral assemblage A in quartzite at the Camp well at a depth of 4376-4383 feet below sea level (core 121). This assemblage also occurs in quartzite in Humble Oil and Refining Co. C. E. Robinson No. 1 (Levy County) which is considered to be Early Ordovician in age on the basis of fossils. The quartzite in core 121 from the camp well is also probably Early Ordovician (Berdan, 1970, written communication).

Three other wells have been drilled in Marion County in none of which igneous rock was reported. They are:

J.S. Cosden, W. L. Lawson No. 1 4334' T.D.

Ocala Oil Corp., Clark-Ray-Johnson No. 1 (York) 6180' T.D.

Sun Oil Co., H. T. Parker No. 1 3845' T.D.

All are reported to have bottomed in quartzitic sandstone (P. L. Applin,

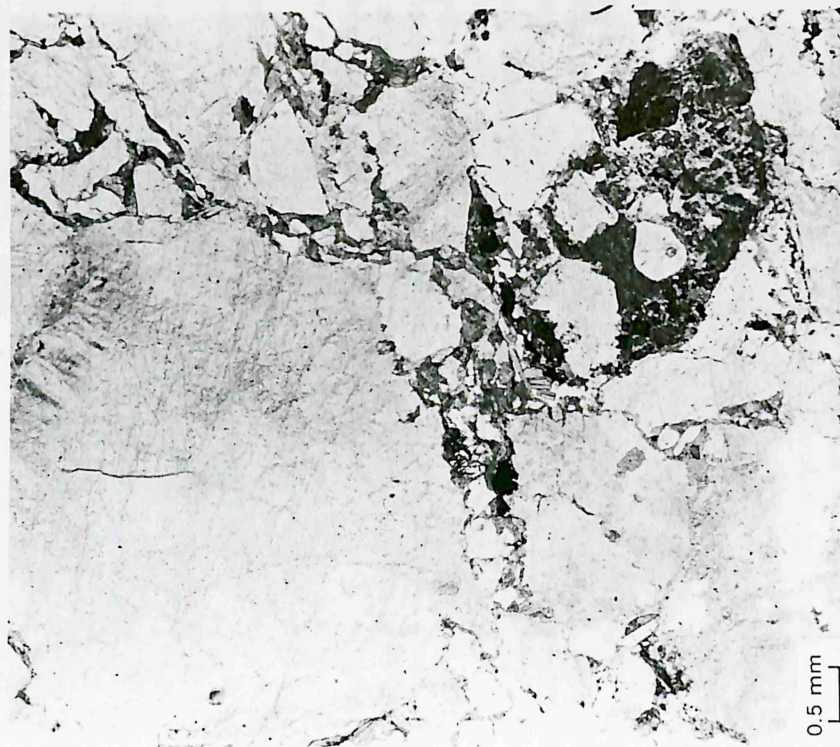


Figure 31. Sun Oil Company, Henry N. Camp No. 1, 4574'-4584', Marion County, Florida.

Coarse agglomerate or arkose. Shows large quartz grains with micro-brecciated structure. The dark grain lower right is rhyolite, with typical rounded quartz phenocryst. Ordinary light X14.

1951), of probable Early Ordovician age (Berdan, 1970, written communication).

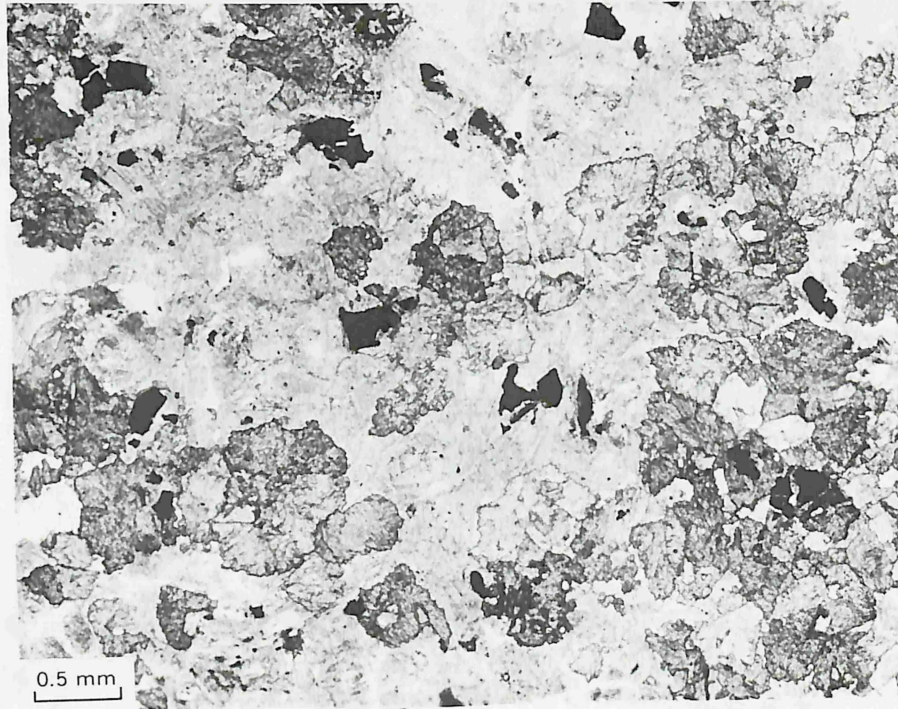
The Sun Henry N. Camp N. 1 with volcanics at 4623' is only about 20 miles east of Ocala Oil Corp. Clark-Ray-Johnson No. 1 (York), which reportedly found no igneous rock down to 6180' T.D.

LEVY COUNTY, FLORIDA
HUMBLE OIL AND REFINING CO.
C. E. ROBINSON NO. 1 T.D. 4609'

Completed 1949 Well locality 13 Applin (1951) No. 60
"4317'-4344' decomposed igneous rock; underlies lower Cretaceous sandstone. 4344'-4377' basalt; overlies altered black shale of Paleozoic age." (Applin 1951)

Three very small samples are available. There is some question as to exactly which cores they represent. The depths, however, are believed to be correct.

Core 59 (?) 4331'-4336' This is a rather coarse granular aggregate, mostly greenish, but also brownish grains. In thin section, the rock is seen to consist of a chlorite-clay(?) matrix with abundant carbonate (dolomite?) areas, both with rather obscure radial crystallization. Coarse opaque grains, some ilmenite, other leucoxene and limonite, are numerous. Quartz is almost absent. (Figure 32).

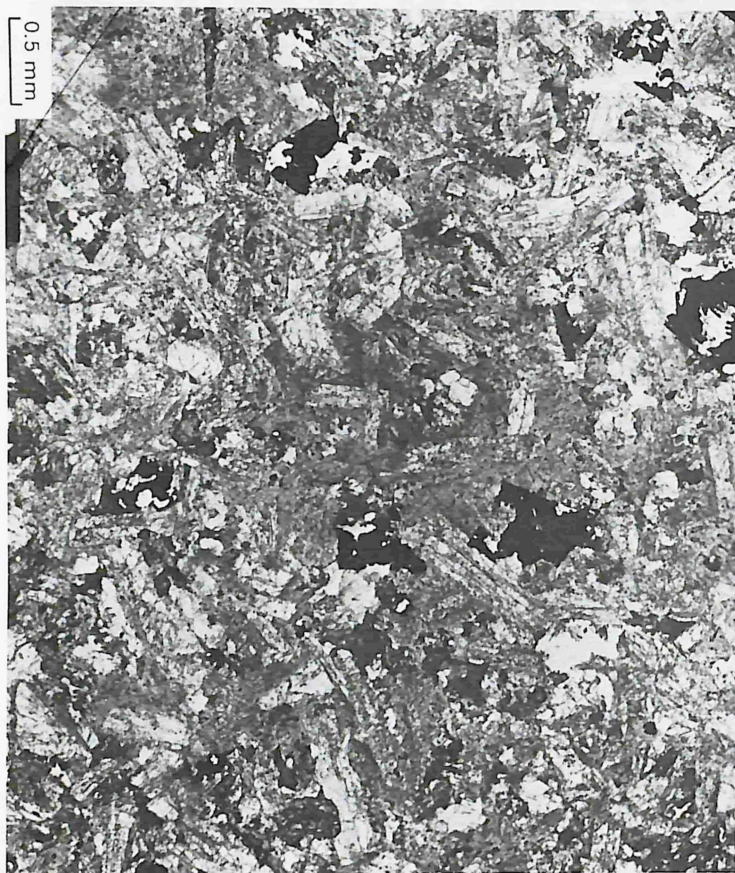


Calcitized basalt

Figure 32. Humble Oil and Refining Company, C. E. Robinson No. 1, Levy County, Florida, 4331'-4336'. Radially crystallized masses of dolomite (?) in a chloritized matrix. Feldspars are replaced by obscurely radial clay (?) material, mafic minerals by pale green chlorite. Ordinary light, X22½.

Core 59 (or 60?) 4344'-4356' near top "overlain by 8 ft. of red clay" — Applin. This is a fairly hard light gray rock. In thin section, it is seen to be a diabasic rock, with fresh plagioclase and calcitized augite. It shows to a relatively minor degree the same type of hydrothermal alteration seen in the preceding specimens (Fig. 33). Pyrite unaltered to limonite, and ilmenite unaltered to leucoxene, are present. The "red clay" of Applin may represent an intensely altered part of the igneous body.

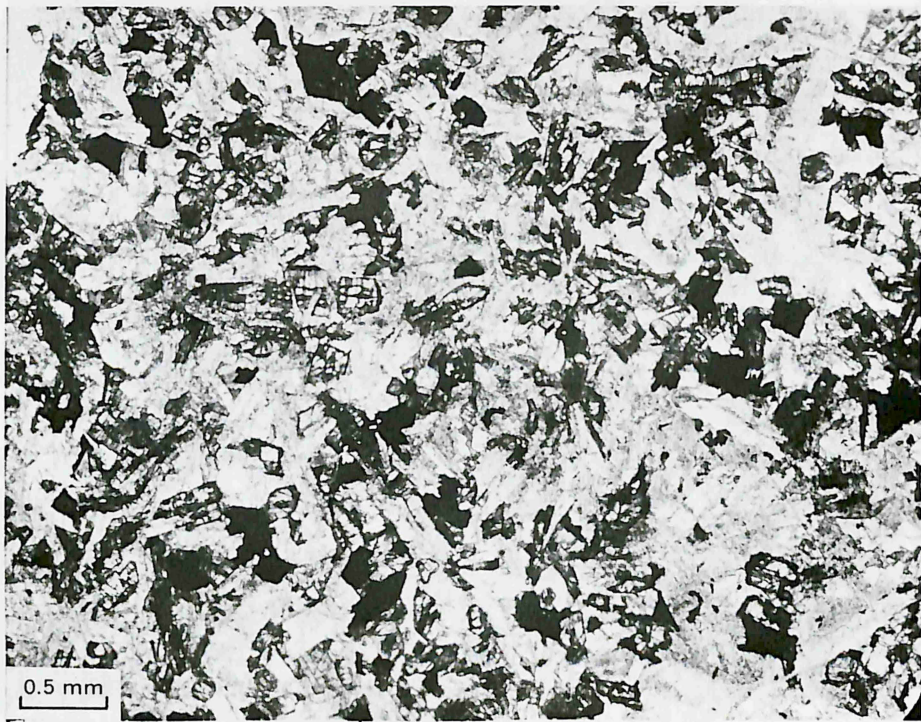
Core 59(?) 4358'-4359' This is augite diabase, showing none of the alteration of the preceding samples (Fig. 34).



Calcitized basalt or diabase

Figure 33. Humble Oil and Refining Company, C. E. Robinson No. 1, Levy County, Florida, 4344'-4356' (near top).

Although the plagioclase is unaltered, nearly all the augite is replaced by calcite. The black areas are mostly fresh magnetite-ilmenite with a little pyrite. Minor quartz is present and green chlorite. Ordinary light, X22.5.



Almost unaltered diabase

Figure 34. Humble Oil and Refining Company, C. E. Robinson No. 1, Levy County, Florida, 4358'-4359'. Ordinary light, X22.5.

Although the 28 feet of igneous section appears to show a progressive degree of alteration from top to bottom, this may not be the result of weathering, but of hydrothermal alteration.

"The diabase in the Robinson well overlies 232 feet of quartzitic sandstone with minor amounts of shale, which is dated as Early Ordovician on the basis of linguloid brachiopods" (Berdan and Bridge, 1951, p. 70).

VOLUSIA COUNTY

GRACE DRILLING CO.,

RETAIL LUMBER CO. NO. 1 T.D. 5424'

Completed 1949 Well locality 14 Applin (1951) No. 26
"Rhyolitic (?) volcanic rock" Applin (1951).

Applin (1951) reports that this well drilled 21 feet in volcanic rock. A specimen of cuttings from 5424½' T.D. show arhyolitic rock almost wholly plagioclase feldspar (near oligoclase-andesine) with a little quartz and little or no mafic minerals. It is illustrated in Figure 35.

This well is less than 20 miles NNW of the Sun Co. Powell Land Co. No. 1, which at a depth of 5922' drilled rock reported as over 400 m.y. age.



Rhyolite

Figure 35. Grace Drilling Co., Retail Lumber Co. No. 1, Volusia County, Florida. 5424½ T.D.

The volcanic rock consists almost entirely of moderately sodic plagioclase in interlocking aggregates of lath shaped crystals, some porphyritic and euhedral, and very minor interstitial quartz. The feldspar is slightly sericitized, with reddish dust giving it a brownish tint in section. Some black ore grains, and a little calcite, are present. The large rectangular crystal is plagioclase feldspar. Ordinary light, X27.

VOLUSIA COUNTY
SUN OIL CO.

POWELL LAND CO. NO. 1 5958 ft. T.D.

Completed 1946 Well locality 15 Applin (1951) No. 7
Hornblende diorite (Applin 1951)

This is one of the three wells in east central Florida that Applin (1951) considered to have reached the "metamorphic basement," the others being Lake County, J. Ray Arnold No. 1 and Osceola County, N. Ray Carroll No. 1. Later the St. Lucie County, Amerada Cowles Magazine No. 2 and Hillsborough County, Humble T. S. Jamison No. 1 drilled into similar "metamorphic" rock.

Bass (1969) has studied specimens from this well in great detail as noted below.

Nineteen specimens from this well, representing depths from 5903' to 5958' T.D. have been studied. "According to D. J. Munroe (Sun Co. Geologist*) this well encountered a weathered zone? beginning at 5910' . . ." memo to Watson Monroe from Applin, April 3, 1947. The following are notes on the samples studied:

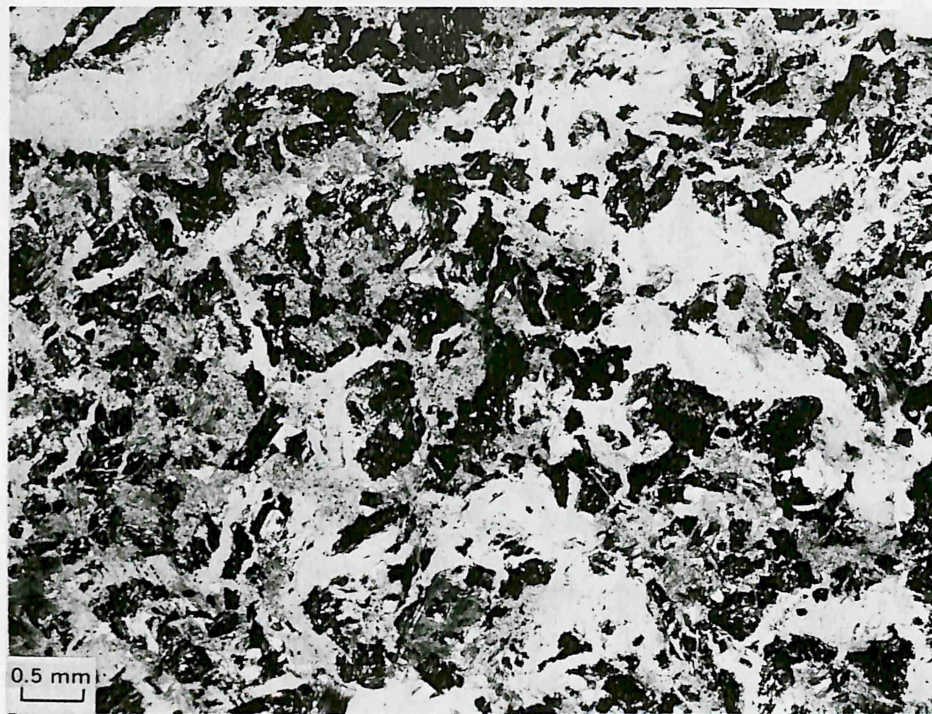
Side Wall Core	5903'	White Sandstone
Side Wall Core	5906'	White sandstone
Cuttings	5910'-20'	White sandstone, etc.
Cuttings	5920'-30'	White sandstone, etc.
Core 178	5922'-25'	3' recovery, top of core. Soft coarse volcanic rock, now clay, but with original texture. (Figure 36)

Core 178 5922'-25' has been interpreted as possibly a weathered zone, and indeed there is a striking contrast between the white sandstone and the underlying volcanics, with no indication that the sandstone has been metamorphosed by the volcanics. In other words, the sandstone deposition is subsequent to the consolidation of the igneous rock. In thin section, the rock is seen in Figure 36. Rather than weathering, intense hydrothermal alteration is possible. The rock is illustrated in Figure 36. Minute angular fragments of fairly fresh alkalic feldspar are seen sparingly, surrounded by clay. Vivid green, strongly pleochroic (yellowish to bright green) platy-fibrous chlorite-like mineral may be ferrostilpnomelane. Small apatite crystals are present.

Bass (1969) classes the rock from 5922-25 ft. as "either transported material or weathered basement rock that was mixed with overlying material during mass movement."

Cuttings	5930'-40'	White sandstone, volcanic debris
Cuttings	5940'-50'	Volcanic debris, white sandstone, etc.
Cuttings	5950'	Volcanic debris, white sandstone, etc.

*Deceased.



"Weathered" igneous rock

Figure 36. Sun Oil Co., Powell Land Co. No. 1, 5922'-5925', Volusia County, Florida.

The light colored areas are cryptocrystalline clayey material; the dark, chloritic aggregates; and the black, limonitic material. Shattered quartz grains (white) suggest explosive hydrothermal activity. The limonitic material may have replaced ferromagnesian silicates; a few black ore grains are unaltered. Ordinary light, X15.5.

Core 179	5951'-52'	There are two samples with this labeling, one hard fresh rock, the other dull "weathered" but probably originally like the other. The fresh rock consists essentially of brown and green hornblende and fresh calcic plagioclase. Spottily, the hornblende is replaced by green chlorite, very similar to that found in the Amerada Cowles Magazine No. 2 cores in St. Lucie County. Some epidote, fresh pyrite, sphene, and apatite are minor accessories.
Cuttings	5951'-52'	Volcanic Rock
Core 180	5952'-54'	Recovery 2' hard diabasic rock, fresh pyrite, black hornblende, glassy feldspar
Core 181	5954'-55'	Recovery 1 hard fresh rock (diorite) In thin section (Figures 37, 38) it consists of oligoclase-andesine, greenish brown hornblende, some quartz, rather coarse sphene, and blue-green chlorite, some of which may have replaced biotite. Some apatite is present, and veinlets of epidote cut the rock.
Cuttings	5950'-57'	Volcanic rock
Core 182	5952'-56'	Recovery 1' hardrock, with syenitic streaks. Equigranular aggregate of quartz, andesine, brown biotite, pale slightly pleochroic hornblende, rather abundant well-distributed magnetite. Figures 39 a, b. This is a rather different rock from the dioritic rocks above particularly in the abundance of brown biotite, and in the granular texture.
Core 183	5956'-57'	Hard volcanic rock
Core 184	5957½'-58'	T.D. recovery 4" same rock as previous. It is illustrated in Figure 40.
Cuttings	5958'	T.D. volcanic rock.

Bass (1969) describes the rock from 5940-5950 ft. (cuttings) as quartz-bearing diorite; the rock from 5951 to 5955 ft. (core) as hornblende diorite with diabasic texture, and the section from 5955.5 to 5958 ft. (T.D.) as "hornfels derived from a clayey volcanic-quartzose sandstone . . . showing possible crossbedding."

BUREAU OF GEOLOGY



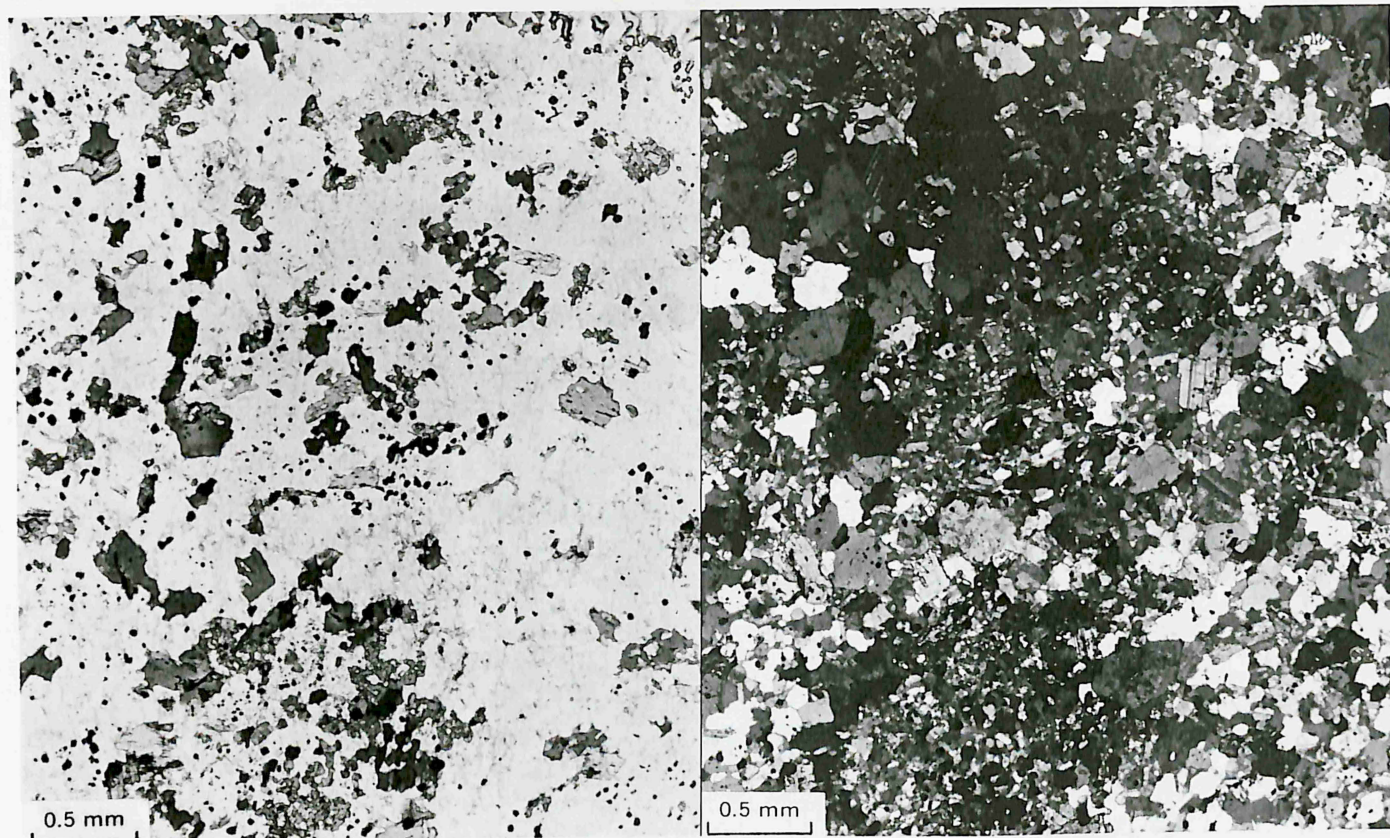
Figure 37. Sun Oil Co., Powell Land Co. No. 1, 5954'-5955', Volusia County, Florida.

The small smooth rectangular area bottom center is green chlorite; another area is at the center. The clear areas are quartz, the darker hornblende; the gray mostly feldspar. Ordinary light, X27.



Diorite with epidote

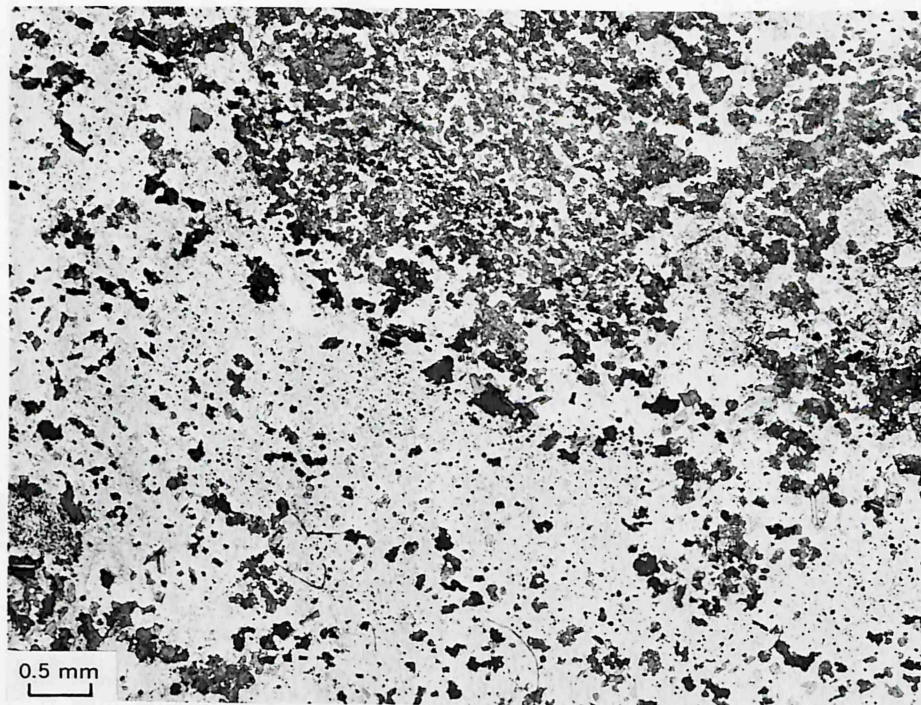
Figure 38. Sun Oil Co., Powell Land Co., No. 1, 5954'-5955', Volusia County, Florida.
Shows epidote veinlet (lower left). Ordinary light, X20.5.



Hornfels

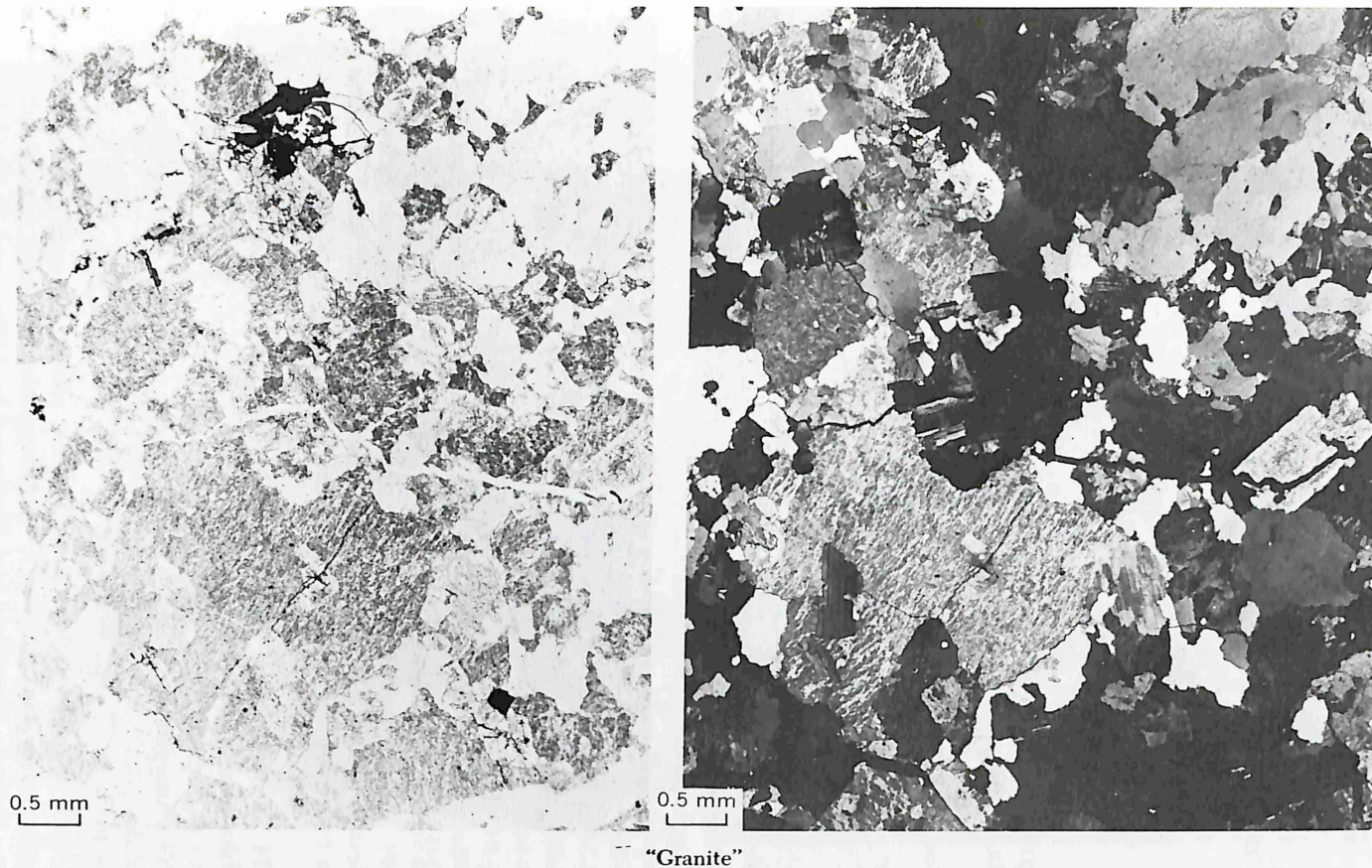
Figures 39a, b. Sun Oil Co., Powell Land Co. No. 1, 5955'-5956', Volusia County, Florida.

Shows brown biotite and pale green hornblende with quartz-sodic plagioclase. Concentrations of either or both together, the ferromagnesian minerals are seen; here the quartz-feldspar is finer grained (lower left). All grains are anhedral, and the texture is granitic. Ordinary light and crossed nicols, X27.



Hornfels

Figure 40. Sun Oil Co., Powell Land Co. No. 1, 5957½'-5958', Volusia County, Florida.
Rock similar to preceding figures, showing mafic concentration. Ordinary light, X16.



Figures 41a, b. Thin section plane polarized light and crossed nicols x 16.

Oil Development Company of Florida South Lake No. 1,6107'-28'

The clear areas are quartz, the grey mostly microcline and oligoclase. A very little brown biotite and black magnetite is present. Very similar rock is known to be arkose more or less metamorphosed by nearby doleritic intrusives.

are regarded in this paper as representing middle Cretaceous rocks, and the well is assumed to be in Jurassic at the bottom of the hole. In this connection it might be mentioned that Schuchert regards granites in Central Cuba as having been intruded at the end of the Jurassic. Dickerson also notes the association of granite with his Oxfordian."

ORANGE COUNTY

WARREN PETROLEUM CORP. GEORGE TERRY NO. 1

Sec. 21 T23S R31E Center SW $\frac{1}{4}$ SE $\frac{1}{4}$ T.D. 6589'

Completed 1955

Well locality 17.

Top of granite at 6550'. Only cuttings. No samples available.

Data from Applin (personal communication, 1967).

INDIAN RIVER COUNTY

AMERADA PETROLEUM CORP.

FONDREN MITCHELL NO. 1 T.D. 9488'

Section 28, T31S R35E 1980' S and 1980' E of NW $\frac{1}{4}$ Sec. 28

Completed 1956

Well locality 18.

Top of weathered (?) igneous rocks at 9410'. Rock reported as "andesite". Applin (personal communication, 1967).

Samples (cuttings) available as follows:

9424-29

9454-64

9429-34

9464-69

2434-39

*9469-74 Figures 44, 45

9439-44

9474-79

*9444-49 Figures 42, 43 9479-84

9449-54

*9484-89 T.D. Figure 46 All in volcanic rock.

* Thin sections as follows.

9444-49 Brown basalt, consists of fresh calcic plagioclase laths with colorless to greenish or reddish monoclinic pyroxene, and black ilmenite. Green to brown chlorite with ilmenite forms small segregations in the rock.

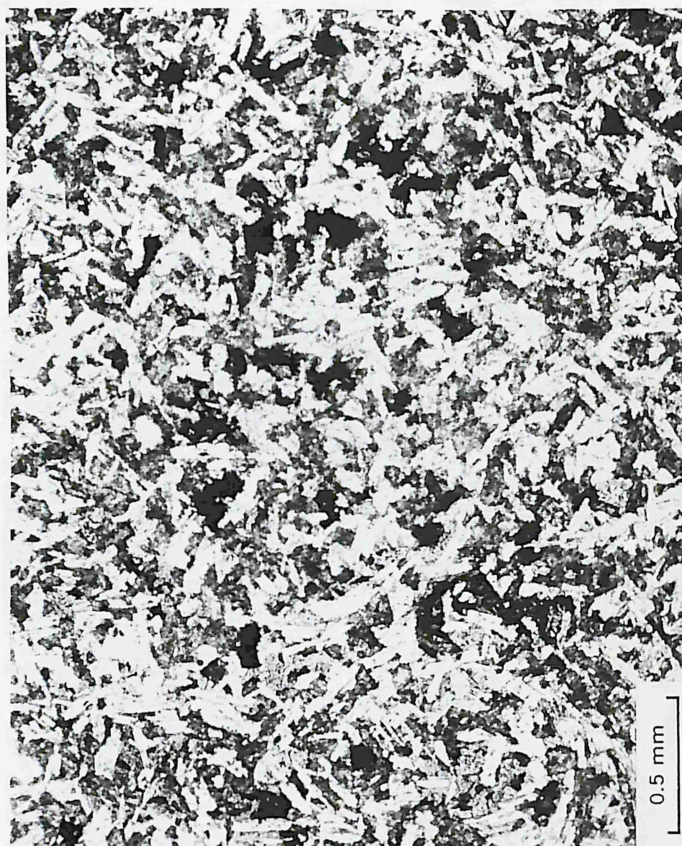
9469-74 Amygdaloidal calcitic basalt; basalt with much calcite veins and chlorite amygdules.

Figures 44 and 45 (?)

9484-89 Amygdular basalt. Much calcite, chlorite and quartz in amygdules.

Figure 46

The rock could be termed a moderately altered amygdaloidal basalt. It appears to be very similar to the amygdaloidal basalt from Appling County, Georgia, described and illustrated by Milton and Hurst (1965);



Basalt

Figure 42. Amerada Fondren Mitchell No. 1, Indian River County, 9444'-9449', Ordinary light x 35.



Diabase with interstitial chlorite-ilmenite.

Figure 43. Amerada Fondren Mitchell No. 1, Indian River County, 9444'-9449'.

Shows plagioclase laths and augite with ilmenite, and green chlorite with black ilmenite aggregates. The chlorite varies in color from green to brown. Ordinary light x 150.

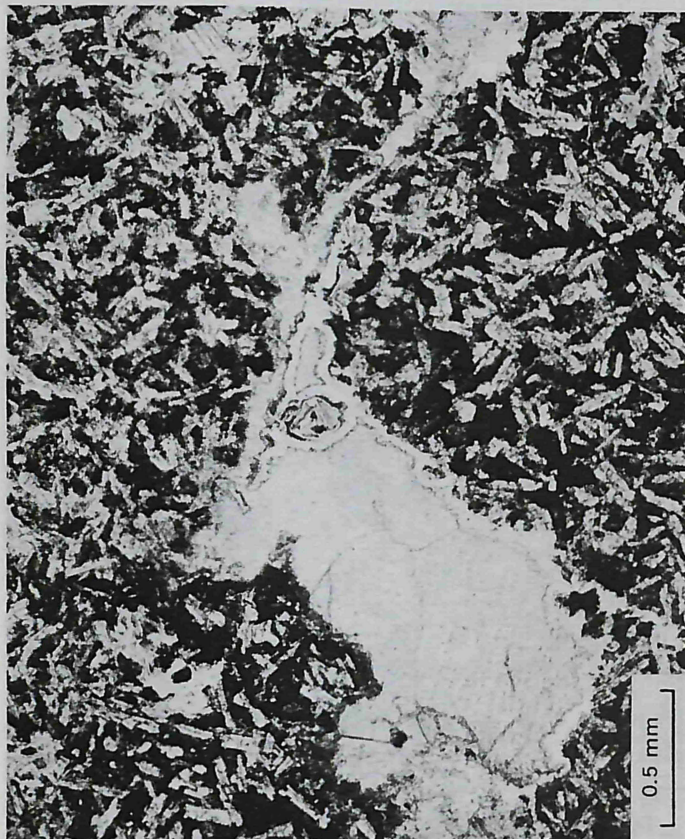


Figure 44. Amerada Fondren Mitchell No. 1, Indian River County, Florida 9469'-9474'.

Calcite-chlorite-quartz segregations in basalt. The large mass (left of center) is calcite, bordered with (clear) quartz. Ordinary light x35.



Figure 45. Amerada Fondren Mitchell No. 1, Indian River County, Florida, 9469'-9474'.

Detail of Figure.

Amygdaloidal basalt. Shows amygdaloid in center of picture with green chlorite (gray areas), plagioclase laths, quartz, and ilmenite; the large grey areas at top, left and right are calcite, and the clear areas bordering the calcite are quartz. Ordinary light x 150.



Figure 46. Amerada Fondren Mitchell No. 1, Indian River County, Florida, 9484'-9489' T.D.

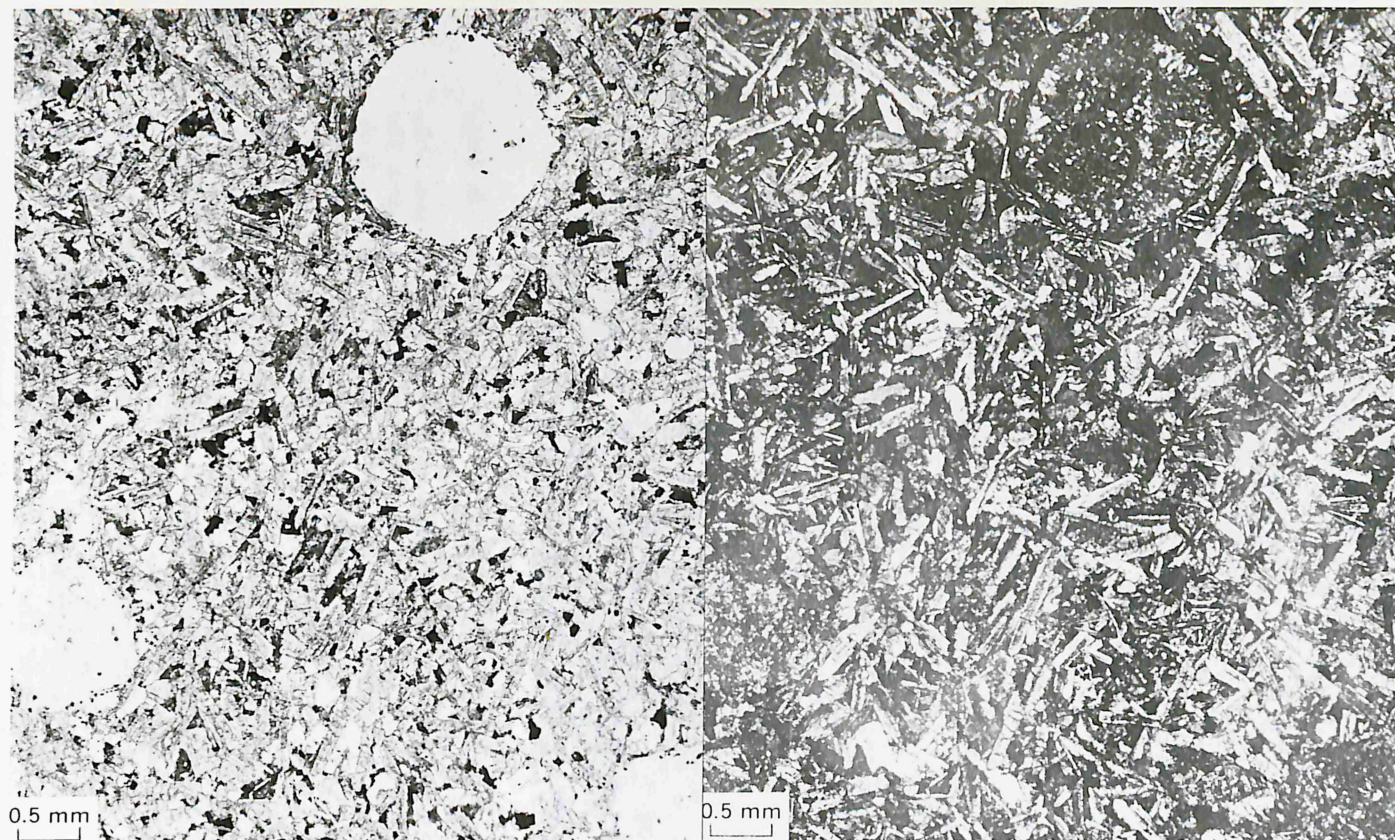
Basalt, with considerable quartz (most of the light-colored areas in the picture). Green chlorite, calcite, and ilmenite are also abundant. The plagioclase feldspar is fairly fresh, but the augite is mostly altered to obscurely crystallized chloritic aggregates. Ordinary light, x12.

and indeed, to the amygdaloidal basalts of northern Florida described elsewhere in this report.

Figures 47a and 47b show the appearance of the rock in thin section. A chemical analysis is given in Table 3.

Dating by Grasty (Table 2) gave a K-Ar age of 89.3 ± 2 m.y. (middle Cretaceous).

12744' In hand specimen resembles the preceding. In thin section however it is markedly different. The texture is fine grained granitic, and the rock consists essentially of quartz and moderately sodic plagioclase, near



Amygdaloidal basalt

Figures 47a, b. Amerada Petroleum Co., Cowle Magazine No. 2, St. Lucie County, Florida, 12734'.

47a (ordinary light). Shows proportion of black ore grains and feldspar, and shape and size of amygdules which contain pale green chlorite apparently identical to the interstitial chlorite replacing augite, etc. which is completely gone.

47b (crossed nicols). The twinned plagioclase feldspars are the most abundant mineral; the black areas are mostly pale green chlorite and ilmenite. Ordinary light and crossed nicols, X16.

andesine in composition. It shows little alteration, usually no more than a few minute chloritic flecks. There is very little of the green chlorite abundant in 12734'; what there is, is mostly associated with opaque ore grains, surrounding and filling cracks in these. One or two areas suggest olivine now replaced by ore and chlorite. No hornblende, abundant in the following 12748' rock, is present; but there is much brown biotite mostly heavily altered to brown chlorite? serpentine? Often the biotite and its alteration product contain a network of rutile needles, hexagonally oriented. Apatite is a minor accessory. Many of the rather coarse black ore grains are shattered and chlorite-serpentine fills the cracks.

Figures 48a and 48b show the microscopic aspect of this rock; and a chemical analysis is given in Table 3.

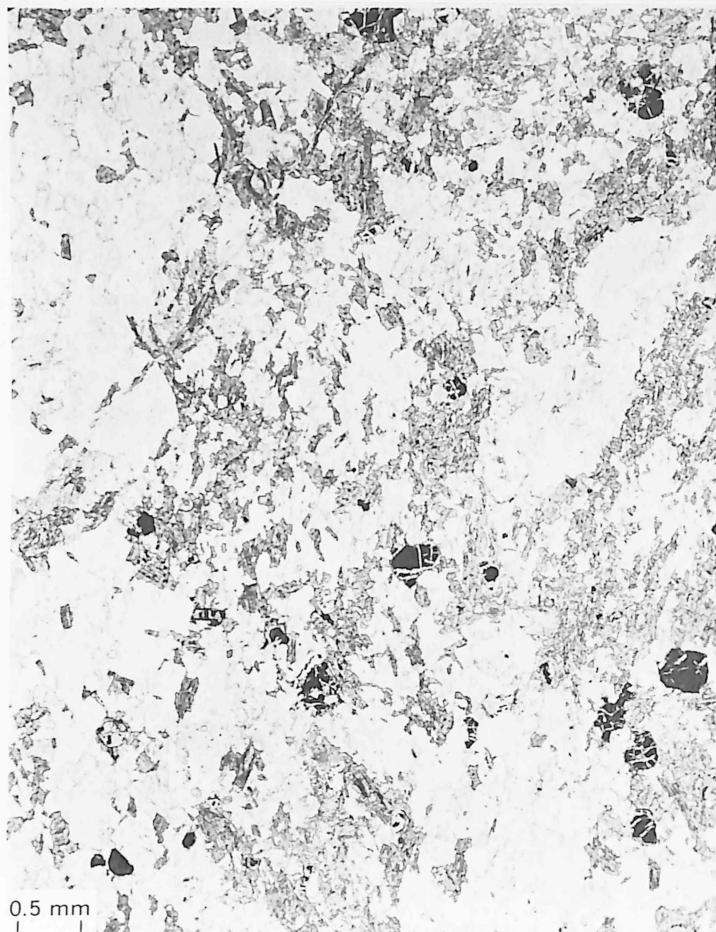
Dating by Grasty (Table 2) of this rock by K-Ar gave 226 ± 6 m.y. and 224 ± 3 m.y. (late Permian or early Triassic). Bass, however (Table 2, obtained two widely different K-Ar ages for samples from this core from 148 m.y. (middle Jurassic) to 399 m.y. (late Silurian or early Devonian), and for a third, by strontium isotopes, 530 m.y. (middle Cambrian).

12748' This rock also resembles the two preceding superficially, but in thin section differs markedly from both.

It has a rather coarsely granular texture, and consists essentially of unaltered green hornblende, quite fresh calcic plagioclase, and quartz. The coarse black ore grains (ilmenite?) are unfractured. A little brown biotite is present, some fresh, but most heavily altered to vague brown chloritic material. Very few and small areas of pale green chlorite similar to that in 12734' and 12744' with irregular outlines are present. Typical areas in thin section are shown in Figures 49a and 49b.

This rock has been K-Ar dated by Grasty (Table 2) 308 ± 5 m.y. (upper Mississippian or lower Pennsylvanian) and the hornblende from it by Bass, also K-Ar (Table 2) 470-503 m.y. (upper Cambrian or lower Ordovician).

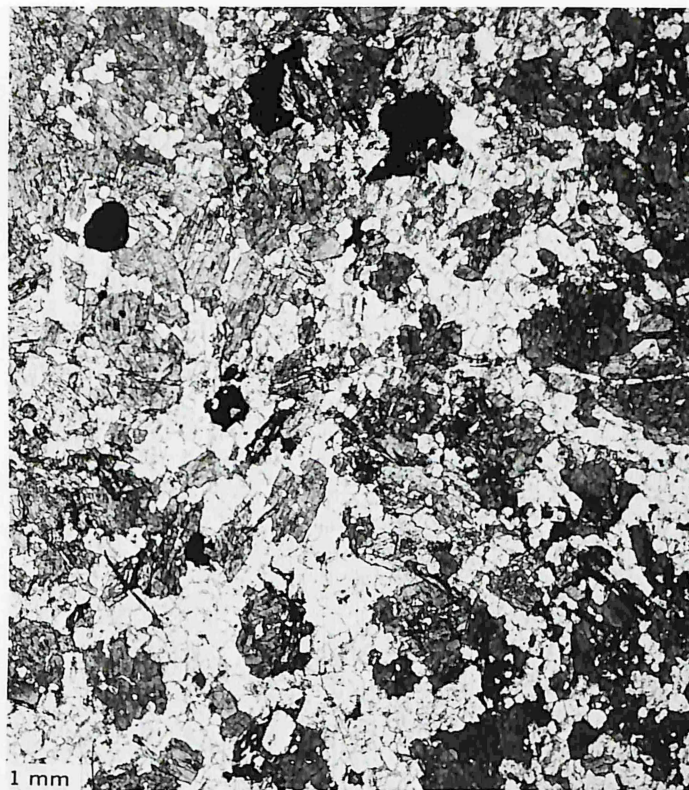
Obviously, these dates do not agree too well, and their precise significance is uncertain.



Granite

Figures 48a, b. Amerada Petroleum Co., Cowles Magazine No. 2, 12744', St. Lucie Co., Fla. Thin section, ordinary light and crossed nicols, X6.

The light colored areas (ordinary light) are quartz and andesinic plagioclase; the gray areas are brown alteration products of hornblende, now mainly altered biotite, serpentine or chlorite. The small black areas (lower right) are mostly black iron (titanium) oxide, probably ilmenite, with a little pyrite. They have been shattered and the cracks filled with serpentinitic-chloritic material.



Diorite

Figures 49a, b. Amerada Petroleum Co., Cowles Magazine No. 2, 12748', St. Lucie Co., Fla. Thin section, ordinary light and crossed nicols, X6.

Shows abundant unaltered green hornblende and calcic plagioclase, with minor quartz and black opaque ilmenite (?).

ST. LUCIE COUNTY

AMERADA PETROLEUM CO., COWLES MAGAZINE NO. 2

Completed 1957 Well locality 19 12749' T.D.

Three specimens of large size core were received from Paul L. Applin, through E. J. Henderson, Geologist, Amerada Petroleum Co., August 20, 1957, from 12734', 12744', and 12748'. The three rocks, although they cover a range of only 14 feet, show remarkable diversity. Whereas the uppermost rock, 12734', can be readily identified as basaltic, the middle specimen 12744' has a granitic aspect, and the bottom rock 12748' would pass as common diorite. The two lower core samples have been studied in considerable detail by Bass (1969) with age determinations; similar studies of all three cores are given here.

12734' is a hard gray rock, mottled with white flecks of calcite a centimeter across, and showing black slickensided surfaces.

In thin section it shows a uniform aggregate of andesinic plagioclase laths, with abundant small euhedral black iron oxide (ilmenite?) grains. Almost as abundant as the plagioclase is green chlorite, interstitial to the feldspar and evidently a replacement of pre-existing mafic minerals, probably pyroxene. Similar chlorite showing low bluish interference colors under crossed nicols, also forms spherical vesicles or blebs, a couple of millimeters across. Around and contiguous to these, the black ore grains are replaced by brown sphene. Irregular small patches of calcite are strewn through the rock. The feldspars in this rock are fairly fresh, mostly apparently unaltered. They are somewhat fissured, the fissures being filled with greenish chlorite.

OSCEOLA COUNTY, FLORIDA

HUMBLE OIL AND REFINING CO.

W. P. HAYMAN NO. 1 T.D. 8798'

Completed 1946 Well locality 20 Applin (1951) No. 24

This is one of two wells in Osceola County (the other being the Humble Oil and Refining Co., Ray Carroll No. 1). Samples are available from 8619' to 8793½', with interruptions.

Rhyolite from 8781' has been K-Ar dated 173 ± 4 m.y. (Lower Jurassic) by Grasty (Table 2).

58 feet of rhyolite, to 8798' (T.D.) were drilled.

Core No. Depth

253	8619'-8629'	Friable gray sandstone
254	8655'-8658'	Gray slickensided shale with coarse quartz grains. In thin section, seen to be largely volcanic debris, probably ash. The quartz grains show no rounding, and many show secondary enlargement.

255	8734'-8744' recovery 5 ft.	"Top 4 ft. of core is gray and black conglomerate sand. Bottom 1 ft. of core is porphyry with sand intrusions." (Drillers' log). Sample consists of small hard gray igneous rock fragments with sandy debris. Top 1 ft. gritty clayey rhyolitic arkose. Consists largely of sub-angular fragments of quartz, micro-pegmatite, and sodic feldspar, with interstitial clayey matrix. Another sample of the same piece of core included both sandstone and volcanic rock fragments. Next to the top 1½ ft. rather firm carbonaceous (coal?) material. Bottom six inches - rhyolite fragments.
256	8744'-8750'	Slate-gray stony tuff (?) with small aphanitic inclusions and white kaolinized feldspars. Microscopic: quartz and oligoclase-andesine phenocrysts in feldspathic groundmass. Quartz euhedral (rhombohedra and prisms), also spheroidally rounded. Plagioclase in part calcitized; no albite twinning, only Carlsbad. No mafics, very scanty chlorite and apatite. (Fig. 50, Rhyolite)
257	8750'-8756'	
258	8753'-8756'	Very much like core 257 8750'-8753' — very small hornblende and biotite, calcite patches. (Figs. 51a and 51b)
259	8756'-8759'	
260	8759'-8765'	
262	8765'-8770'	
263	8770'-8772'	"Rhyolite 173 ± 4 m.y." Lower Jurassic (Table 2)
264	8772'-8775'	
265	8775'-8778'	
266	8778'-8780'	
271	8781'-8781½'	
273	8781½'-8783'	Dark gray stony rock with red feldspar phenocrysts. Quartz and albitic-oligoclase phenocrysts in microcrystalline matrix. No mafics. (Figs. 52a and 52b)
275	8786'-8787'	
276	8789'-8790'	Same

277	8790'-8790½'	
279	8792¾'-8793½'	
280	8795½'-8796¼'	Same



Rhyolite

Figure 50. Humble Oil and Refining Company, W. P. Hayman No. 1, Osceola County, Florida, Core 257, 8750'-8753'

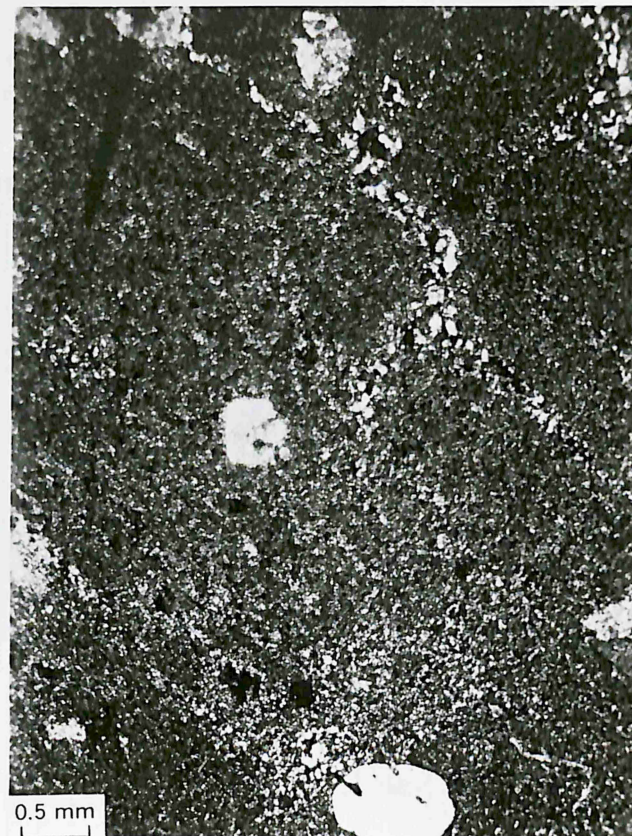
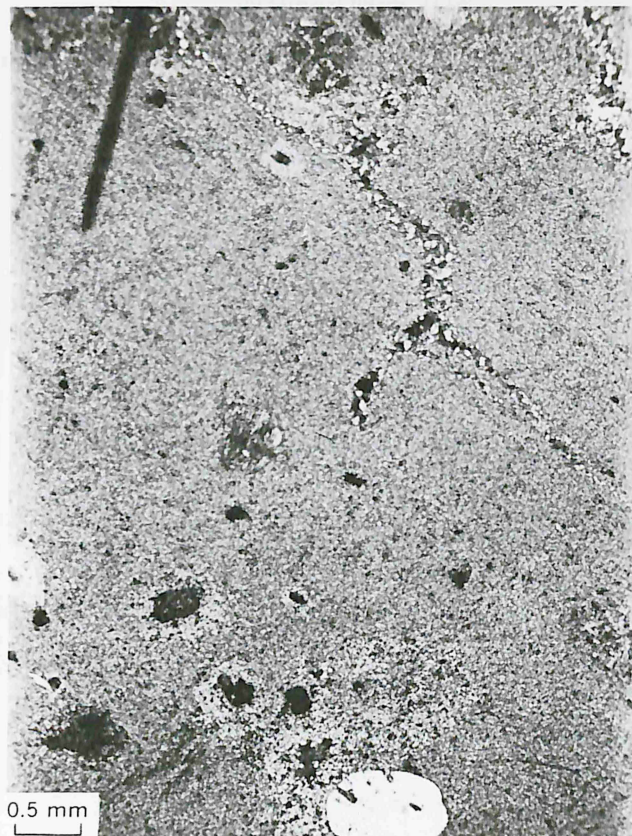
Rounded and sub-rounded quartz phenocrysts in fine grained felsic groundmass. Near the center is a small sodic plagioclase phenocryst. Ordinary light X17½.



Porphyritic rhyolite

Figures 51a, b. Humble Oil and Refining Co., W. P. Hayman No. 1, Osceola County, Florida, Core 262, 8765'-8770 ft.

Shows rounded quartz phenocrysts and large sodic plagioclase in fine-grained felsic groundmass. Ordinary light and crossed nicols X17½.



Rhyolite

Figures 52a, b. Humble Oil and Refining Co., W. P. Hayman No. 1, Osceola County, Florida, Core 275, 8786-8787 ft.

Rounded quartz and sodic plagioclase phenocrysts in a fine-grained felsic groundmass, which is coarser in irregular streaks. Ordinary light and crossed nicols X17½.

OSCEOLA COUNTY

HUMBLE OIL AND REFINING CO. J. RAY CARROLL NO. 1
8044½' T.D. Well locality 21 Applin (1951) No. 6
Applin (1951) lists the 14 feet of bottom rock in this well as "altered and veined biotite granite" as determined by F. F. Grout. He also gives T.D. as 8049 ft.

This is one of the three "metamorphic basement" wells in central eastern Florida (the other two Volusia County Powell Land Co. No. 1 and Lake County Oil Development Co. South Lake No. 2 - J. R. Arnold No. 1) which led Applin (1951, Fig. 1) to indicate a triangular area of several thousand square miles, including all or part of Volusia, Seminole, Lake, Orange, Osceola, Polk, and Brevard Counties as underlain by "pre-Cambrian granite, diorite, and metamorphic rocks."

Bass (1969) describes rock from this well as quartz monzonite.

Material studied from this well is:

Core 174 7904'-7914'

Core 175 7965'-7975'

Core 176 7975'-7984'

All of these are sand and friable sandstone.

Core 177 8034'-8042' The top of the igneous rock is in this core (P. L. Applin).

Core 178 8042'-8042½' T.D.

Both of the last two cores are of similar rock, granitic in appearance, with much coarse pink feldspar and green chloritic areas. Microscopically it resembles a hydrothermally altered aplite, containing abundant quartz and kaolinized-sericitized albite-oligoclase with veins and replacements of calcite; potash feldspar, with small optic angle (sanidine?) is sparingly present. Green chlorite, strongly pleochroic, apparently originally biotite is the only mafic mineral. Minor accessories are magnetite — ilmenite, leucoxene, apatite, and an occasional zircon.

Three thin sections show little variation.

This rock has been dated by Bass (1969) by $\text{Sr}^{87}/\text{Sr}^{86}$ as 530 m.y. The rock is shown in Figures 53a and 53b.



Figure 53a. Humble Oil and Refining Company, Ray Carroll No. 1, Osceola County, Florida, 8042'-8042½'

The light colored areas are anhedral quartz, whose sutured aggregates are shown well under crossed nicols. The gray areas are euhedral sodic plagioclase; the black area, right center, is magnetite-ilmenite, with many fractures filled with green chlorite; the dark mass just to the right of this is chlorite with many small inclusions of leucoxene, originally magnetite-ilmenite. Ordinary light X15.



Figure 53b. Humble Oil and Refining Co., Ray Carroll No. 1, Osceola County, Florida. 8042'-8042½'.

The light colored areas are anhedral quartz, whose sutured aggregates are shown well under crossed nicols. The gray areas are euhedral sodic plagioclase; the black area, right center, is magnetite-ilmenite, with many fractures filled with green chlorite; the dark mass just to the right of this is chlorite with many small inclusions of leucoxene, originally magnetite-ilmenite. Ordinary light X15.

OKEECHOBEE COUNTY
AMERADA PETROLEUM CORP.

MARIE SWENSON NO. 1 T.D. 10838'

Completed 1955 Well locality 22 Sec. 5, T. 36 S., R. 34 E.
Center NW $\frac{1}{4}$ NW $\frac{1}{4}$

"Top of volcanic rocks 10,750 ft." P. L. Applin (written commun., 1967).

Reference: Applin and Applin (1965)

9 samples (cuttings) available:

10750'-60' All mostly grains of quartz, anhydrite and more or
*10760'-70' less igneous rock, with contact rock ("baked shale")
*10770'-80' fragments.

10780'-90'

10790'-10800'

10800'-10'

10810'-20'

10820'-30'

*10830'-40' *Thin sections

10760'-10770' Thin sections were made of 6 grains; these were basalt, consisting of fairly fresh calcic plagioclase laths with green chlorite, calcite, and ilmenite; the fourth was perhaps a chilled phase of this basalt with obscurely crystallized feldspar in a heterogeneous fine grained matrix with much ilmenite; the other two were hydrothermally altered shale (Figures 56 and 58).

Fig. 54 shows a chlorite-quartz amygdule in the basalt. Fig. 55 shows another calcitic basalt fragment, not amygdular.

10770'-10780' Thin sections were made of 8 grains, all basalt, some amygdular. Figure 59 shows an amygdule consisting of quartz and chlorite. The basalt consists of plagioclase feldspar (reddish in thin section), chloritized amphibole, chlorite, with much rather coarse black ilmenite.

10830'-10840' Includes 6 thin sectioned grains, all but one basalt similar to the preceding. The other consists of chalcedonic quartz with pale greenish chlorite or clay mineral with calcite and black ilmenite; perhaps hydrothermally deposited. Figure 60.

OKEECHOBEE COUNTY
SUN OIL CO.

AMERADA PETROLEUM CORP.

HARRIS-HOLMES NO. 1 T.D. 9840 ft.

Completed 1966 Well locality 23 Sec. 8, T. 33 S., R. 34 E.

"Top of rhyolite porphyry 9682 ft." P. L. Applin (written commun., 1967).

No specimens available.



Amygdular basalt

Figure 54. Okeechobee County, Florida, Amerada Swenson No. 1, 10760'-10770'.

Amygdule, consisting of quartz and chlorite. The basaltic matrix is obscurely crystallized with much ilmenite. Ordinary light X150.

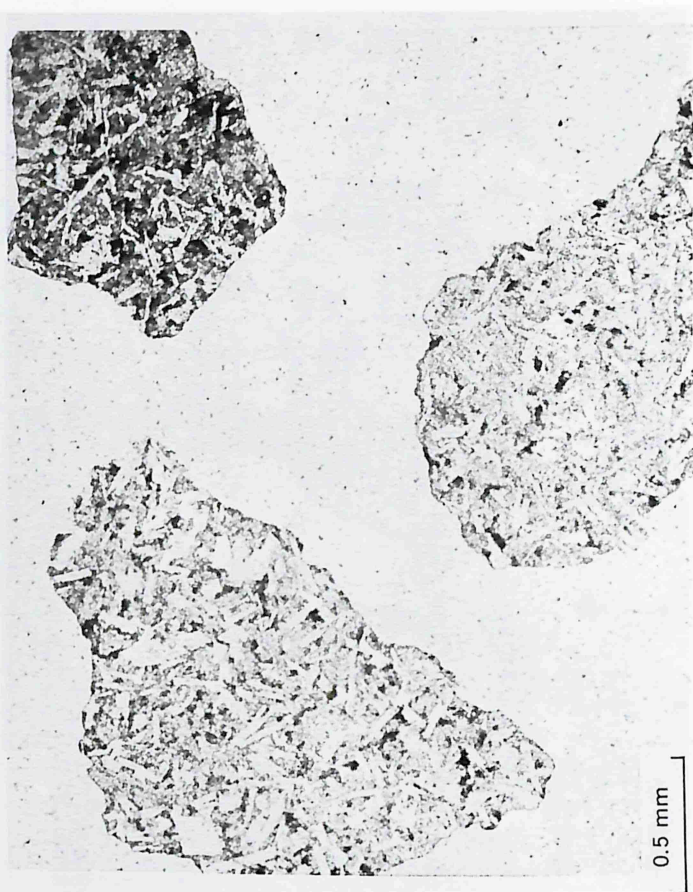


Figure 55. Amerada Swenson No. 1, Okeechobee County, Florida. 10760'-10770'. Shows three fragments of basalt, non-amygdular. Ordinary light x35.

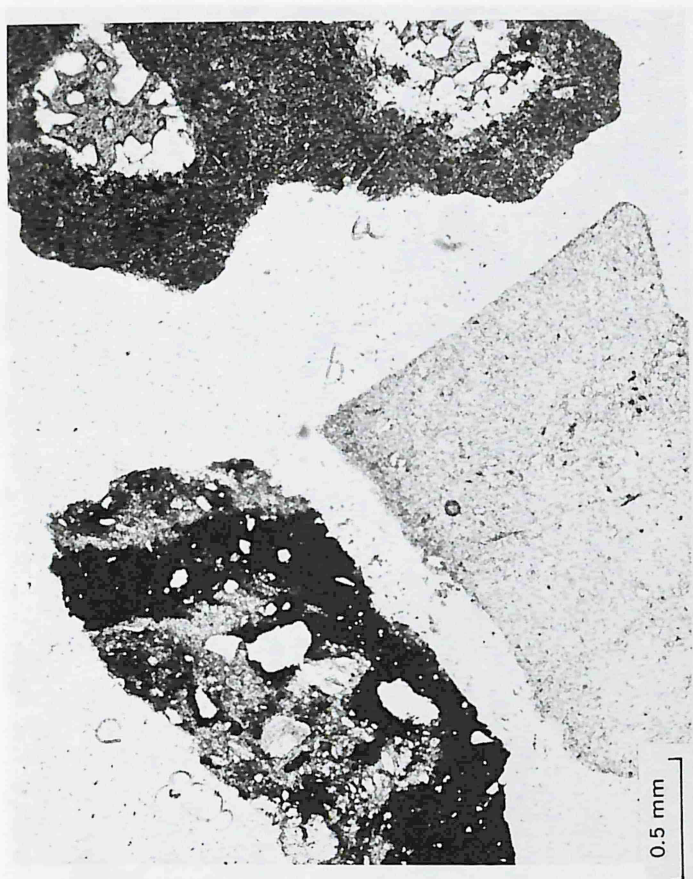
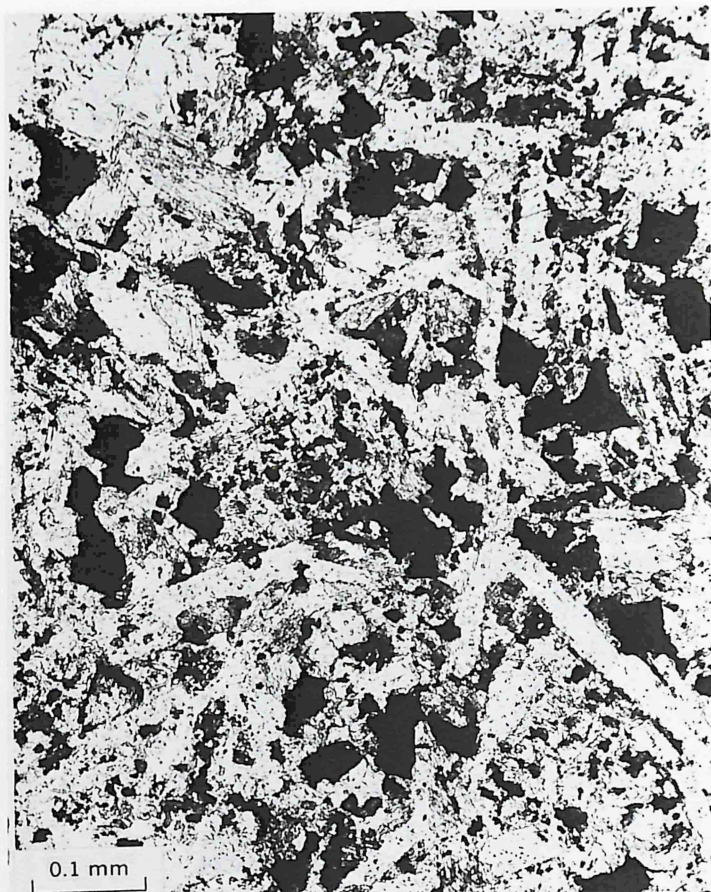


Figure 56. Amerada Swenson No. 1, Okeechobee County, Florida. 10760'-10770'.

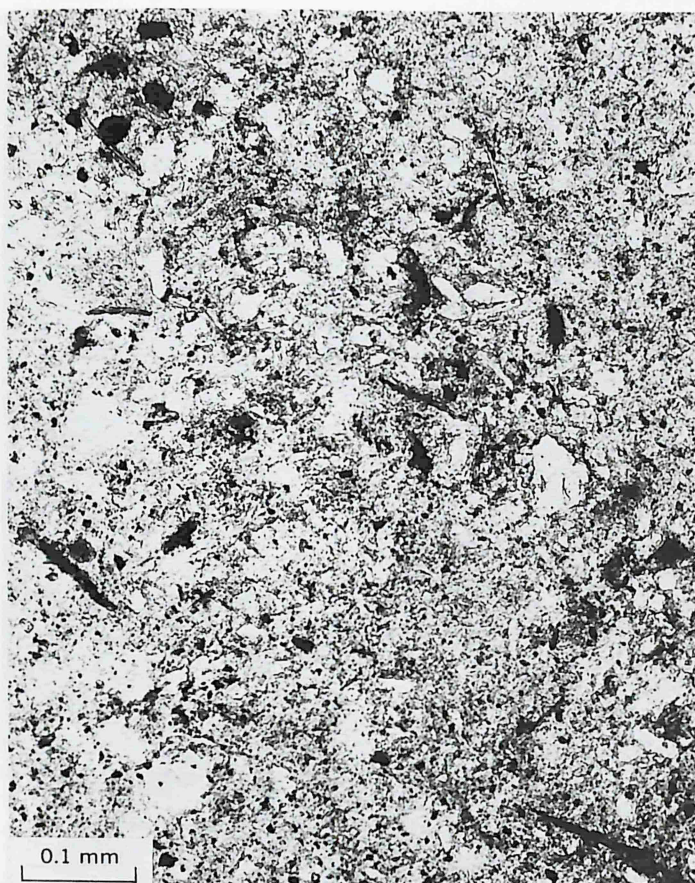
Shows three fragments, all different. Left, sandy hydrothermally altered shale, lower center, fine-grained clayey altered shale; right, amygdular basalt, also shown in Figure 54. Ordinary light x32.



Basalt

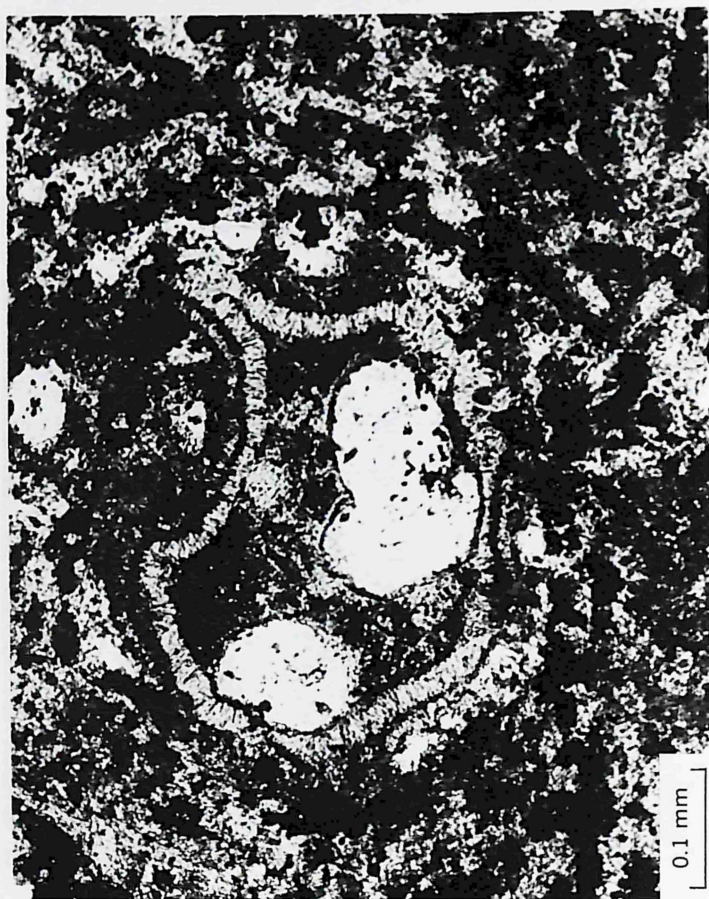
Figure 57. Amerada Swenson No. 1, Okeechobee County, Florida. 10760'-10770'.

Shows plagioclase laths, ilmenite, with chlorite and calcite. This grain is also shown in Figure 55. Ordinary light x150.



Baked shale

Figure 58. Amerada Swenson No. 1, Okeechobee County, Florida. 10760'-10770'.
Shows angular quartz particles in obscure sericitic fine grained clayey
(?) matrix. Ordinary light x150.



Amygdular basalt

Figure 59. Amerada Swenson No. 1, Okeechobee County, Florida. 10770'-10780'.

Amygdule consists of clear rounded quartz (white) with bright green bands of platy chlorite.

Figure ■■■ also illustrates this grain. Ordinary light X150.



Figure 60. Amerada Swenson No. 1, Okeechobee County, Florida. 10830'-10840' T.D.
Hydrothermal quartz (chalcedonic) - chlorite - calcite - ilmenite rock.
Ordinary light X150.

HIGHLANDS COUNTY
HUMBLE OIL AND REFINING CO.
G. C. CARLTON ESTATE NO. 1

Completed 1946 Well locality 24 Applin (1951) No. 21

This well drilled 367 ft. in igneous rock, the greatest thickness penetrated by any well in Florida. Applin (1951) reports that it drilled in "amygdaloidal basalt, rhyolite porphyry and related kinds of igneous rock." It is also the southernmost of the wells in Florida that have encountered igneous rock, as well as the deepest.

A very large collection of samples, from core No. 335, 12563'-12673' to Core No. 379, 12982'-12985' (T.D.) is available.

DESCRIPTION OF SAMPLES

Core 335 12563'-73' recovery 6½ ft. top 5½ ft. is friable pinkish-white sandstone bottom 1 ft. is reddish powdery earthy material mostly sand grains as in top 5½ ft. There are also fragments of brown shale, and at least one small fragment of material somewhat like that of the next core.

Core 336 12618'-25' ("top of igneous at 12618'," Applin) top 3 ft. is brown fine-grained shale (?) ash (?) or altered volcanic rock. It is now ferruginous clay, with green secondary clay minerals along slickensided surfaces. Bottom 4 ft. is greenish volcanic rock, interlayered with calcite.

Core 338 12664'-67' recovery 2 ft. is greenish grey volcanic rock, with sparse feldspar phenocrysts, and zeolitic coating on fracture planes. Rock from 12664 ft. has been dated, 183 ± 10 m.y. Triassic-Jurassic (Table 2).

Core 339 12667'-72' recovery 8 ft. (?C.M.) is fine grained red volcanic (ash?). In thin section appears to be a highly altered ash, now essentially ferruginous clay. However, it may be altered massive volcanic.

Core 340 12672'-78' recovery 6 ft. This is a highly amygdaloidal brown volcanic rock.

Core 341 12678'-84' recovery 1½ ft. similar to preceding.

Core 343 12689'-94' recovery 5 ft. much like core 338 above.

Core 344 12694'-99' recovery 4 ft. Same as preceding. In thin section shows an original fine grained basaltic structure, with marked hydrothermal alteration of the original constituents. The original glassy (?) matrix is now a greenish-brown obscure aggregate of chloritic, amphibole (?) biotite (?) calcite, etc. Original ilmenite is now leucoxene. The feldspar laths are only slightly altered. Veinlets of green chlorite (?) or serpentine (?) traverse the rock. (Fig. 61).

Core 345 12699'-12708' Recovery 4½ ft. Same rock as preceding.

Core 346 12708'-12715' Recovery 4½ ft. Similar to preceding, with marked alteration effects — zeolitization, calcitization, etc., with shearing.

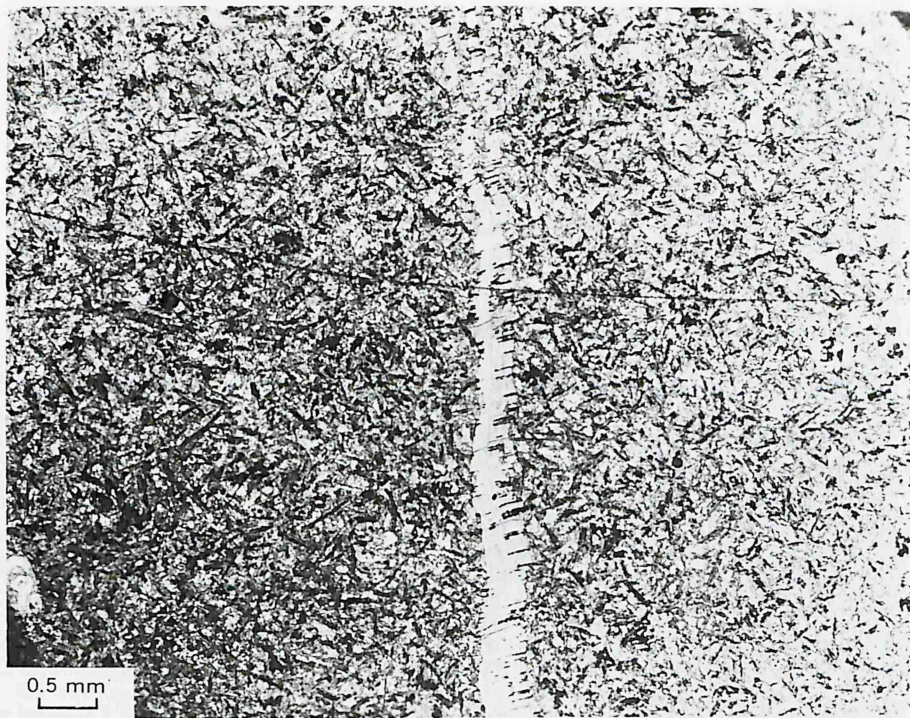


Figure 61. Humble Oil and Refining Company, G. C. Carlton Estate No. 1, Highlands County, Florida. 12694'-12699'. Basalt with green veinlet. X15.

Core 347 12715'-12721' top 3 ft. fine grained brown basalt. In thin section shows obscurely crystallized groundmass with scattered small chloritized plagioclase (?) crystals. (Fig. 62). Bottom 3 ft. similar to preceding.

Core 348 12721'-12722' Composite volcanic rock, part brown, part green. The green appears to cut the brown, and may be of hydrothermal origin. In thin section the green material is seen to be chloritic calcite. (Figs. 63 and 64).

Core 350 12766'-12771' Recovery 2½ ft. grey green fine grained volcanic.

Core 351 12771'-12775' Same as preceding. In thin section shows the usual fine grained felsic groundmass, crowded with black opaque iron oxide particles. A chloritized mafic phenocryst is present; they are not common in the rock from this well. (Fig. 65).

Core 352 12775'-12778' recovery 3 ft. Heavily slickensided grey-green volcanic rock.

Core 353 12778'-12783' recovery 4 ft. fine grained grey volcanic.

Core 354 12783'-12786' recovery 1½ ft. fine grained grey and brown volcanic, showing the usual hydrothermal alteration.

Core 357 12803½'-12805' grey volcanic.

Core 358 12824'-12827' recovery 1½ ft. green and brown volcanic.

12826'-12827' amygdaloidal basalt (Figures 66 and 67).

Core 360 12837'-12847' recovery 2½ ft. brown volcanic, with green (chloritic) amygdules.

Core 362 12852'-12857' same as preceding.

Core 363 12857'-12862' same as preceding, with pink amygdules (heulandite?)

Core 367 12878'-12885' recovery 4½ ft. Same as preceding.

Core 368 12928'-12932' Same as preceding.

Core 369 12932'-12936' Same as preceding.

Core 370 12937'-12940' Same as preceding.

Core 371 12940'-12945' heavily slickensided (sheared) volcanic, like preceding.

Core 373 12948'-12949' Same as preceding.

Core 374 12970'-12972' recovery 1½ ft.

Core 375 12972'-12974' recovery 1½ ft.

Core 376 12974'-12976' "recovery 6 ft?" (thin section-see below).

Core 377 12976'-12979' recovery 2½ ft. (thin section-see below).

Core 378 12979'-12982' recovery 1½ ft.

Core 379 12982'-12985' T.D. recovery 1½ ft.

All of these cores are of similar material, differing markedly from the preceding.

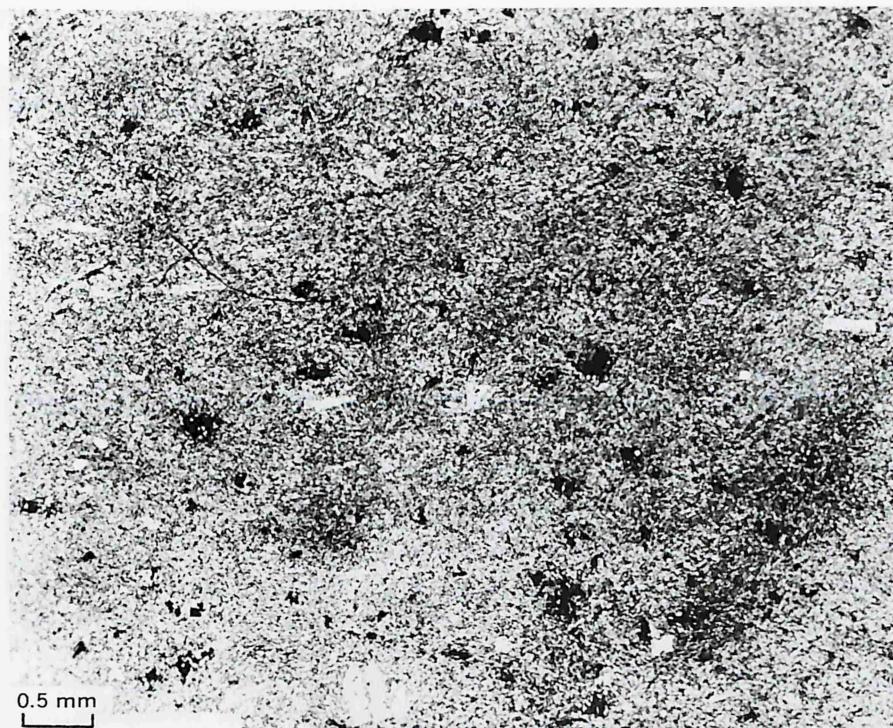


Figure 62. Humble Oil and Refining Company, G. C. Carlton Est. No. 1, Highlands County, Florida, 12715'-12721'.

Fine grained basalt with microporphyritic feldspars (?) replaced by quartz-chlorite. The rock is stained red by fine grained limonite. X18.



Basalt

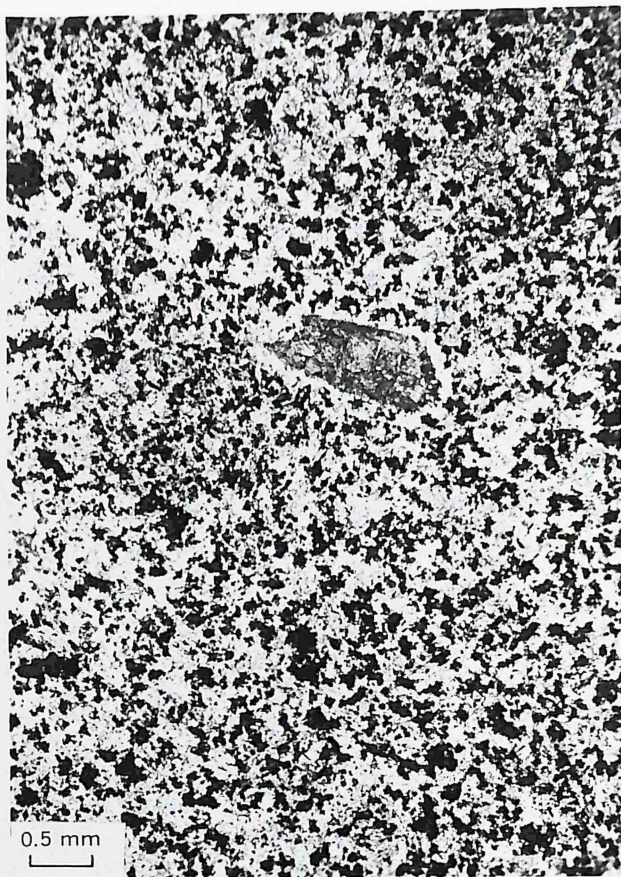
Figure 63. Humble Oil and Refining Company, G. C. Carlton Estate No. 1, Highlands County, Florida, 12721'-12722'.

The vein (upper right) is mostly calcite with a little green chlorite. X18.



Figure 64. Humble Oil and Refining Company, G. C. Carlton Est. No. 1, Highlands County, Florida, 12721'-12722'.

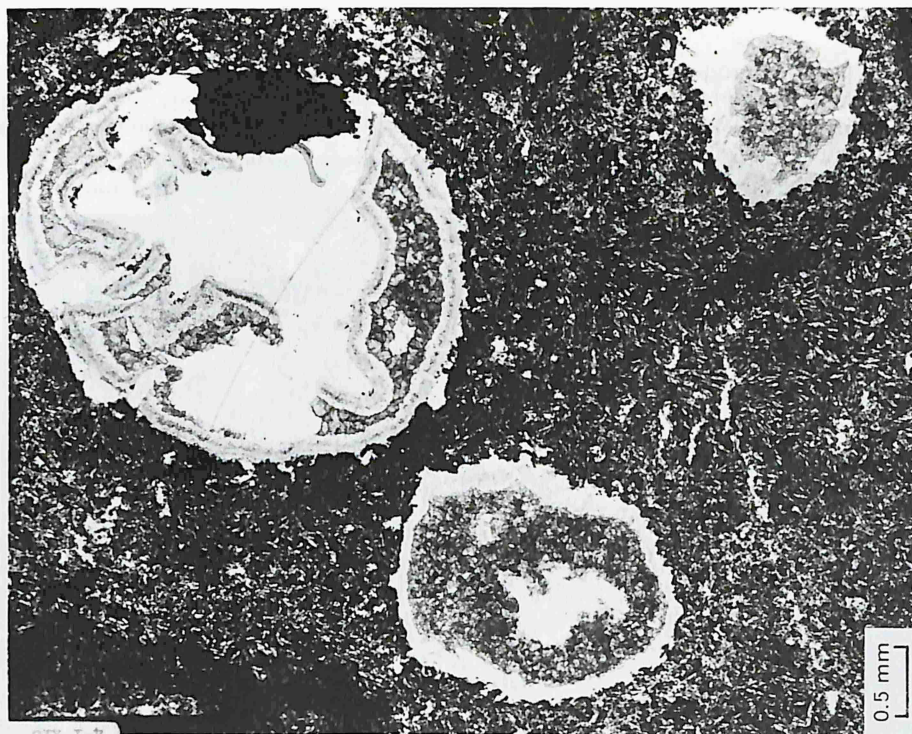
Basalt with quartz-chlorite-calcite veins. Chlorite is the major mineral in the vugs and veins shown. Note broken vein, lower left. Ordinary light X18.



Basalt

Figure 65. Humble Oil and Refining Company, Carlton No. 1, Highlands County, Florida. 12771'-12775'.

Shows typical obscurely crystallized groundmass of volcanic rock with a chloritized phenocryst, originally olivine or augite. Ordinary light X17½.



Amygdaloidal Basalt

Figure 66. Humble Oil and Refining Company, G. C. Carlton Est. No. 1, Highlands County, Florida, 12826'-12827'.

Shows three of abundant amygdules in this part of the basalt. The matrix is the same as in the other specimens, but amygdules were found only in this one. Their mineralogy is rather complex; the major minerals are chalcedonic (?) quartz, radial green chlorite, and zeolite. The dark area (right in upper amygdule) is limonite, which is abundant in the matrix, together with magnetite grains. Ordinary light X18.



Figure 67. Humble Oil and Refining Company, G. C. Carlton Estate No. 1, Highlands County, Florida, 12826'-12827'.

Amygdaloid in basalt. Shows a large amygdaloid, about a centimeter across, with complex structure and mineralogy. The light colored area with (two) good cleavages at right angles are coarsely crystallized zeolite; the darker areas are chlorite; there is also limonite (black) and chalcedonic quartz (white area). X27.

The specimens are coarse grained, pink, and to a lesser extent, grey in color, and superficially resemble weathered orthoclase granite. However, they are all volcanic rock, apparently agglomerate with definite volcanic ash (shard structure).

Core 376 12974-12976 consists of equal amounts of coarsely crystallized red zeolite, stony grey rock and a green chloritic material. The stony grey rock is a fine grained rhyolitic tuff, with scarce quartz phenocrysts. These are shattered and partly resorbed. The matrix of these phenocrysts shows characteristic shards, indicative of explosive release of internal gas-pressures. Calcite is present in thin veinlets.

Core 377 12976-12979 This is a rhyolite porphyry, with numerous phenocrysts, more or less resorbed, but chemically unaltered, of albitic plagioclase and quartz. The few mafics (pyroxene?) are chloritized.

HIGHLANDS COUNTY CONTINENTAL OIL CO.

G. C. CARLTON, et al. T.D. 12630'

Completed 1955

Well locality 25

Sec. 20, T. 38 S., R. 28 E Center SW $\frac{1}{4}$ NE $\frac{1}{4}$

"Top of volcanic rocks (?) core 13 at 12,601 ft" P. L. Applin (written commun., 1967).

Reference Applin and Applin (1965)

Specimens available and examined as follows:

- | | | |
|---------------|--------|---|
| 12600'-12609' | Top | Fine grained black ash (?) with reddish areas (hematitic) and whitish (clayey) streaks. In thin section, seen to be altered basaltic ash, with much finely-divided red to black hematitic dust, and irregular schlieren and vesicles of whitish clayey material. No mafic minerals remain, and the plagioclase laths are altered and outlined by hematitic dust. Figure 68 |
| | Middle | Red basalt with clay and calcite. |
| | Bottom | Brown finely granular basalt with conspicuous lighter colored calcite bands 1 or 2 mm wide. The calcite is granular, and is associated with white or greenish clayey vesicles and schlieren. These are also abundant in the basalt in which there is little calcite. No mafic minerals remain in the basalt, which is heavily impregnated with black hematitic dust. Figure 69. |



Figure 68. Continental Oil Co., G. C. Carlton No. 1, Highlands County, 12600'-12609' top.

Heterogeneous altered basaltic ash, with clay-mineral veinlets. Ordinary light X23.

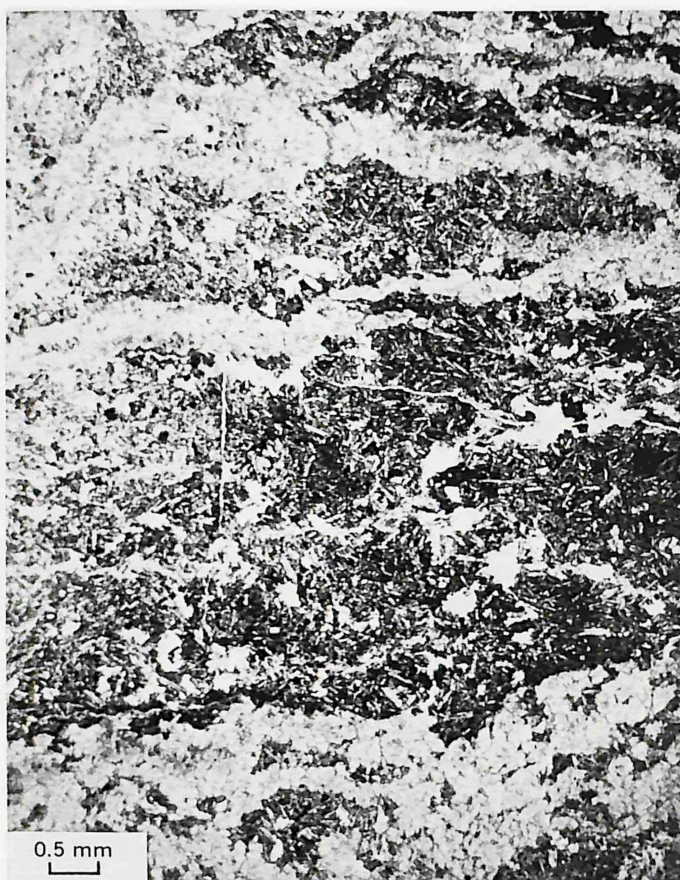


Figure 69. Continental Oil Co., G. C. Carlton No. 1, Highlands County, 12600'-12609' bottom.
Basalt with calcite bands. Ordinary light X13.

12614'-12630'

Top

Middle

Lower middle Basalt, with chalcedony (?) amygdules and veins and disseminations of calcite. No mafics — all replaced by chlorite and calcite, as is also much of the feldspar. A little quartz is associated with the calcitic veins. The larger amygdules have an inner greenish core within a fine-grained colorless zone (Figure 70). Complex veinlets, containing green chlorite, red heulandite (?), quartz and calcite cut the basalt (Figure 71).

Bottom Basalt with chalcedony (?) amygdules and minor calcite. No unaltered mafics (not calcitized, but represented by obscure debris and black ilmenite). The larger amygdules contain an inner core of olive-green chlorite surrounded by finely crystallized white chalcedony (?) (Figure 72).

12629' T.D.

Amygdaloidal basalt (Figure 73).



Figure 70. Continental Oil Co., G. C. Carlton No. 1, Highlands County, 12614'-12630' lower middle.

Zoned chlorite amygdale in basalt. Much of the lath-shaped feldspar has been calcitized. Ordinary light X130.

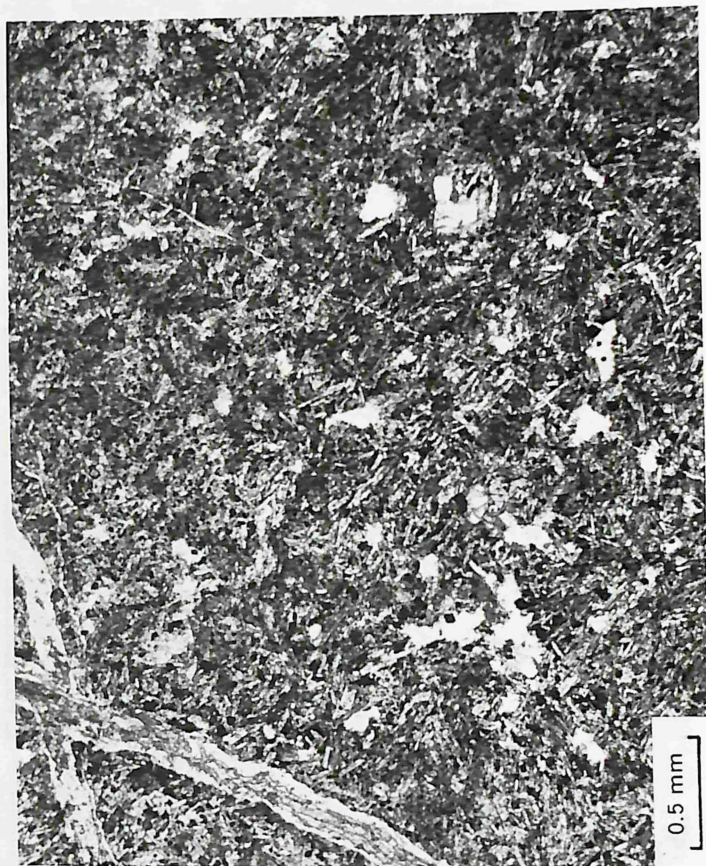


Figure 71. Continental Oil Co., G. C. Carlton No. 1, Highlands County, Florida, 12614'-12630' lower middle.

Amygdaloidal basalt, with complex veinlets, containing green chlorite, red heulandite (?), quartz, and calcite. Ordinary light X28.

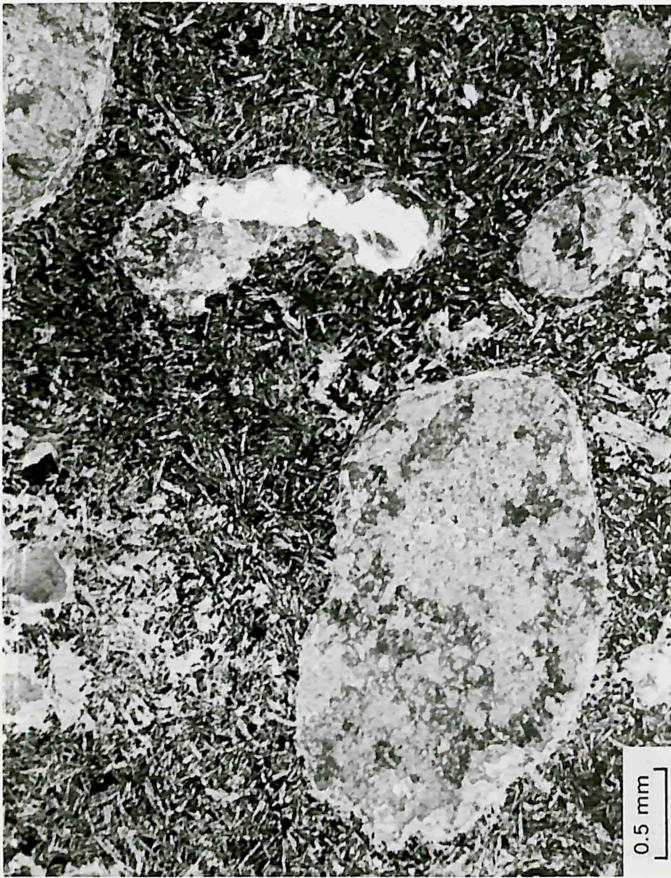


Figure 72. Continental Oil Co., G. C. Carlton No. 1, Highlands County, Florida, 12614'-12630' bottom.

Basalt with large calcite (grey), quartz (white) amygdules. Ordinary light X23.



Figure 73. Continental Oil Co., G. C. Carlton No. 1, Highlands County, Florida, 12629' Bottom of hole.

Amygdaloidal basalt with olive-green chlorite and white chalcedony (?). Ordinary light X29.

HARDEE COUNTY
HUMBLE OIL AND REFINING COMPANY

B. T. KEEN NO. 1 11934 T.D.

Completed 1948. Well locality 26 Applin (1951) No. 20.

Applin puts the top of the igneous rock at 11828 ft. Samples are available from 11853' to 11933' as follows:

Core 181 11853'-11857'

This is a fine grained dark greenish gray volcanic rock, with reddish stains on fractured surfaces. No phenocrysts are seen. In thin section (Figure 74) an aggregate of turbid plagioclase laths with interstitial green chlorite (replacing augite?), rather abundant black ore grains, scattered quartz (also in veinlets), and a little calcite is seen. A few large grains are now wholly chloritized, and a few chlorite amygdules are present.

This rock has been dated by R. L. Grasty as 143 ± 7 m.y. or 147 ± 3 m.y. (Upper Jurassic).

Core 182 11857'-11867'

This is somewhat coarser and more gray than green.

Core 183 11867'-11877' recovery 8½'

Agglomerate of rounded dark gray masses up to an inch across, in a lighter colored matrix.

In thin section is seen an aggregate of fine grained or glassy basalt fragments, mostly opaque because of black iron oxide dusty particles, but crowded with laths of unaltered plagioclase feldspar. The matrix of these fragments is pale green chlorite with finely crystallized quartz. Chlorite also fills numerous irregular vesicles in the basalt fragments. There are also fragments of quartzite with a rim of chlorite around the fragment. A few of the basalt fragments have larger porphyritic feldspar, completely unaltered. Figures 75a, b and 76a, b show these features.

Core 185 11874'-11881' fine grained dark gray basalt

Core 189 11886'-11888' recovery 2'

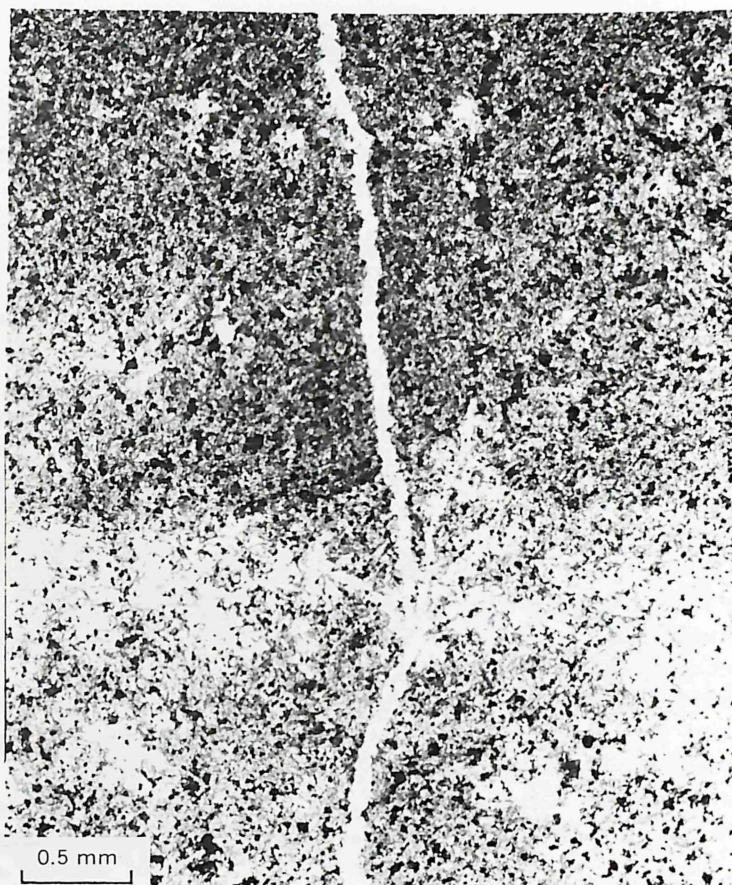
Very fine grained dark gray basalt. One piece of core has a large quartz lined vug, over an inch across. The quartz is coarsely crystallized, and the vug has a banded structure at the contact.

In thin section, uniform fine grained basalt, with fresh augite interstitial to plagioclase laths. A very few larger feldspars, and vugs with chalcedonic silica and bright orange-brown zeolite (?) are present. Similar reddish brown isotropic (?) material is strewn through the rock, with numerous small black ore grains.

The large quartz amygdule mentioned above has a complex structure, including a thin reddish zeolite band.

In thin section:

Core 190 11888'-11890' fine grained dark gray basalt



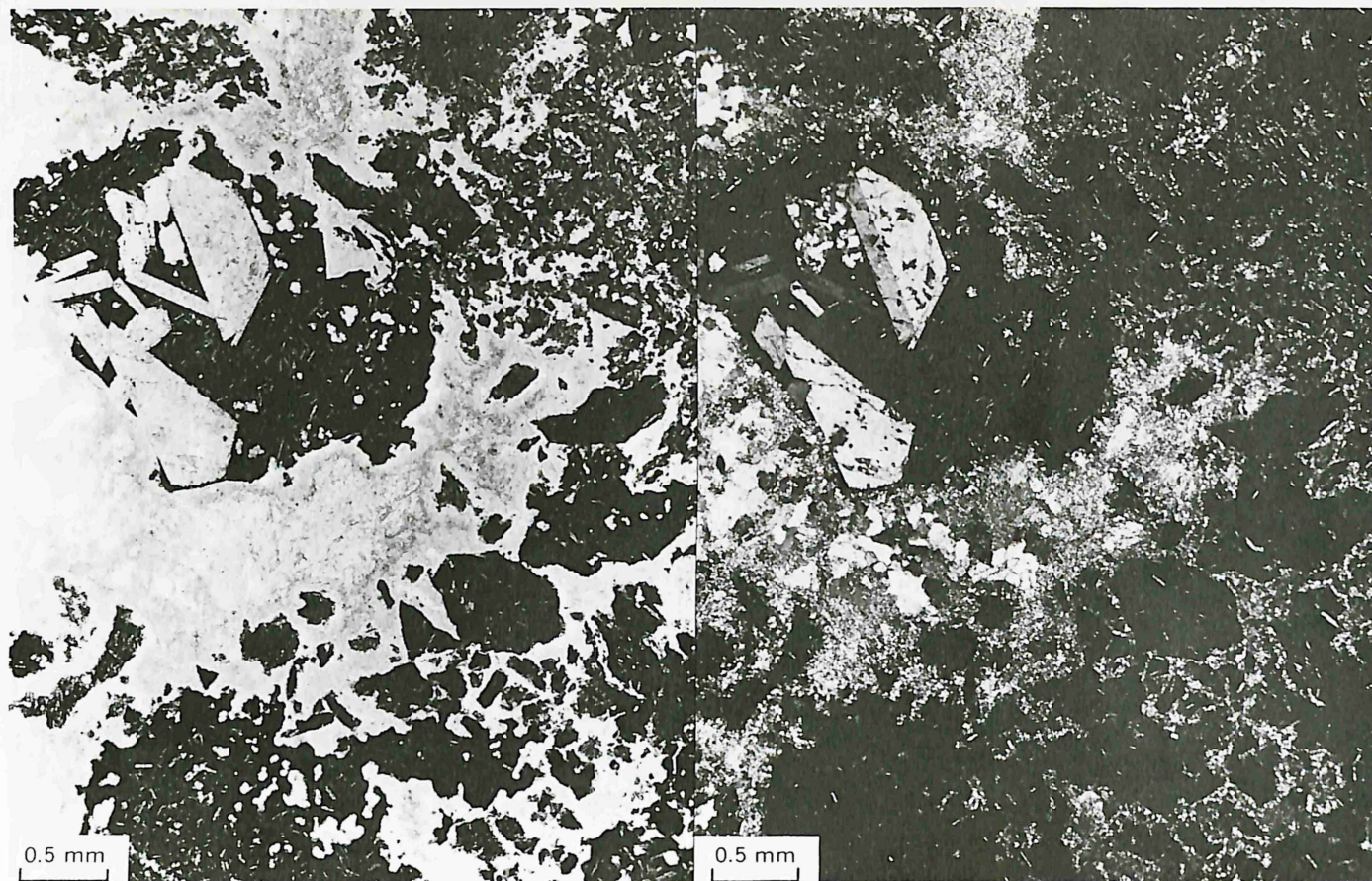
Basalt with quartz veinlet

Figure 74. Humble Oil and Refining Company, B. T. Keen No. 1, Hardee County, Florida, 11853'-11857'. X28.



Figures 75a, b. Humble Oil and Refining Company, B. T. Keen No. 1, Hardee County, Florida, 11867'-11877'.

Basalt with chlorite-quartz amygdule. The interior of the amygdule is granular quartz, the border, pale green chlorite. The basalt has been brecciated, the fissures filled with chlorite. Ordinary light and crossed nicols, X17.



Amygdular brecciated basalt

Figures 76a, b. Humble Oil and Refining Company, B. T. Keen No. 1, Hardee County, Florida, 11867'-11879'.

Another area in same thin section, showing porphyritic feldspars in basaltic fragment (black) surrounded by chlorite-quartz aggregate. Ordinary light and crossed nicols, X23.

- Core 191 11890'-11892' same
 Core 192 11892'-11895' same
 Core 194 11898'-11902' same
 Core 195 11902'-11906' same
 Core 197 11908'-11918' recovery 4' The rock is red-brown and decomposed to an earthy mass, but microscopically it is about the same as core 183 (11863'-11877') above, although quite vesicular.
 Core 198 11918'-11923' fine grained dark basalt
 Core 199 11923'-11928' dark basalt
 Core 200 11928'-11930' dark basalt
 Core 201 11930'-11932' dark basalt
 Core 202 11932'-11933' T.D. recovery 1 ft. The same as core 189 (11886'-11888') above, with a few plagioclase phenocrysts in addition to the minerals mentioned. Figures 77a and 77b.
 Bass (1969) describes a core sample from 11930 to 11932 ft. as basalt, and comments on its lack of metamorphism or weathering.

HILLSBOROUGH COUNTY
 HUMBLE OIL AND REFINING COMPANY
 T. S. JAMESON NO. 1 T.D. 10129'

Completed 1946 Well locality 27 Applin (1951) No. 22.
 "Rhyolite and volcanic agglomerate." Applin (1951)

Samples from 9995' to 10125' have been studied. The well according to Applin drilled into 119 feet of volcanic rock, beginning at 10010'.

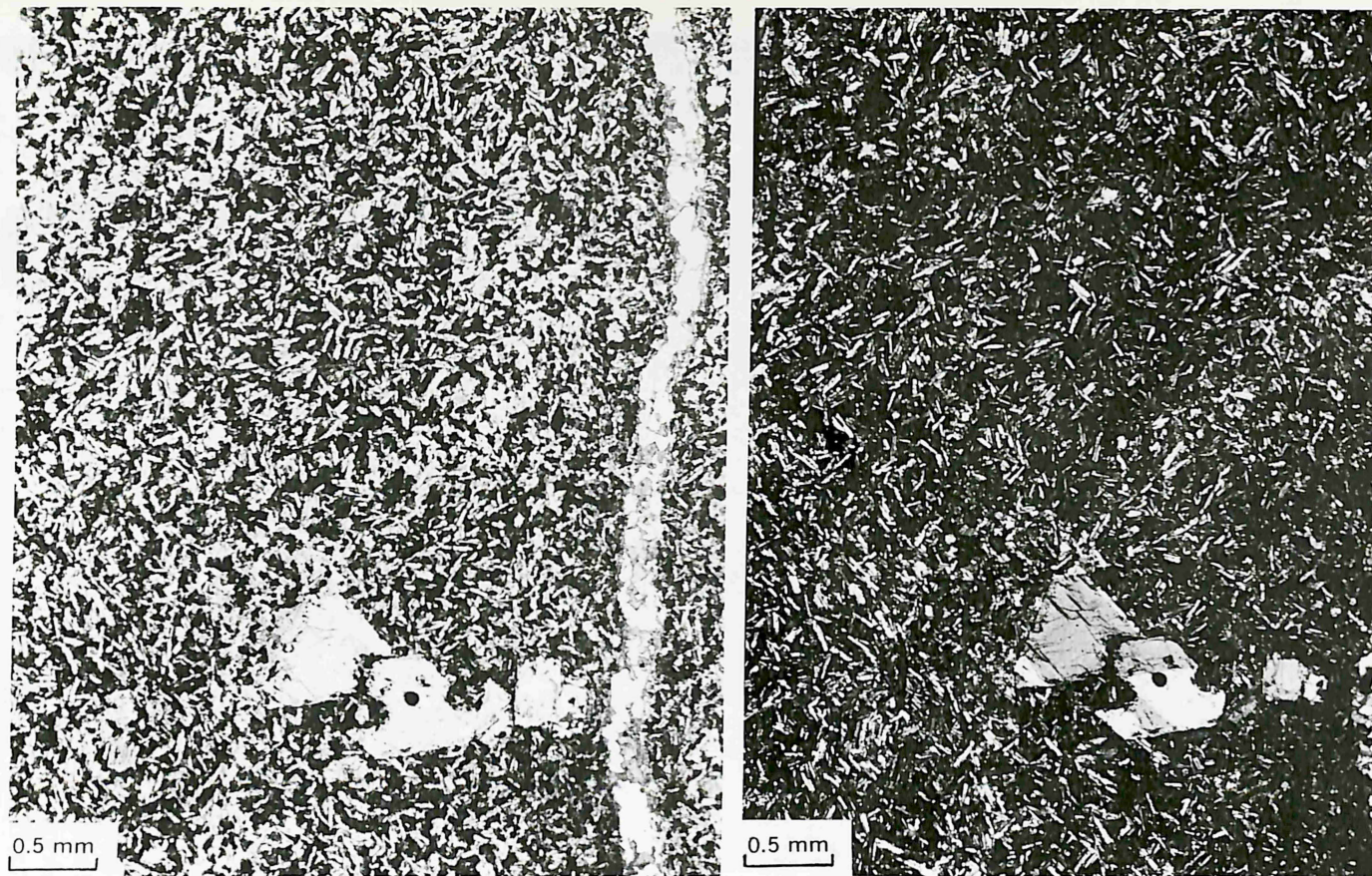
Core 122 9995'-10003' is a gray arkosic gritty sandstone, mostly slightly round grains of quartz with some microcline. There is considerable isotropic (?) interstitial material, perhaps halloysite. One quartz grain has numerous tiny pale blue tourmaline crystals. No volcanic material was seen in thin section (Figures 78a and 78b).

Core 123. 10003'-10010' is similar to preceding, however, the top 2' 10" from which a thin section was made shows that the clayey(?) matrix is recrystallized to a sericitic aggregate (Figures 79a and 79b).

Core 124. 10010'-10019' is a hard reddish rhyolitic agglomerate, very siliceous, in thin section showing large areas of microgranular quartz, besides numerous euhedral "high-temperature" quartz crystals. Large feldspar crystals are numerous. Flowage is seen in thin section (Figure 80). Ross (1956) has described this rock as welded tuff.

Core 125. 10019'-10022' similar to preceding. Under a binocular, specular hematite with green chlorite is seen in microscopic vugs. In thin section micro-granular quartz with some calcite and epidote is seen. Figures 81a, b illustrate this rock.

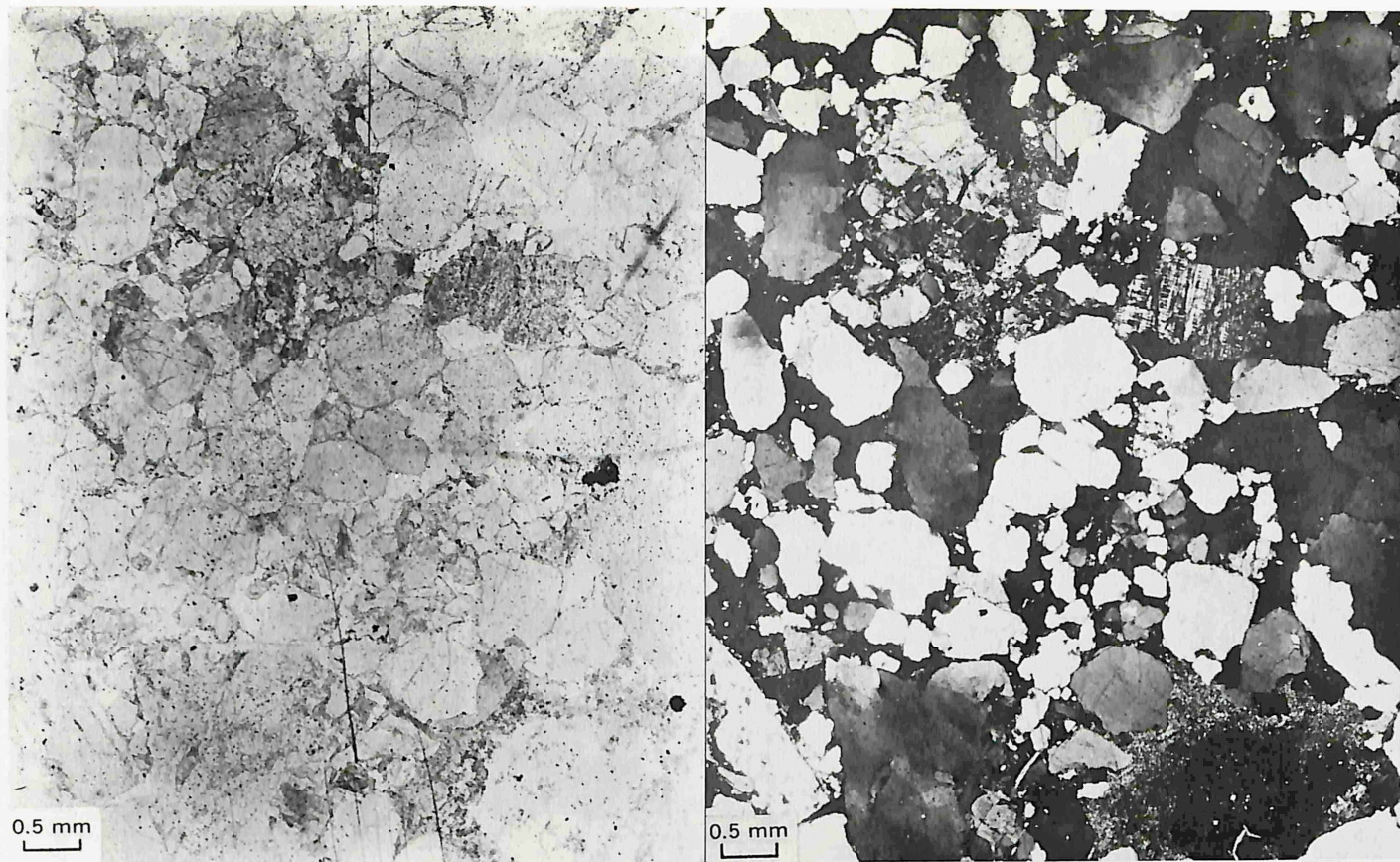
10025' Similar. The color of the core changes abruptly; one side



Basalt

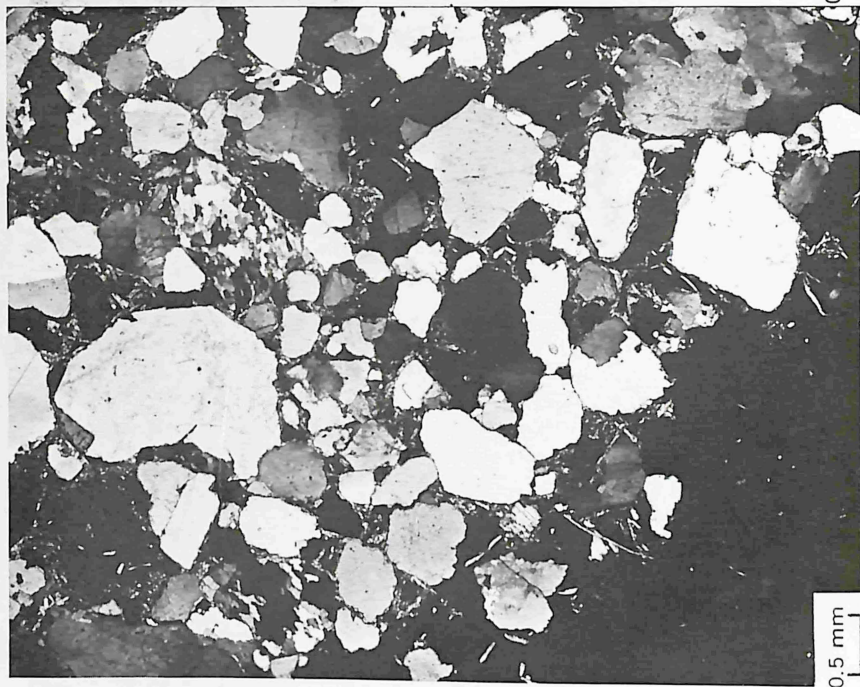
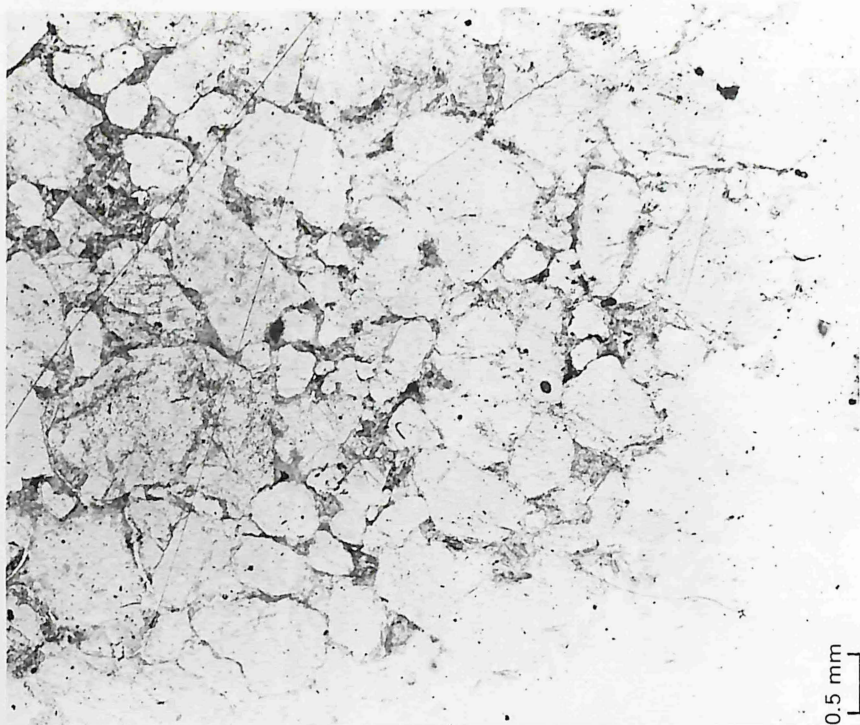
Figures 77a, b. Humble Oil and Refining Company, B. T. Keen No. 1, Hardee County, Florida, 11932'-11933'.

This specimen is markedly different from the preceding, being much like a normal fine grained diabase. There is alteration of the plagioclase or augite or abundant magnetite-ilmenite. The veinlet however is the quartz-chlorite aggregate of the other specimens. In the picture the quartz is clear, the green chlorite appears gray. Ordinary light and crossed nicols, X23.



Arkosic sandstone

Figures 78a, b. Humble Oil and Refining Company, T. S. Jameson No. 1, Hillsborough County, Florida, 9995'-10003'. Fairly fresh microcline is seen upper right center. Ordinary light and crossed nicols, X15.



Grit or arkose

Figures 79a, b. Humble Oil and Refining Company, T. S. Jameson No. 1, Hillsborough County, Florida, 10003'-10010'.

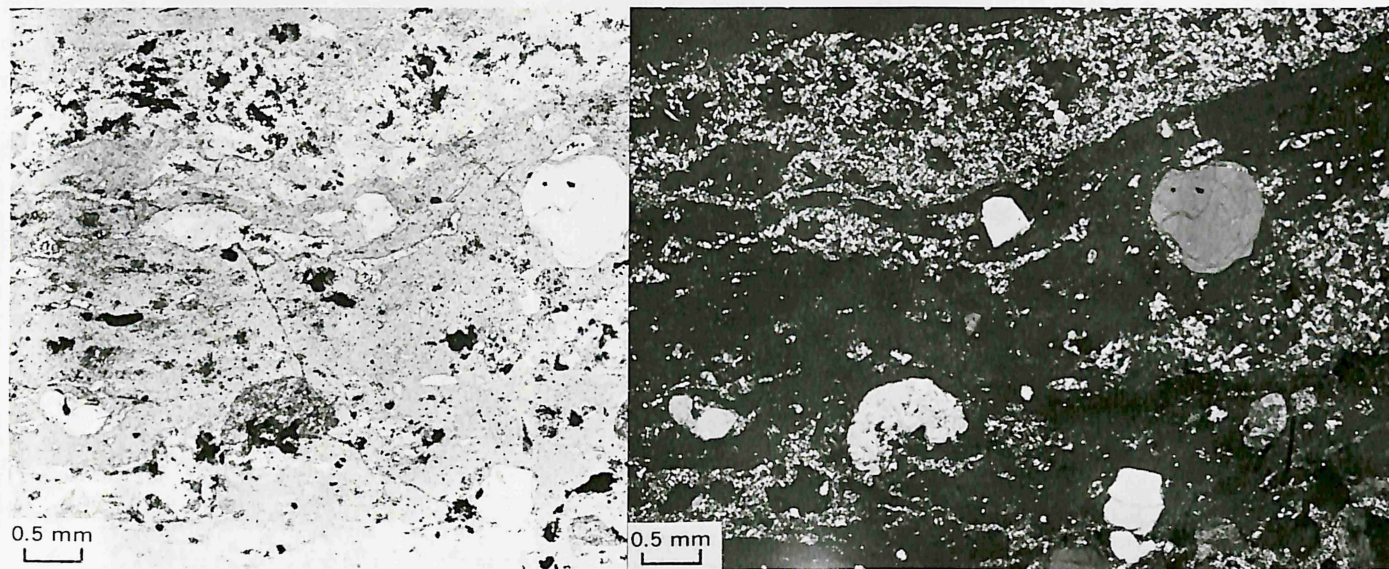
Shows matrix material, recrystallized to a sericitic aggregate. Ordinary light and crossed nicols, X15.



Rhyolite

Figure 80. Humble Oil and Refining Company, T. S. Jameson No. 1, Hillsborough County, Florida, 10010'-10019'.

Shows quartz (clear) in rhyolite. Many of the quartz crystals are euhehedral with strong rhombohedral development, characteristic of high temperature quartz. The darker gray areas are large feldspars, the matrix mostly microgranular quartz. X15.



Welded tuff (C. S. Ross) or rhyolite

Figures 81a, b. Humble Oil and Refining Company, Jameson No. 1, Hillsborough County, Florida, 10019'-10022'.

This is lineated aggregate of rhyolitic fragments, of varying texture with quartz and feldspar grains fused together. The half-circular area (lower left) is a corroded feldspar; to the right of it (center and lower center) are several quartz grains. Ordinary light and crossed nicols, X15.

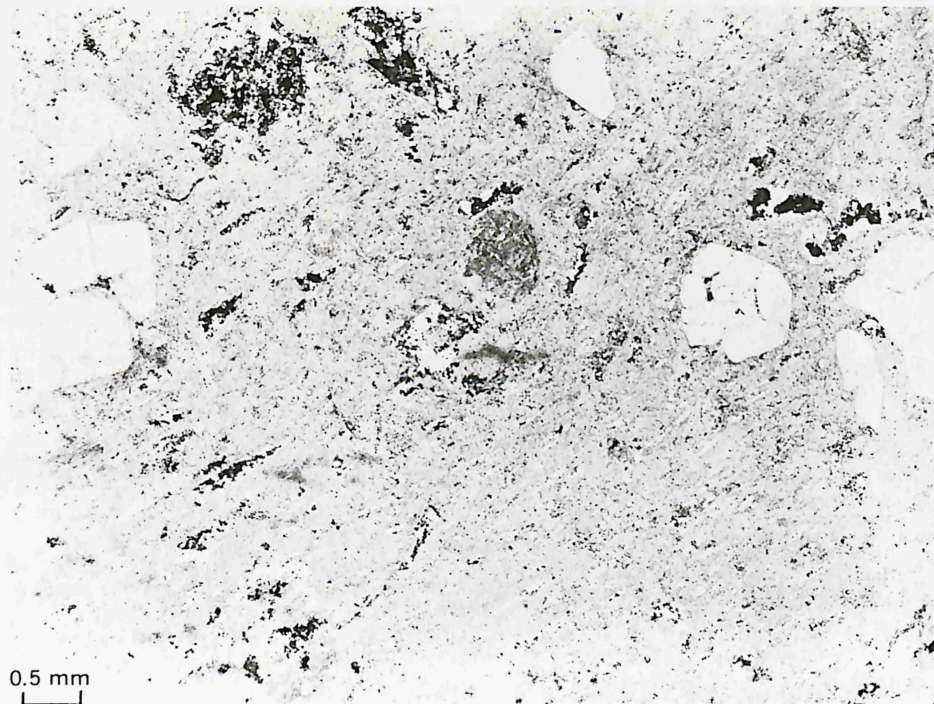
reddish, the other gray. Microscopically, it is similar to preceding with no evident compositional change (Figure 82).

Core 129. 10040'-10043' Similar grayish agglomerate. A thin section (Figure 83) shows characteristic corroded euhedral high temperature quartz, and similar feldspar. Hematite is relatively coarsely crystallized in patches.

10043'-10053' This shows in thin section lithophysae ("stone bubbles") in the finely granular quartz areas. Some contain calcite with green chlorite, most are filled with granular quartz. They are illustrated in Figure 84.

10115'-10125' This is different from the preceding; it is a gray crystalline rock with reddish areas, zeolite or carbonate, obviously volcanic agglomerate but not rhyolitic as the overlying rock. This is confirmed by a thin section (Figure 85), which shows an aggregate of different sorts of fine grained rather basic volcanic rock. There are no coarse feldspars, or quartz crystals, or granular quartz, as in the rhyolitic rocks above. Epidote and green hornblende with calcite appear to be secondary. The rock appears to be metabasaltic, rather than rhyolitic and resembles to some degree the metabasaltic rock from the St. Lucie County well, 12748'.

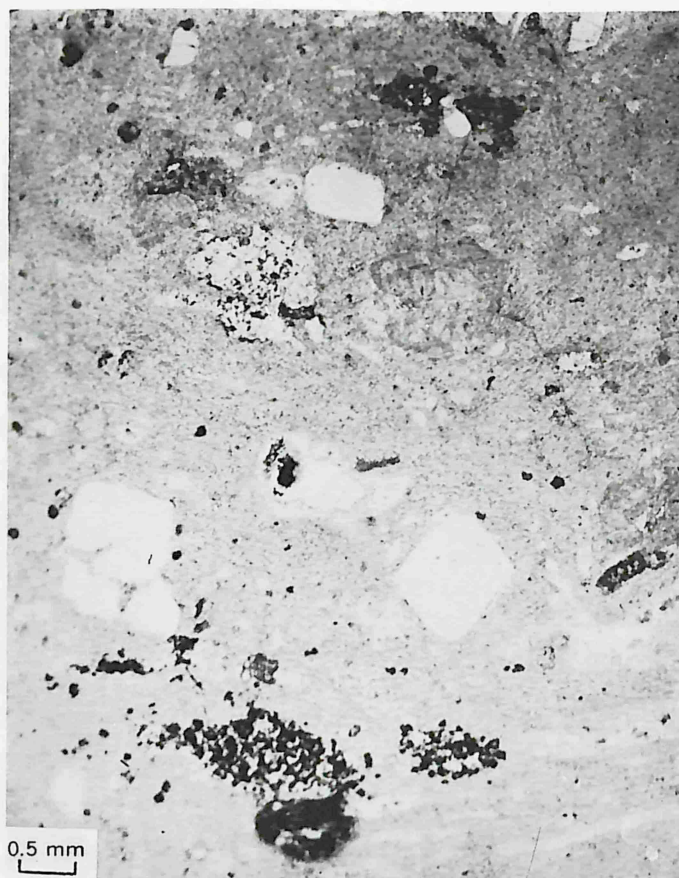
Bass (1969) describes tuff from 10106' to 10115'; and Ross (1958) refers to welded tuff in three core samples between 10010' and 10034'.



Rhyolite

Figure 82. Humble Oil and Refining Company, T. S. Jameson No. 1, Hillsborough County, Florida, 10025'.

This is a typical unaltered rhyolite porphyry with quartz (clear) and feldspar phenocrysts (gray, center) and chloritic areas (dark gray, upper left). The groundmass shows flow lineation. Ordinary light X15.



Rhyolite or welded tuff

Figure 83. Humble Oil and Refining Company, T. S. Jameson No. 1, 10040'-10043'.

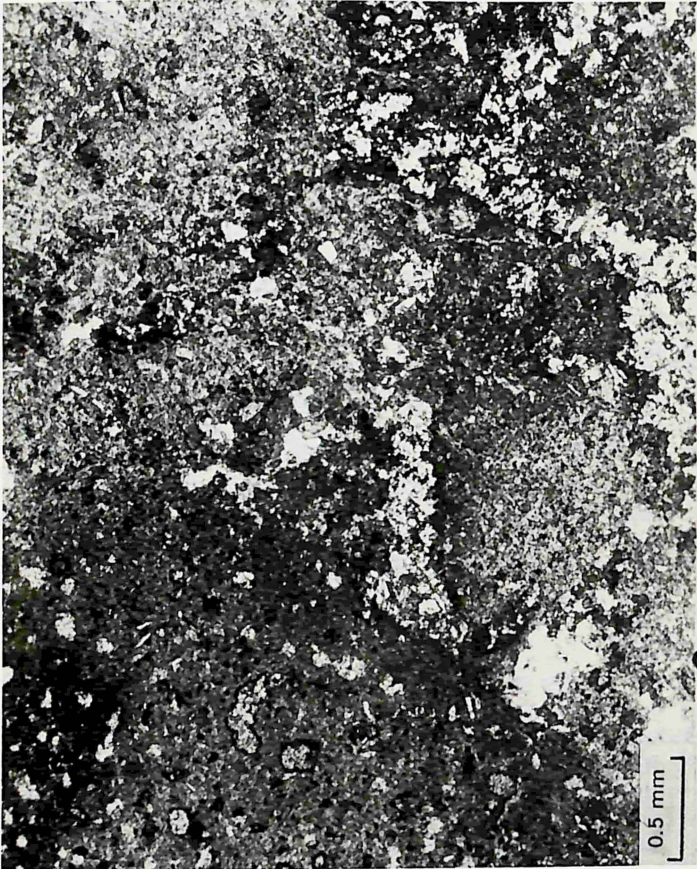
Shows euhedral but partly dissolved high temperature quartz (clear). At the left edge near the center is an altered feldspar. The dark spots are mostly hematitic. Ordinary light X15.



Rhyolite

Figure 84. Humble Oil and Refining Company, T. S. Jameson No. 1, Hillsborough County, Florida, 10043'-10053'.

Shows lithophysae ("stone bubbles") in rhyolitic agglomerate or welded tuff. Ordinary light X27.



Intensely altered basaltic rock

Figure 85. Humble Oil and Refining Company, T. S. Jameson No. 1 Hillsborough County, Florida, 10115'-10125'.

Rather coarse epidote and green hornblende, with sodic feldspar and calcite, is strewn through this rock, which retains very little of its original character. Ordinary light, X27.

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