

A microscopic image of a rock sample, likely a thin section, showing mineral grains and fractures. The image is characterized by a complex pattern of brown, tan, and blue-green colors, with some areas appearing more crystalline and others more fractured. The text is overlaid on this image.

**GEOCHEMICAL, MINERALOGICAL AND
PETROGRAPHIC CHARACTERIZATION OF
ROCKS COMPRISING THE UPPER FLORIDAN
AQUIFER SYSTEM IN SOUTH FLORIDA**

**FLORIDA GEOLOGICAL SURVEY
REPORT OF INVESTIGATION NO. 113**

Cover: Polarized light photomicrograph of peloidal grainstone from the Avon Park Formation containing foraminifera and algae, well W-18728, 2,140-2,160 feet deep. Magnification approximately 250X.

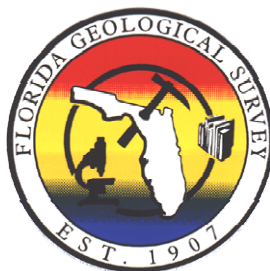
STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Herschel T. Vinyard Jr., *Secretary*



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Jeff Littlejohn, *Deputy Secretary*

FLORIDA GEOLOGICAL SURVEY
Jonathan D. Arthur, *State Geologist and Director*

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By

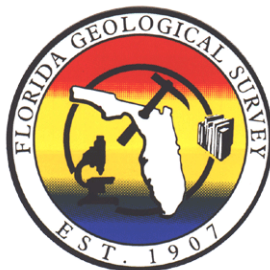
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PREFACE



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The Office of the Florida Geological Survey, Regulatory Programs, Florida Department of Environmental Protection, is publishing its Report of Investigation No. 113, *Geochemical, Mineralogical and Petrographic Characterization of Rocks Comprising the Upper Floridan Aquifer System in South Florida*. Chemical and trace mineral compositions of aquifer system rocks (storage zones and confining units) in this region are limited. Studies such as this are beneficial to identify processes that may adversely affect native and recovered water quality due to aquifer storage and recovery (ASR) activities. State, regional, county and local governmental agencies as well as the public will find this information useful in support of natural resource management and conservation decisions.

Jonathan D. Arthur, Ph.D., P.G.
State Geologist and Director
Office of the Florida Geological Survey
Florida Department of Environmental Protection

ACKNOWLEDGEMENTS

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ABBREVIATIONS AND ACRONYMS

Actlabs	Activation Laboratories Ltd.	FUS-MS	fusion- mass spectrometer
Al ₂ O ₃	aluminum oxide	Hg	mercury
ASR	aquifer storage and recovery	IC	ion chromatography
As	arsenic	ICP-MS	inductively coupled plasma - mass spectrometer
BDL	below detection limit	ICP-OES	inductively coupled plasma - optical emission spectrometer
BLS	below land surface	IR	infrared detector
BP	interparticle	INAA	instrumental neutron activation analysis
BSE	backscatter electron	K ₂ O	potassium oxide
C	carbon	M	moldic
Ca	calcium	Mg	magnesium
CERP	Comprehensive Everglades Restoration Plan	µg/L	microgram per liter
cm	centimeters	mg/L	milligrams per liter
CO ₂	carbon dioxide	mM/kg	millimoles per kilogram
COUL	colorimetry	µM	micromoles
CP	composite photo	Mn	manganese
EDS	energy-dispersive spectroscopy	Mo	molybdenum
EPA	U.S Environmental Protection Agency	Na ₂ O	sodium oxide
eV	electron volt	nA	nanoampere
EPMA	electron probe microanalysis	NOM	natural organic matter
FCAEM	Florida Center for Analytical Electron Microscopy	P	phosphorus
FDEP	Florida Department of Environmental Protection	P ₂ O ₅	diphosphorus pentoxide
FGS	Florida Geological Survey	ppb	parts per billion or µg/L
Fe	iron	ppm	parts per million or mg/L
Fe ₂ O ₃	ferric oxide	S	sulfur
FeS ₂	iron sulfide (pyrite)	S(SO ₄)	total sulfur as sulfate
FIMS	flow injection mercury system	SO ₄ ²⁻	sulfate
FIU	Florida International University	SEM	scanning electron microscope
ft	feet	Sb	antimony
FUS-ICP	fusion- inductively coupled plasma	SFWMD	South Florida Water Management District
TD-ICP	total digestion-inductively coupled plasma	SiO ₂	silica dioxide
U	uranium	Sr	strontium
USGS	U.S. Geological Survey	SrSO ₄	strontium sulfate (celestite)
		V	vanadium
		WDS	wavelength dispersive spectroscopy

CONVERSIONS FACTORS

Multiply	By	To obtain
foot (ft)	0.305	meter (m)
inch (in)	2.54	centimeter (cm)
mg/L	1000	µg/L
millimeter (mm)	1000	micron (µm)
percent (or weight percent)	10000	parts per million
parts per million	1000	parts per billion
mile	1.609	kilometer

**GEOCHEMICAL, MINERALOGICAL AND PETROGRAPHIC
CHARACTERIZATION OF ROCKS COMPRISING THE UPPER
FLORIDAN AQUIFER SYSTEM IN SOUTH FLORIDA**

By

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INTRODUCTION

Recent studies have demonstrated that carbonate rocks of the Floridan aquifer system in central Florida are chemically heterogeneous, and that these rocks interact with injected water during aquifer storage and recovery (ASR) activities resulting in water quality changes (Arthur et al., 2005, 2008a; Jones and Pichler, 2007; Price and Pichler, 2006; de Ruiter and Stuyfzand, 1998). Some of the metals (and metalloids) mobilized from the aquifer matrix into the injected waters include arsenic (As), iron (Fe), manganese (Mn), molybdenum (Mo), antimony (Sb), vanadium (V) and uranium (U). The source of these metals may include organics, minerals within the carbonate matrix and fracture or grain coatings. Mobilization of these metals is a known concern for ASR.

Arsenic is naturally present in soils and rocks, though usually in trace (parts per million) concentrations. In Florida, background soil concentrations range from 0.01 to 50.6 ppm, with median values of 0.2 to ~2 ppm, depending upon soil type (Chen et al., 2002). Understanding the chemical processes involved in the mobilization of arsenic and other metals are important to the implementation of ASR. In south Florida, carbonates of the Upper Floridan aquifer comprise the potential storage zone for the Comprehensive Everglades Restoration Plan (CERP) ASR wells. Geochemical studies involving the compositions of these aquifer system rocks are limited and as such additional studies are beneficial to identify processes that may adversely affect native and recovered water quality resulting from ASR activities.

Objective and Scope

The primary objective of this project was to characterize chemical and mineralogical compositions within and adjacent to potential ASR storage zones in order to facilitate assessment of reactions and constituents that might impact the suitability of the rock as an ASR storage zone. Whole-rock geochemical analyses of 14 core samples from three different cores were completed to achieve project objectives. The samples included three cores through Hawthorn Group siliciclastic sediments and carbonates of the Upper Floridan aquifer. Whole-rock geochemical analyses for these samples included multi-element, multi-method techniques with detection limits and precision that meet those required for possible future geochemical modeling efforts. Lithologic descriptions, lithostratigraphic formation determination, petrographic descriptions, lithogeochemical analyses and archival photography of core samples were

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completed. Detailed mineralogical analyses were accomplished through a combination of scanning electron microscopy and electron probe microanalysis.

METHODS

Sample Collection

Core sampling from the three wells was intended to represent targeted and non-targeted lithologies including areas of anomalous textural, lithological or mineralogical characteristics (e.g., chemically reduced or oxidized zones, organic-rich sediments, sulfide minerals and interlayered carbonates/siliciclastics). These samples represented both homogenous and heterogeneous strata from within or proximal to the ASR storage zone (Table 1, Figure 1) with the exception of W-18728, which is below the storage zone and represents the lower part of the Avon Park Formation. W-18728 arrived with insufficient labeling and documentation. It appeared that the interval 2140-2160 feet below land surface (' BLS) had poor core recovery and therefore, definitive depths could not be assigned and samples were labeled 2140-2160 A and 2140-2160 B with the sample labeled 'A' more shallow than 'B'.

Table 1. Wells and sampled intervals (ft BLS) and lithostratigraphic formations.

FGS W #	Name	County	Sampled interval	Formation
W-18728	PBF-15 (L-8 test well)	Palm Beach	2140-2160A	Avon Park Formation
W-18728	PBF-15 (L-8 test well)	Palm Beach	2140-2160B	Avon Park Formation
W-18776	EXKR-MW1 (MW-0010)	Okeechobee	657-658	Ocala Limestone
W-18776	EXKR-MW1 (MW-0010)	Okeechobee	662-663	Ocala Limestone
W-18776	EXKR-MW1 (MW-0010)	Okeechobee	723-724	Ocala Limestone
W-18776	EXKR-MW1 (MW-0010)	Okeechobee	805-806	Avon Park Formation
W-18776	EXKR-MW1 (MW-0010)	Okeechobee	812-813	Avon Park Formation
W-18778	Cape Coral (MWH L-1028)	Lee	652-653	Hawthorn Group
W-18778	Cape Coral (MWH L-1028)	Lee	754-755	Hawthorn Group
W-18778	Cape Coral (MWH L-1028)	Lee	763-764	Suwannee Limestone
W-18778	Cape Coral (MWH L-1028)	Lee	848-849	Suwannee Limestone
W-18778	Cape Coral (MWH L-1028)	Lee	983-984	Suwannee Limestone
W-18778	Cape Coral (MWH L-1028)	Lee	995-996	Suwannee Limestone
W-18778	Cape Coral (MWH L-1028)	Lee	1119-1120	Suwannee Limestone

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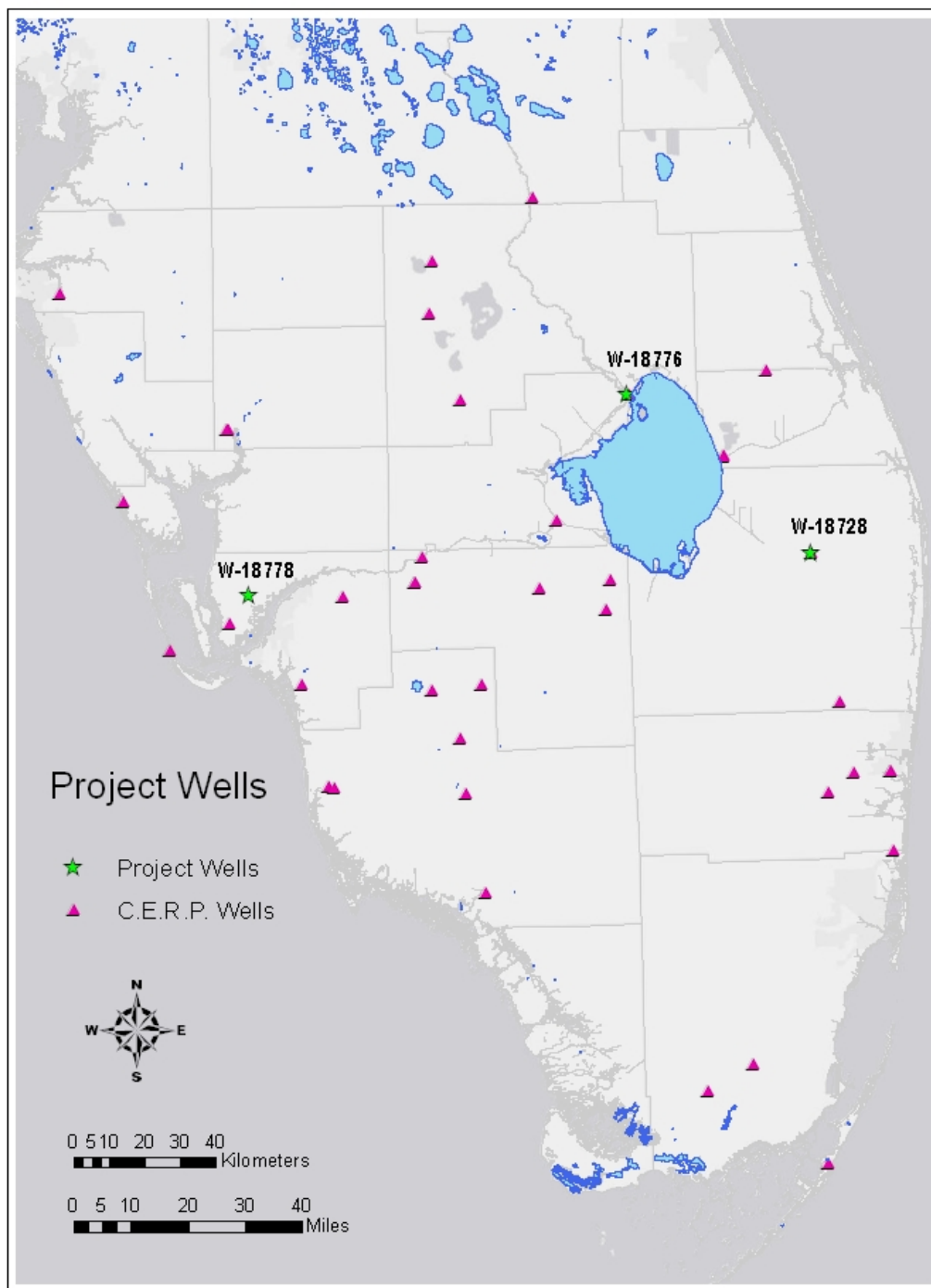


Figure 1. Location of project wells and previous CERP study wells (Arthur et al., 2007).

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Sample Preparation

Each sample consisted of an approximately six inch length (15.24 cm) of core, diameter varied between 1.5 to 4 inches (3.8 to 10.2 cm). Samples were photographed prior to processing (Figure 2). Core exteriors were removed using a water-cooled trim saw to remove drilling mud impregnated along the core exterior, post-drilling oxidized zones and precipitates (e.g., gypsum formed during core storage), as well as any possible anthropogenic contaminants. To minimize contamination, the trim saw is reserved solely for projects requiring geochemical analysis. After trimming, each sample was rinsed with distilled de-ionized water. The samples were air-dried overnight on a clean countertop in the laboratory.



Figure 2. Example of sample archive photograph.

Splitting and powdering

Bulk rock powders and polished thin sections were prepared. Rock powders were required for lithogeochemical analyses. Crushing, pulverization and splitting were done by a commercial laboratory, Activation Laboratories Ltd. (Actlabs), analysis code RX2. Additional details on the laboratory methods can be found at the Actlabs website: <http://www.actlabs.com/list.aspx?menu=64&app=226&cat1=549&tp=12&lk=no>

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Petrographic/Mineralogic Analyses

This investigation included petrographic descriptions of 14 thin sections. Thin sections were cut parallel to the long axis of the core to yield more stratigraphy and increased heterogeneity. Two sets of thin section tabs were sent to Spectrum Petrographics, Inc. who prepared the thin sections which were finished to 30 μm thick and impregnated with blue dye under vacuum. One set of selected thin sections were polished for microanalyses. Petrographic descriptions included characterization of sample lithology, mineralogy, rock fabric (Dunham, 1962), depositional environment and pore types. This information was supported by extensive photomicrographic documentation.

Scanning Electron Microscopy and Microprobe Analysis

Trace mineralogical analyses were completed using reflected light microscopy, scanning electron microscopy (SEM), back-scattered electron imaging (BSE) and electron probe microanalysis (EPMA) which included energy-dispersive x-ray spectroscopy (EDS) and wavelength dispersive spectroscopy (WDS). Prior to image analyses, all thin sections were sputter-coated with carbon at the Florida Department of Environmental Protection/Florida Geological Survey (FDEP/FGS) Microanalysis Laboratory or at the Florida International University (FIU) Florida Center for Analytical Electron Microscopy (FCAEM) (Figure 3). Secondary electron (topographic) imagery is useful for identifying textures. BSE images enhance contrast between different minerals or mineral compositions based on the average atomic number; the higher the average atomic number the brighter the mineral (Figure 4).

Quantitative EPMA were completed remotely via the Internet at FIU/FCAEM (http://www.fiu.edu/~emlab/inst_EPMA.html) using a JEOL 8900R Superprobe with four 2-crystal detectors. A beam of accelerated electrons is focused (within 1-9 cubic microns) on the surface of the specimen and characteristic X-rays are produced and detected at a particular energy (or wavelength) and the intensity is measured to determine concentration. It is these "characteristic x-ray lines", ranging in energy from 0.1 - 15 keV that the electron microprobe uses to identify and quantify the elements present in the sample. Each element has a specific set of X-rays that it emits. These X-rays are collected as peaks in a spectrum which correspond to specific X-ray lines and the elements can be easily identified. A typical peak width for WDS is 2-20 eV allowing better resolution than EDS which is 70-130 eV (Goldstein et al., 2007). The increased resolution of WDS allows easier detection and identification of peaks at concentrations about a factor of ten lower than EDS. The resolutions are also important in situations in which adjacent peaks overlap making it difficult to identify or quantify each of the peaks.

Polished, carbon-coated thin sections were analyzed using a 20 nA probe current. Each analysis included eight elements (see Table 2 for element conditions). Element maps are based on intensity (or counts) over the collection period and represent a greater concentration based on

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material concentration (Figure 5). To clarify the patterns and reduce noise, the images were filtered with edge enhancement and, in some cases, a median-value filter. Within each element map is a composite picture (CP) that outlines the mineral edges, but does not reflect composition. Analytical detection limits for all metal analyses and element maps were approximately 200 parts per million (ppm) or 0.02 weight percent (Tom Beasley, pers. comm., FIU/FCAEM).



Figure 3. FDEP/FGS microanalysis laboratory (left) and the electron probe at the FIU/FCAEM facility (right).

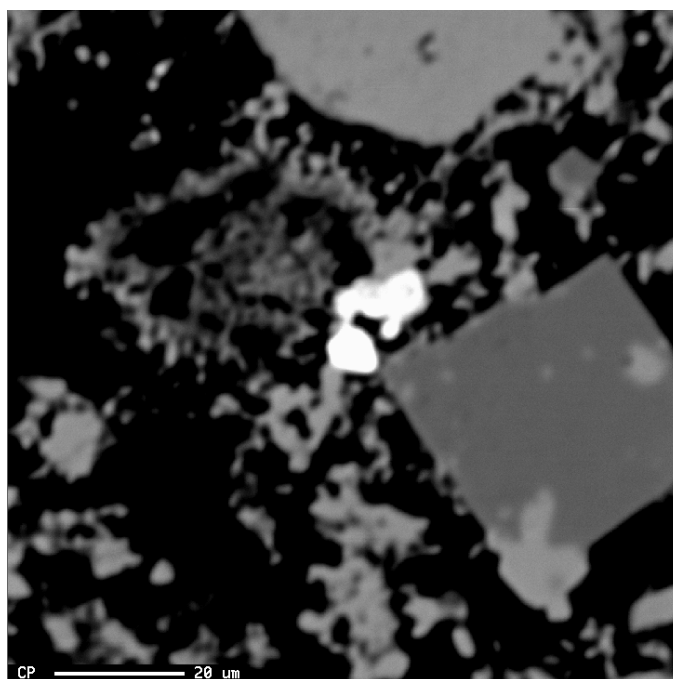


Figure 4. BSE image of pyrite framboids (white) and dolomite rhomb showing lighter areas of different composition in W-18776, 662-663' BLS.

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Table 2. EPMA element conditions for geochemical standard and unknown analyses.

	Elem- 1	Elem- 2	Elem- 3	Elem- 4	Elem- 5	Elem- 6	Elem- 7	Elem- 8
Elements	Mg	Fe	S	As	Ca	Mo	U	Sb
Name	Mg	Fe	S	As	Ca	Mo	U	Sb
X-ray Name	Ka	Ka	Ka	Ka	Ka	La	Ma	La
Order	1	1	1	1	1	1	1	1
Channel	1	2	3	2	3	2	3	2
Crystal	TAP	LIF	PETJ	LIF	PETJ	PETJ	PETJ	PETJ
Spect. Pos.(mm)	107.606	134.679	172.131	81.537	107.616	173.188	125.179	110.081
Back (+) (mm)	3.500	5.000	5.500	7.000	13.000	6.000	5.000	6.000
Back (-) (mm)	17.500	10.500	5.500	5.000	11.500	8.000	5.000	5.000
Time/Count	Time	Time	Time	Time	Time	Time	Time	Time
Peak Seek W.	1	1	1	1	1	1	1	1
Mes. Time (sec)	10.0	10.0	10.0	100.0	10.0	15.0	10.0	10.0
Bac. Time (sec)	5.0	5.0	5.0	20.0	5.0	5.0	5.0	5.0
Mes. Count	10000	10000	10000	10000	10000	10000	10000	10000
Bac. Count	500	500	500	500	500	500	500	500
PHA gain	32	32	128	32	64	128	64	64
High V.(V)	1712	1706	1682	1666	1688	1674	1708	1694
Base L.(V)	2.00	0.50	2.50	0.50	1.00	2.00	2.00	0.50
Window (V)	5.00	8.00	3.50	9.00	7.00	4.00	4.00	9.00
Diff/Int	Diff	Diff	Diff	Diff	Diff	Diff	Diff	Diff
Sequence	1	1	1	2	2	3	3	4

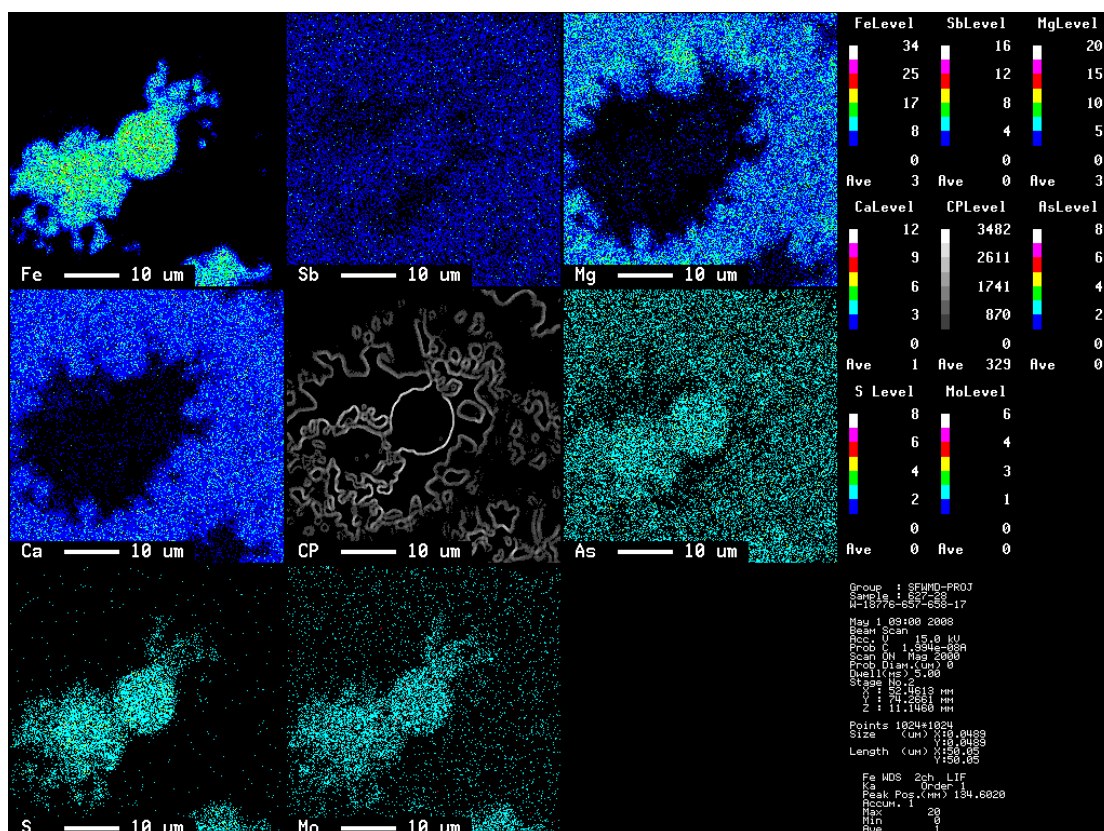


Figure 5. EPMA element maps of pyrite cluster in W-18776, 657-658' BLS. Brighter areas indicate higher element concentrations. "CP" frame is an edge-sharpened BSE image. Note the association of As and Mo and, to a much lesser extent, Sb, with the pyrite (FeS_2).

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Validation of the arsenic analyses was assessed using non-certified reference material obtained from the U.S. Geological Survey (USGS). The reference material, a basalt glass, was spiked with As and reported average concentrations of 723 ppm, 3200 ppm, and 8600 ppm. The glasses were mounted and polished at FIU/FCAEM. Our independent assessment of the reference material shows reasonably good precision and linearity (Figure 6). A nominal WDS detection limit of 200 ppm (0.02 percent) was assumed for all analyzed elements (Tom Beasley, pers. comm., FIU/FCAEM). However, based on our WDS arsenic analysis (Figure 6) of the USGS reference material, a detection limit of about 500 ppm may be more realistic to reflect the observed analytical uncertainty (Long and Winefordner, 1983; Thomsen et.al, 2003).

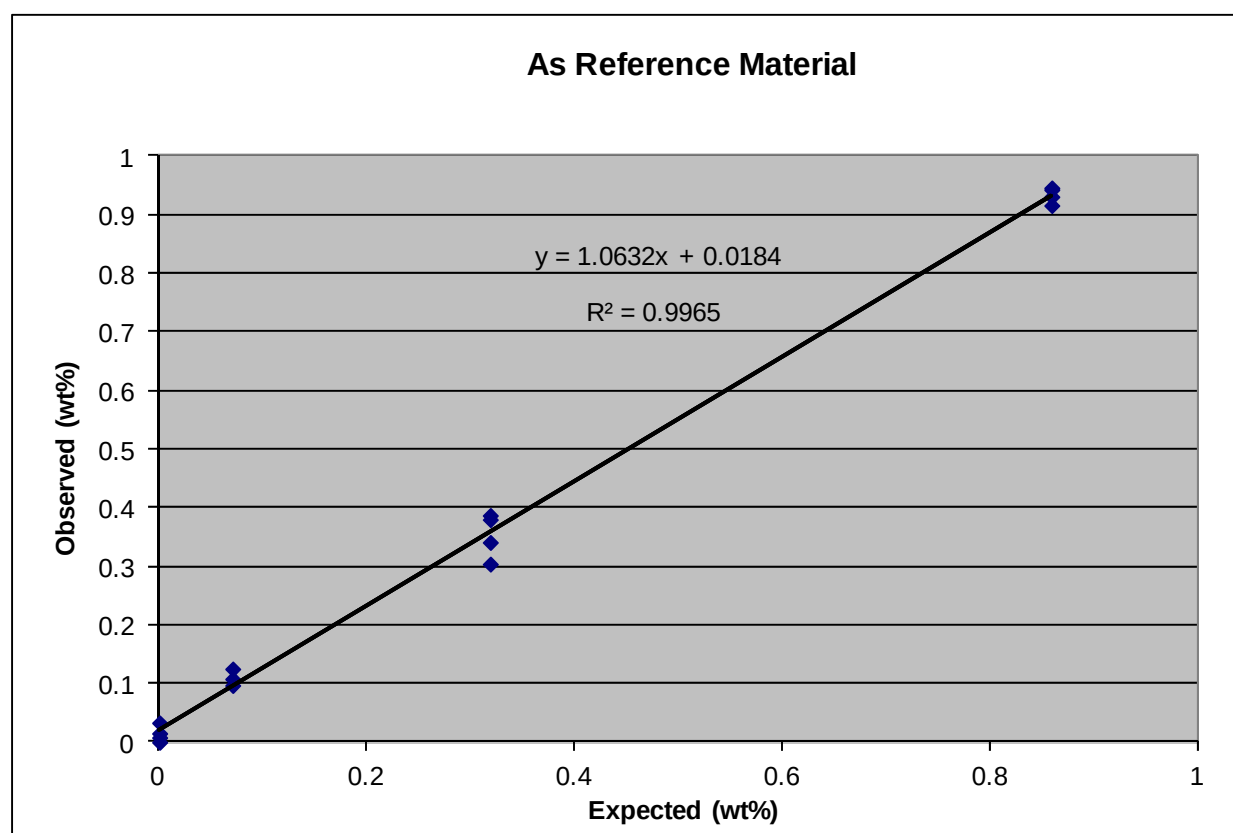


Figure 6. Independent assessment of basalt glass reference material.

Lithogeochemistry

Major, trace, and rare-earth element geochemical analyses were completed at Actlabs for 14 core samples. The multi-method analytical package (4E-Research) included use of these analytical methods: Mass spectrometry (ICP-OES and trace element fusion ICP-MS), instrumental neutron activation analysis (INAA), and x-ray fluorescence spectrometer. Carbon and sulfur were analyzed using an automated LECO CS-344 analyzer and a solid-state infrared

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detector to yield CO₂, total C, graphitic C, organic C, S and S(SO₄). Mercury (Hg) was measured using a Perkin Elmer Flow Injection Mercury System (FIMS) 100 cold vapor Hg analyzer. Analytical accuracy was monitored by using international standard reference materials. For a more detailed description of the methods used by the laboratory see Appendix 1.

RESULTS AND DISCUSSION

Lithology and Petrography

Samples collected in this study represented, from oldest to youngest, the Middle Eocene Avon Park Formation, the Upper Eocene Ocala Limestone, the Lower Oligocene Suwannee Limestone and the Oligocene-Miocene Arcadia Formation (Hawthorn Group). Lithologic descriptions of all samples are provided in Appendix 2. Lithostratigraphic unit boundaries were taken from consultant reports or South Florida Water Management District's (SFWMD) DBHYDRO: <http://www.sfwmd.gov/portal/page/portal/xweb%20environmental%20monitoring/dbhydro%20application>. If lithostratigraphic boundary selections were unavailable, boundaries were determined using some combination of available data such as chemical, mineral, paleontologic, or gamma-ray response.

An overview of the petrographic descriptions for the 14 thin sections from three cores is presented herein. Four thin sections from the Avon Park Formation, three from the Ocala Limestone, five from the Suwannee Limestone, and two from the Arcadia Formation (Hawthorn Group) were examined for their mineralogy, grain types, sedimentary structures, depositional fabrics and porosity.

A detailed petrographic report, including photomicrographs, observations and lithostratigraphic units by well, is given in Appendix 3. For additional information regarding these lithostratigraphic units and their subsurface distribution, the reader is referred to Davis et al., 2001; Reese and Richardson, 2008 and Arthur et al., 2008b. Petrographic descriptions in this report apply the Wentworth scale to all grains, regardless of mineralogy. Thus "silt" may refer to carbonate minerals or quartz depending on the context of the sentence. For example, a "silty packstone" refers to carbonate-mineral grains. If the silt is quartz, it is specified.

Avon Park Formation

The Middle Eocene Avon Park Formation in south Florida generally varies between limestone and dolostone. The limestone is generally cream to light brown, poorly to well indurated, variably fossiliferous, skeletal/peloidal wackestone to grainstone with minor mudstone, at times interbedded with dark brown to tan, very fine to coarse-grained, vuggy, fossiliferous, sucrosic dolostones. Varying degrees of recrystallization and alteration, including complete dolomitization, are observed. Minor clay beds and organic-rich laminations occur, especially at or near the top of the unit. Although not common, sedimentary structures can include cross-beds and burrows. Accessory minerals include chert, gypsum, quartz and pyrite

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with gypsum becoming more abundant with depth (Arthur et al., 2007; Arthur et al., 2008b). Porosity in the Avon Park Formation is generally intergranular in the limestone section. Fracture porosity occurs in the more densely recrystallized dolostone, and intercrystalline porosity is characteristic of sucrosic textures. Pinpoint vugs and fossil molds are present to a lesser extent.

Petrographic analyses of four Avon Park Formation samples included typical facies for the unit. Of the samples analyzed, all were limestones or dolomitic limestones. Textures ranged from wackestone to packstone to grainstone. Two samples, with laminae of mud and/or organics, likely formed in a shallow platform setting which included shallow subtidal to supratidal settings. All samples included skeletal fragments which were mostly comprised of shallow water benthic foraminifera. Allochems included peloids, micritized grains, miliolids and other shallow water bioclasts which occurred in varying abundances with a few intraclasts (Figure 7). Two of the four Avon Park Formation samples contained microscopically visible pyrite (Appendix 3).

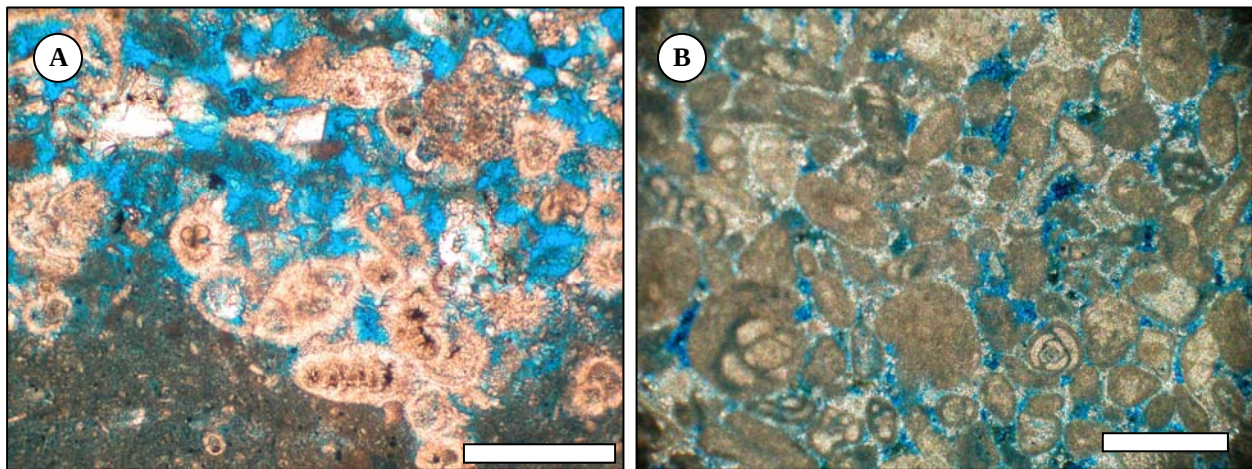


Figure 7. Avon Park Formation: A) W-18776, 812-813' BLS; top half low-mud packstone, lower half high-mud wackestone layer. B) W-18728, 2140-2160B' BLS; highly micritized moderately to well cemented grainstone, with miliolids. Scale bar is 0.25 mm in A and 1.0 mm in B.

Ocala Limestone

The Upper Eocene Ocala Limestone in south Florida varies from white to light gray with variable induration, generally ranging from a packstone to a grainstone. Grainstones of the Ocala Limestone are among the most permeable zones in the Upper Floridan aquifer. Porosity within the unit is generally moldic and intergranular with occasional macrofossil molds. Secondary porosity, due to carbonate dissolution, is extensive and can greatly enhance permeability, especially where confining beds are either breached or absent. Chert occurs throughout the formation; however, it is more common where the unit is at or near land surface (Arthur et al., 2008b). Trace amounts of organics and clay could represent post depositional infilling (Green et al., 1995). Pyrite is also present as a trace mineral.

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The three Ocala Limestone samples, all packstones, consisted of limestone to dolomitic limestone. One was slightly dolomitic, another about 30 percent dolomite. All of the Ocala Limestone samples showed evidence of bioturbation and contained of large benthic foraminifera. All exhibited polymodal grain sizes with large benthic foraminifera and echinoids in the coarse fraction, small benthic foraminifera in the sand fraction, and peloids, finely broken skeletal debris and silt-sized dolomite rhombs in the silt fraction (Figure 8). Pyrite was observed throughout these samples. All the Ocala Limestone samples were interpreted to have been deposited on a broad subtidal ramp having formed in middle to lower-middle ramp settings (Loizeaux, 1995).

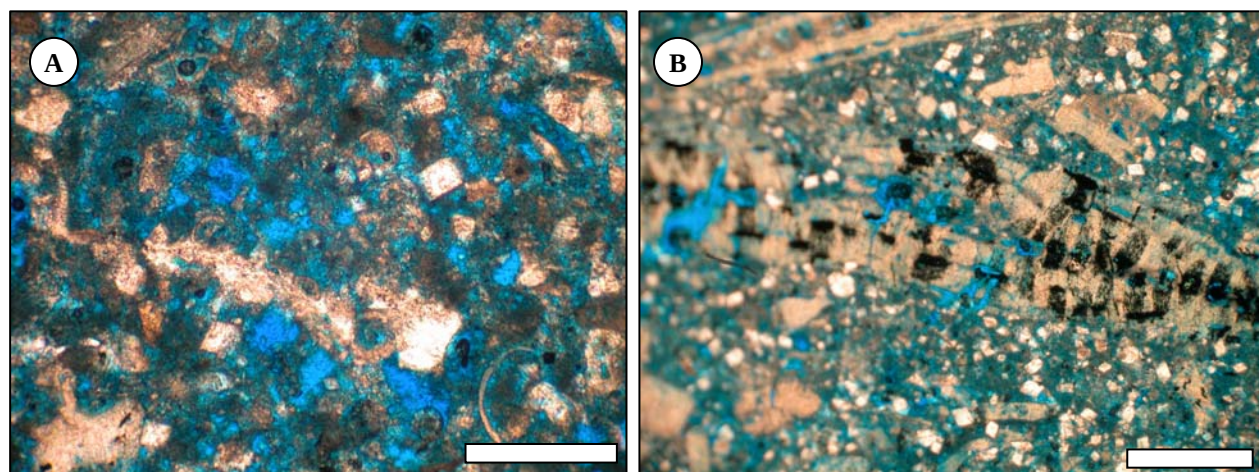


Figure 8. Ocala Limestone: A) W-18776, 662-663' BLS; low-mud packstone, skeletal debris, few scattered dolomite rhombs. B) W-18776, 723-724' BLS; dolomitic muddy packstone, large foraminifera and finer mixed skeletal debris with very fine dolomite rhombs, pyrite (black) in intragranular chambers of *Lepidocyclina* sp. Scale bars in A and B are 1.0 mm.

Suwannee Limestone

The Lower Oligocene Suwannee Limestone in south Florida ranges from a light gray to white, variably moldic packstone to grainstone with variable dolomitization. Allochems are generally miliolids and peloids. Small amounts of quartz sand (generally < 3 percent) and clay commonly occur within the uppermost part of the unit when overlain by Hawthorn Group sediments; however, sand content is greater along the southwest Florida coast (Charlotte County and south; Arthur et al., 2008b). In some locations, quartz sand forms beds that are several feet thick (Missimer, 2002). Trace amounts of pyrite and organics also occur throughout this formation (Arthur et al., 2001; Price and Pichler, 2006; Lazareva and Pichler, 2007). Chert is present throughout the Suwannee Limestone, especially within the updip part of the unit. Sedimentary structures include bedding, cross-bedding and bioturbation (Budd, 2002). Porosity types observed are moldic and intergranular.

The five Suwannee Limestone samples consisted primarily of limestone. They contained a diverse assemblage of marine organisms, algae and peloids indicating deposition in shallow

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subtidal to restricted marine to lagoonal settings. Fauna included miliolids, ostracods, mollusks, bryozoa, oncolites and echinoids. Two of the samples were grainstones, one was a muddy packstone and two were wackestones. Most were bioturbated. Three of the five contained minor amounts of quartz sand and only one was dolomitic. Four of the five samples contained microscopically visible pyrite (Figure 9).

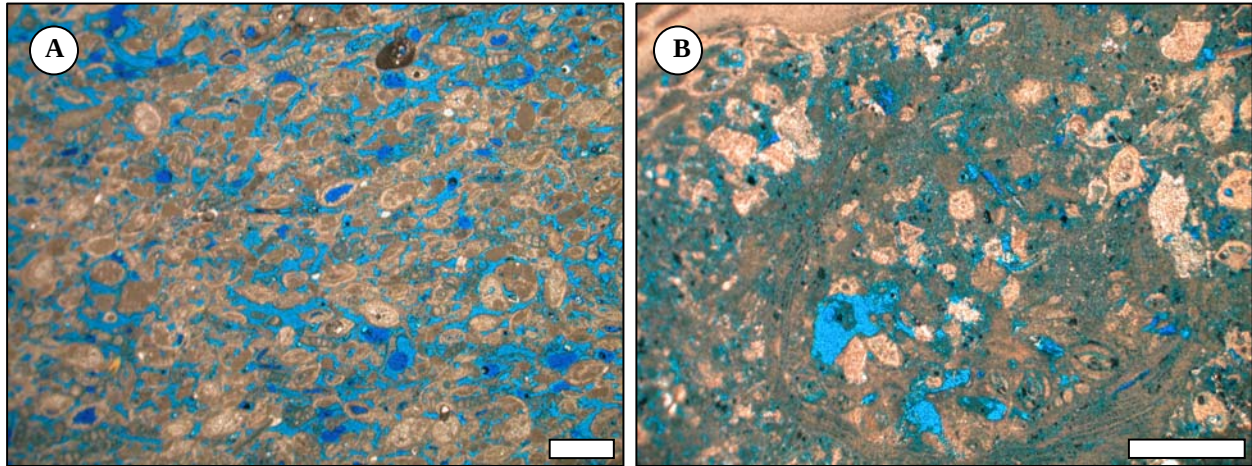


Figure 9. Suwannee Limestone: A) W-18778, 763-764' BLS; Grainstone consisting of micritized peloids, miliolids, ostracods and small benthic foraminifera. Inter- and intragranular pore spaces with minimal to moderate cementation. B) W-18778, 1119-1120' BLS; Muddy wackestone consisting of small foraminifera, miliolids, echinoids, algal laminations and scattered pyrite. Scale bar in A is 1.0 mm and B is 2.0 mm.

Arcadia Formation (Hawthorn Group)

The Upper Oligocene to Middle Miocene Arcadia Formation (Hawthorn Group), in south Florida is comprised of a yellowish gray to white, variably sandy (quartz and phosphate) carbonate with interbedding siliciclastics. Although limestone is present, dolostone is common, with a crystalline texture of microcrystalline to sucrosic. Porosity types are commonly intergranular and moldic. Throughout the tables and appendices in this report, the broader characterization of Hawthorn Group is used (in the abbreviated form “H” to avoid confusion with “A,” which represents the Avon Park Formation).

Of the two Arcadia Formation samples, one was a packstone and the other a wackestone/packstone. Both were dolomitic. Characteristics common to these Arcadia Formation samples included detrital, sand-sized quartz and phosphate grains, with dolomite and pyrite as accessory minerals. Allochems included a limited number of small benthic foraminifera, ostracods, peloids, echinoids, glauconite and algae. The limited diversity of the foraminifera types and the ostracods and peloids would suggest a restricted, low-energy environment while echinoids, dasycladacean algae and quartz sand would suggest a restricted to open marine lagoonal depositional environment (Hammes, 1992). The wackestone/packstone in W-18778, 754-755 ft BLS revealed, due to bioturbation, varied grain and mud densities throughout the section. The depositional environment of the packstone from W-18778, 652-653

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ft BLS, was indeterminate due to secondary alteration and lack of biota., but was believed to be a marine setting relatively shallow with a slow rate of deposition due to the presence of glauconite (Flügel, 2004). Very fine silt-sized dolomite was prevalent in this sample (Figure 10).

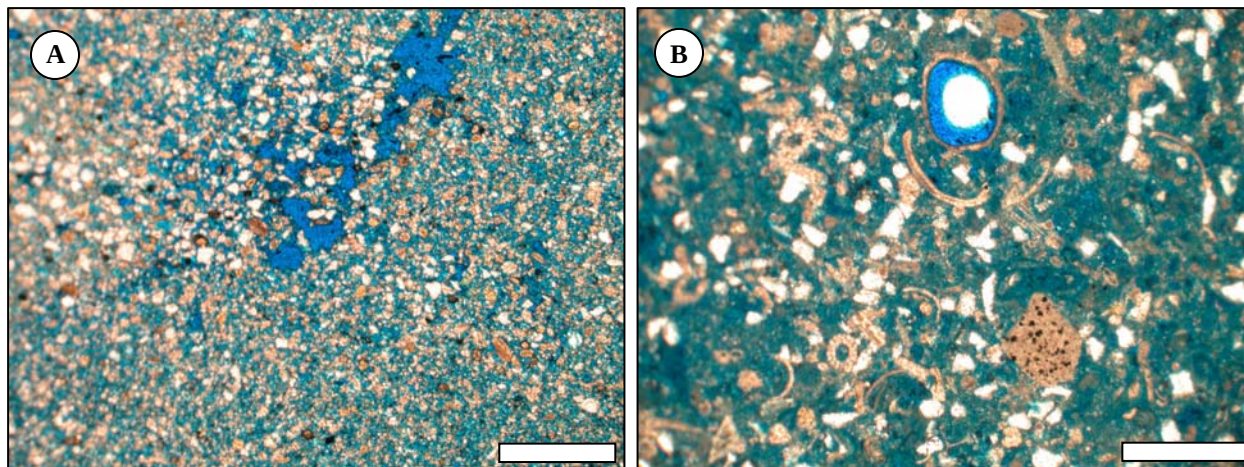


Figure 10. Arcadia Formation (Hawthorn Group): A) W-18778, 652-653' BLS; Sandy, phosphatic, dolomitic packstone. Quartz and dolomite (bright white grains) and detrital phosphate (light brown). Varied grain densities and sizes, surrounding moldic pores are probably due to bioturbation. The lack of biota and secondary alteration inhibits interpretation of the depositional environment. B) W-18778, 754-755' BLS; Mixed skeletal, sandy, muddy wackestone/packstone with small foraminifera, peloids, ostracods, echinoids, and green algae (dasycladacean). Accessory minerals present are quartz sand, phosphate, scattered dolomite rhombs, and pyrite. Scale bars are 2.0 mm in A and 1.0 mm in B.

Pyrite Relationships as Observed Microscopically

Pyrite was microscopically observed in 11 of the 14 samples and was present as euhedral crystals, framboids and as anhedral masses (possibly interlocking framboids). Pyrite was observed in intraparticle pore spaces of foraminifera (Figure 11A), and in cements of the limestones and dolostones. Also observed were anhedral replacement masses filling interparticle pore spaces and/or burrows (Figure 11B; Appendix 3, Figures 21, 27 and 45).

Presence or absence of pyrite does not seem to depend on the depositional environment, which is interpretive, but appears more dependent on the rock texture (e.g. grainstone, packstone and wackestone), which is observational (Arthur et. al, 2007). Pyrite was not as common in the grainstones as it was in the silty packstones and wackestones. It was most commonly observed in the siliciclastic wackestones. Additional aspects of pyrite occurrence and chemistry are discussed in subsequent sections of this report. Additional petrographic descriptions and images for all thin sections are compiled in Appendix 3.

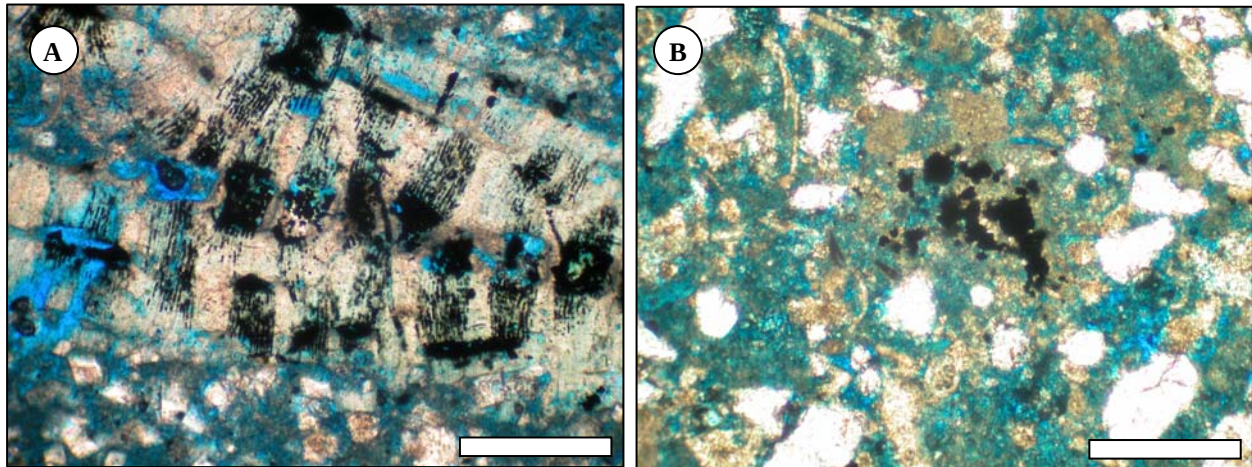


Figure 11. A) W-18776, 723-724' BLS; Close up view of *Lepidocyclina* sp. with pyrite (black) forming in the intraparticle pore spaces. B) W-18778, 754-755' BLS; Pyrite (black) forming in interparticle pore spaces with cement. Scale is 0.25 mm for both A and B.

Trace Mineralogy and Mineral Chemistry

Characterization of trace minerals was accomplished by SEM, EDS and EPMA (Appendix 4). The goal was to determine the various mineral phases present in the rock matrix and their associated trace metals. This information could be useful in determining possible metals of concern for water quality during ASR activities. Presence or absence of the various minerals may also be used in future hydrogeochemical modeling with respect to water-rock interaction during ASR activities. Detailed assessment of mineralogy and mineral chemistry facilitates achieving this goal.

Mineral Composition

Polished thin sections were examined by SEM and EPMA (EDS and WDS) to identify trace minerals and determine qualitative or quantitative trace-metal compositions. The EDS technology does not discern elemental compositions less than approximately 1-2 weight percent, while WDS detection limits were approximately 200 ppm (0.02 percent) (personal communication Tom Beasley, FIU/FCAEM). Although, upon completion of the project and further reflection on the data and the analytical uncertainties involved, the detection limit may have been higher (Long and Winefordner, 1983; Thomsen et.al, 2003). Energy-dispersive spectroscopy analyses focused on minerals of high-average atomic number, as revealed by BSE imaging, with an emphasis on pyrite abundance and morphology. Concentrating on the quantitative analysis of trace metals in the pyrite, the following constituents were chosen for EPMA: As, Ca, Fe, Mg, Mo, S, Sb and U. These were metals of concern with respect to water quality and water/rock interactions; Ca and Mg were chosen to help determine if the point of

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analysis was correct, since the carbonate matrix would contain Ca and or Mg and should not be present in a pyrite analysis.

In addition to pyrite and calcite reconnaissance, EDS microprobe analyses detected other minor mineral phases including ilmenite (FeTiO_2 , observed only in the Suwannee Limestone; Figure 12), celestite (SrSO_4 , observed only in the Avon Park Formation; Figure 13) and zircon (ZrSiO_4 , observed in the Avon Park Formation and the Arcadia Formation (Hawthorn Group); Figure 14). Grains of phosphate and quartz were observed in the Arcadia Formation (Hawthorn Group) (Appendix 4, Figures 20, 22 and 25). Dolomite was observed in all formations (Appendix 4, Figures 14, 15 and 22). Additional SEM/BSE images and pyrite element maps are compiled in Appendix 4.

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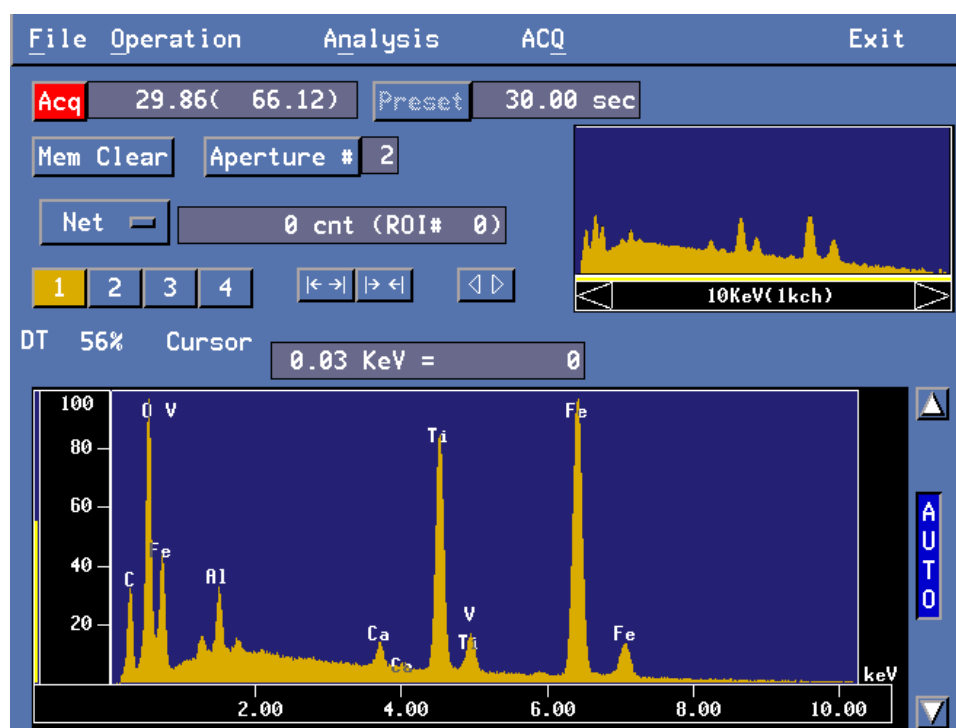
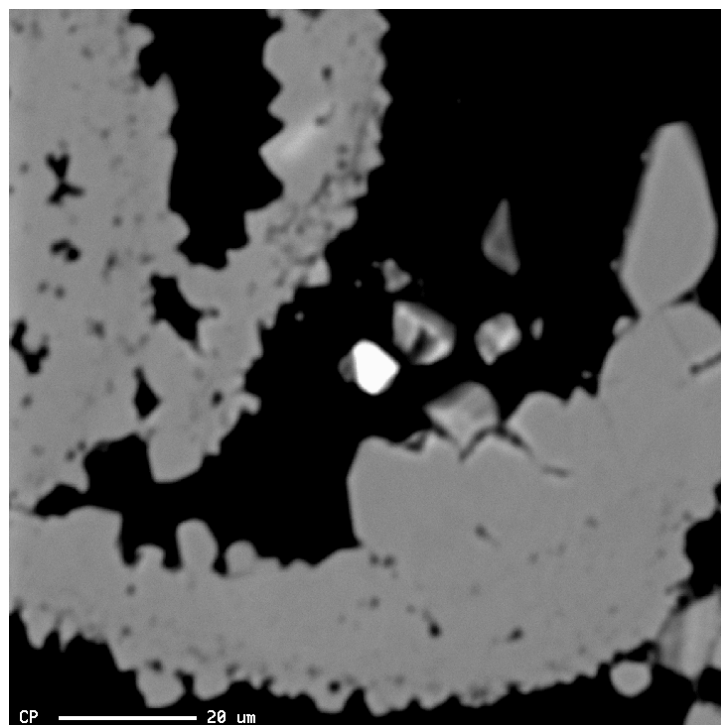


Figure 12. W-18778, 995-996' BLS; BSE image (upper) and spectra (lower) of ilmenite in interparticle pore space of the Suwannee Limestone. Ilmenite is indicated by Fe, Ti, and O content.

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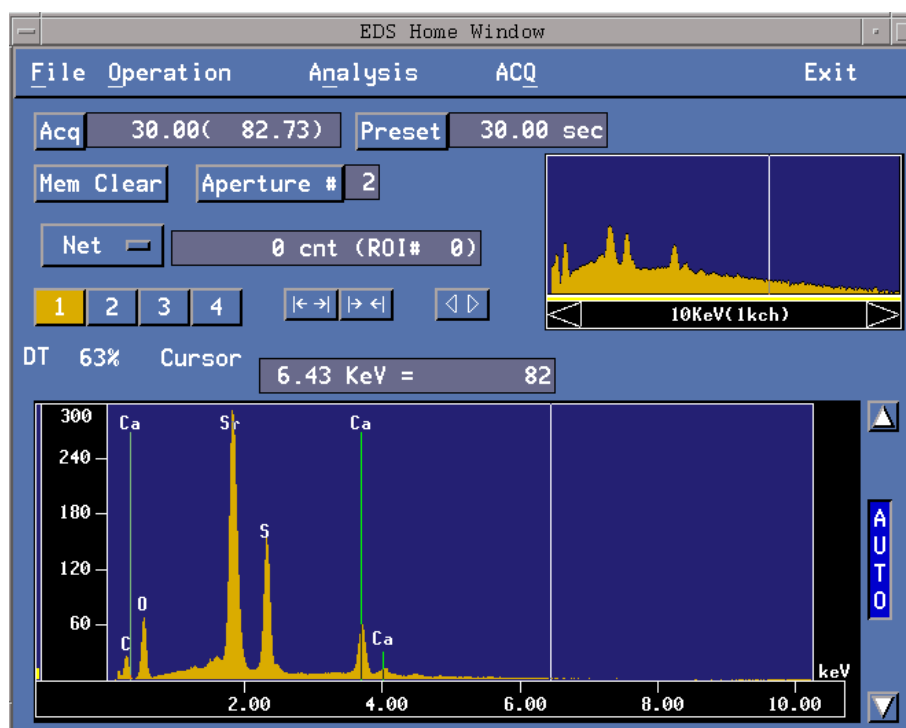
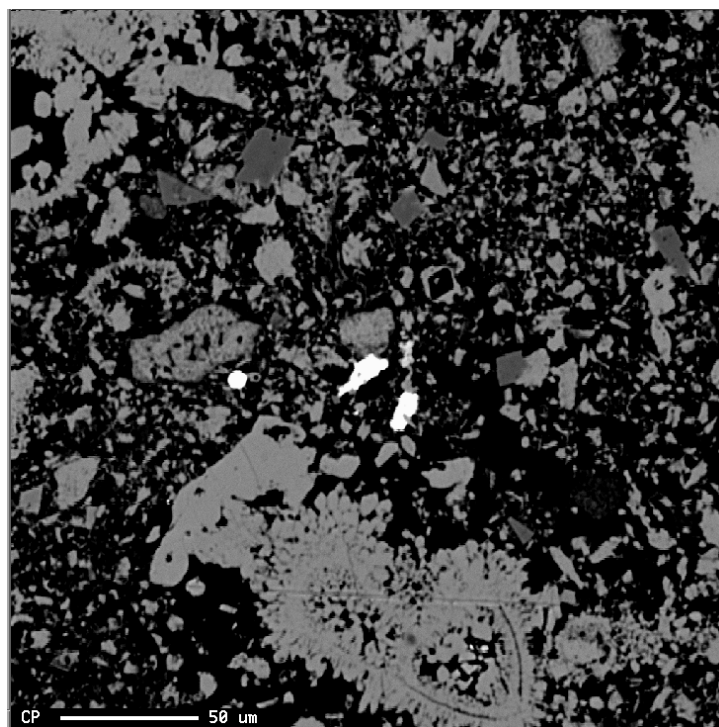


Figure 13. W-18776, 812-813' BLS; BSE image (upper) and spectra (lower) of celestite (bright grain on right side of image) with pyrite framboid (bright round grain on left side of image) in dolomitic limestone from the Avon Park Formation.

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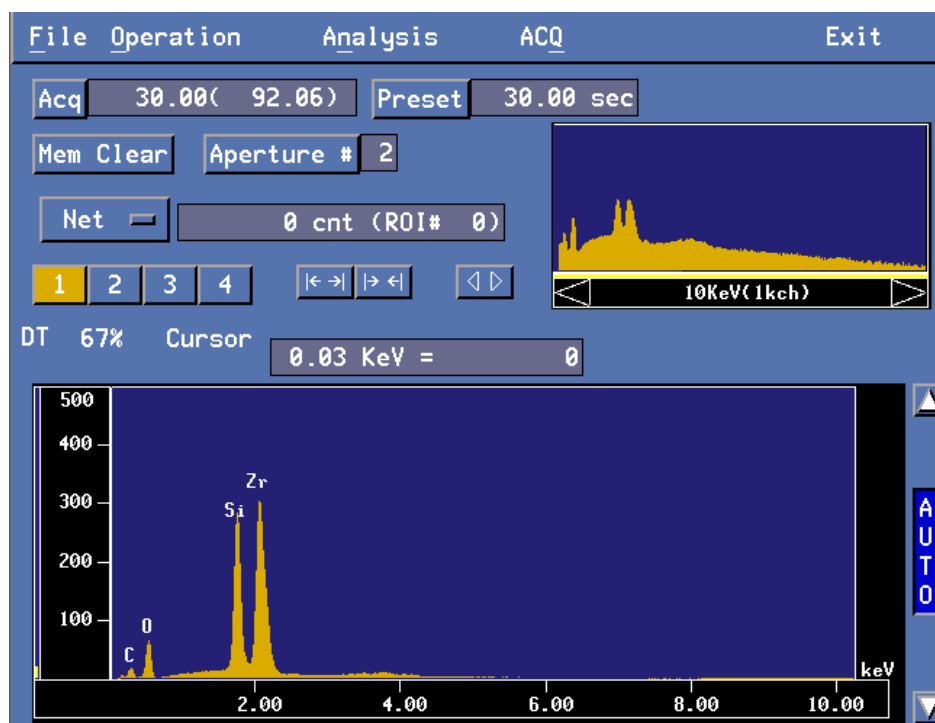
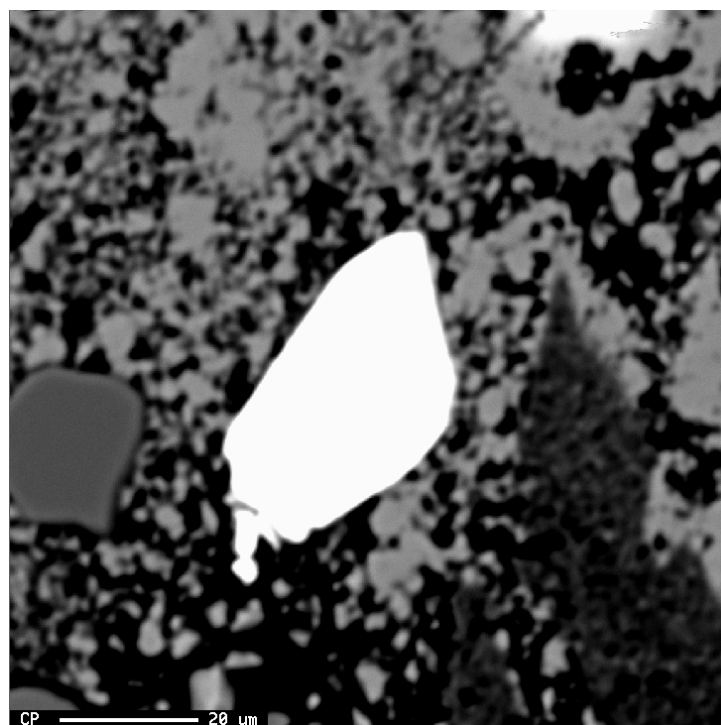


Figure 14. W-18778, 754-755' BLS; BSE image (upper) and spectra (lower) of euhedral zircon in Arcadia Formation (Hawthorn Group).

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Pyrite

The occurrence of pyrite in the samples was, for the most part, pervasive and no apparent trend existed in relation to core, ASR study area or lithostratigraphic unit. Due to the limited number of lithogeochemical analyses relative to the extent (vertical and lateral), statistical conclusions cannot be drawn regarding pyrite occurrence. However, qualitative statements can be made about the thin sections. Pyrite was noted in petrographic descriptions (microscopic analysis) for 11 of the 14 samples and pyrite was found in all samples when using EPMA. Pyrite was observed scattered throughout the thin sections sometimes filling voids and interparticle pore spaces. While no pyrite was observed microscopically in the two samples from W-18728, 2140-2160' BLS (A and B), a few very small pyrite grains were found using EPMA (Figure 15). These very small pyrites had some of the highest As concentrations, up to 2.17 percent, (average 0.796 percent; Table 3). While pyrite was most abundant and larger in samples from W-18776, from the Avon Park Formation (805-806' and 812-813'), the average As concentration in the pyrite was lower (0.052 and 0.147 percent, respectively Figure 16, Table 3). Pyrite was sparse in W-18778 which included samples from the Arcadia Formation and Suwannee Limestone. Pyrite in trace amounts was detected in W-18728, representing the Avon Park Formation. Pyrite also occurred as framboids in the foraminifera moldic porosity of the Ocala Limestone (Figure 17 A and B). Some pyrite oxidation may be evident in Figure 17A, where the pyrite framboids appear irregular and ragged.

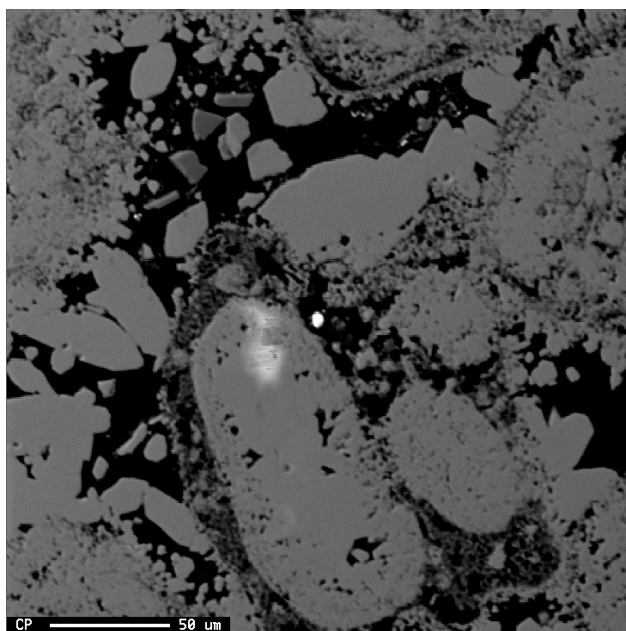


Figure 15. W-18728, 2140-2160B' BLS; Avon Park Formation, BSE image of 2-3micron grain of pyrite.

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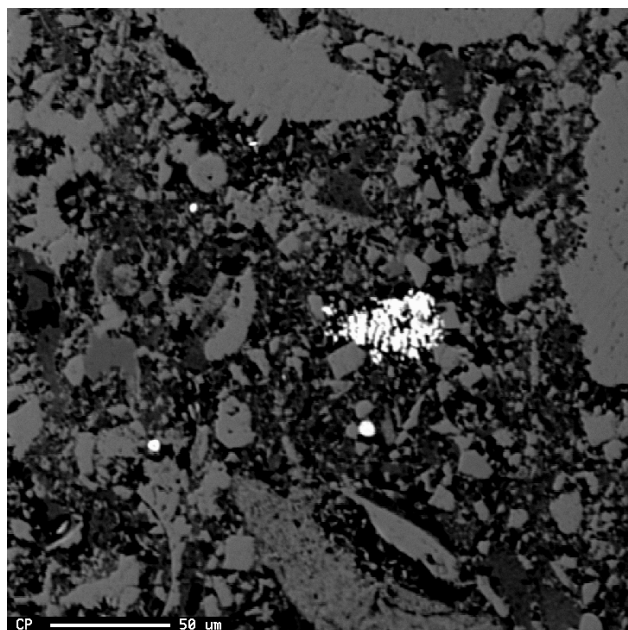


Figure 16. W-18776, 812-813' BLS; Avon Park Formation, BSE image of pyrite cluster and framboids.

Table 3. Pyrite EPMA mean arsenic concentrations for each thin section. Values in percent. N/A = not applicable, only one pyrite analyzed.

Core ID and depth ft	# of analyses	Arsenic Mean	Standard Error	Minimum	Maximum
W18728 2140 -2160A	8	0.80	0.29	BDL	2.17
W18728 2140-2160B	1	N/A	N/A	0.30	0.30
W18776 657-658	11	0.16	0.04	BDL	0.37
W18776 662-663	9	0.39	0.19	BDL	1.66
W18776 723-724	10	0.12	0.03	BDL	0.27
W18776 805-806	6	0.05	0.02	BDL	0.10
W18776 812-813	13	0.15	0.03	BDL	0.37
W18778 652-653	9	0.10	0.02	BDL	0.25
W18778 754-755	11	0.14	0.03	BDL	0.31
W18778 763-764	8	0.17	0.04	BDL	0.33
W18778 848-849	11	0.19	0.05	BDL	0.48
W18778 983-984	8	0.07	0.02	BDL	0.18
W18778 995-996	6	0.02	0.01	BDL	0.06
W18778 1119-1120	6	0.14	0.06	BDL	0.40

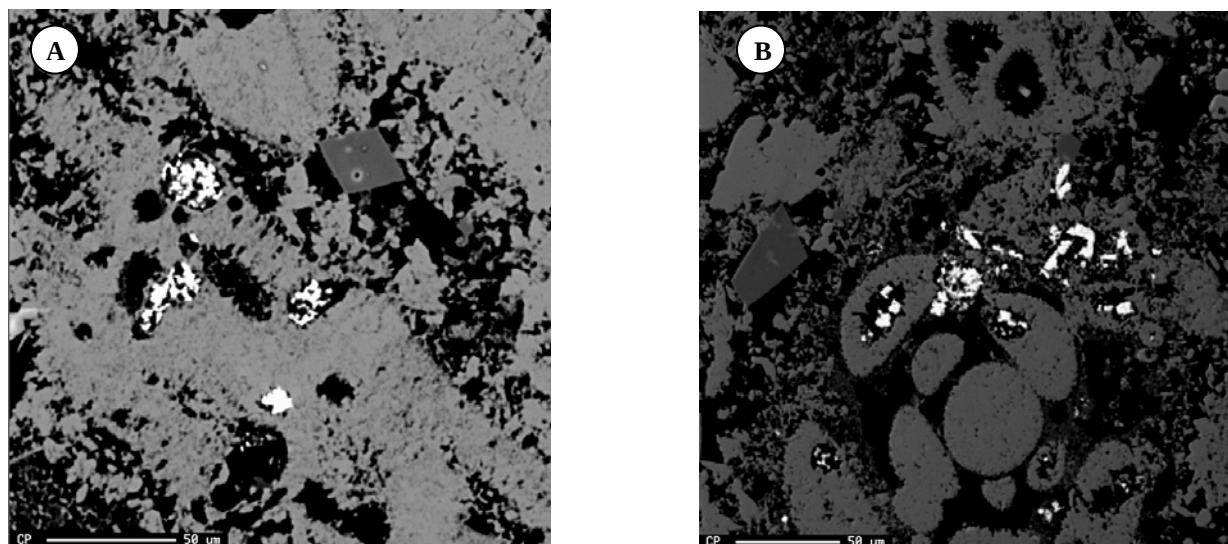


Figure 17. BSE images: A) W-18776, 657-658' BLS; Ocala Limestone, pyrite in intraparticle pores of *Lepidocyclina* sp.; B) W-18776, 662-663' BLS; Ocala Limestone, pyrite in pore spaces (intra- and interparticle).

Pyrite may host a variety of metals at trace concentrations (As, Mo, Sb, Cu, Ni, Co, Pb, Bi, Tl). Conditions surrounding pyrite formation (including the metastable minerals, mackinawite and greigite) plus the depositional environment will affect which trace metals are incorporated into the pyrite structure (Dippold, 2009; Berner et al., 2013). These metals are incorporated by different processes, including precipitation, co-precipitation, chemical or physical adsorption, ionic replacement, as well as redox reactions between dissolved species and the pyrite surface or its precursors (Berner et al., 2013; Kornicker and Morse, 1991; Morse and Arakaki, 1993). The WDS element maps revealed an association of As, Mo, and Sb with pyrite (Figures 18, 19 and 20). A Mo association with pyrite is reported in the literature (Berner et al., 2013; Abraitis et al., 2004; and Huerta-Diaz and Morse, 1990) and was observed in both this study and the CERP study (Arthur et al., 2007); yet, it is curious that most of the Mo concentrations in pyrite were approximately 0.5 percent, making Mo the most consistently abundant impurity. However, with EPMA analysis there is a noteworthy peak overlap of the Mo and S and this can present problems with quantitative analysis (Goldstein et al., 2007; Remond et al., 2002). WDS is able to qualitatively distinguish the S and Mo peaks because of its high resolution, but the overlap becomes an issue in quantitative analysis (Goldstein et al., 2007).

To quantify the overlapped elements a process called peak deconvolution is employed using a procedure called spectral decomposition. It is based on least squares fitting techniques of the measured spectrum (peak position, intensity and width). This technique is not without limitation especially where there are differences in the composition of the unknown and the standard used for calibration (Goldstein et al., 2007; Remond et al., 2002). Therefore, further

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research is warranted to determine whether this consistent value is an artifact caused by the overlap. The WDS data do not show a correlation between Mo, As or Sb in the pyrite. However, based on the means of each sample, a positive correlation ($R^2 = 0.8417$) existed between As and Sb (Figure 21). While this was a strong correlation, further study of the As-Sb relationship is warranted due to the small sample size and few data points at one end of the trendline, as well as the large extent of the study area. Average metal compositions for all pyrites $\pm$ standard error analyzed by EPMA were: As = 0.19 percent ± 0.03 , Mo = 0.58 percent ± 0.01 and Sb = 0.06 percent ± 0.01 . Appendix 5 summarizes statistical results of all EPMA analyses.

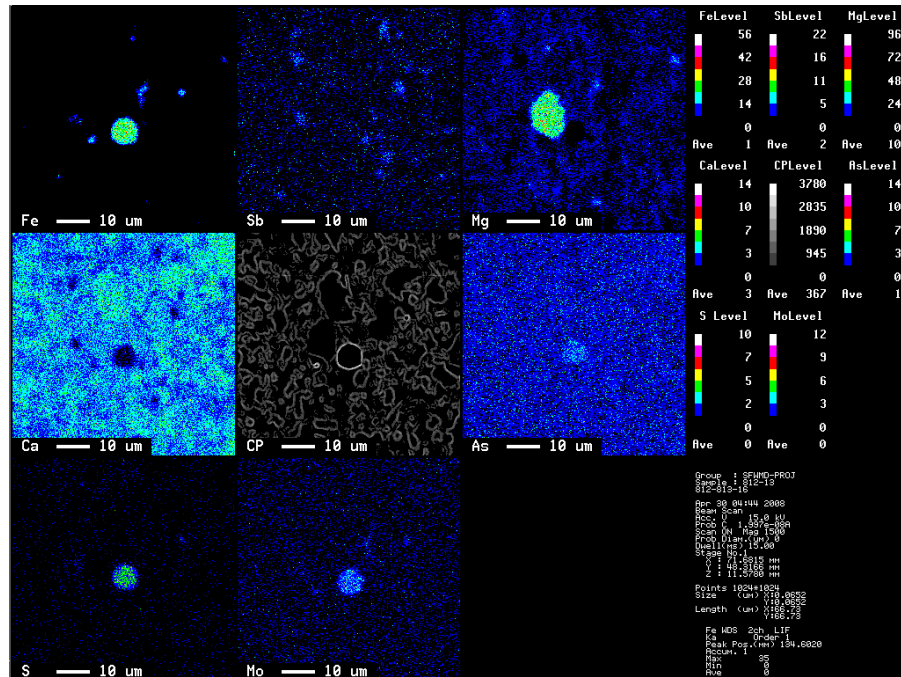


Figure 18. W-18776, 812-813' BLS; Avon Park Formation, EPMA element maps reveal spatial association of the pyrite framboid with Mo and As. “CP” is a BSE image that has been filtered (edge enhancement and median filters applied).

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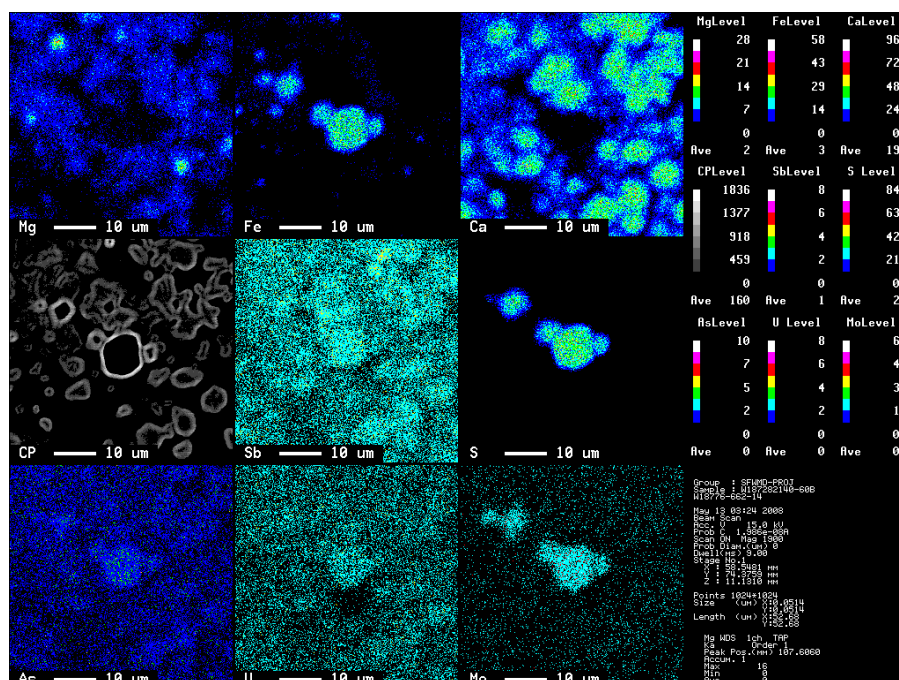


Figure 19. W-18776, 662-663' BLS; Ocala Limestone, EPMA element maps. Note association of As, Mo and Sb with the pyrite. Mg and Ca concentrations vary, suggesting partial dolomitization.

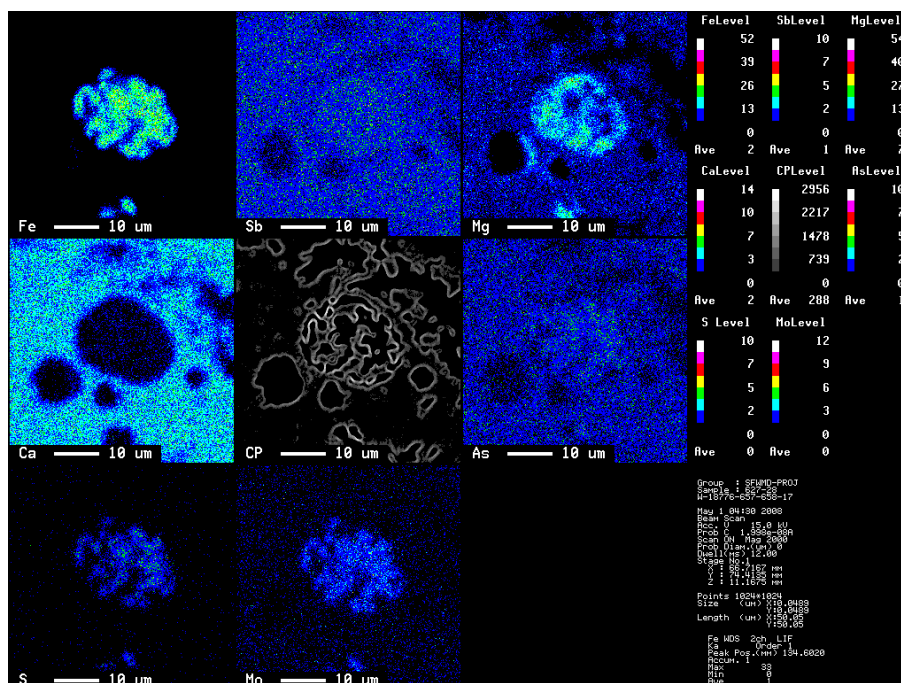


Figure 20. W-18776, 657-658' BLS; Ocala Limestone, EPMA element maps. Note association of Mo, Sb and As with the pyrite.

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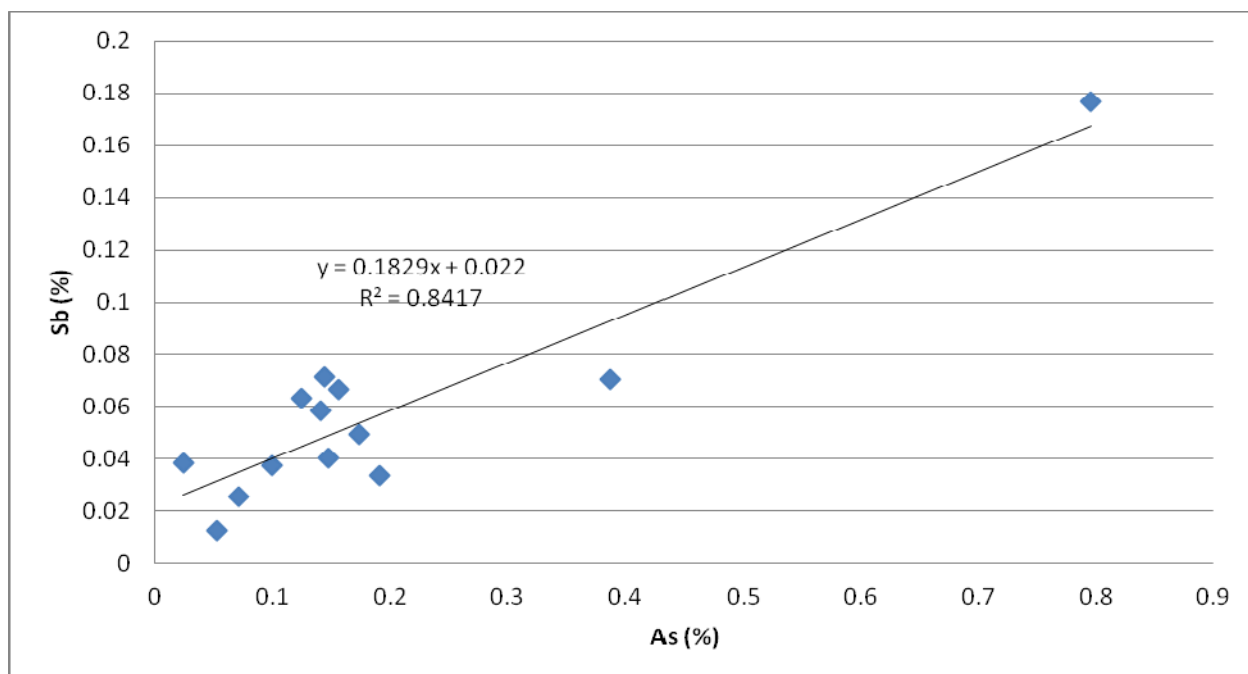


Figure 21. Bivariate relationship between As and Sb (mean values from pyrite analyses) from each sample, with linear regression line; data from EPMA.

Carbonate

The WDS analyses suggested that the carbonates contained detectable As and Sb (Appendix 6). Based on calibrations completed with the spiked basalt glass (see Methods section), approximately 44 percent (n=49) of the analyzed carbonates contained As in concentrations above the analytical detection limit. However, the distribution was highly skewed and for this reason the median is reported. For samples with detectable As, the median As concentration equaled 0.08 percent and the maximum was 0.60 percent (Appendix 5). For all analyses, including non-detects (half the detection limit used in calculations), the median As concentration was 0.03 (n=90). Antimony was detected in approximately 90 percent (n=81) of all carbonate analyses, with a median concentration of 0.11 percent, (maximum of 0.60 percent). The median Sb concentration for all carbonate analyses (0.10 percent) was greater than that in pyrite (0.02 percent).

These As and Sb values appear unrealistically high when one considers the bulk rock was at least 95 percent carbonate. There are a number of possible reasons for the discrepancy between the total bulk rock and the total WDS analysis. Part of the difference may be related to the carbonate matrix being very different than the basalt glass used for the calibration. Ideally, the calibration standards should be similar to the material being analyzed and at the same concentrations expected in the unknown samples. However, other than the basalt glass reference material, suitable low As and Sb standards were not available. It is possible there may be

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interferences in the carbonate matrix that affect the detection limits for As and Sb. The set up of the element conditions in the instrument is important in quantifying elements with peak overlaps. Other factors such as grain size, grain type and proximity to pyrite can also have an effect on the observed trace metal concentrations. Some of the grain types analyzed as carbonate included sparry calcite, foraminifera, algal material, dolomite, shell material, calcilutite, ooids, etc. It is a reasonable assumption that these different grains could have different propensities for As adsorption (Mirlean et al., 2011, 2012; So et al., 2008). There are known peak overlaps involving As and Mg, and S and Mo (Goldstein et al., 2007). Setting the instrument element conditions to minimize the overlap of these peaks during WDS analysis is critical when quantifying low concentrations of these metals (Goldstein et al., 2007). Given these uncertainties, the detection limit for the carbonates may be higher than the 200 ppm reported. If the detection limit is higher, then As and Sb concentrations for the carbonates may not be significant. More research is needed to clarify whether As and Sb are present in the carbonates (calcite and dolomite).

However, there is general support in the literature for As sorption on carbonates, though the As concentrations used in some of those experiments were higher than what was usually encountered in our bench studies. Román-Ross et al. (2006) investigated As(III) sorption on calcite. In their co-precipitation experiments, As(III) was readily taken up in solid solution with calcite, and As availability was the limiting factor rather than the calcite structure. In a system where calcite was precipitating in the presence of high As(III) concentrations, an average of 30 ± 6 mM/kg As (~0.2 percent As) could be incorporated into the calcite structure (Román-Ross et al., 2006). Studies by Mirlean et al., (2011, 2012) showed As bound to fragments of calcareous red algae had the highest concentrations, with the highest values associated with the finer grain sizes. Mirlean et al., (2011, 2012) determined that living specimens of calcareous red algae had much lower concentrations of As than the non-living material. They also found not all calcareous material retained As as effectively as the calcareous red algae. Thus, if As was not uniformly distributed within the different carbonate grain types, it could explain the difference between the total bulk rock and WDS analysis. There is also debate about the mechanism responsible for the As retention whether it is by sorption, co-precipitation or calcium arsenate formation (Mirlean et al., 2012). So et al., (2008) worked with lower As concentrations commonly observed in groundwater. They found that arsenate could sorb strongly on calcite while arsenite did not and the adsorption was affected by the solution chemistry and pH. Maher and Butler (1988) report average As concentrations in modern open oceans on the order of 1-2 $\mu\text{g/L}$. Although further study is needed, the ambient As concentrations in paleo-ocean water during deposition of these Upper Floridan aquifer rocks may have been the source of the As.

Dolomite

An assessment of dolomite showed detectable As and Sb (Appendix 6). Approximately 50 percent of the analyzed dolomites contained As in concentrations above 200 ppm. For samples with detectable As, the median As concentration equaled 0.03 percent and the maximum

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equaled 0.06 percent. Ninety percent (n=18) of all dolomite analyses included detectable Sb, median 0.08 percent, with a maximum of 0.18 percent (Appendix 5).

Lithogeochemistry

All whole-rock geochemical analyses and detection limits are tabulated in Appendix 7. Appendix 8 contains statistical summaries of the CERP geochemical data (Arthur et al., 2007), and the current project lithogeochemistry, for selected constituents, for each lithostratigraphic unit including the Arcadia Formation (Hawthorn Group), Suwannee Limestone, Ocala Limestone and the Avon Park Formation. For the CERP statistical calculations, one-half the detection limit was used for concentrations that were below detection.

Statistical Summary of Lithogeochemistry

The data in Appendix 8 bracket the range of compositions for lithostratigraphic units studied in the region. A review of the CERP data indicated that, while some element compositions were normally distributed, some were not (Arthur et al., 2007). As such, median, rather than mean, values were discussed.

The CERP study (Arthur et al., 2007) consisted of 315 rock samples from 40 wells collected within an ~18,000 square mile (46,620 square kilometer) study area, resulting in an average spacing of one well per 450 square miles (1,165 square kilometers). The present study included 14 rock samples from three wells (Figure 1). This section highlights a subset of 16 constituents of interest analyzed both in the CERP study (Arthur et al., 2007) and the present study (Appendix 8). For the purpose of comparison to the CERP study (Arthur et al., 2007) the present study's Arcadia Formation samples will be referred to as Hawthorn Group.

Major Elements

Noteworthy differences exist in SiO₂, Fe₂O₃ (total Fe as Fe (III) [T]), Na₂O, K₂O and P₂O₅ among the lithostratigraphic units. The Hawthorn Group is a mixed siliciclastic and carbonate unit, while the other formations are predominantly carbonates. Higher concentrations of Na₂O and K₂O observed in the Hawthorn Group samples were expected given their higher clay content. The siliciclastic nature of the Hawthorn Group was also seen in the higher SiO₂ concentration (median value for the CERP study was 5.3 percent), relative to the other lithostratigraphic units. The median SiO₂ in the Suwannee Limestone, while half of the Hawthorn Group median concentration, was two to three times greater than the Ocala Limestone or Avon Park Formation. A facies change in the Suwannee Limestone exists in southwest Florida (Lee County and surrounding region; Missimer, 2002). This is represented by an increase in siliciclastic, constituents such as SiO₂ and P₂O₅ being higher than expected, well above what is considered "normal" for this unit. In the current study, the maximum value for SiO₂ (18.28 percent) was found in the Hawthorn Group in Lee County (W-18778, 652-653' BLS).

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Higher concentrations of P_2O_5 (CERP study median 0.53 percent) generally distinguished the Hawthorn Group from the other units. The Hawthorn Group in this study also had the highest P_2O_5 values, which then declined with increasing depth of the lithostratigraphic units (older units).

The availability of soluble Fe is important with regard to the behavior of As during ASR. The CERP study median value for Fe_2O_3 [T] was highest in the Hawthorn Group (0.17 percent). In the present study, the Hawthorn Group had the highest Fe_2O_3 [T] concentration which then decreased in the underlying Suwannee Limestone and Ocala Limestone before increasing again in the Avon Park Formation.

Four forms of carbon were analyzed: total, graphitic (high temperature), inorganic (as CO_2) and organic. The latter two forms were particularly relevant. While CO_2 content is primarily a function of the amount of carbonate minerals (e.g., calcite, dolomite, and ankerite) in the rock samples, CO_2 can also be associated with natural organic matter (NOM). Median inorganic C (as CO_2) was lowest in the Hawthorn Group in both studies, owing to the relative abundance of non-carbonate minerals. Natural organic matter was detected by the organic C analyses. The Avon Park Formation contained the highest organic C in both studies (0.22 median percent, CERP study). This was expected given the common occurrence of organic-rich laminae or finely disseminated NOM in the upper part of the unit. Within the existing datasets, no apparent relationship existed between organic C and either As or Hg concentrations.

Median S (total) and S (as SO_4) were generally consistent across the lithostratigraphic units, with the highest median values for both types of S occurring in the Hawthorn Group and Avon Park Formation. The maximum total S content (1.71 percent) from the CERP samples were observed in the Avon Park Formation, which generally contained the highest amount of sulfate minerals (e.g., gypsum and celestite). The S (total) concentration also reflected the pyrite distribution, in this case, the highest Fe value corresponded to the highest S (total) value. The maximum S (as SO_4) from CERP occurred in the Hawthorn Group samples. Both S (total) and S (as SO_4) in the present study reflect these same trends as in the CERP study.

Trace Metals

Based on solubility, water-quality, and environmental health concerns, the trace metal discussion in this section is limited to As, Mo, Sb, Hg and U. Median bulk rock As values in the CERP samples were ≤ 2 ppm for all lithostratigraphic units; however, maximum concentrations were highly variable. Maximum observed As concentrations occurred within the Hawthorn Group and Ocala Limestone (33 ppm and 23 ppm, respectively) in the CERP study. The As median value in the Suwannee Limestone was < 1 ppm. In the present study, the maximum As value (3 ppm) occurred in the Avon Park Formation. Molybdenum, a metal associated with water-quality concerns has a USEPA lifetime health advisory level for drinking water of 40 $\mu g/L$ (USEPA, 2012). Median bulk rock Mo values for the CERP samples were < 1 ppm for all units except the Avon Park Formation, where the median was 8 ppm. In the present study, Mo values in the three Ocala Limestone samples (W-18776) were above the detection limit. Of the

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four Avon Park Formation samples, only one was above the detection limit for Mo and it was the maximum concentration of 10 ppm (W-18776). Antimony concentrations were generally consistent for all units in both studies, ranging from 0.2 to 0.4 ppm. Mercury concentrations in the present study were all BDL with the exception of one Suwannee Limestone sample (W-18778) with a value of 5 ppb. Numerous samples in the CERP study contained Hg in excess of 100 ppb, and the maximum observed concentration equaled 1300 ppb¹ (W-18721; 952-953' BLS, Hawthorn Group). Uranium concentrations showed more distinct differences between the lithostratigraphic units, with the CERP study Hawthorn Group rocks corresponding to the highest median concentration (7.58 ppm) as expected due to the relative abundance of carbonate fluorapatite. In the present study, however, the maximum observed U concentration occurred in the Suwannee Limestone with a value of 9.77 ppm (W-18778) and the lowest was in the Avon Park Formation with a value of 1.23 ppm (W-18728).

SUMMARY OF OBSERVATIONS

W-18728 (PBF-15, L-8 test well)

- Pyrite was not noted in the petrographic descriptions. However, small pyrites were infrequently observed using EPMA.
- The highest arsenic EPMA value (2.23 percent) detected in this project was observed in a very small pyrite crystal from the Avon Park Formation at a depth of 2140-2160A' BLS.
- Bulk rock Mo was below detection, while EPMA values averaged ~0.5 percent. Due to potential peak overlaps of Mo and S, further study is warranted to be confident in these findings.
- Antimony EPMA values for analyzed pyrites ranged from below detection (< 200 ppm) to 0.52 percent.
- EPMA analysis found detectable levels of Sb in all but two of the calcite mineral analyses, but at lower concentrations than in the pyrite.

W-18776 (EXKR-MW1, MW-0010)

- Maximum As EPMA value in pyrite was 1.70 percent in the Ocala Limestone at a depth of 662-663' BLS.
- Maximum lithogeochemical values of As and Mo were 3 ppm and 10 ppm respectively in the Avon Park Formation at a depth of 812-813' BLS.
- Overall the bulk rock molybdenum values were greater than the other core values and ranged from below detection to 10 ppm, while EPMA results were ~0.5 percent, further research is needed to confirm the presence of Mo in pyrite.
- All but one calcite mineral analysis had detectable levels of Sb.
- Calcite had higher concentrations of Sb than pyrite.

¹ Analysis repeated to confirm value; second analysis: Hg = 1390 ppb.

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W-18778 (Cape Coral MWH L-1028)

- This core had the lowest As EPMA concentrations in pyrite, with a maximum value of 0.48 percent.
- Only one sample had Mo above the detection limit for bulk rock analysis, while all samples had detectable Mo in all analyzed pyrites, with an average value of ~0.5 percent. More research is needed to confirm the EPMA concentrations.
- Most calcite and dolomite had detectable EPMA concentrations of Sb, while fewer pyrites had detectable concentrations of Sb.

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Appendix 1.
Extended methodology descriptions from Activation Laboratories Ltd.

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Sample pulverization (from Activation Laboratories)

As a routine practice with rock and core, the entire sample is crushed to a nominal minus 10 mesh (1.7 mm), mechanically split (riffle) to obtain a representative sample and then pulverized to at least 95% minus 150 mesh (106 microns). A sand blank is run between each sample to avoid contamination. Quality of crushing and pulverization is routinely checked as part of our quality assurance program. The only contamination from crushing and milling is Fe which depends on sample hardness (0.01 to 0.2% Fe added).

Hydrogeochemistry cation analyses (from Activation Laboratories)

Samples must be acidified prior to analysis. Water samples are analyzed by Perkin Elmer Sciex ELAN 6000, 6100 or 9000 ICP/MS. A blank and two water standards are run at the beginning and end of each group of 32 samples. A reagent blank is run at the beginning of the group and every tenth sample is run in duplicate. If instrument suppression occurs, sample(s) affected are re-run at appropriate dilutions until response is normal. Dilution factors will increase by the same factor that samples were diluted. For analysis of marine waters or brines, detection limits will be correspondingly elevated depending on the dilution necessary to run the water samples. Sample introduction, ionization, detection and data output are controlled by the system computer. Values which exceed the upper limits should be analyzed by Code 6 inductively coupled plasma - optical emission spectrometer (ICP/OES).

The ICP technique relies on placing the sample material into solution using specific partial leaches, single acids, mixed acids or fusion techniques using fluxes. The sample solution is then introduced into a radio frequency excited plasma (~8000°K). Atoms within the samples are excited to the point that they emit wavelength-specific photons or light which is characteristic of a particular element. The number of photons produced is directly related to the concentration of that element in the sample.

Ion Chromatography

Un-acidified water samples are analyzed using the DIONEX DX-120 Ion Chromatography System to determine and quantify a group of seven anions. This analysis is applicable to concentrations less than 75 mg/L for Cl, NO₂ and NO₃; less than 50 mg/L for F; less than 125 mg/L for PO₄; less than 250 mg/L for Br and less than 375 mg/L for SO₄. Samples exceeding these ranges (with high total dissolved solids) must be diluted to avoid over-saturation. Measurement uncertainty is evaluated and controlled by an appropriate quality assurance program, including the use of regular laboratory duplicates of samples and verification of the precision/calibration of the instrument through regular runs of various primary dilution standard solutions.

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Lithogeochemical Analysis

Instrumental neutron activation analysis (INAA)

A one g aliquot is encapsulated in a polyethylene vial and irradiated with flux wires and an internal standard (1 for every 11 samples) at a thermal neutron flux of $7\text{E}^{12} \text{ n cm}^{-2} \text{ s}^{-1}$.

After a seven day period to allow Na-24 to decay, the samples are counted on a high purity Ge detector with resolution of better than 1.7 KeV for the 1332 KeV Co-60 photopeak. Using the flux wires, the decay-corrected activities are compared to a calibration developed from multiple certified international reference materials. The standard present is only a check on accuracy and is not used for calibration purposes. From 10-30% of the samples are rechecked by re-measurement. For values exceeding the upper limits, assays are recommended. One standard is run for every 11 samples. One blank is analyzed per work order. Duplicates are analyzed when samples are provided. The method is described by Hoffman, (1992).

Major Elements

A 0.2 g sample is mixed with a mixture of lithium metaborate/lithium tetraborate and fused in a graphite crucible. The molten mixture is poured into a 5% nitric acid solution and shaken until dissolved (~ 30 minutes). The samples are run for major oxides and selected trace elements on a combination simultaneous/sequential Thermo Jarrell-Ash Enviro II ICP. Calibration is achieved using a variety of international reference materials. Independent control standards are also analyzed.

Base Metals and Selected Trace Elements

A 0.25 g sample is digested with with hydrofluoric acid, followed by a mixture of nitric and perchloric acids, heated using precise programmer controlled heating in several ramping and holding cycles which takes the samples to dryness. After dryness is attained, samples are brought back into solution using hydrochloric acid. With this digestion, certain phases may be only partially solubilized. These phases include zircon, monazite, sphene, gahnite, chromite, cassiterite, rutile and barite. Ag greater than 100 ppm and Pb greater than 5,000 ppm should be assayed as high levels may not be solubilized. Only sulfide sulfur will be solubilized. An in-lab standard (traceable to certified reference materials) or certified reference materials are used for quality control. Samples are analyzed using a Perkin Elmer Optima 3000 ICP.

Carbon and Sulfur

Total carbon and sulfur are determined on an ELTRA CS 2000 Carbon Sulfur Analyzer. A weighed sample is mixed with iron chips and a tungsten accelerator and is then combusted in an oxygen atmosphere at 1370°C. The moisture and dust are removed and the CO₂ gas and SO₂ gas are measured by a solid-state infrared detector. CO₂ is determined by digestion with 2N perchloric acid and the dissolved CO₂ is titrated using a UIC colorimeter. The separate sample is ignited at 600°C in order to drive off the CO₂

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and the organic carbon. The remaining C is graphitic carbon which is analyzed as above. Organic carbon is determined by difference after subtracting the above species. Sulfide sulfur is determined by calculating remaining sulfur after sulfate sulfur is subtracted from total sulfur. Sulfate sulfur is determined by roasting at 850°C to drive off the sulfide sulfur with analysis of the sulfur in the roast residue. This is converted to sulfate by calculation.

Mercury add-on (selected samples)

A 0.5 g sample is digested with aqua regia at 90°C. The Hg in the resulting solution is oxidized to the stable divalent form. Since the concentration of Hg is determined via the absorption of light at 253.7 nm by Hg vapor, Hg (II) is reduced to the volatile free atomic state using stannous chloride. Argon is bubbled through the mixture of sample and reductant solutions to liberate and to transport the Hg atoms into an absorption cell. The cell is placed in the light path of an Atomic Absorption Spectrophotometer. The maximum amount absorbed (peak height) is directly proportional to the concentration of mercury atoms in the light path. Measurement can be performed manually or automatically using a flow injection technique (FIMS). Hg analysis is performed on a Perkin Elmer FIMS 100 cold vapor Hg analyzer.

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Symbol	Compound	Unit of Measure	Detection Limit	Method of Analysis
Hg	Mercury	ppb	5	Hg-FIMS
SiO ₂	Silica	%	0.01	FUS-ICP
Al ₂ O ₃	Aluminum	%	0.01	FUS-ICP
Fe ₂ O ₃ (T)	Iron	%	0.01	FUS-ICP
MnO	Manganese	%	0.001	FUS-ICP
MgO	Magnesium	%	0.01	FUS-ICP
CaO	Calcium	%	0.01	FUS-ICP
Na ₂ O	Sodium	%	0.01	FUS-ICP
K ₂ O	Potassium	%	0.01	FUS-ICP
TiO ₂	Titanium	%	0.001	FUS-ICP
P ₂ O ₅	Phosphate	%	0.01	FUS-ICP
LOI	Loss on ignition	%	N/A	FUS-ICP
Au	Gold	ppb	1	INAA
Ag	Silver	ppm	0.5	MULT INAA / TD-ICP
As	Arsenic	ppm	1	INAA
Ba	Barium	ppm	1	FUS-ICP
Be	Beryllium	ppm	1	FUS-ICP
Bi	Bismuth	ppm	0.1	FUS-MS
Br	Bromine	ppm	0.5	INAA
Cd	Cadmium	ppm	0.5	TD-ICP
Co	Cobalt	ppm	0.1	INAA
Cr	Chromium	ppm	0.5	INAA
Cs	Cesium	ppm	0.1	FUS-MS
Cu	Copper	ppm	1	TD-ICP
Ga	Gallium	ppm	1	FUS-MS
Ge	Germanium	ppm	0.5	FUS-MS
Hf	Hafnium	ppm	0.1	FUS-MS
Hg	Mercury	ppm	1	INAA
In	Indium	ppm	0.1	FUS-MS
Ir	Iridium	ppb	1	INAA
Mo	Molybdenum	ppm	2	FUS-MS
Nb	Niobium	ppm	0.2	FUS-MS
Ni	Nickel	ppm	1	TD-ICP
Pb	Lead	ppm	5	TD-ICP
Rb	Rubidium	ppm	1	FUS-MS
S	Sulfur	%	0.001	TD-ICP
Sb	Antimony	ppm	0.1	INAA
Sc	Scandium	ppm	0.01	INAA
Se	Selenium	ppm	0.5	INAA
Sn	Tin	ppm	1	FUS-MS
Sr	Strontium	ppm	2	FUS-ICP
Ta	Tantalum	ppm	0.01	FUS-MS
Th	Thorium	ppm	0.05	FUS-MS
U	Uranium	ppm	0.01	FUS-MS
V	Vanadium	ppm	5	FUS-ICP
W	Tungsten	ppm	1	INAA
Y	Yttrium	ppm	1	FUS-ICP
Zn	Zinc	ppm	1	MULT INAA / TD-ICP
Zr	Zirconium	ppm	1	FUS-MS
La	Lanthanum	ppm	0.05	FUS-MS
Ce	Cerium	ppm	0.05	FUS-MS
Pr	Praseodymium	ppm	0.01	FUS-MS
Nd	Neodymium	ppm	0.05	FUS-MS
Sm	Samarium	ppm	0.01	FUS-MS
Eu	Europium	ppm	0.005	FUS-MS
Gd	Gadolinium	ppm	0.01	FUS-MS
Tb	Terbium	ppm	0.01	FUS-MS
Dy	Dysprosium	ppm	0.01	FUS-MS
Ho	Holmium	ppm	0.01	FUS-MS
Er	Erbium	ppm	0.01	FUS-MS
Tl	Thallium	ppm	0.05	FUS-MS
Tm	Thulium	ppm	0.005	FUS-MS
Yb	Ytterbium	ppm	0.01	FUS-MS
Lu	Lutetium	ppm	0.002	FUS-MS
Mass	Sample Mass	g	N/A	INAA
C-Total	Total Carbon	%	0.01	IR
C-Graph	Graphitic Carbon	%	0.05	IR
C-Organ	Organic Carbon	%	0.05	IR
CO ₂	Carbon Dioxide	%	0.01	COUL
Total S	Total Sulfur	%	0.01	IR
SO ₄	Sulfate	%	0.3	IR

**Appendix 2.
Lithologic descriptions**

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WELL NUMBER: W-18728

8 SAMPLES FROM 413 TO 2160 FT.

LAT = 26D 44M 17S

LON = 80D 21M 48S

ELEVATION:15 FT

OWNER/DRILLER: PBF-15 (L-8 TEST WELL)

WORKED BY: CINDY FISCHLER. MOST OF THIS WELL HAS POOR RECOVERY. QUESTIONABLE

LABELING ON ONE BOX. OUTSIDE LABELED 410'-417' INSIDE LABELED

400'-407'. PREVIOUS EMAIL LISTS 410-417 SO ASSUME 410-417. WELL PREVIOUSLY SAMPLED FOR CERP. DEPTH OF 2140-2160 A & B SAMPLED FOR THIS PROJECT.

0 - 413 NOT SAMPLED

413 - 414 CLAY;

POROSITY: INTERGRANULAR, LOW PERMEABILITY

ACCESSORY MINERALS: SILT, MICA, QUARTZ SAND

PHOSPHATIC SAND

FOSSILS: SPICULES

414 - 797 NOT SAMPLED

797 - 798 SILT;

POROSITY: INTERGRANULAR; MODERATE INDURATION

CEMENT TYPE(S): CALCILUTITE MATRIX, CLAY MATRIX

SEDIMENTARY STRUCTURES: BIOTURBATED

ACCESSORY MINERALS: CLAY, QUARTZ SAND

PHOSPHATIC SAND, CALCILUTITE

VERY SANDY AND PHOSPHATIC. PHOSPHATIC GRAVEL. BURROWS ARE

FILLED WITH SAND AND CALCILUTITE.

798 - 944 NOT SAMPLED

944 - 945 PACKSTONE;

POROSITY: INTERGRANULAR

GRAIN TYPE: SKELETAL, CALCILUTITE, PELLET

GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM

MODERATE INDURATION

CEMENT TYPE(S): CALCILUTITE MATRIX

ACCESSORY MINERALS: QUARTZ SAND, PHOSPHATIC SAND

ORGANICS

FOSSILS: BENTHIC FORAMINIFERA

TRACE OF PHOSPHATE. IRON SULFIDE/ORGANICS THROUGHOUT.

945 - 1040 NOT SAMPLED

1040 - 1050 PACKSTONE;

POROSITY: INTERGRANULAR

GRAIN TYPE: SKELETAL, CALCILUTITE, PELLET

GRAIN SIZE: FINE; RANGE: MICROCRYSTALLINE TO MEDIUM

MODERATE INDURATION

CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT

SEDIMENTARY STRUCTURES: LAMINATED

OTHER FEATURES: MEDIUM RECRYSTALLIZATION

FOSSILS: BENTHIC FORAMINIFERA

VERY POOR RECOVERY. IRON SULFIDE/ORGANICS THROUGHOUT.

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1050 - 1276 NOT SAMPLED

1276 - 1277 PACKSTONE;
POROSITY: INTERGRANULAR, PIN POINT VUGS
GRAIN TYPE: SKELETAL, CALCILUTITE, PELLET
GRAIN SIZE: FINE; RANGE: MICROCRYSTALLINE TO MEDIUM
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
OTHER FEATURES: MEDIUM RECRYSTALLIZATION
FOSSILS: BENTHIC FORAMINIFERA
DICTYOCONUS. IRON SULFIDE PRESENT.

1277 - 1289 NOT SAMPLED

1289 - 1290 LIMESTONE;
POROSITY: INTERGRANULAR
GRAIN TYPE: CALCILUTITE, SKELETAL, PELLET
GRAIN SIZE: VERY FINE; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, DOLOMITE CEMENT
SPARRY CALCITE CEMENT
SEDIMENTARY STRUCTURES: LAMINATED
ACCESSORY MINERALS: DOLOMITE
OTHER FEATURES: DOLOMITIC
FOSSILS: BENTHIC FORAMINIFERA
SOME PARTS MORE DOLOMITIC THAN OTHERS.

1290 - 2140 NOT SAMPLED

2140 - 2160A PACKSTONE;
POROSITY: MOLDIC, INTERGRANULAR, PIN POINT VUGS
GRAIN TYPE: SKELETAL, PELLET, SKELTAL CAST
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT, SPARRY CALCITE CEMENT
SEDIMENTARY STRUCTURES: MOTTLED
OTHER FEATURES: DOLOMITIC, HIGH RECRYSTALLIZATION
FOSSILS: BENTHIC FORAMINIFERA
POORLY LABELED CORE. CAN ONLY SAY A IS BETWEEN 2140 AND 2160
AND MORE SHALLOW THAN B. DOLOMITIC PACKSTONE/GRAINSTONE.
MOLDIC WITH SPAR FILLING MANY OF THE VOIDS.

2140 - 2160B PACKSTONE;
POROSITY: MOLDIC, INTERGRANULAR, PIN POINT VUGS
GRAIN TYPE: SKELETAL, PELLET, SKELTAL CAST
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT, DOLOMITE CEMENT
OTHER FEATURES: MEDIUM RECRYSTALLIZATION
FOSSILS: BENTHIC FORAMINIFERA, MILIOLIDS
POORLY LABELED CORE. CAN ONLY SAY B IS BETWEEN 2140 AND 2160
AND IS DEEPER THAN A. PACKSTONE/GRAINSTONE LESS DOLOMITIC
THAN PREVIOUS SAMPLE.

REPORT OF INVESTIGATION NO. 113

WELL NUMBER: W-18776

5 SAMPLES FROM 657 TO 813 FT.

LAT = 27D 09M 17S

LON = 80D 52M 27S

ELEVATION:20.33 FT

OWNER/DRILLER:EXKR-MW1 MW-0010

WORKED BY:CINDY FISCHLER

0 - 657 NOT SAMPLED

657 - 658 PACKSTONE;

POROSITY: INTERGRANULAR, PIN POINT VUGS

GRAIN TYPE: SKELETAL, PELLET, SKELTAL CAST

MODERATE INDURATION

CEMENT TYPE(S): SPARRY CALCITE CEMENT

ACCESSORY MINERALS: PYRITE-<1%

OTHER FEATURES: MEDIUM RECRYSTALLIZATION

FOSSILS: BENTHIC FORAMINIFERA, ECHINOID

LEPIDOCYCLINA, PYRITE THROUGHOUT.

658 - 662 NOT SAMPLED

662 - 663 GRAINSTONE;

POROSITY: INTERGRANULAR, PIN POINT VUGS

GRAIN TYPE: SKELETAL, PELLET, SKELTAL CAST

MODERATE INDURATION

CEMENT TYPE(S): SPARRY CALCITE CEMENT, DOLOMITE CEMENT

ACCESSORY MINERALS: PYRITE-<1%

OTHER FEATURES: MEDIUM RECRYSTALLIZATION

FOSSILS: BENTHIC FORAMINIFERA

LEPIDOCYCLINA. GRAINSTONE / PACKSTONE. A FEW OF THE LARGER
LEPIDOCYCLINA ARE RECRYSTALLIZED.

663 - 723 NOT SAMPLED

723 - 724 PACKSTONE;

POROSITY: INTERGRANULAR, INTERCRYSTALLINE

GRAIN TYPE: SKELETAL, PELLET, CRYSTALS

MODERATE INDURATION

CEMENT TYPE(S): SPARRY CALCITE CEMENT, DOLOMITE CEMENT

ACCESSORY MINERALS: PYRITE, DOLOMITE-40%

OTHER FEATURES: HIGH RECRYSTALLIZATION, DOLOMITIC

FOSSILS: BENTHIC FORAMINIFERA

DOLOMITIC PACKSTONE. MATRIX IS HIGHLY RECRYSTALLIZED

(Euhedral dolomite crystals). ABUNDANT LARGE AND SMALL
LEPIDOCYCLINA.

724 - 805 NOT SAMPLED

805 - 806 PACKSTONE;

POROSITY: INTERGRANULAR, PIN POINT VUGS

GRAIN TYPE: SKELETAL, PELLET, SKELTAL CAST

MODERATE INDURATION

CEMENT TYPE(S): SPARRY CALCITE CEMENT, DOLOMITE CEMENT

SEDIMENTARY STRUCTURES: LAMINATED

ACCESSORY MINERALS: PYRITE

FLORIDA GEOLOGICAL SURVEY

OTHER FEATURES: DOLOMITIC, MEDIUM RECRYSTALLIZATION
FOSSILS: BENTHIC FORAMINIFERA, ECHINOID, ORGANICS
PYRITE PRESENT THROUGHOUT ~ 1-2%; ALSO PYRITIZED
FORAMINIFERA. NOT AS DOLOMITIC AS PREVIOUS SAMPLE. TRACE OF
ORGANICS IN SOME OF THE LAMINATIONS.

806 - 812 NOT SAMPLED

812 - 813 WACKESTONE;
POROSITY: INTERGRANULAR
GRAIN TYPE: CALCILUTITE, SKELETAL, SKELTAL CAST
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT, DOLOMITE CEMENT
SEDIMENTARY STRUCTURES: LAMINATED
ACCESSORY MINERALS: PYRITE- 1%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, DOLOMITIC
FOSSILS: ECHINOID, BENTHIC FORAMINIFERA
FEW SCATTERED MOLDS OF ECHINOIDS. WACKESTONE / PACKSTONE
WITH ALTERNATING MUDSTONE LAMINAE THROUGHOUT.
PYRITE THROUGHOUT MORE IN CLAY LAMINAE. DOLOMITIC.

REPORT OF INVESTIGATION NO. 113

WELL NUMBER: W-18778

7 SAMPLES FROM 652 TO 1120 FT.

LAT = 26.66052

LON = 81.96203

ELEVATION: 12 FT

OWNER/DRILLER: CAPE CORAL MWH L-1028

WORKED BY: CINDY FISCHLER. ALL DEPTHS ARE APPROXIMATE - CORE IS VERY POORLY LABELED.

0 - 652 NOT SAMPLED

652 - 653 SANDSTONE;

POROSITY: INTERGRANULAR

GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM

ROUNDNESS: ANGULAR TO SUB-ANGULAR; MEDIUM SPHERICITY

MODERATE INDURATION

CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT

DOLOMITE CEMENT

SEDIMENTARY STRUCTURES: MOTTLED

ACCESSORY MINERALS: PHOSPHATIC SAND, SPAR

OTHER FEATURES: SUCROSIC

FOSSILS: MOLLUSKS

VERY FINE GRAINED PHOSPHATE, ROUNDED.

653 - 754 NOT SAMPLED

754 - 755 PACKSTONE;

POROSITY: INTERGRANULAR, PIN POINT VUGS

GRAIN TYPE: SKELETAL, PELLET, CRYSTALS

GRAIN SIZE: MEDIUM; RANGE: MICROCRYSTALLINE TO GRAVEL

MODERATE INDURATION

CEMENT TYPE(S): CALCILUTITE MATRIX

ACCESSORY MINERALS: PHOSPHATIC SAND, PYRITE

QUARTZ SAND

OTHER FEATURES: MEDIUM RECRYSTALLIZATION

FOSSILS: MILIOLIDS, MOLLUSKS, BENTHIC FORAMINIFERA

PYRITE PRESENT THROUGHOUT SMALL CLUSTERS, SOME SHELL

MATERIAL IS RECRYSTALLIZED AND SOME SHELL MATERIAL IS CHALKY

755 - 763 NOT SAMPLED

763 - 764 GRAINSTONE;

POROSITY: MOLDIC, VUGULAR, POSSIBLY HIGH PERMEABILITY

GRAIN TYPE: SKELETAL, PELLET, SKELETAL CAST

GRAIN SIZE: COARSE; RANGE: MEDIUM TO GRAVEL

MODERATE INDURATION

CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT

ACCESSORY MINERALS: PYRITE

OTHER FEATURES: MEDIUM RECRYSTALLIZATION

FOSSILS: BENTHIC FORAMINIFERA, MOLLUSKS, MILIOLIDS

MEDIUM TO HIGH RECRYSTALLIZATION. APPEARS TO BE LAYERED BY

VARYING PERMEABILITY. PYRITE SCATTERED IN SOME OF THE

MOLDS. TRACE OF PHOSPHATE. ARCHAIAS AND TURRITELLA.

764 - 848 NOT SAMPLED

FLORIDA GEOLOGICAL SURVEY

848 - 849 WACKESTONE;

GRAIN TYPE: SKELETAL, INTRACLASTS, CALCILUTITE
GRAIN SIZE: COARSE; RANGE: MICROCRYSTALLINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
SEDIMENTARY STRUCTURES: MOTTLED, BIOTURBATED
ACCESSORY MINERALS: ORGANICS
OTHER FEATURES: MEDIUM RECRYSTALLIZATION
FOSSILS: BENTHIC FORAMINIFERA, MOLLUSKS
MOTTLED AND BIOTURBATED WITH VERY THIN WISPY ORGANIC
LAMINAE. INTRACLASTS ARE MUDSTONE. MATRIX IS CHALKY, GRAINS
ARE RECRYSTALLIZED. PYRITE SCATTERED - LESS THAN PREVIOUS
SAMPLES.

849 - 983 NOT SAMPLED

983 - 984 PACKSTONE;

POROSITY: MOLDIC, VUGULAR, INTERGRANULAR
GRAIN TYPE: PELLET, SKELTAL CAST, CRYSTALS
GRAIN SIZE: COARSE; RANGE: MICROCRYSTALLINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT, CALCILUTITE MATRIX
ACCESSORY MINERALS: SPAR
OTHER FEATURES: HIGH RECRYSTALLIZATION
FOSSILS: FOSSIL MOLDS, BENTHIC FORAMINIFERA, MOLLUSKS
SPAR LINING MOLDS. PACKSTONE / GRAINSTONE.

984 - 995 NOT SAMPLED

995 - 996 GRAINSTONE;

POROSITY: VUGULAR, MOLDIC
GRAIN TYPE: PELLET, SKELETAL, SKELTAL CAST
GRAIN SIZE: MEDIUM; RANGE: MICROCRYSTALLINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT, CALCILUTITE MATRIX
OTHER FEATURES: HIGH RECRYSTALLIZATION
FOSSILS: MILIOLIDS, BENTHIC FORAMINIFERA
SPARSE MOLDS. ARCHAIA.

996 - 1119 NOT SAMPLED

1119 - 1120 PACKSTONE;

POROSITY: INTERGRANULAR, PIN POINT VUGS, MOLDIC
GRAIN TYPE: SKELETAL, SKELTAL CAST, OOLITE
GRAIN SIZE: COARSE; RANGE: MICROCRYSTALLINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT, CALCILUTITE MATRIX
DOLOMITE CEMENT
ACCESSORY MINERALS: CLAY
OTHER FEATURES: HIGH RECRYSTALLIZATION
FOSSILS: ECHINOID, MOLLUSKS, CORAL, BRYOZOA
MOTTLED. SOME LARGER ECHINOIDS FILLED WITH SEDIMENT.
ONCOLITES - NOT AS RECRYSTALLIZED AS OTHER GRAINS.

Appendix 3.

Detailed petrography report.

All sample depths are feet below land surface (HTWN=Hawthorn Group, Swnn=Suwannee Limestone, Ocala=Ocala Limestone, AVPK=Avon Park Formation, BP=pore space between grains).

FLORIDA GEOLOGICAL SURVEY

Well	Depth	Geologic Unit	General lithology	Acc. Minerals Abundance	Dominant Grain Types	Diagenesis	Sorting	Sedimentary Structures	Porosity	BP Mud	Texture	Interpreted Depositional Setting	Dominant pore Network
W-18728	2140-2160A	AVPK	Limestone	trace of organics	foraminifera, peloids, mollusk, miliolids	well cemented, micritized, dissolution features		mottled	~10%	low	packstone	shallow subtidal platform	Moldic, slight interparticle and microporosity
W-18728	2140-2160B	AVPK	Limestone	trace of organics, glauconite	foraminifera, peloids, miliolids, echinoids and mollusk fragment	moderately cemented, micritized, compacted			~15	very low	grainstone	shallow subtidal platform	Interparticle, microporosity
W-18776	657-658	Ocala	Limestone	pyrite, trace of organics	large & small forams, algae, peloids, skeletal fragments. echinoids, miliolids	burrowed, some micritization and compaction	multi-modal	bioturbated	~25	muddy	packstone	middle ramp	microporosity, interparticle
W-18776	662-663	Ocala	Limestone	pyrite and scattered dolomite rhombs	large & small forams, algae, peloids, skeletal fragments. echinoids, miliolids	slightly dolomitic, micritized, compacted		bioturbated	~30	low	packstone	middle ramp	Interparticle, microporosity minor moldic
W-18776	723-724	Ocala	Limestone	pyrite, organics, 25-30% dolomite	large forams, algae, peloids	dolomitic, compacted	bi-modal	bioturbation, lamina	~10	muddy	packstone	lower middle ramp	interparticle, intercrystalline, intraparticle, moldic
W-18776	805-806	AVPK	Limestone	dolomite 3-5%, pyrite in forams, organics, trace of glauconite and or pyrite	small forams, intraclast, miliolids, peloids, echinoids	micritized, moderately cemented		variably muddy laminated	mud layers ~10-15%, not so muddy ~30-35%	muddy	packstone	shallow subtidal to supratidal	interparticle, intraparticle
W-18776	812-813	AVPK	Limestone	organics, pyrite, trace of glauconite, few scattered dolomite rhombs	small forams, few ostracods, algae, echinoids, miliolids, peloids	micritized grains, moderately cemented	moderately sorted	variably muddy laminated	mud layers ~5-10%, not so muddy ~30-35%	hi mud	wackestone / packstone	shallow subtidal to supratidal possibly restricted at times	intergranular, microporosity, minor intragranular
W-18778	652-653	HTWN	Limestone	possible pyrite, quartz 5%, phosphate 5%, dolomite, trace of glauconite	mollusk	moderately cemented		bioturbated	~30%	low mud	packstone	not determined	moldic and microporosity
W-18778	754-755	HTWN	Limestone	quartz 15%, pyrite, Trace of phosphate, scattered dolomite rhombs	echinoids, ostracods, peloids, green algae	Micritized, minimal cement, fracture		bioturbated	~15%	high mud	wackestone/ packstone	restricted marine and shallow lagoon	moldic and microporosity
W-18778	763-764	SWNN	Limestone	some pyrite, <1% quartz	miliolids, forams, ostracods, peloids, few intraclast, echinoids, mollusk & gastropod molds	compaction, fractures, and minimal cementation	minimal to moderately sorted	laminations	~35%	low mud	grainstone	restricted lagoonal environment	moldic and interparticle

REPORT OF INVESTIGATION NO. 113

Well	Depth	Geologic Unit	General lithology	Acc. Minerals Abundance	Dominant Grain Types	Diagenesis	Sorting	Sedimentary Structures	Porosity	BP Mud	Texture	Interpreted Depositional Setting	Dominant pore Network
W-18778	848-849	SWNN	Limestone	organics, trace of quartz and pyrite	peloids, ostracods, miliolids, forams, coral, sparse bryozoa, intraclast and echinoids	micritized, fracture		bioturbated and laminations	~20%	high mud	wackestone	restricted lagoonal to subtidal	moldic and microporosity
W-18778	983-984	SWNN	Limestone	pyrite, few dolomite rhombs and organics	mollusk & gastropod molds, oncolites, echinoids, miliolids, forams, peloids	well cemented micritized	poorly sorted	bioturbated and compacted	~30-40%	moderately muddy	packstone	semi-restricted to open marine	moldic, minor interparticle and microporosity
W-18778	995-996	SWNN	limestone	trace of quartz	miliolids, ostracods, echinoids, peloids, molds, few intraclasts	Micritized, minimal cement, fracture	moderately sorted	bioturbated	~35%	low mud	grainstone	semi-restricted to open marine with lagoonal influence	interparticle and intraparticle with minor microporosity
W-18778	1119-1120	SWNN	Limestone	organics, trace of pyrite and glauconite	forams, echinoids, bryozoa, mollusk, oncolites, miliolids, algae	micritized and moderately cemented	poorly sorted	bioturbated, algal laminations	~35%	high mud	wackestone	deep lagoon outer ramp shoal	interparticle, microporosity and minor intraparticle

FLORIDA GEOLOGICAL SURVEY

Core W-18728

Core is poorly labeled, can only state core section A is more shallow than core section B within the given depth range.

2140-2160A (Figures 1-4)

Lithostratigraphic Unit: Avon Park Formation.

Lithology: Limestone - peloidal, low-mud, well cemented packstone with foraminifera.

Porosity ~ 5%.

Micritized peloids and benthic foraminifera are the dominant grain types (Figure 1). Cement fills much of the interparticle spaces and molds. Traces of organics were noted. Possible dissolution surface is followed by mud infill exhibiting geopetal fabric. Dissolution cavity is not completely filled with mud, rim of spar cement starting to infill remaining cavity (Figure 2). The amount of moldic porosity and degree of micritization is variable.

The dominant porosity type is moldic, with some interparticle and moldic porosity (Figures 3 and 4). Many of the molds are infilled with sparry cement.

The depositional environment is likely a shallow, subtidal platform (Randazzo et al., 1990; Cander, 1991; Randazzo and Zachos, 1984; Budd, 2001). Much of the mud was originally winnowed out of the packstone, but enough mud is present to partially infill the dissolution cavity.

REPORT OF INVESTIGATION NO. 113

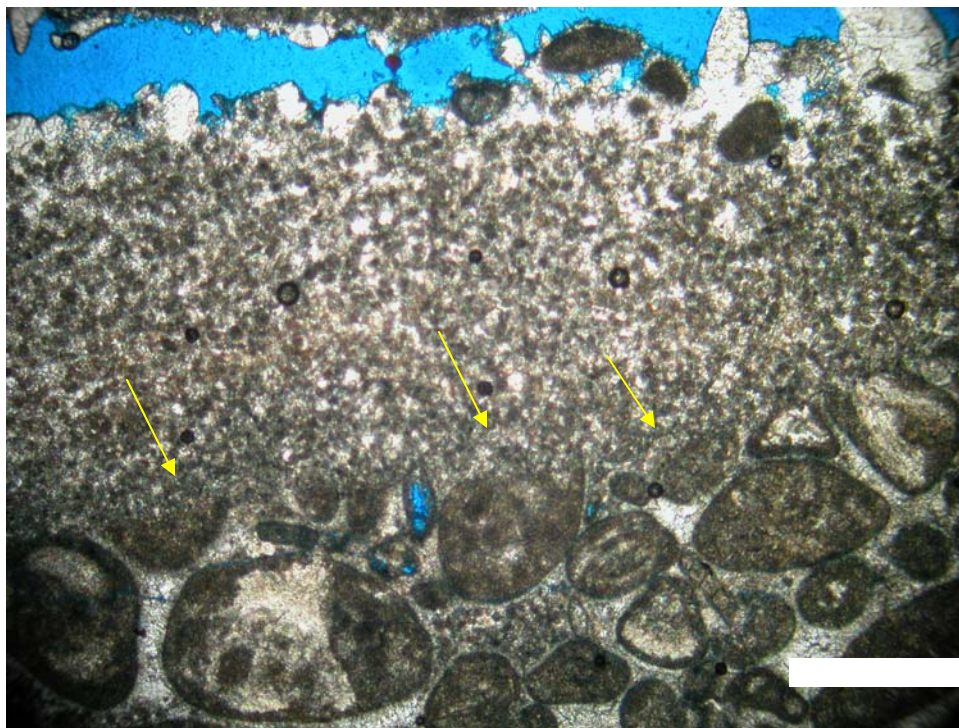


Figure 1. W-18728, 2140-2160A. Peloidal packstone with foraminifera. Possible dissolution surface (arrows) infilled with carbonate mud. Spar filling interparticle spaces. Plane polarized light. Scale bar is 0.5 mm.

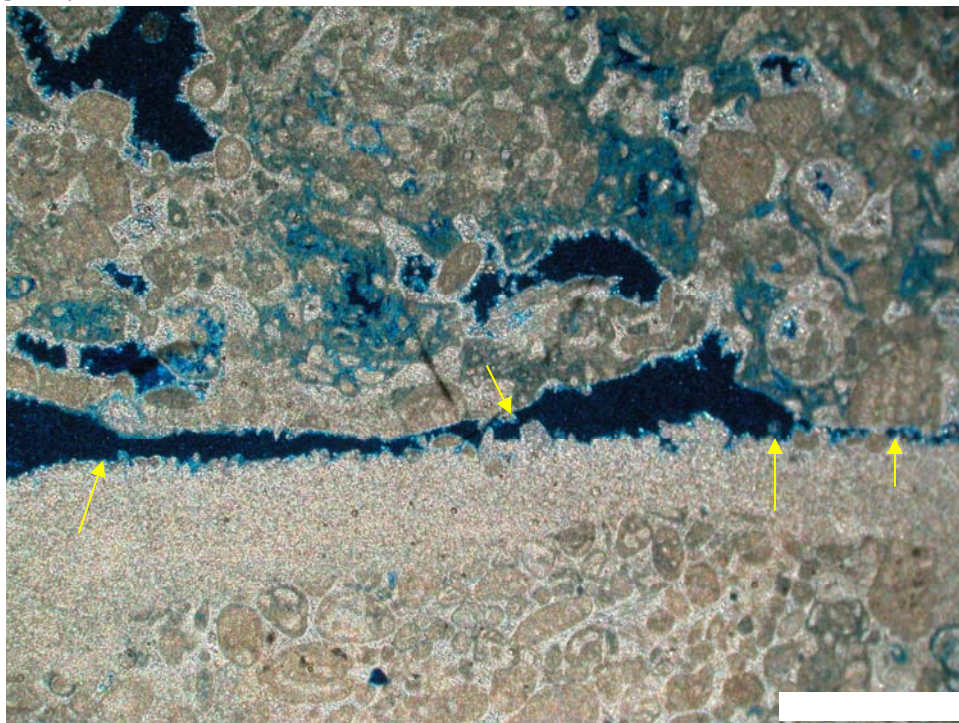


Figure 2. W-18728, 2140-2160A. Peloidal packstone with foraminifera. Dissolution surface from previous figure partially infilled with mud. Note open part of void is now filling with spar (Note light blue rim - arrows). Transmitted light. Scale is 2.0 mm.

FLORIDA GEOLOGICAL SURVEY

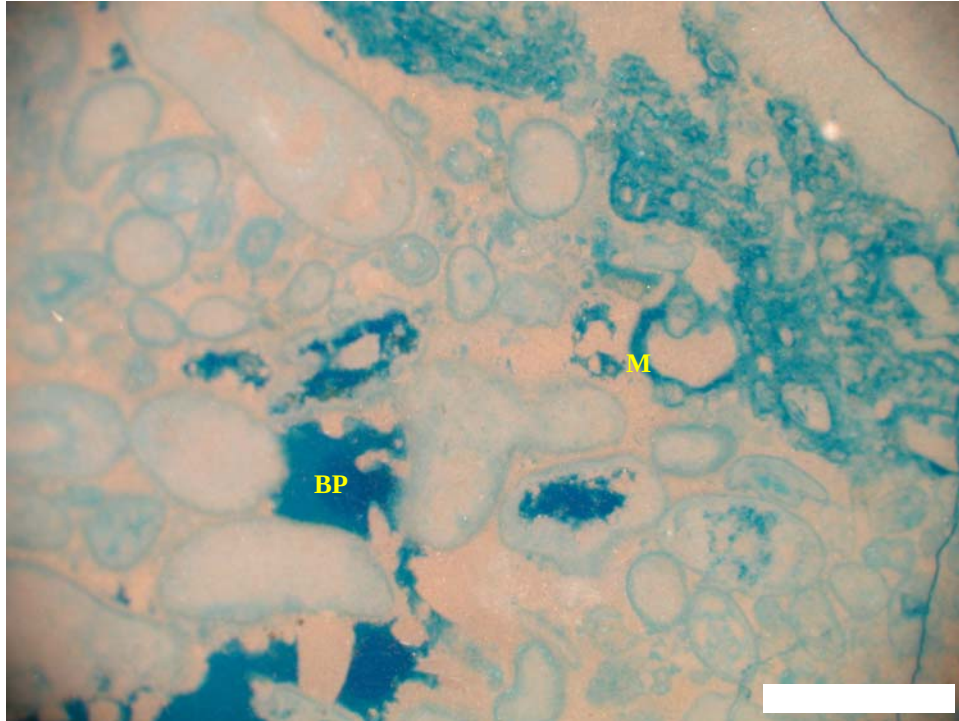


Figure 3. W-18728, 2140-2160A. Peloidal packstone with foraminifera. Interparticle (BP) and moldic (M) porosity. Reflected light. Scale is 1.0 mm.

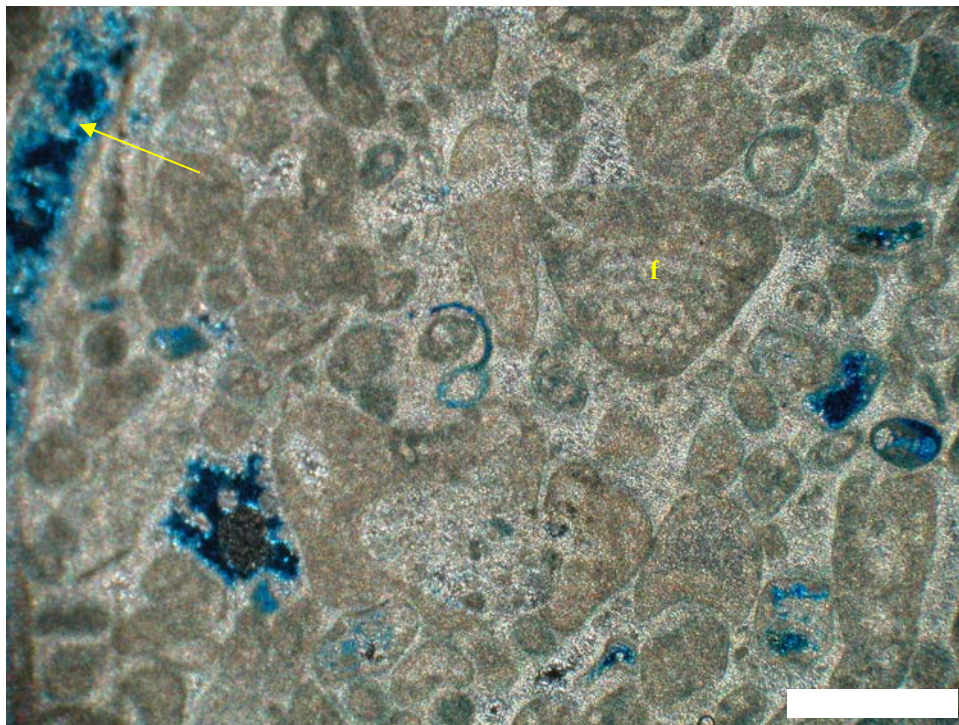


Figure 4. W-18728, 2140-2160A. Peloidal packstone with foraminifera (f). Micritized grains with many of the internal features no longer discernable; cement filling most of the voids between grains and continuing to fill open molds. Note mollusk mold in upper left side (arrow) partially filled with cement. Transmitted light. Scale is 0.5 mm.

REPORT OF INVESTIGATION NO. 113

Core W-18728

Core is poorly labeled, can only state A is more shallow than B within the given depth range.

2140-2160B (Figures 5-8)

Lithostratigraphic Unit: Avon Park Formation.

Lithology: Limestone – Peloidal, very low-mud, moderately cemented grainstone with foraminifera.

Porosity ~ 20%.

Similar to sample from W-18728, 2140-2160A but with more open pore space and thus slightly higher porosity (Figure 5). Dominant grain types are peloids, small benthic foraminifera and miliolids (Figures 5 and 6). Present to a lesser degree are echinoids and mollusk fragments as well as algae and a trace of organics. Some grains are partially to completely micritized (Figures 5-8). Small amounts of glauconite are also present in interparticle pore spaces (Figures 5, 7, and 8). Close packing of grains in addition to broken and indented grains are evidence of mechanical compaction (Figure 7) (Budd, 2001; Melzer, 2004). Dominant grain size is medium sand.

The dominant porosity type is interparticle with minor intraparticle and some microporosity within some of the fine-grained interparticle cement. Some calcite cement occurs in intraparticle pore spaces.

The depositional environment is likely a shallow subtidal platform (Randazzo et al., 1990; Cander, 1991).

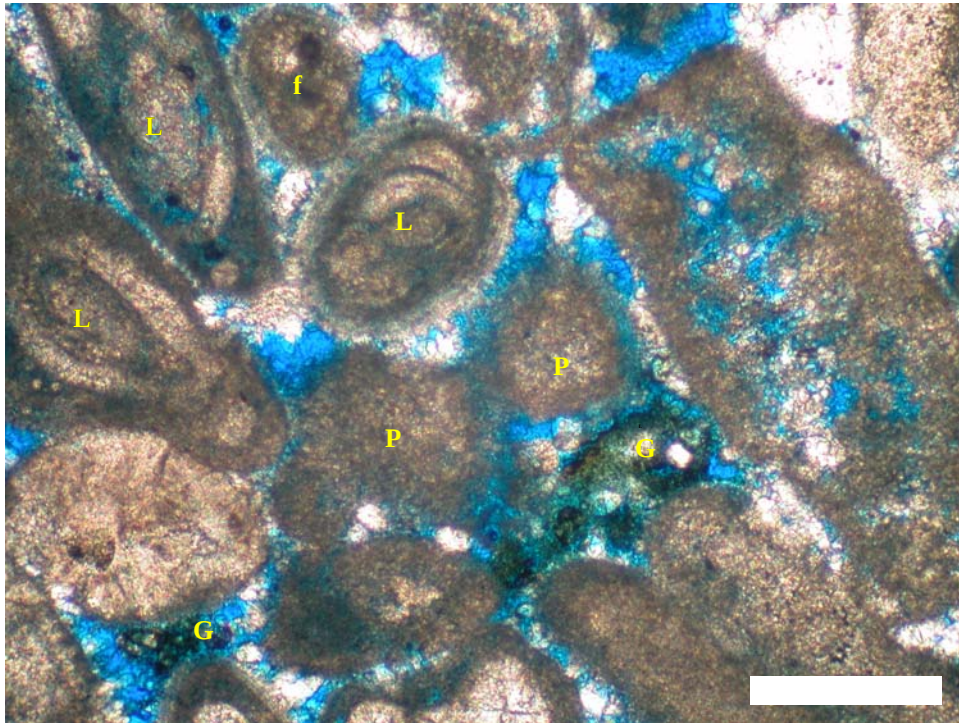


Figure 5. W-18728, 2140-2160B. Peloidal grainstone with foraminifera (f). Micritized peloids (P) and miliolids (L). Glauconite (G) in the interparticle pore space. Cement filling much of the interparticle pore space as evidenced by the blue haze (microporosity) with outline of sparry cement crystals. Transmitted light. Scale is 1.0 mm.

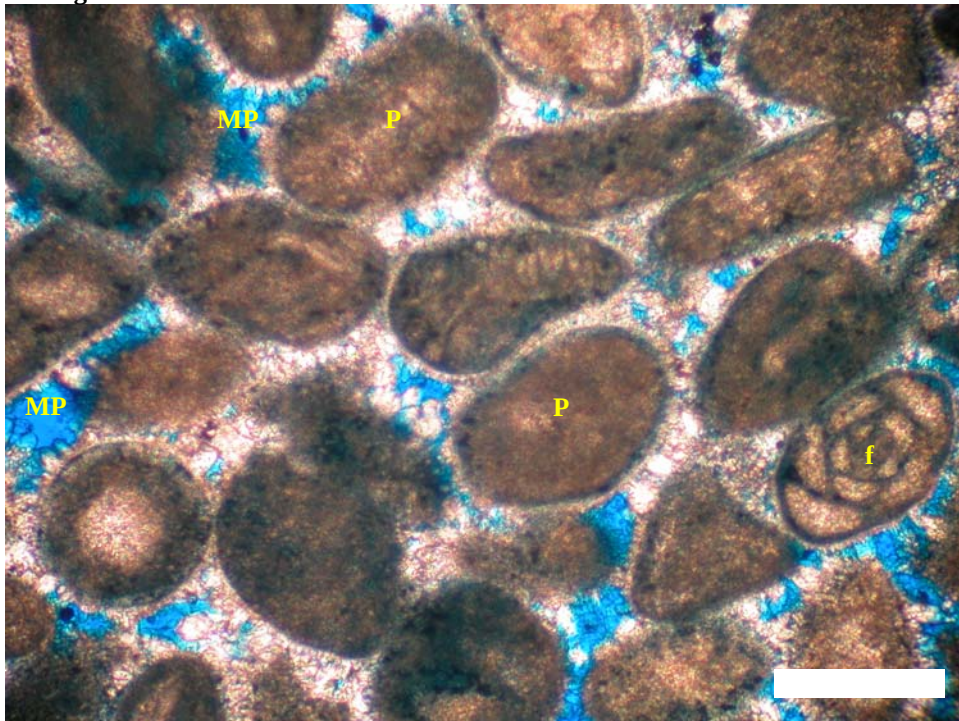


Figure 6. W-18728, 2140-2160B. Peloidal grainstone with foraminifera (f). Micritized peloids (P) with sparry cement filling much of the interparticle pore space. Cement exhibiting some microporosity (MP) throughout. Plane polarized light. Scale is 0.5 mm.

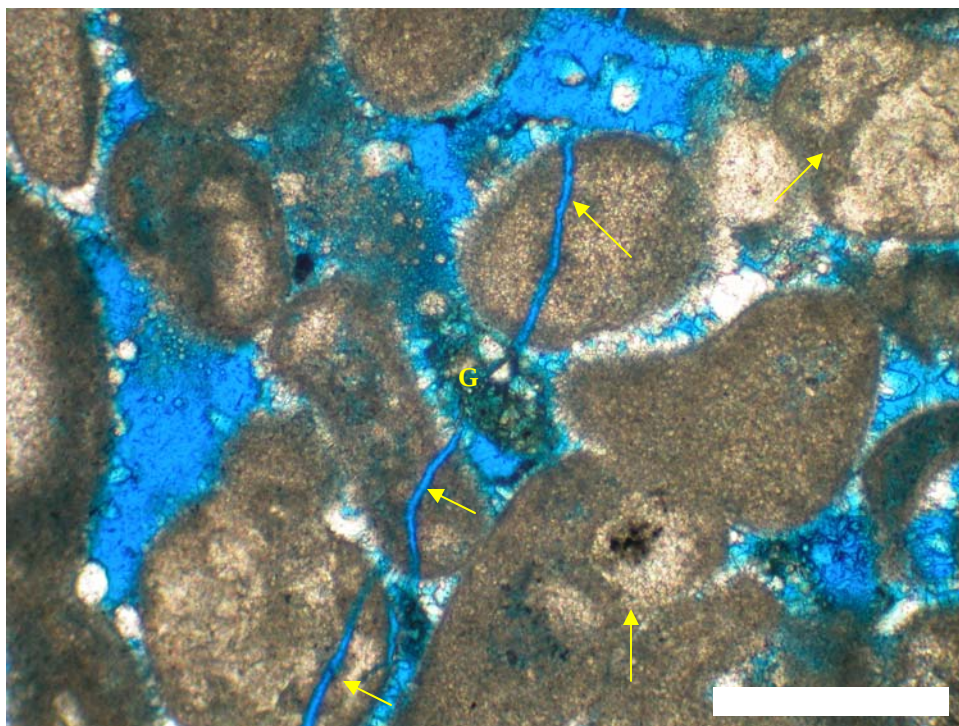


Figure 7. W-18728, 2140-2160B. Peloidal grainstone with foraminifera. Broken peloids evidence of compaction (arrows). Small grain of glauconite (G) does not appear fractured, glauconite formed after grainstone. Plane polarized light. Scale is 0.25 mm.

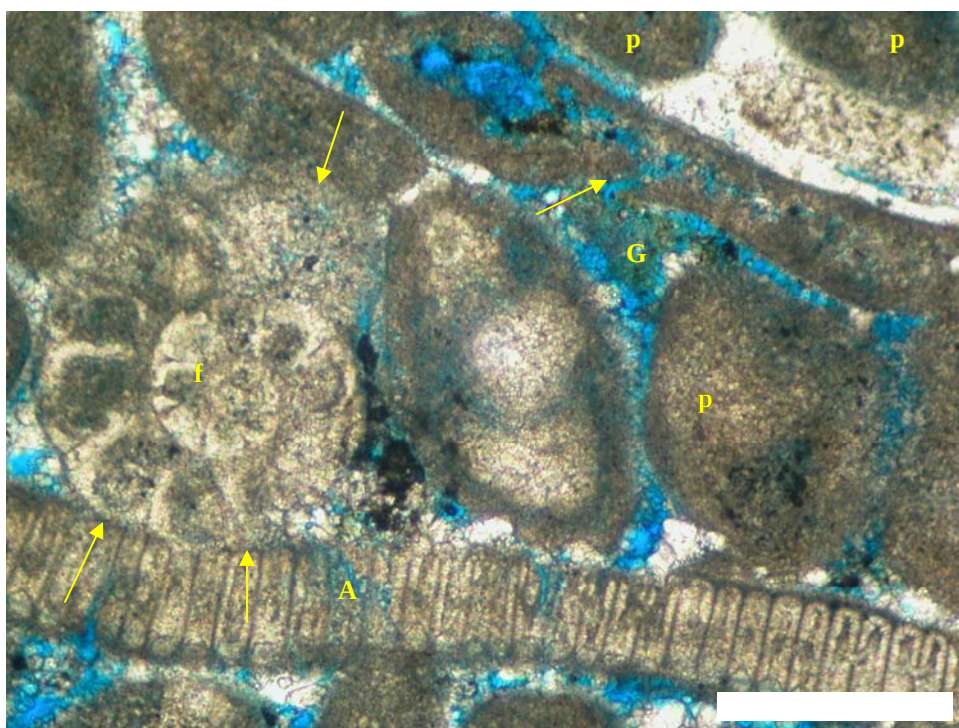


Figure 8. W-18728, 2140-2160B. Peloidal grainstone with foraminifera (f). Evidence of compaction-broken grains and indented grains (arrows). Glauconite (G) in interparticle pores. Algae present (A). Micritized peloids (p). Plane polarized light. Scale is 0.25 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18776

657-658 (Figures 9-14)

Lithostratigraphic Unit: Ocala Limestone.

Lithology: Limestone - mixed skeletal, silty, muddy packstone with foraminifera.

Porosity ~ 25%.

Much of the sample consists of mixed skeletal fragments (Figures 9, 10 and 11). There are large foraminifera, *Lepidocyclina* sp. and *Nummulites* sp., broken and whole along with other smaller foraminifera (Figure 12). Other grain types present are peloids, echinoids, miliolids, and algae (red and green types) (Figures 9, 10 and 13). Some of the grains are micritized. Some of the smaller foraminifera are hard to identify due to micritization. The sample is multi-modal. The coarse fraction is represented by the large foraminifera and algal fragments. The fine fraction is represented by the broken fragments of foraminifera, small foraminifera and peloids. The silt-sized fraction is represented by finely broken skeletal debris and micrite. Ovoid patches of localized increases in mud are evidence of bioturbation (Figures 11 and 12). Pyrite is found throughout the sample as well as traces of organics (Figures 13 and 14). Dasycladacean (green algae) found is associated with normal marine waters (Figure 13) (Arthur et al., 2007). Broken fragments of large foraminifera are evidence of compaction (Figure 12) (Budd, 2001; Melzer, 2004).

The dominant porosity types are interparticle and microporosity (Figures 9 and 10). Much of the interparticle pores are open and where they are filled with mud microporosity is evident (Figure 11). Cement occurs as some minor fine crystalline interparticle spar. Some of the larger foraminifera exhibit intraparticle porosity.

The depositional environment was likely a middle ramp setting, suggested by the large foraminifera and silt-sized matrix. The fine grained matrix is a result of reworking and downslope transport of the skeletal material (Beavington-Penny and Racey, 2004; Beavington-Penny et al., 2005; Loizeaux, 1995).

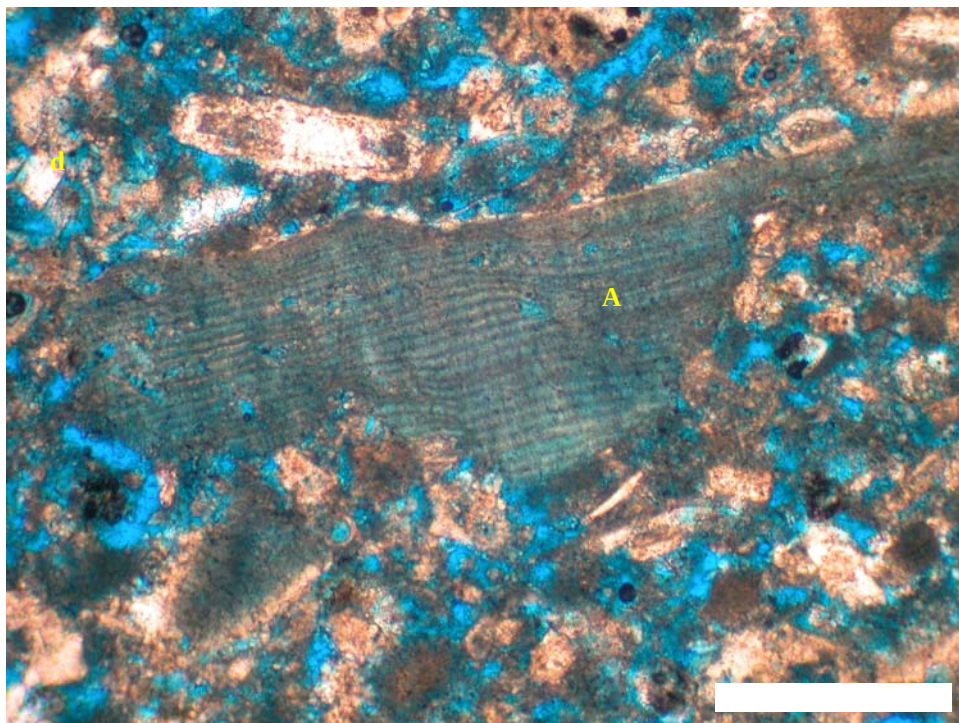


Figure 9. W-18776, 657-658. Mixed skeletal, silty, muddy packstone. Poorly cemented. Algal fragment (A) probably red algae. Finely broken pieces of large foraminifera and peloids in a muddy matrix. Dolomite rhomb near top left side of photo (d). Plane polarized light. Scale is 0.25 mm.

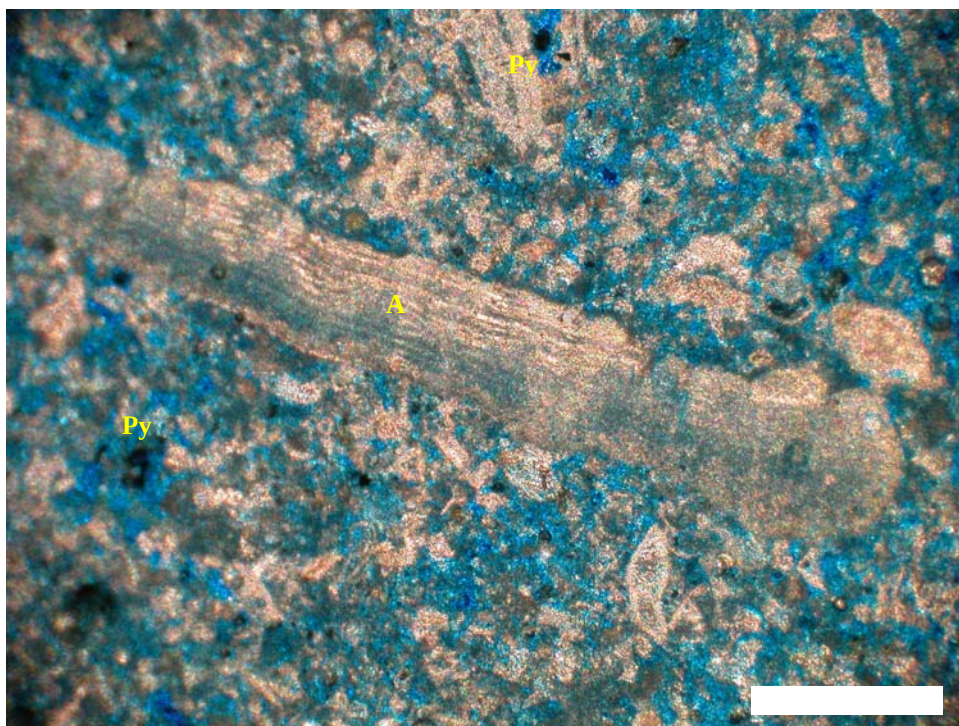


Figure 10. W-18776, 657-658. Mixed skeletal, silty, muddy packstone. Algal fragment (A) probably red algae. Pyrite framboids (Py) scattered. Matrix consists of small foraminifera and skeletal fragments in silty mud. Transmitted light. Scale is 1.0 mm.

FLORIDA GEOLOGICAL SURVEY

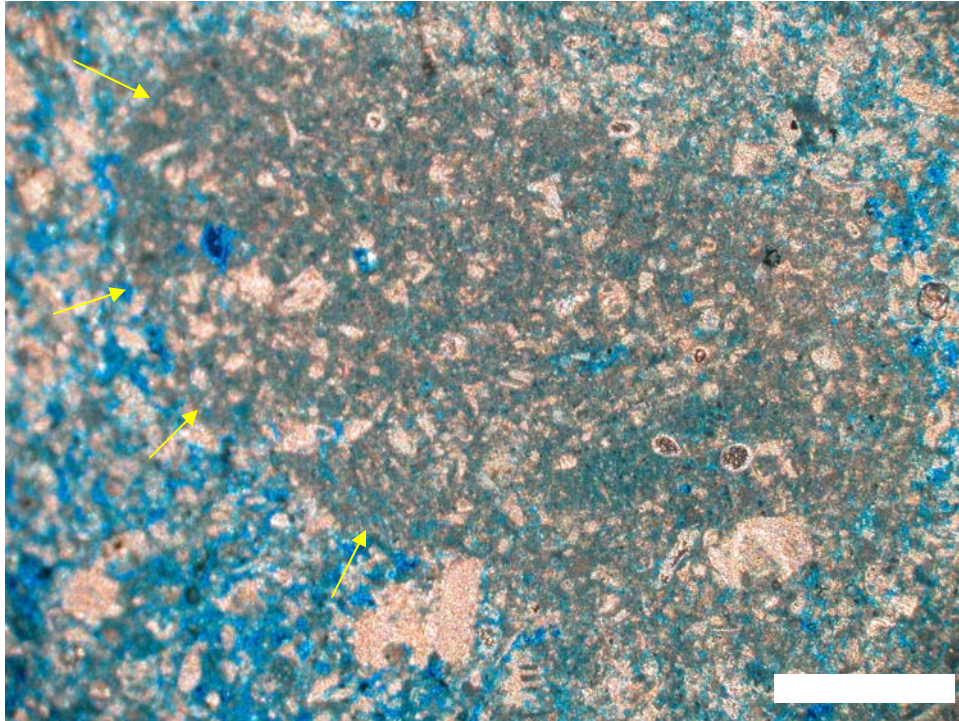


Figure 11. W-18776, 657-658. Mixed skeletal, silty, muddy packstone. Localized increase in micrite denotes bioturbation (arrows). Transmitted light. Scale is 2.0 mm.

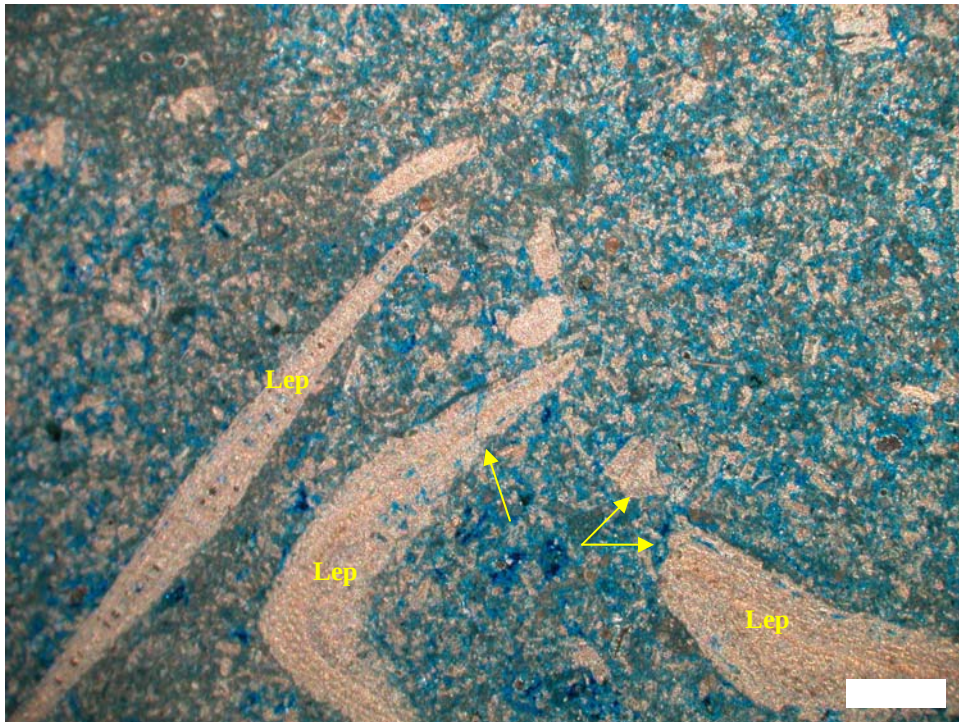


Figure 12. W-18776, 657-658. Mixed skeletal, silty, muddy packstone. *Lepidocyclina* sp. (Lep) broken fragments showing evidence of compaction (arrows). Top left corner showing increase in mud content indicating bioturbation. Transmitted light. Scale is 1.0 mm.

REPORT OF INVESTIGATION NO. 113

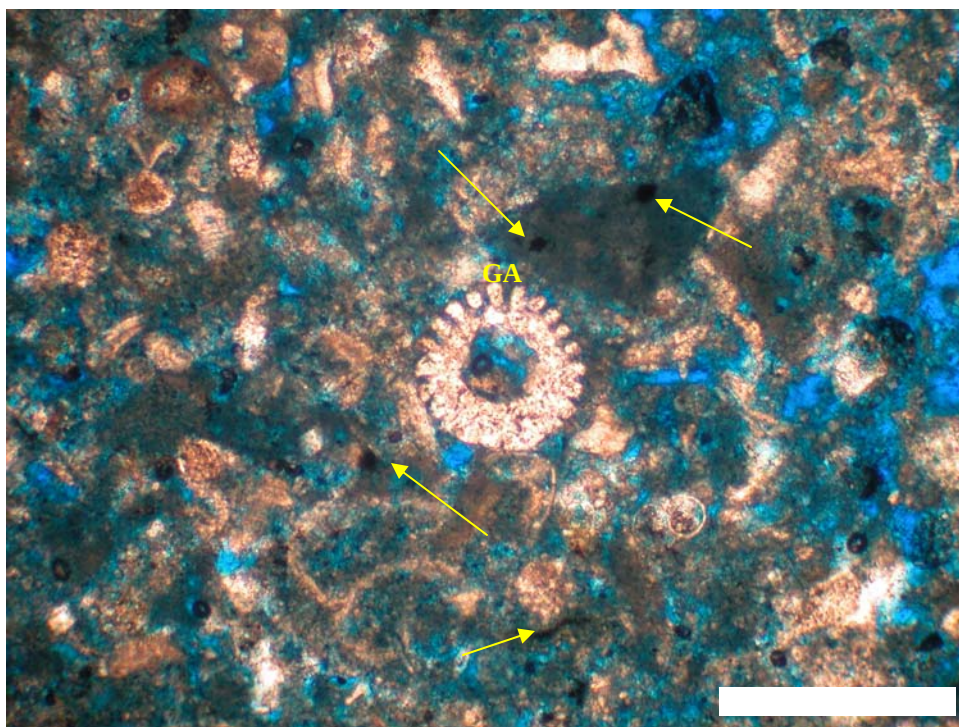


Figure 13. W-18776, 657-658. Mixed skeletal, silty, muddy packstone. Few green algae (GA) fragments (dasycladacean) associated with normal marine waters. Trace of organics and pyrite framboids (arrows). Micritized mixed skeletal grains. Plane polarized light. Scale is 0.25 mm.

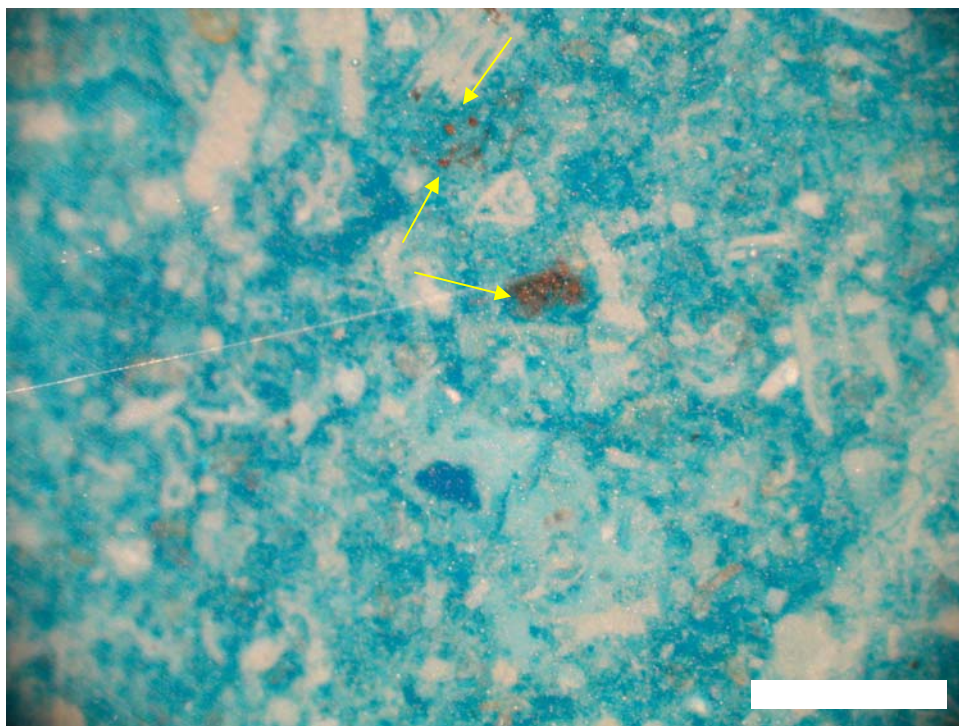


Figure 14. W-18776, 657-658. Mixed skeletal, silty, muddy packstone. Pyrite framboids (arrows) in interparticle pore spaces. Reflected light. Scale is 0.5 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18776

662-663 (Figures 15-20)

Lithostratigraphic Unit: Ocala Limestone.

Lithology: Limestone, slightly dolomitic – mixed skeletal, low-mud packstone.

Porosity ~ 30%.

Similar to sample W-18776, 657-658 ft but with slightly less mud. Sample consists of mixed skeletal fragments, small foraminifera, large foraminifera (*Lepidocyclina* sp., and *Nummulites* sp.), echinoids, and micritized peloids (Figures 15, 16 and 17). Mechanical compaction is evident in the broken algal fragments (Figure 18). A varying amount of mud is present between grains but over half of the interparticle space is open (Figures 17 and 18). There are slight variations in mud content and grain size; circular shapes containing less mud in some areas are evidence of bioturbation (Figure 19)(Arthur et al., 2007). Pyrite is present throughout the sample (Figures 15, 16, and 20). Overall grain size seems slightly finer than previous sample, although there is a coarse fraction, the fine fraction appears finer. Micritized grains are present as well as red and green algae. Cement is present in interparticle pores and molds and rimming some of the mixed skeletal fragments. The sample is slightly dolomitic with some scattered very fine dolomite rhombs (Figure 17).

Dominant porosity types are interparticle and microporosity and some moldic porosity. Microporosity is evident in the cement of intraparticle pore space and molds due to the fine grained nature of the cement (Figure 16).

Depositional environment is likely a middle ramp setting with reworking and downslope transport of skeletal material (Beavington-Penny and Racey, 2004; Beavington-Penny et al., 2005; Loizeaux, 1995). The reworking and transport allows the grains to be further broken into finer material.

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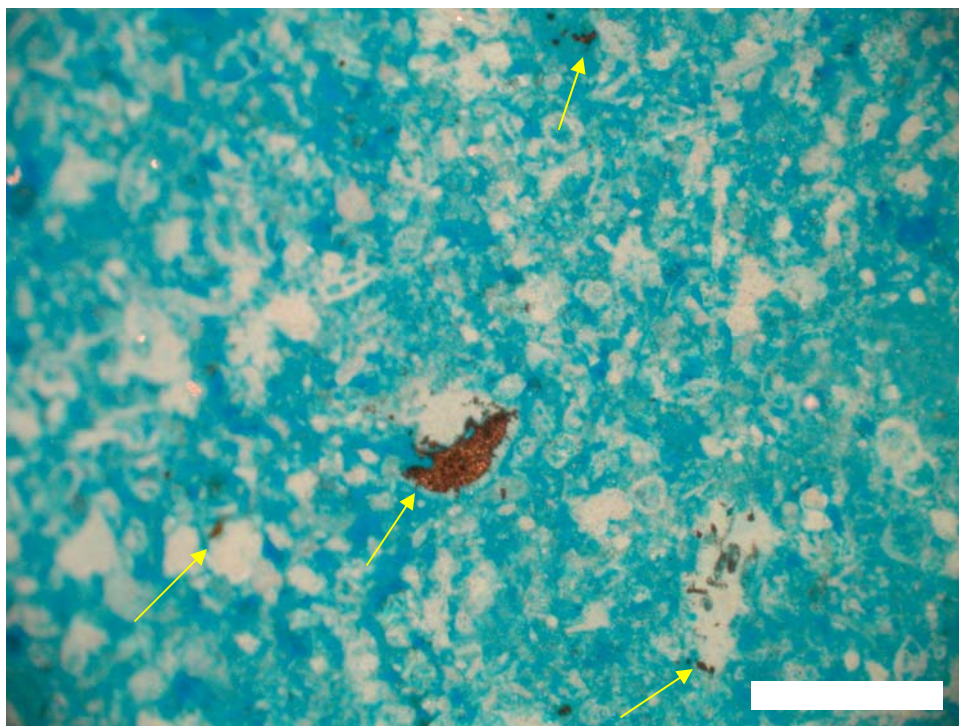


Figure 15. W-18776, 662-663. Mixed skeletal, low-mud packstone. Pyrite (arrows) occurs as masses or clusters replacing some grains and as framboids. Reflected light. Scale is 1.0 mm.

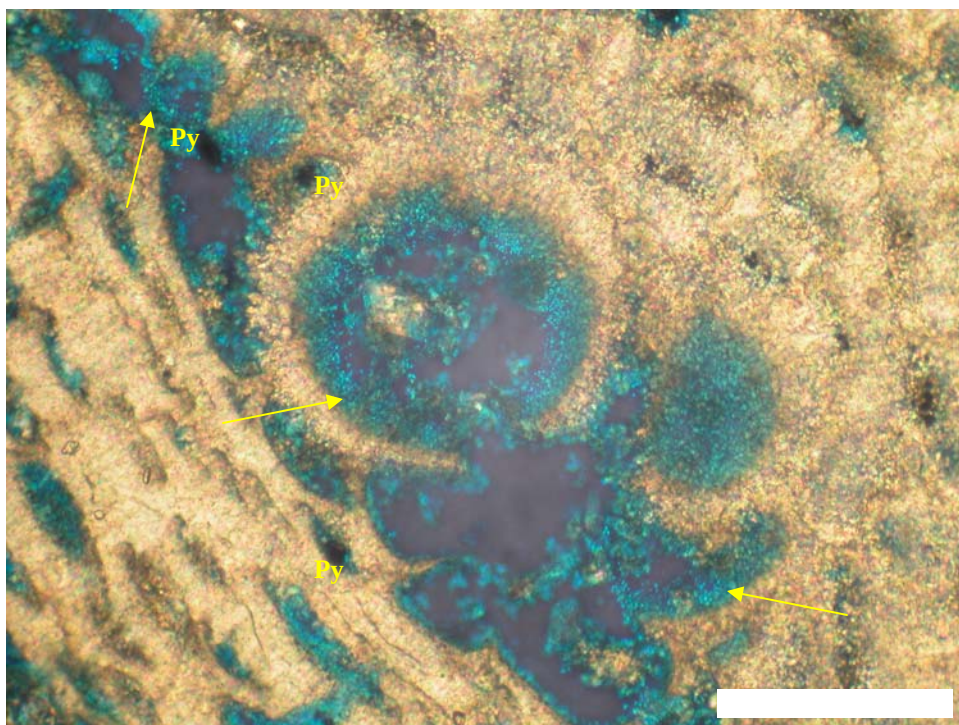


Figure 16. W-18776, 662-663. Mixed skeletal, low-mud packstone. *Lepidocyclina* sp. (large foraminifera) exhibiting intraparticle microporosity (arrows). Microporosity evident throughout the cement that is partially filling intraparticle pore space. Few scattered pyrite framboids (Py) in intraparticle pore space. Cross-polarized light. Scale is 0.25 mm.

FLORIDA GEOLOGICAL SURVEY

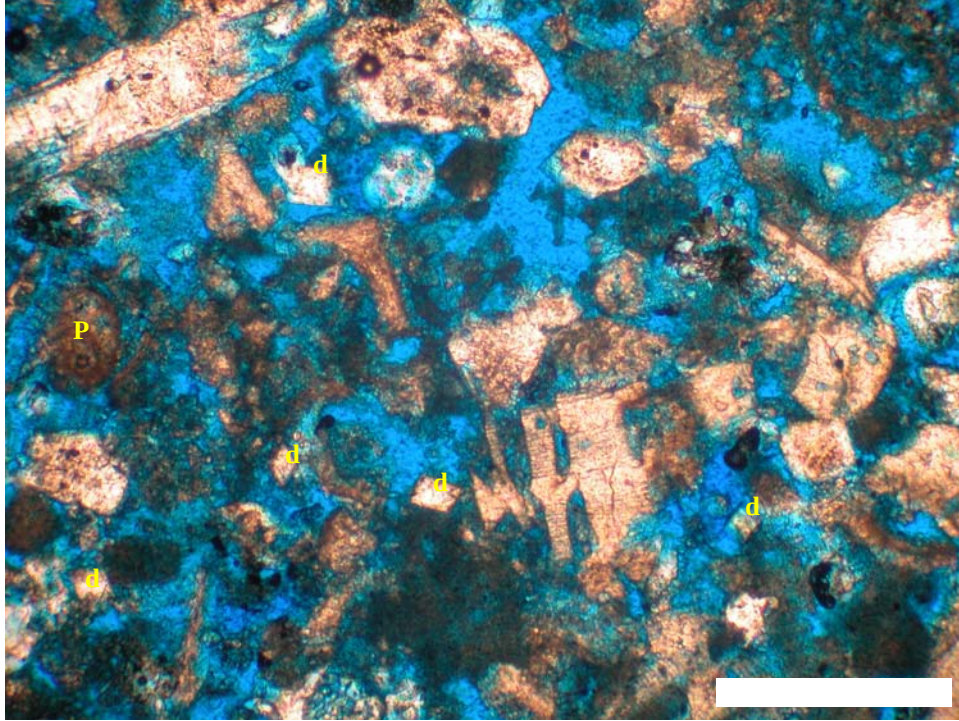


Figure 17. W-18776, 662-663. Mixed skeletal, low-mud packstone. Micritized peloids (P) and broken skeletal debris with small amount of mud in interparticle pores. Few scattered dolomite rhombs (d). Small cement crystals partially filling but not closing pores and rims around grains. Plane polarized light. Scale is 0.25 mm.

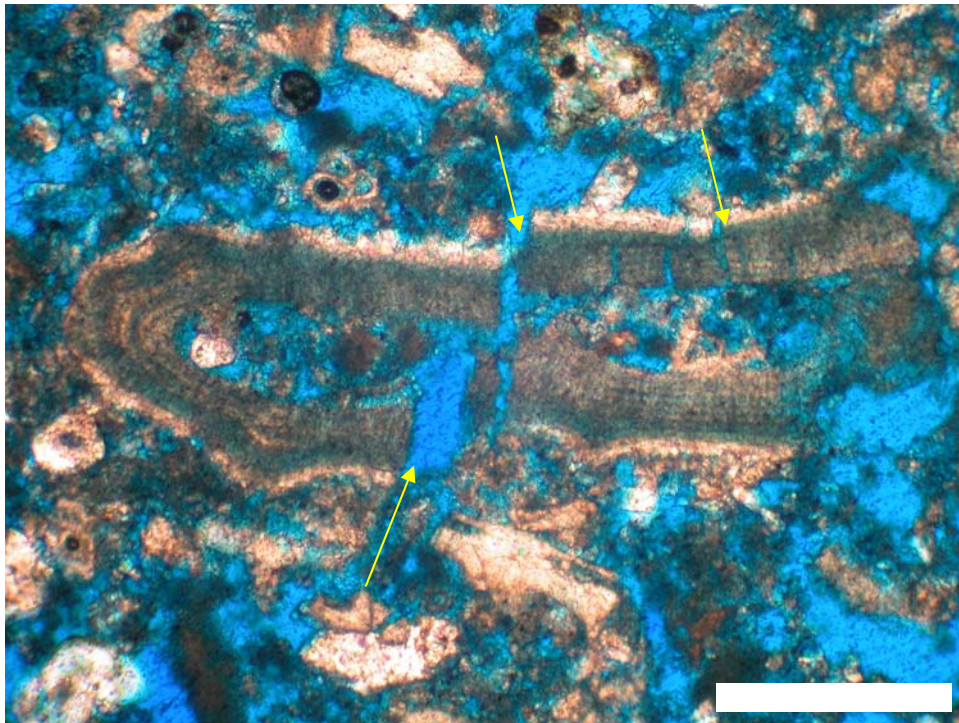


Figure 18. W-18776, 662-663. Mixed skeletal, low-mud packstone. Broken algal fragments (red algae?) evidence of mechanical compaction (arrows). Plane polarized light. Scale is 0.25 mm.

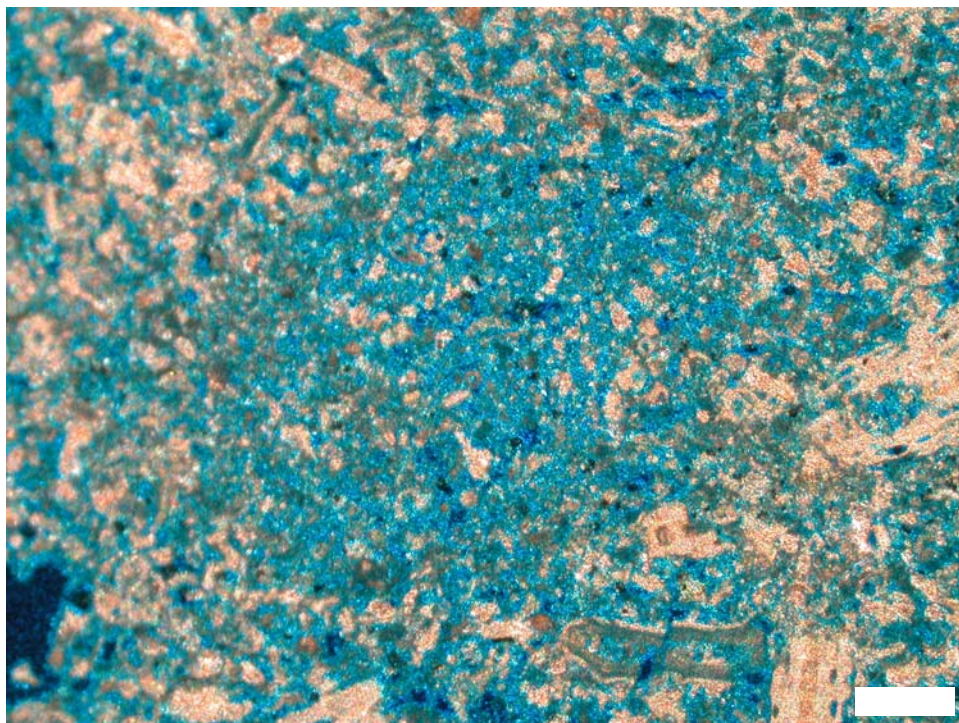


Figure 19. W-18776, 662-663. Mixed skeletal, low-mud packstone. Evidence of bioturbation in center of photo, circular area with less mud and finer grained. Transmitted light. Scale is 1.0 mm.

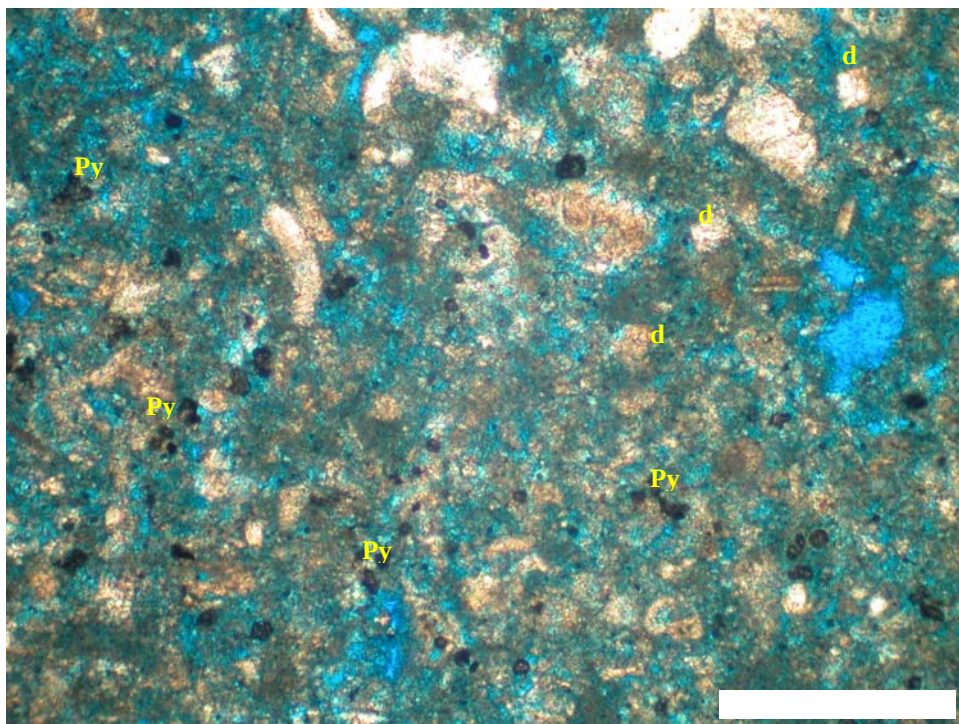


Figure 20. W-18776, 662-663. Mixed skeletal, low-mud packstone. Area of increased mud and lower porosity as compared to above figure. Mixed skeletal fragments finely broken, few scattered dolomite rhombs (d), and scattered pyrite framboids (Py) throughout. Plane polarized light. Scale is 0.25 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18776

723-724 (Figures 21-26)

Lithostratigraphic Unit: Ocala Limestone.

Lithology: Dolomitic limestone – mixed skeletal, muddy packstone with large foraminifera.

Porosity ~ 10%.

The sample is similar in composition to the previous samples for this well. The main differences are the abundance of dolomite rhombs (~ 25-30 percent) and the amount of micrite. The dominant grains are the dolomite rhombs, large foraminifera, mixed skeletal material and pyrite (Figures 21-24). This sample is finer grained than the previous samples. The *Lepidocyclina* sp. and *Nummulites* sp. are smaller and less prevalent (Figure 24). The matrix is finer grained, making skeletal identification difficult especially when combined with micritization (Figure 25). There is evidence of bioturbation, a burrow with recrystallized dolomite rhombs which are finer grained than the surrounding matrix (Figures 22 and 23). Organics are present in the sample as small thin wispy laminations. Pyrite is found throughout the sample and in the intraparticle pore spaces of large foraminifera (Figures 21 and 26). Mechanical compaction is evident in the broken large foraminifera and the muddy matrix infilling interparticle pore spaces in the broken areas (Figure 24). The sample appears bi-modal. The coarse fraction composed of large foraminifera and the fine fraction is made up of finely ground matrix material and dolomite rhombs. Dolomite rhombs appear to be very fine to silt-sized grains. There is some cementation, but the muddy matrix and micritization make it hard to determine how much.

The dominant porosity types are interparticle and intercrystalline along with intraparticle in the large foraminifera. Microporosity is sometimes evident in the mud fraction.

The depositional environment is likely a lower-middle ramp with extensive reworking and transport of material allowing fewer large foraminifera to survive intact and explaining the finer grained nature of the matrix (Beavington-Penny and Racey, 2004; Beavington-Penny et al., 2005; Loizeaux, 1995).

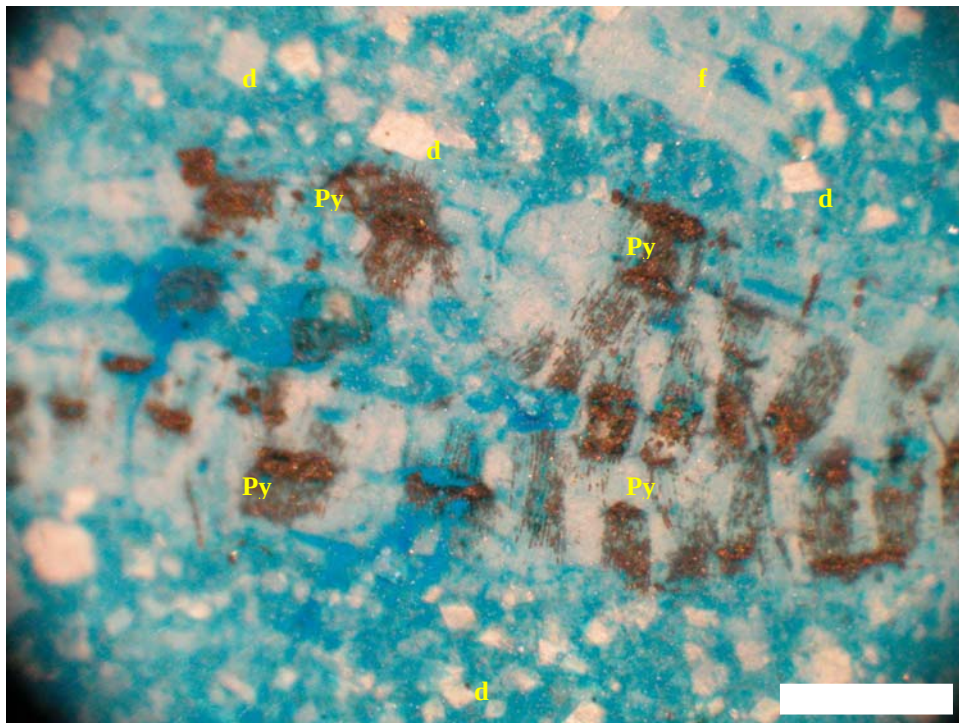


Figure 21. W-18776, 723-724. Dolomitic, muddy packstone with large foraminifera and mixed skeletal material. *Lepidocyclina* sp. with pyrite (Py) filling some intraparticle pore spaces. Matrix consists of broken foraminifera fragments and micrite with dolomite rhombs (d) throughout. Reflected light. Scale is 0.5 mm.

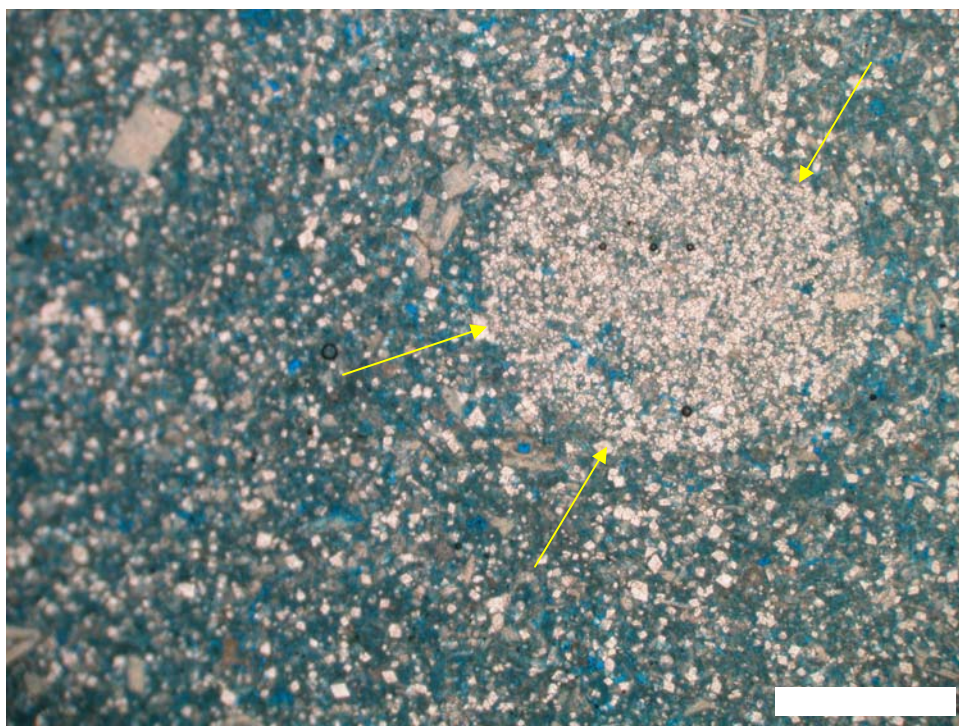


Figure 22. W-18776, 723-724. Dolomitic, muddy packstone with large foraminifera and mixed skeletal material. Burrow (arrows) filled with dolomite rhombs which replaced the original fill material. Porosity is significantly lower in burrow. Transmitted light. Scale is 2.0 mm.

FLORIDA GEOLOGICAL SURVEY

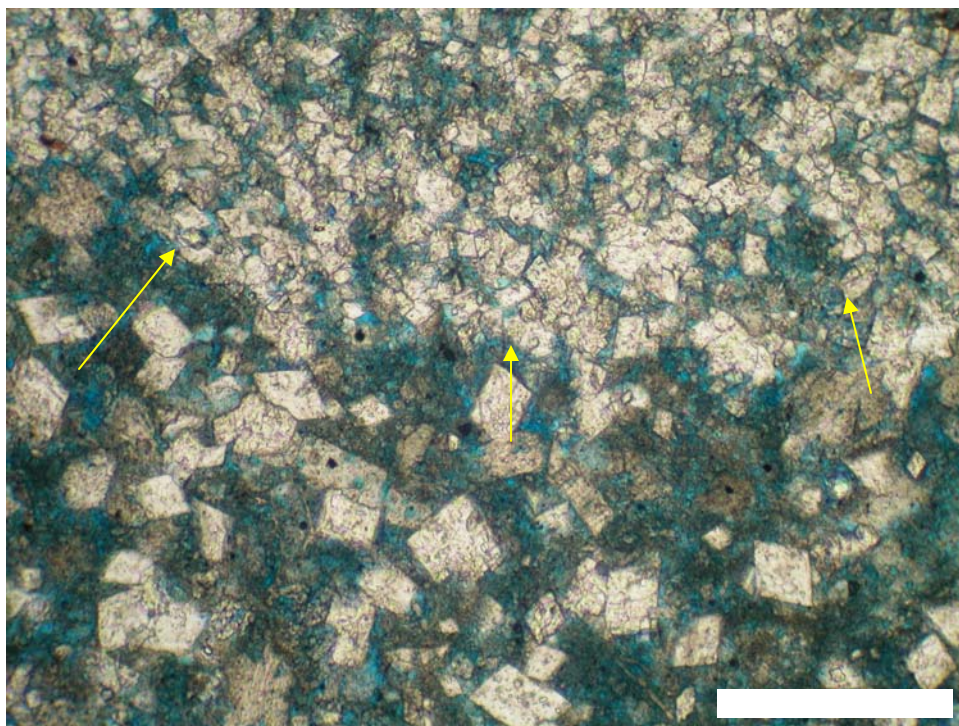


Figure 23. W-18776, 723-724. Dolomitic, muddy packstone with large foraminifera and mixed skeletal material. Enlargement of previous photo showing grain size difference of dolomite rhombs in burrow (arrows) and those in the matrix. Plane Polarized light. Scale is 0.25 mm.

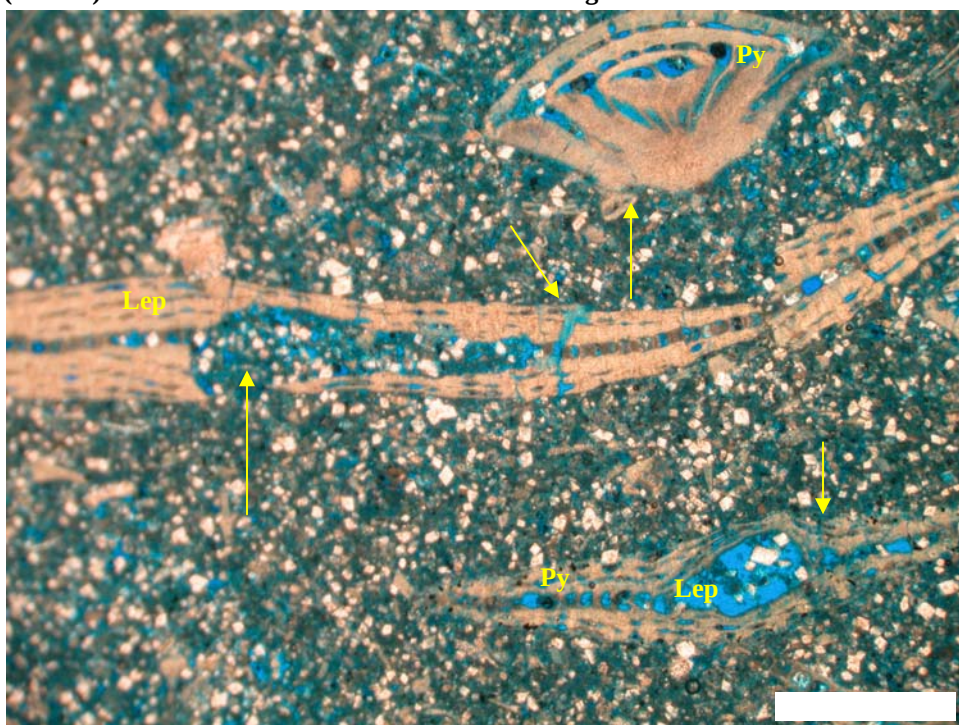


Figure 24. W-18776, 723-724. Dolomitic, muddy packstone with large foraminifera and mixed skeletal material. Broken *Lepidocyclina* sp. (Lep) and *Amphistegina* sp. exhibit mechanical compaction (arrows). Some intraparticle pore space of broken *Lepidocyclina* sp. infilled with mud and dolomite rhombs. Matrix material is much finer grained than the large foraminifera. Pyrite (Py) is present. Transmitted light. Scale is 2.0 mm.

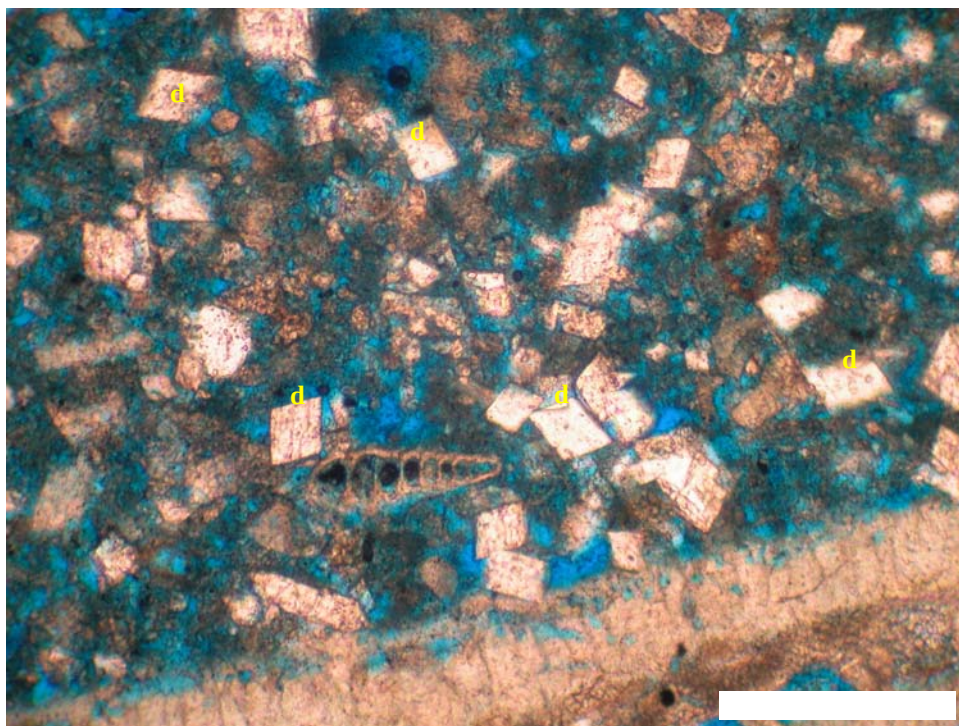


Figure 25. W-18776, 723-724. Dolomitic, muddy packstone with large foraminifera and mixed skeletal material. *Lepidocyclina* sp. across bottom of photo. Dolomite rhombs (d) very fine to silt sized in micritic matrix along with micritized grains. Plane polarized light. Scale is 0.25 mm.

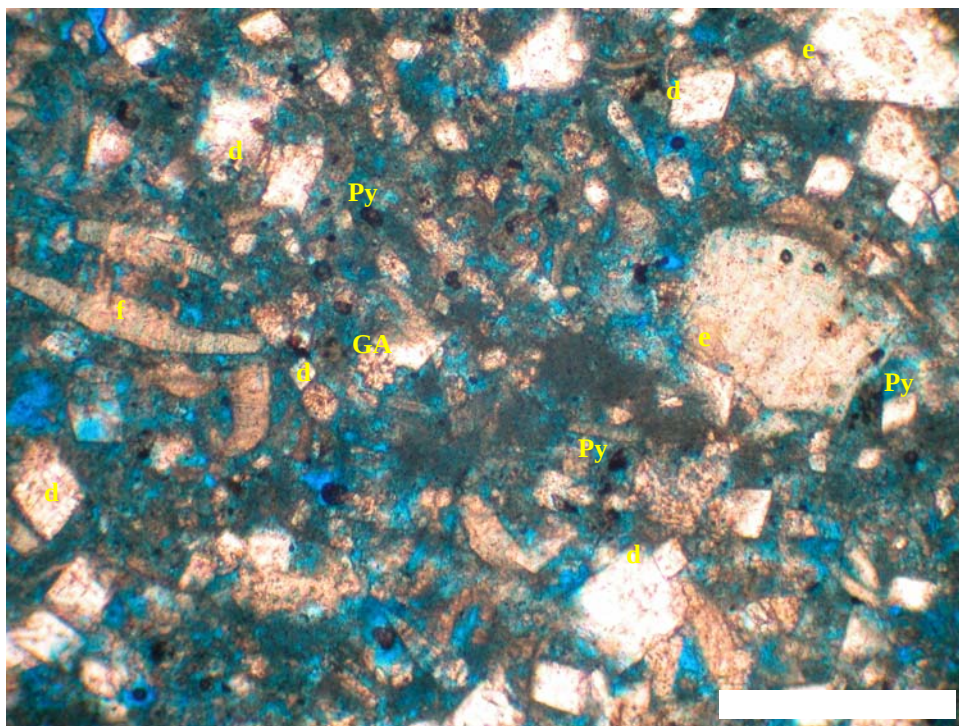


Figure 26. W-18776, 723-724. Dolomitic, muddy packstone with large foraminifera and mixed skeletal material. Micritized peloids, foraminifera (f), echinoids (e) and green algae (GA) in a micritic matrix with very fine to silt size dolomite and scattered pyrite (Py). Plane polarized light. Scale is 0.25 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18776

805-806 (Figures 27-32)

Lithostratigraphic Unit: Avon Park Formation.

Lithology: Limestone, slightly dolomitic - muddy, micro-laminated packstone with small foraminifera.

Porosity varies within laminae. High-mud laminae are ~ 10-15% percent, low-mud laminae is ~ 30-35%.

Allochems are a diverse assemblage of benthic foraminifera, miliolids and echinoids. Many of the grains (foraminifera and peloids) are micritized. Some of the foraminifera appear to be pyritized with pyrite filling the intraparticle pore spaces. Pyrite is also associated with some of the thin wispy laminae of organics (Figure 27). Micritic intraclasts are scattered throughout the laminae (Figure 28). Mud fills much of the interparticle pore space in the muddy laminae. The sample is moderately cemented. Fine-grained cement surrounds the micritized rims of some of the grains (Figures 29-32); while bladed fine-grained circumgranular cement surrounds and fills some of the miliolids. The interparticle pore spaces include very fine grains of cement allowing for microporosity (Figures 29 and 30). There are also traces of glauconite and dolomite rhombs (3-5 percent) scattered throughout (Figures 30, 31 and 32).

The dominant porosity types are intraparticle and interparticle. Microporosity also occurs within the interparticle spaces and is sometimes difficult to distinguish from interparticle porosity because of the fine-grained nature of the cement. Low-mud laminae exhibit a few fenestral pores.

The depositional environment is likely a shallow subtidal to supratidal setting (Randazzo et al., 1990; Cander, 1991; Randazzo and Zachos, 1984; Budd, 2001). The lack of bioturbation and presence of laminations suggests a restricted environment, possibly at times anoxic with the deposition of pyrite (Arthur et al., 2007).

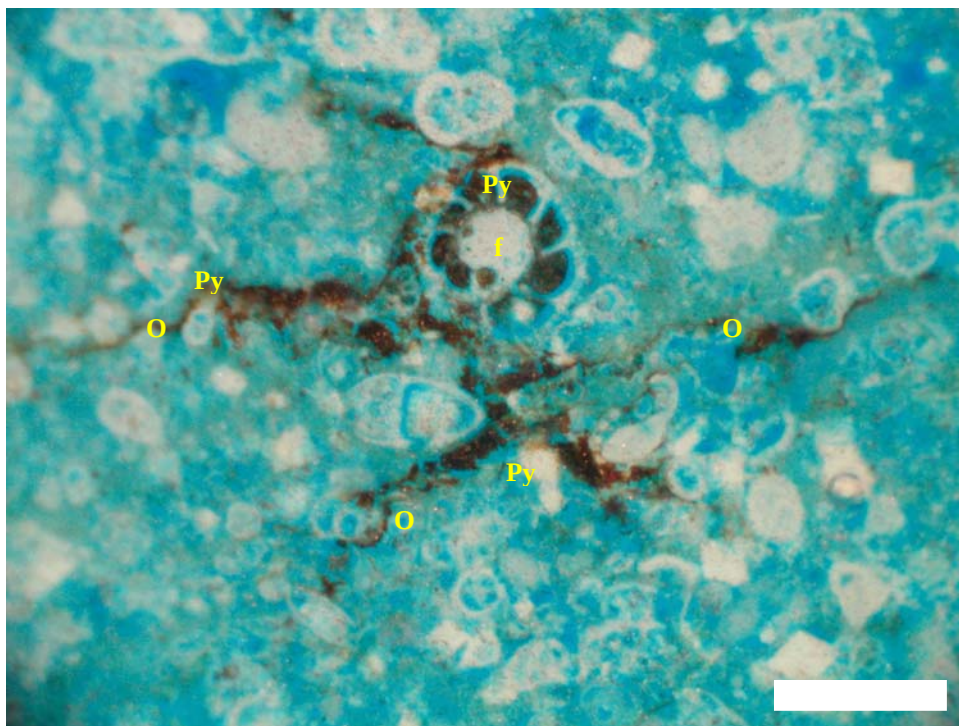


Figure 27. W-18776, 805-806. Peloidal, muddy, micro-laminated packstone with small foraminifera. Foraminifera (f) with pyrite (Py) filling intraparticle pore spaces. Small wispy laminae of organics (O) with pyrite throughout the laminae. Reflected light. Scale is 0.5 mm.

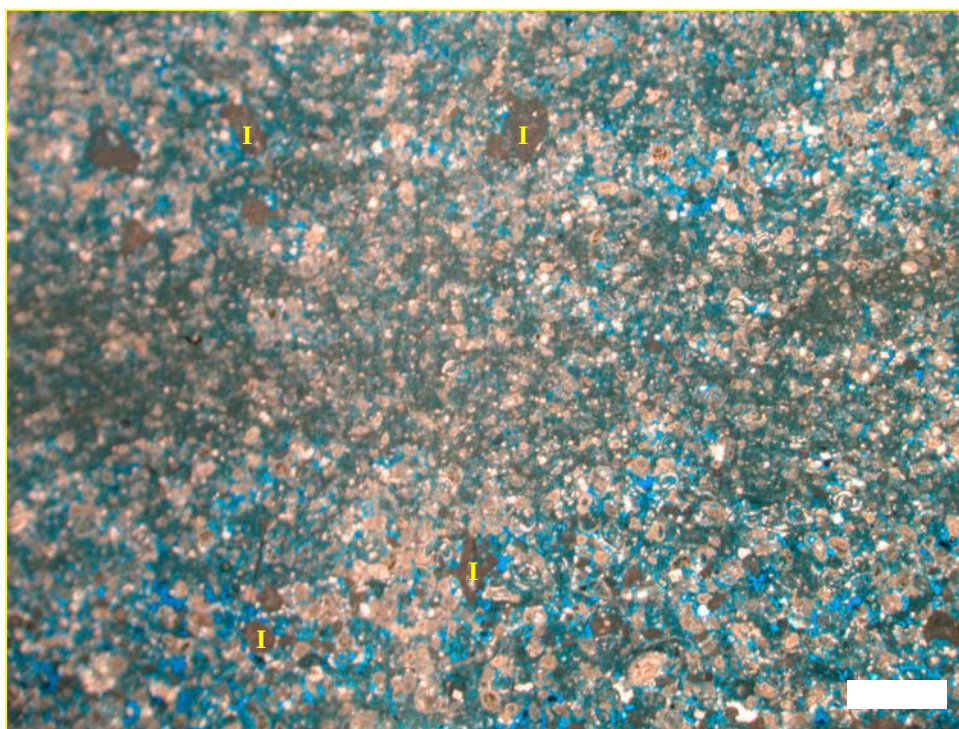


Figure 28. W-18776, 805-806. Peloidal, muddy, micro-laminated packstone with small foraminifera. Overview of slide illustrating horizontal micro-laminations. Micritic intraclasts (I) are scattered throughout slide. Transmitted light. Scale is 1.0 mm.

FLORIDA GEOLOGICAL SURVEY

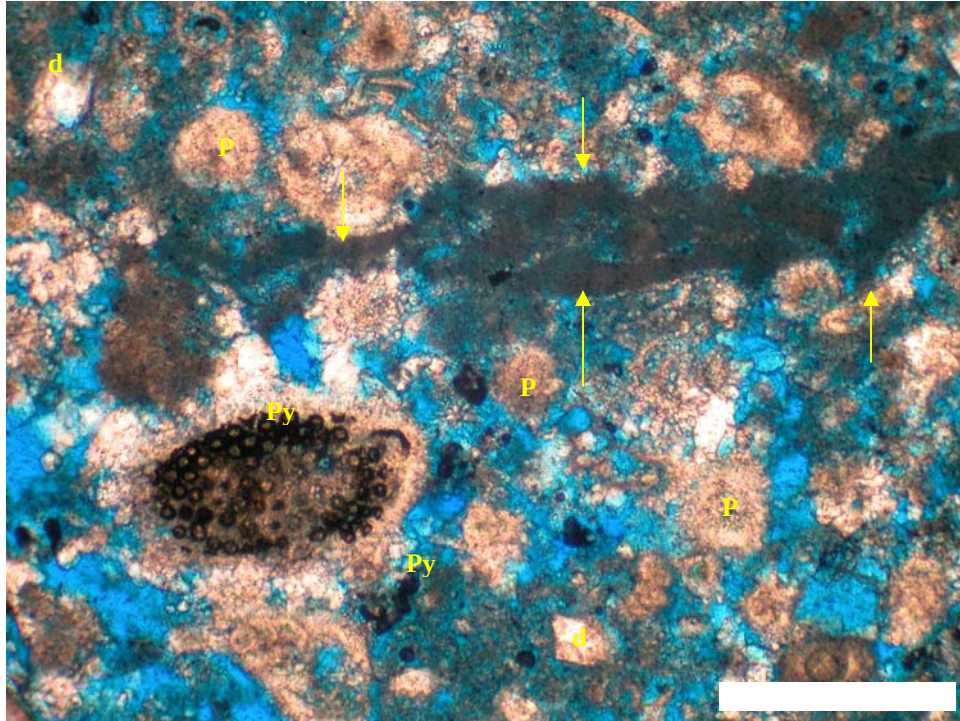


Figure 29. W-18776, 805-806. Peloidal, muddy, micro-laminated packstone with small foraminifera. Small lens of organics across top half of photo (arrows). Micritized grain with some framboids of pyrite (Py). Small micritized peloids (P) and a few scattered rhombs of dolomite (d). Cement rimming micritized grain and very fine micrite cement filling interparticle pore spaces. Plane polarized light. Scale is 0.25 mm.

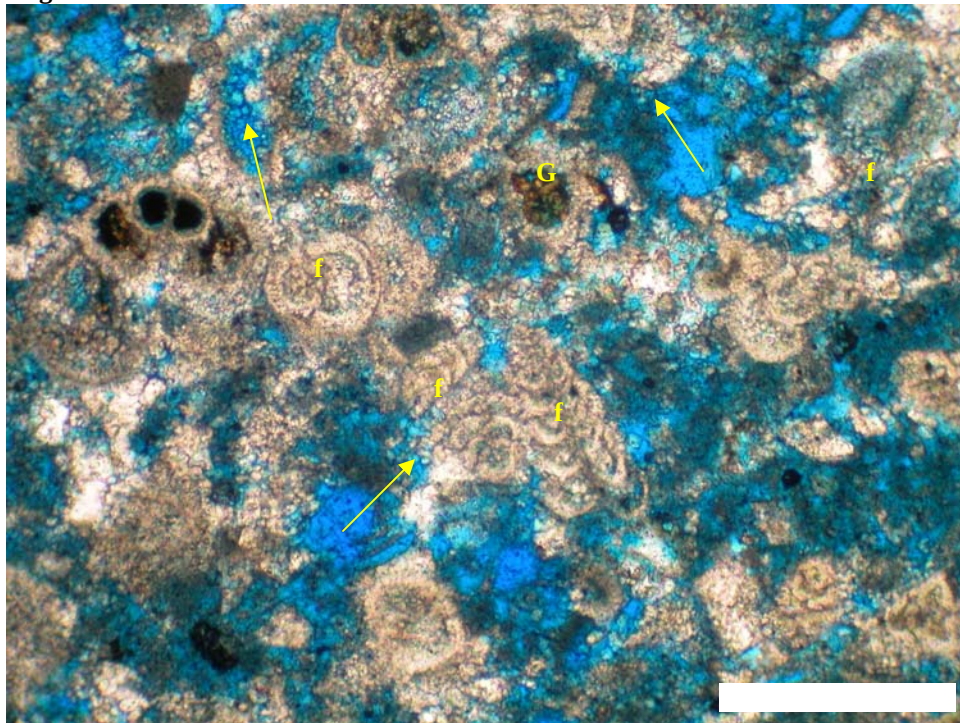


Figure 30. W-18776, 805-806. Peloidal, muddy, micro-laminated packstone with small foraminifera. Foraminifera (f) rimmed with micrite cement. Cement partially filling interparticle pore spaces (arrows). Trace of glauconite (G) throughout sample. Plane polarized light. Scale is 0.25 mm.

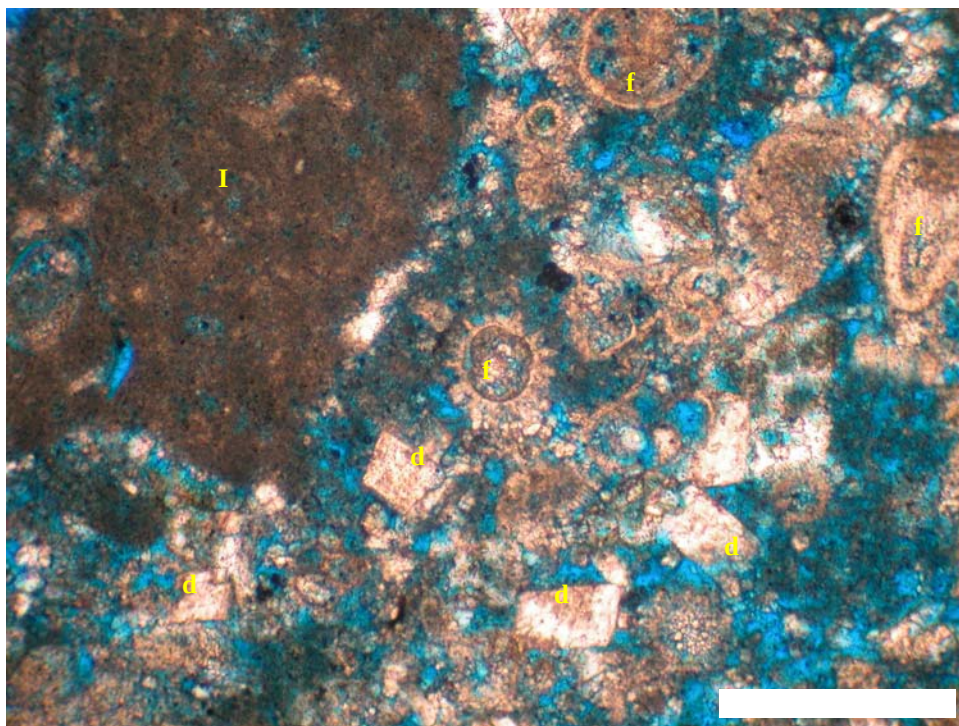


Figure 31. W-18776, 805-806. Peloidal, muddy, micro-laminated packstone with small foraminifera. Micritized intraclast (I) top left. Micritized foraminifera (f) and scattered dolomite (d). Plane polarized light. Scale is 0.25 mm.

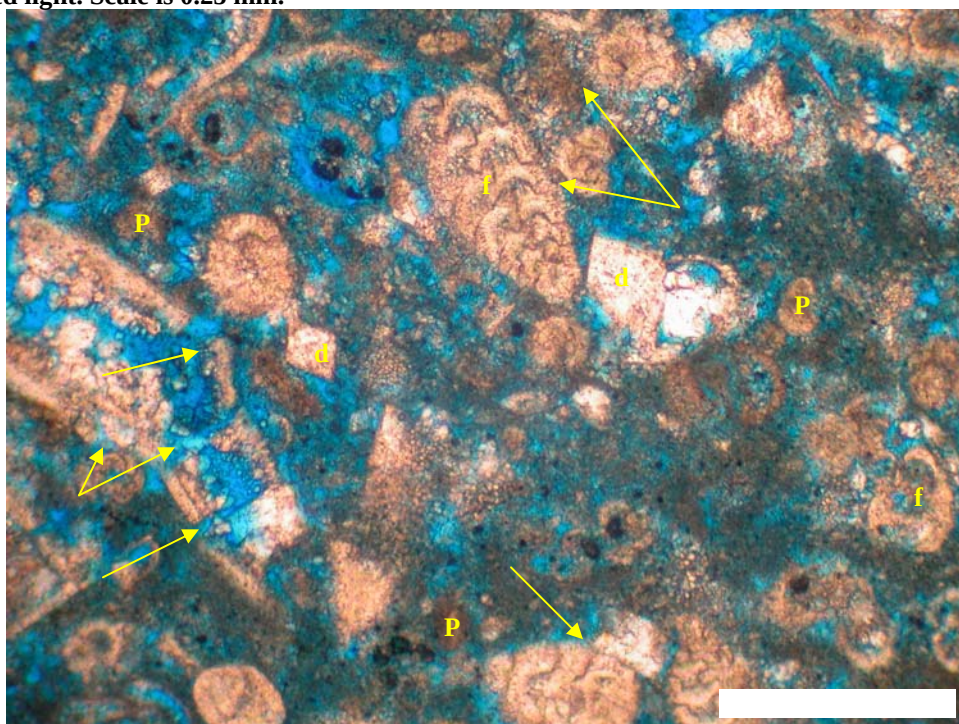


Figure 32. W-18776, 805-806. Peloidal, muddy, micro-laminated packstone with small foraminifera. Micritized peloids (P) and various small foraminifera (f) scattered dolomite rhombs (d). Evidence of early compaction (arrows) broken grains with very fine cement sometimes rimming broken grains (hazy blue exhibiting microporosity) and close packing of some foraminifera. Plane polarized light. Scale is 0.25 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18776

812-813 (Figures 33-38)

Lithostratigraphic Unit: Avon Park Formation.

Lithology: Limestone, slightly dolomitic – mixed skeletal, muddy, micro-laminated packstone/wackestone with small foraminifera and peloids.

Porosity varies between laminae. Wackestone laminae are ~ 5-10% and packstone lamina is ~ 30-35% (Figure 33).

Allochems are a diverse assemblage of micritized peloids, foraminifera and echinoids (Figures 33-38). There are also traces of glauconite and dolomite rhombs scattered throughout. Pyrite and organics are more prevalent than previous samples (Figures 34 and 36). Pyrite is pervasive throughout the mud-rich wackestone laminae but also occurs to a lesser degree in the packstone laminae with a slightly larger grain size. Pyrite and/or organics appear in the intraparticle spaces of some of the foraminifera. Mud fills much of the interparticle pore space in the wackestone laminae while the packstone laminae are less muddy and moderately cemented, as evidenced by the microporosity (Figure 35). The large echinoid (Figure 33) and the ostracod (Figure 38) exhibit micritized cement around the edges and circumgranular cement partially filling the intraparticle space. Small lenses of the coarser packstone material are interspersed within the muddy wackestone laminae. Algae is scattered in a few places throughout the slide, including some very small green algae (dasycladacean; Figure 37).

The dominant porosity types are intergranular and microporosity. Microporosity occurs where the cement is very fine grained, predominantly in the packstone laminae (Figure 35). Some intraparticle porosity exists in the larger foraminifera and echinoids.

The depositional environment is likely a shallow subtidal to supratidal setting (Randazzo et al., 1990; Cander, 1991; Randazzo and Zachos, 1984; Budd, 2001). The presence of pyrite and the preservation of muddy laminae may suggest a restricted environment, possibly anoxic at times (Arthur et al., 2007).

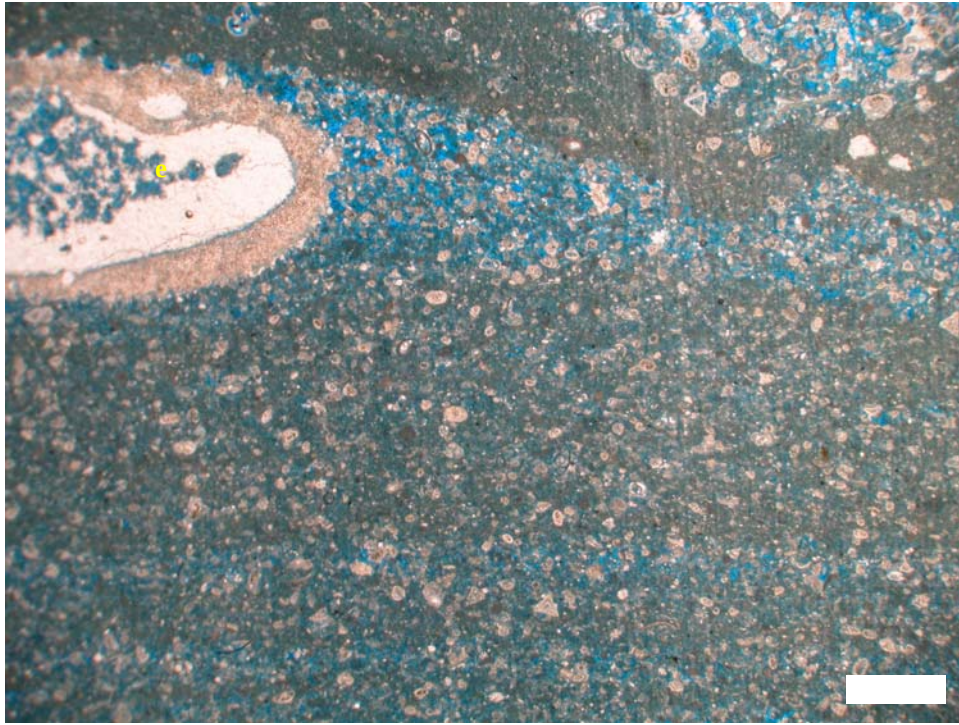


Figure 33. W-18776, 812-813. Foraminiferal, peloidal laminated muddy packstone/wackestone. Laminae alternate from muddy wackestone to less muddy packstone. Echinoid (e) in upper left corner with cement infilling intraparticle pore space. Transmitted light. Scale is 1.0 mm.

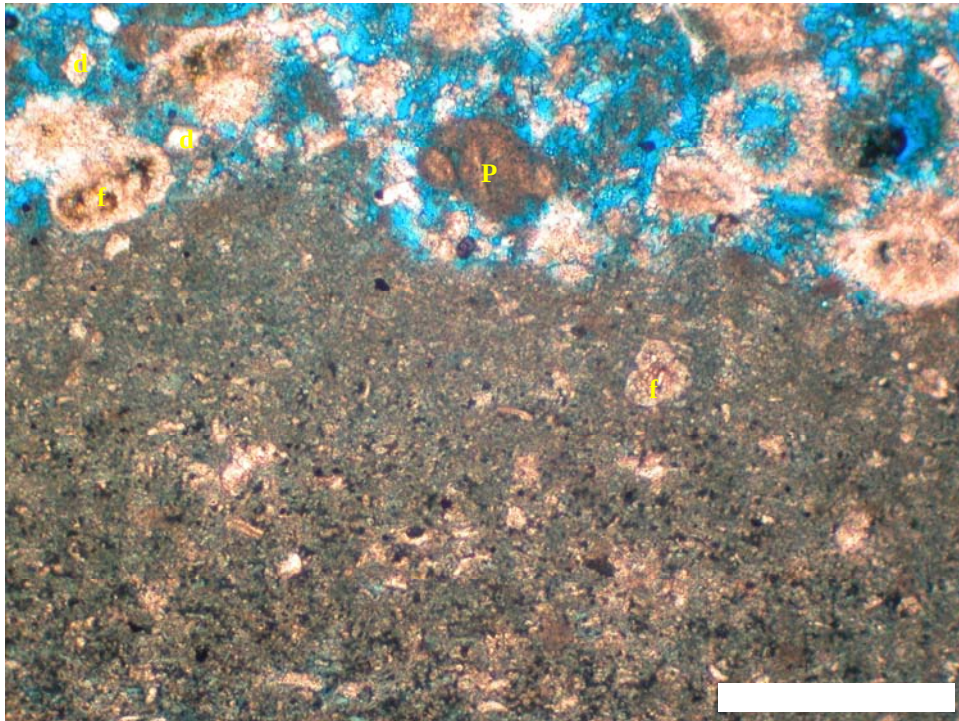


Figure 34. W-18776, 812-813. Foraminiferal, peloidal laminated muddy packstone/wackestone. Muddy wackestone with pyrite and organics concentrated in lower part of slide and appears to be fining upward. This lamina is overlain by less muddy packstone with larger peloids (P) and foraminifera (f) and scattered dolomite rhombs (d). Microporosity is evident in packstone lamina with fine grained cement partially filling interparticle pore spaces. Plane polarized light. Scale is 0.25 mm.

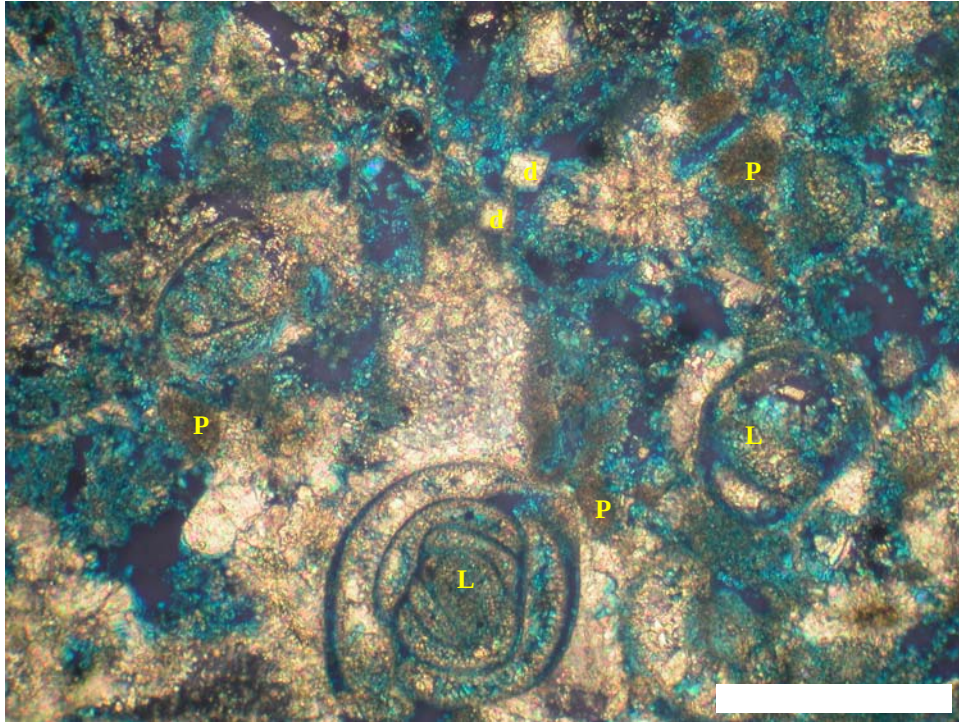


Figure 35. W-18776, 812-813. Foraminiferal, peloidal, laminated muddy packstone/wackestone. Micritized peloids (P) and miliolids (L) in moderately cemented packstone. Note fine grained cement exhibits microporosity in interparticle and intraparticle pore spaces (light blue). Few scattered dolomite rhombs (d). Cross-polarized light. Scale is 0.25 mm.

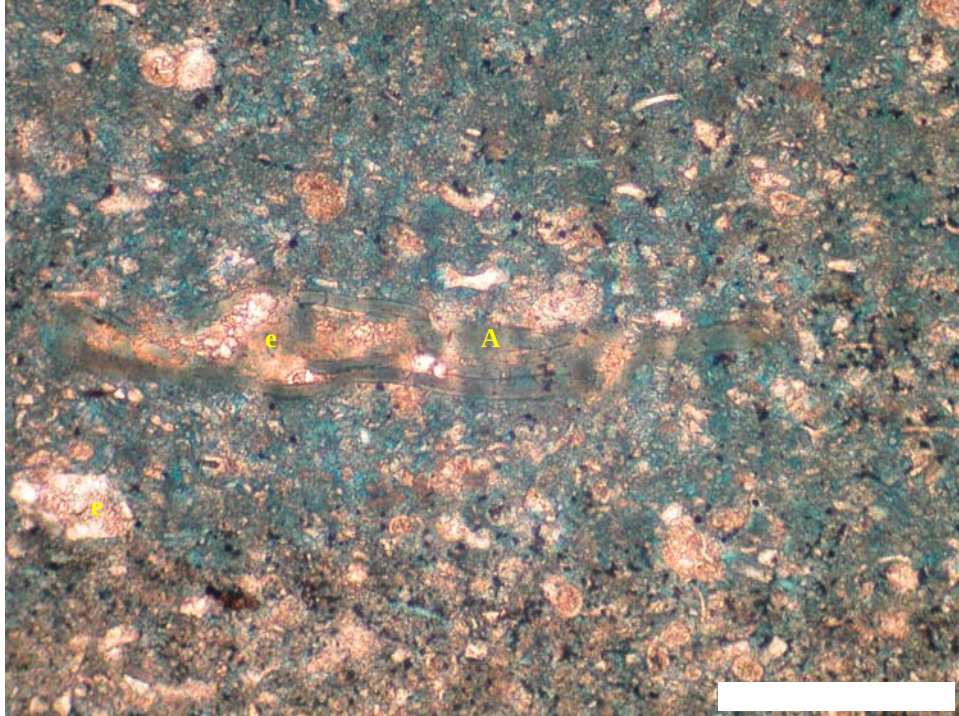


Figure 36. W-18776, 812-813. Foraminiferal, peloidal, laminated muddy packstone/wackestone. Scattered organics / pyrite throughout slide. Lower lamina is high-mud and finer grained than upper lamina. Algae (A) appears to be formed around echinoid (e) fragments. Plane polarized light. Scale is 0.25 mm.

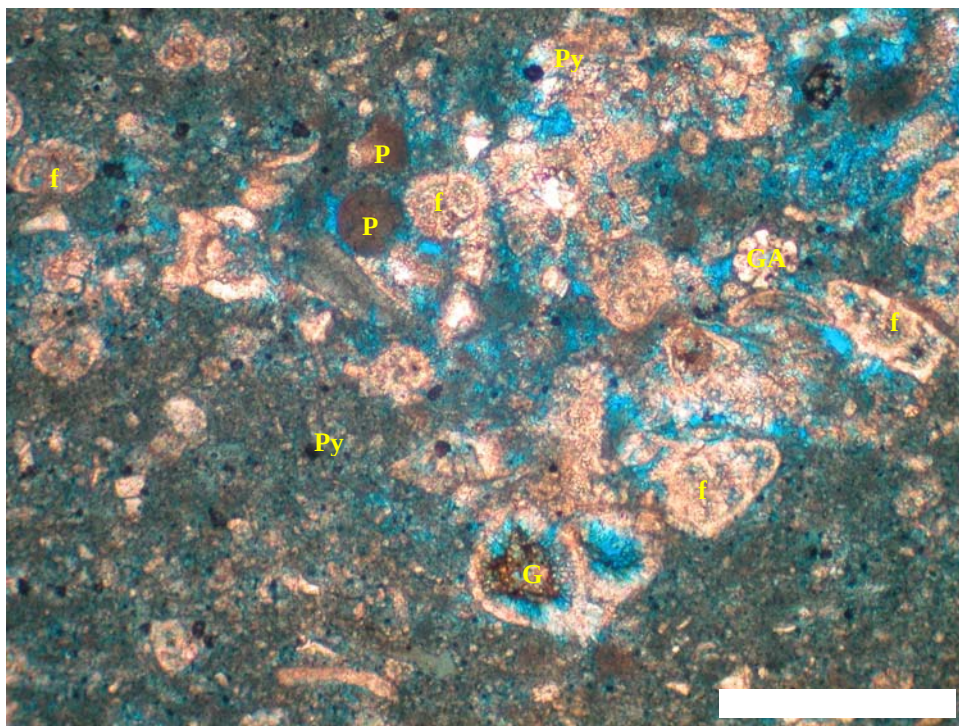


Figure 37. W-18776, 812-813. Foraminiferal, peloidal, laminated muddy packstone/wackestone. Micritized peloids (P), foraminifera (f), green algae (GA; dasycladacean) in coarser grained packstone surrounded by finer grained wackestone with pyrite (Py) and trace of glauconite (G). Plane polarized light. Scale is 0.25 mm.

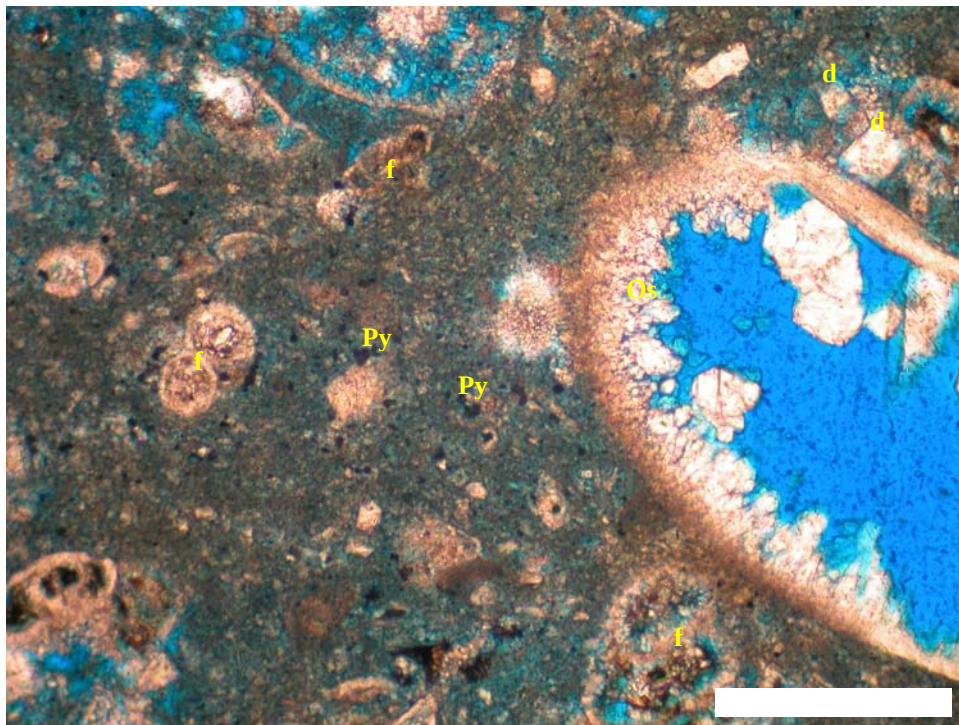


Figure 38. W-18776, 812-813. Foraminiferal, peloidal, laminated muddy packstone/wackestone. Micritized ostracod (Os) with sparry cement infilling intraparticle pore space. Micritized foraminifera (f) in a muddy matrix with a few scattered dolomite rhombs (d) and scattered pyrite (Py) and organics throughout the muddy lamina. Plane polarized light. Scale is 0.25 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18778

652-653 (Figure 39-43)

Lithostratigraphic Unit: Arcadia Formation, Hawthorn Group.

Lithology: Limestone - sandy, phosphatic, dolomitic packstone.

Porosity ~ 30%.

There are varied grain densities throughout the section, areas surrounding molds seem to be coarser grained and contain less mud. This is probably due to bioturbation (Figures 39 and 40). The sample is predominantly fine grained, making skeletal identification difficult. Fine-grained quartz (~ 5 percent) and rounded and very-fine grained detrital phosphate ~ 5 percent are dispersed throughout the section. There may be some pyrite in the sample, but because of the fine grain size it is difficult to distinguish the pyrite from the phosphate. There is a trace of glauconite in the thin section (Figure 41). Glauconite and pyrite commonly form in the same reducing environments therefore it is not uncommon to find them together (Williams et al., 1982). Dolomite rhombs are common throughout the sample; some rhombs are fine silt sized (Figures 42 and 43). Much of the dolomite is probably due to recrystallization and masks original textures. Under higher magnification it is evident the sample is moderately cemented, as fine cementing crystals are visible in the interparticle pore spaces (Figures 42 and 43).

The dominant porosity types are moldic and microporosity. Molds are probably mollusks. Microporosity is exhibited in the very fine micrite filling much of the interparticle pore space (Figures 42 and 43).

The depositional environment is indeterminate due to secondary alteration and lack of biota but is likely a marine setting due to the presence of glauconite.

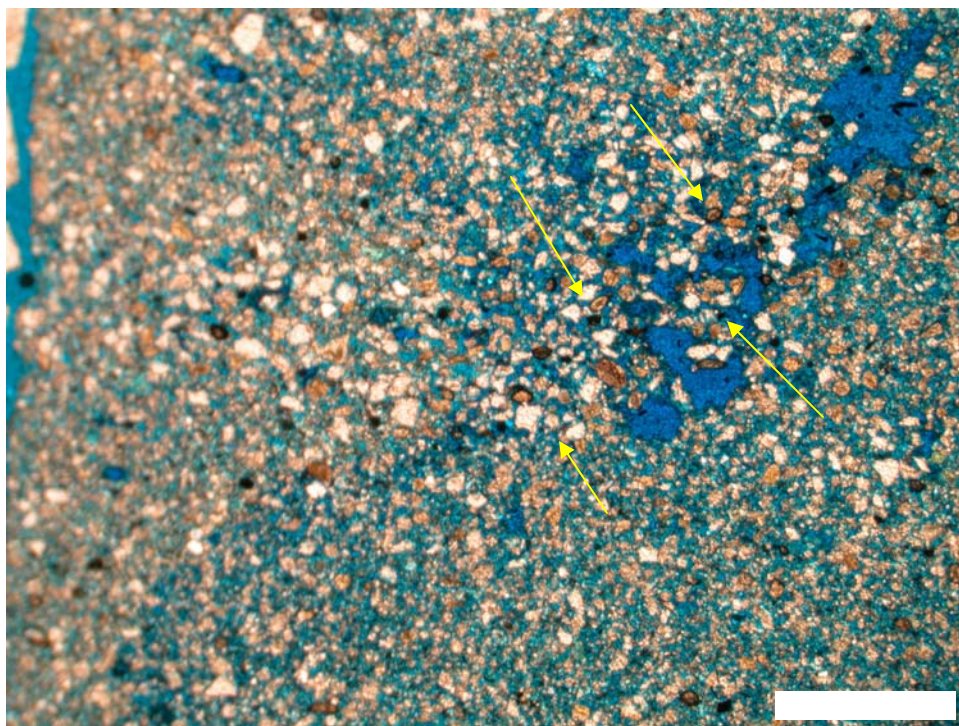


Figure 39. W-18778, 652-653. Sandy, phosphatic, dolomitic packstone. Varied grain densities throughout the section are indicative of bioturbation. Moldic section is more coarse grained and less muddy than other sections (arrows). Transmitted light. Scale is 2.0 mm.

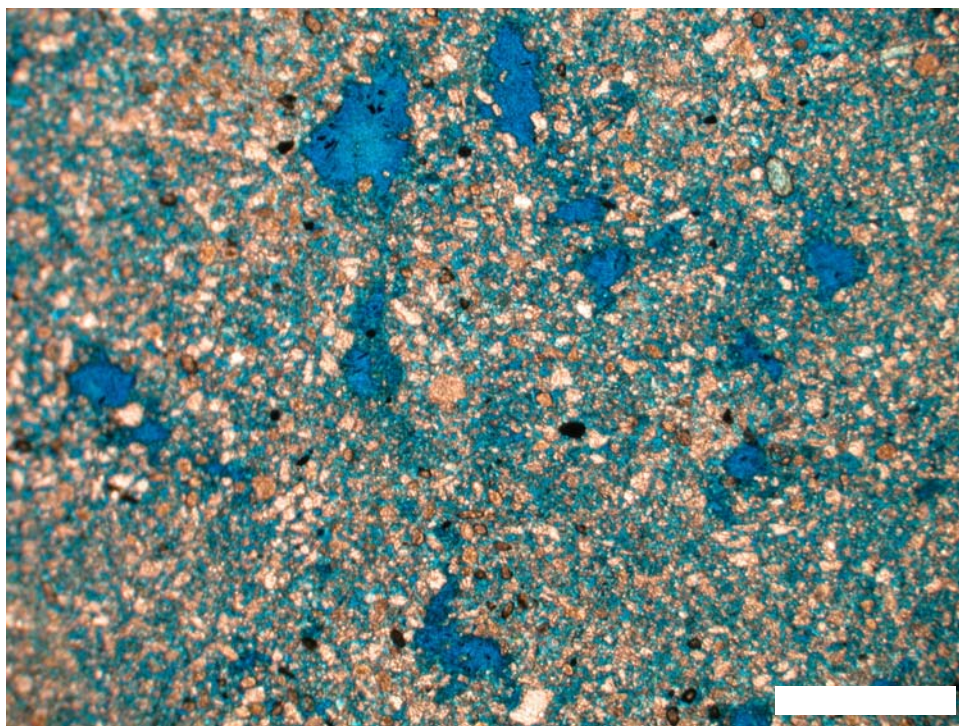


Figure 40. W-18778, 652-653. Sandy, phosphatic, dolomitic packstone. Isolated large and small moldic pores. Transmitted light. Scale is 2.0 mm.

FLORIDA GEOLOGICAL SURVEY

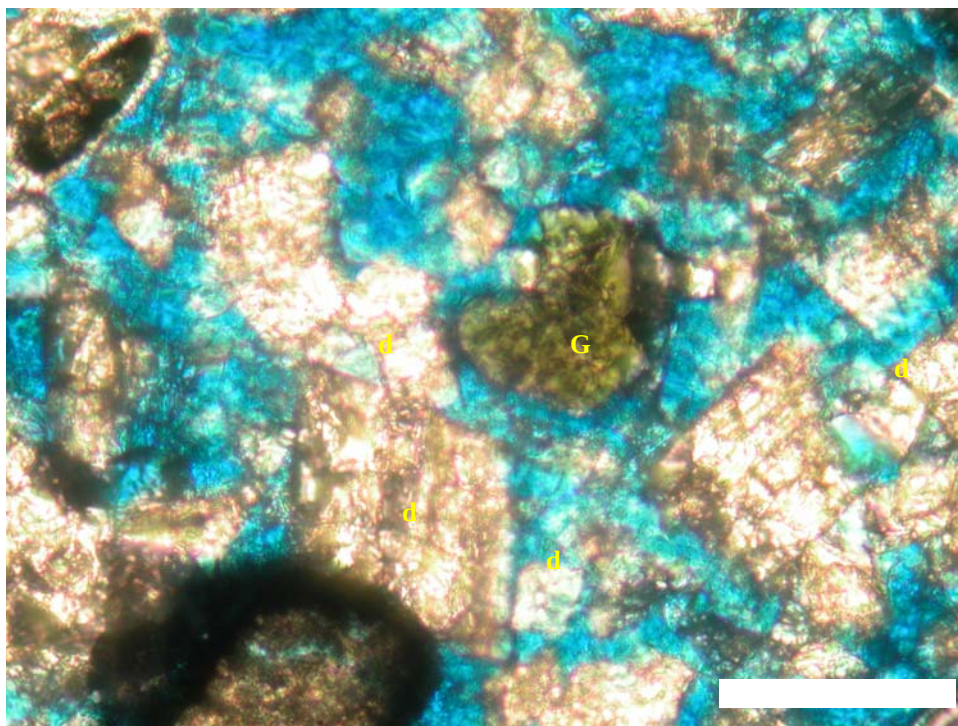


Figure 41. W-18778, 652-653. Sandy, phosphatic, dolomitic packstone. Trace of glauconite (G) in sample. Dolomite rhombs (d). Plane polarized light. Scale is 0.05 mm.

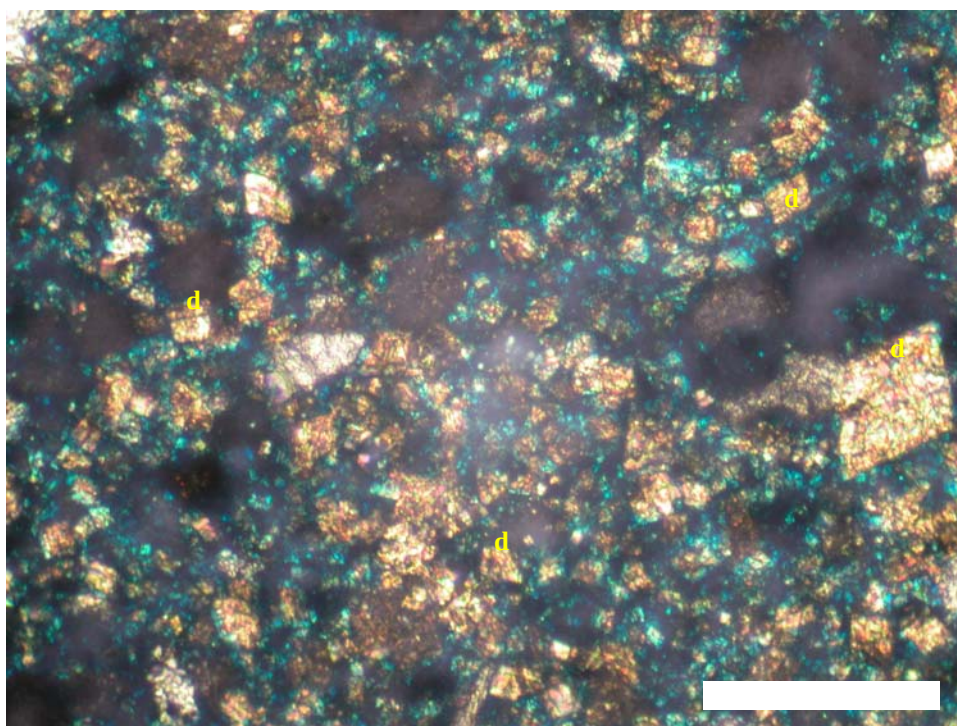


Figure 42. W-18778, 652-653. Sandy, phosphatic, dolomitic packstone. Note microporosity – much of the interparticle pore space (light blue color) is filled by small sparry calcite crystals. Dolomite rhombs (d) are varied in size. Cross-polarized light. Scale is 0.25 mm.

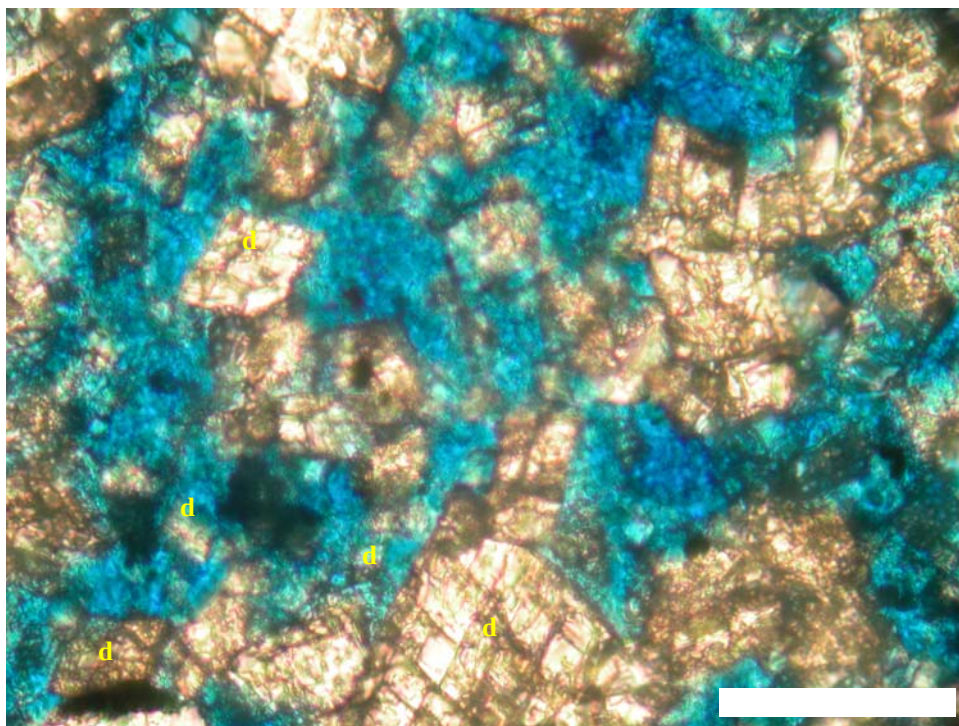


Figure 43. W-18778, 652-653. Sandy, phosphatic, dolomitic packstone. Note fine silt-sized dolomite rhombs (d) and microporosity of the interparticle pore space. Plane polarized light. Scale is 0.05 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18778

754-755 (Figures 44-49)

Lithostratigraphic Unit: Arcadia Formation, Hawthorn Group.

Lithology: Limestone – mixed skeletal, sandy, muddy wackestone/packstone with small foraminifera and peloids.

Porosity ~ 15%.

Due to bioturbation, there are varied grain and mud contents throughout the section (Figure 44). The varied mud content accounts for texture differences of wackestone and packstone. Quartz is scattered throughout, (~ 15 percent), with a trace of phosphate and a few dolomite rhombs (Figures 44 - 47). Pyrite is widely dispersed throughout (Figures 45, 46, 48 and 49). It appears in interparticle pore spaces and the intraparticle spaces of foraminifera and echinoids. Allochems are a diverse assemblage of echinoids, foraminifera, peloids, ostracods and green algae (dasycladacean Figures 46-48). Echinoid fragments, ostracods and green algae are predominant in this sample. Many of the grains are micritized. Micritized rims are all that is left of some of the foraminifera and ostracods (Figures 47-49). The sample appears to be minimally cemented but has a muddy micrite matrix, especially in the sections exhibiting a wackestone texture (Figures 45, 48 and 49). There is a fracture through the section (Figure 49) which cuts through peloids and ostracod fragments with no apparent offset. Fracture line appears micritized.

The dominant porosity types are moldic and microporosity. Microporosity is present throughout the micrite matrix. Moldic porosity is most obvious in the ostracods and some of the foraminifera.

The depositional environment is likely a restricted marine and shallow lagoon. Ostracods and peloids indicate a restricted low energy environment. Echinoids and dasycladacean algae and quartz reflect a semi-restricted to open marine lagoon (Hammes, 1992).

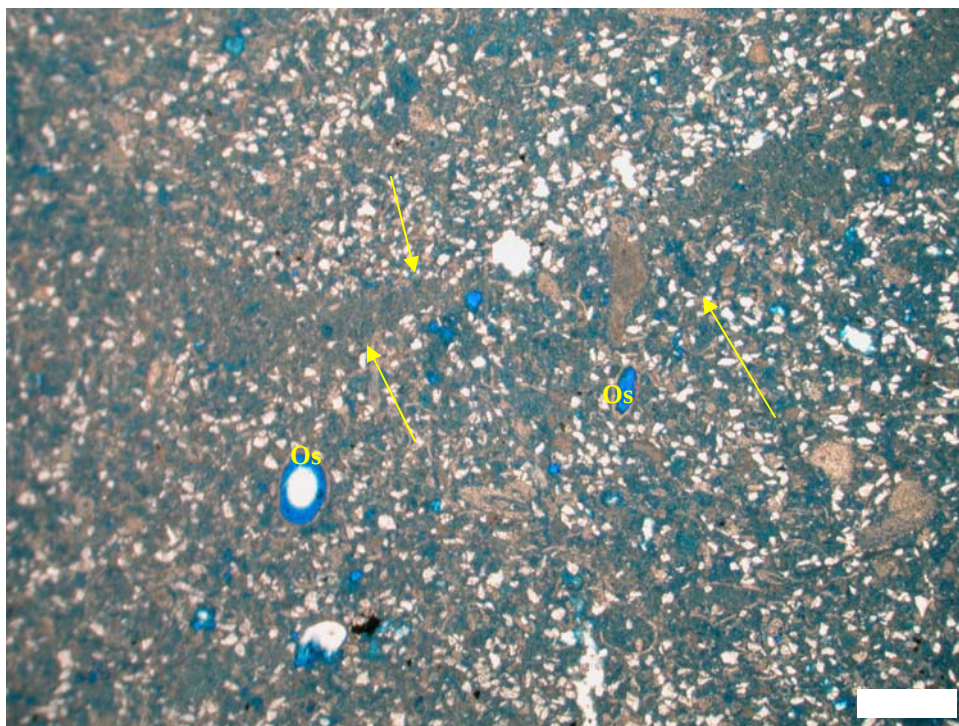


Figure 44. W-18778, 754-755. Mixed skeletal, sandy, muddy wackestone/packstone with small foraminifera and peloids. Varied grain and mud densities are evidence of bioturbation (arrows). Moldic porosity in ostracods (Os). Quartz sand scattered throughout. Transmitted light. Scale is 1.0 mm.

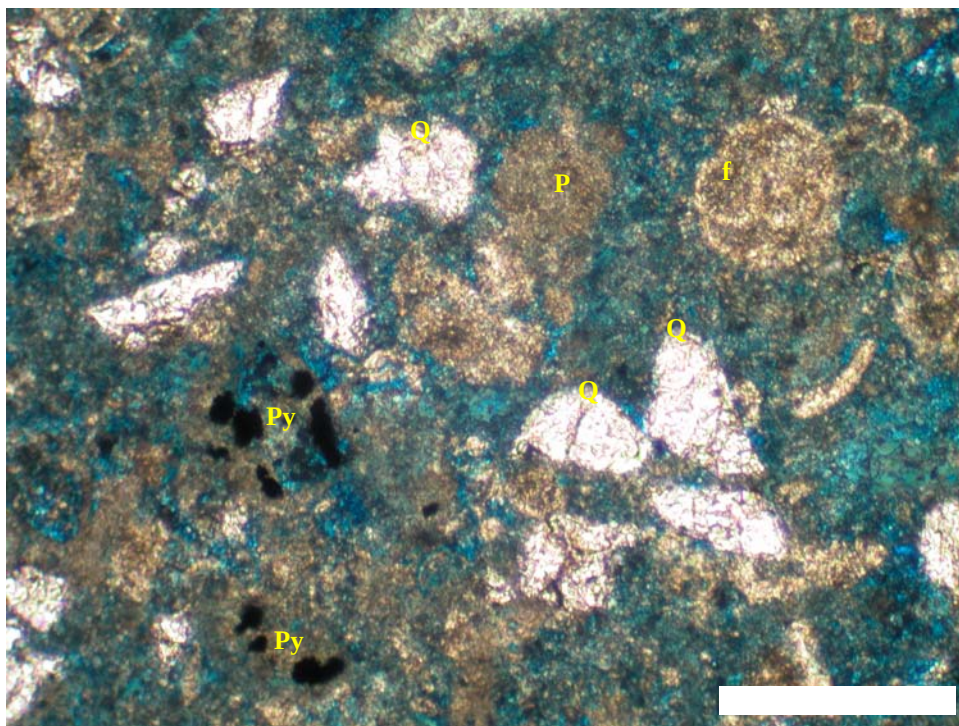


Figure 45. W-18778, 754-755. Mixed skeletal, sandy, muddy wackestone/packstone with small foraminifera and peloids. Micritized peloids (P), and foraminifera (f), and quartz (Q) in a muddy matrix exhibiting microporosity. Pyrite (Py) in micritized grains, probably foraminifera. Plane polarized light. Scale is 0.25 mm.

FLORIDA GEOLOGICAL SURVEY

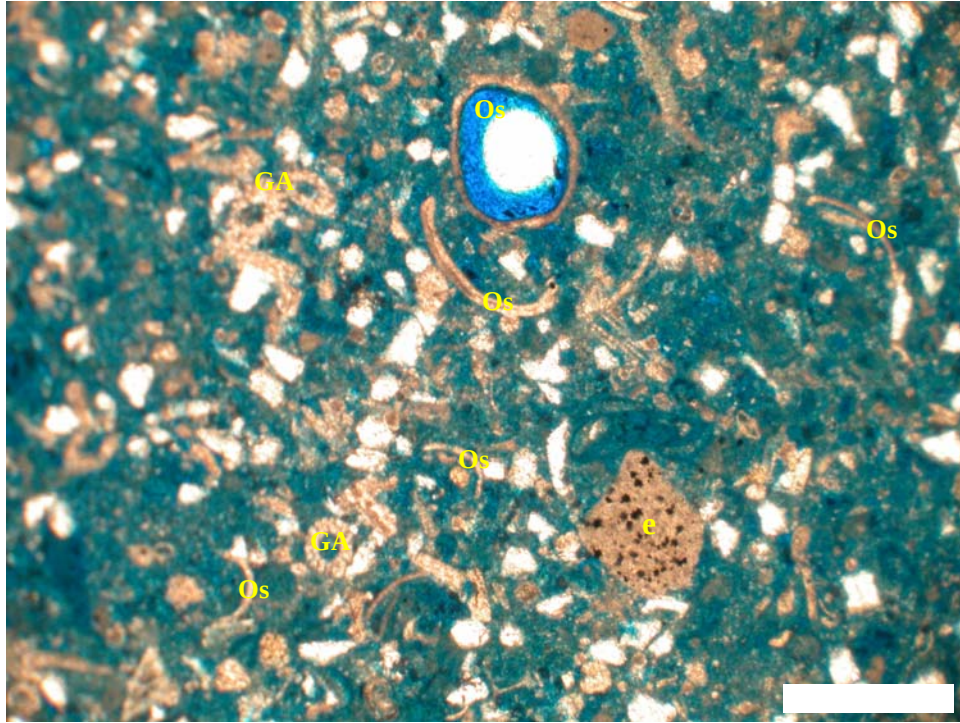


Figure 46. W-18778, 754-755. Mixed skeletal, sandy, muddy wackestone/packstone with small foraminifera and peloids. Echinoid (e) fragment with pyrite throughout. Green algae (GA dasycladacean) and ostracods (Os) are common. Transmitted light. Scale is 0.5 mm.

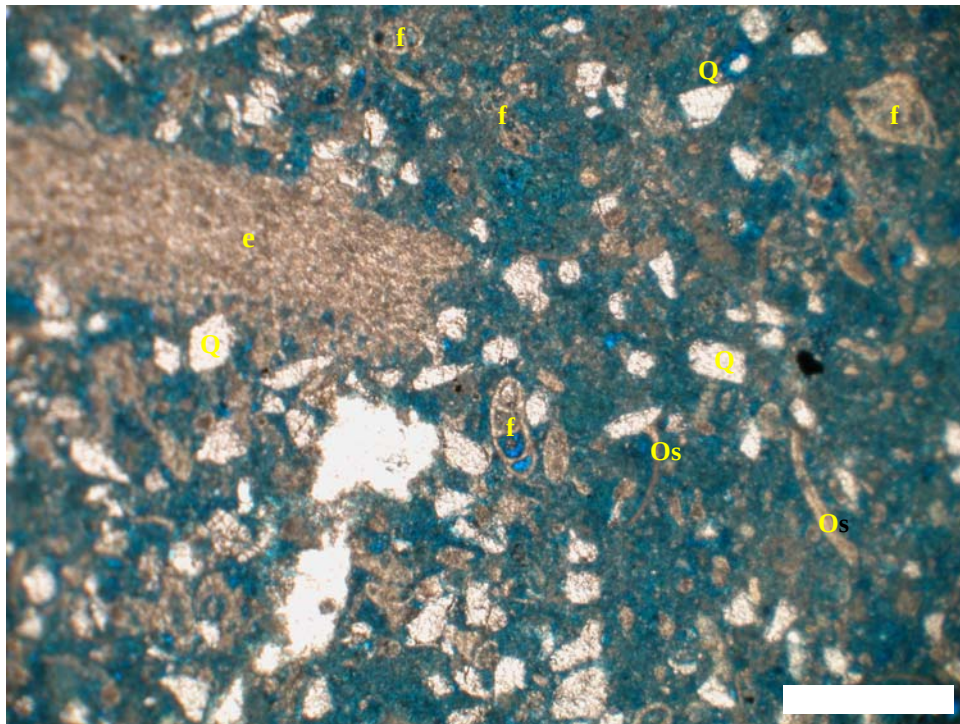


Figure 47. W-18778, 754-755. Mixed skeletal, sandy, muddy wackestone/packstone with small foraminifera and peloids. Micritized echinoid (e), ostracods (Os) and foraminifera (f). Scattered quartz (Q) throughout. Transmitted light. Scale is 0.5 mm.

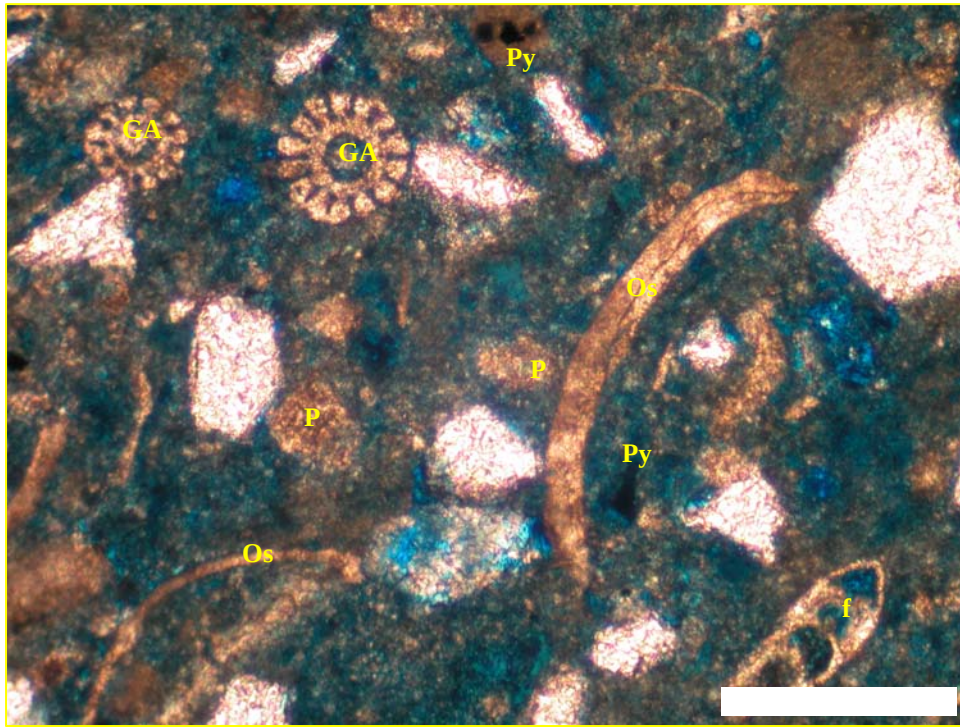


Figure 48. W-18778, 754-755. Mixed skeletal, sandy, muddy wackestone/packstone with small foraminifera and peloids. Micritized ostracods (Os), foraminifer (f), peloids (P) and green algae (GA) in a muddy matrix with some intergranular porosity and pyrite (Py). Plane polarized light. Scale is 0.25 mm.

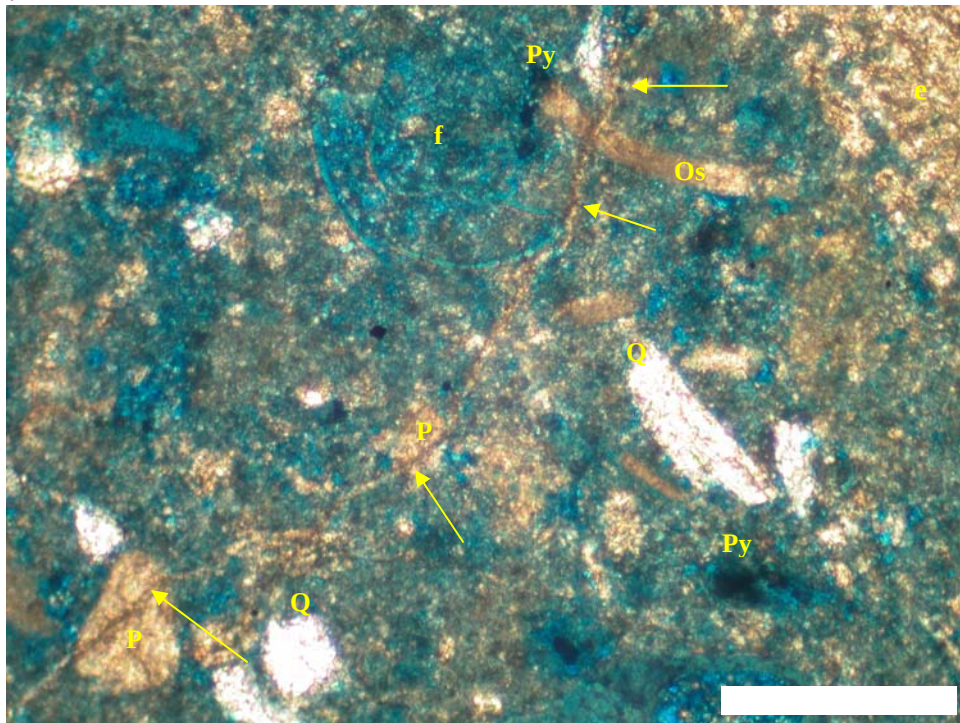


Figure 49. W-18778, 754-755. Mixed skeletal, sandy, muddy wackestone/packstone with small foraminifera and peloids. Fracture through sample (arrows) cutting micritized peloid (P) and ostracod (Os). Echinoid (e) in top right corner. Few scattered grains of quartz (Q) and pyrite (Py). Moldic pore of foraminifer (f) the result of partial dissolution. Plane polarized light. Scale is 0.25 mm

FLORIDA GEOLOGICAL SURVEY

Core W-18778

763-764 (Figures 50-55)

Lithostratigraphic Unit: Suwannee Limestone.

Lithology: Limestone - mixed skeletal, grainstone with small foraminifera and peloids.

Porosity ~ 35%.

There is a trace of quartz and pyrite throughout the section. The dominant grain types are miliolids, ostracods, peloids, foraminifera, and minor echinoids (Figures 50-55). Variation in porosity throughout the section appears layered (Figures 50 and 51). This layered appearance may be an artifact of the gastropods and mollusks molds that are scattered throughout, combined with mechanical and chemical compaction. There is substantial evidence for compaction. The grains are closely packed. There are grain to grain penetration, linear grain contacts and grain breakage (Budd, 2002; Melzer, 2004) (Figures 52-55). Dissolution of the shells that formed the molds most likely occurred after compaction as evidenced by the preservation of the delicate micritized rims of the molds with very little breakage and displacement (Figure 52). The sample is minimally to moderately cemented. Much of the intraparticle pore space is filled with cement (Figures 52-55). There is a rim of very fine-grained cement surrounding most grains and interparticle pore spaces showing microporosity (Figure 54). Figure 55 shows a syntaxial cement overgrowth on an echinoid that has preserved the normal packing of grains while the foraminifera surrounding the echinoid show close packing and linear grain contacts (Budd, 2002). The thin section is heavily micritized throughout with only partially preserved skeletal detail in many of the grains (Figures 52-55) making identification impossible in some instances.

The dominant porosity types are moldic and interparticle. Moldic porosity is present in some of the foraminifera molds and dissolved molds of mollusks and gastropods. Microporosity is minor in the very fine-grained cement surrounding the grains and interparticle pore spaces.

The depositional environment is likely a restricted lagoonal environment with an abundance of ostracods, miliolids and peloids (Hammes, 1992).

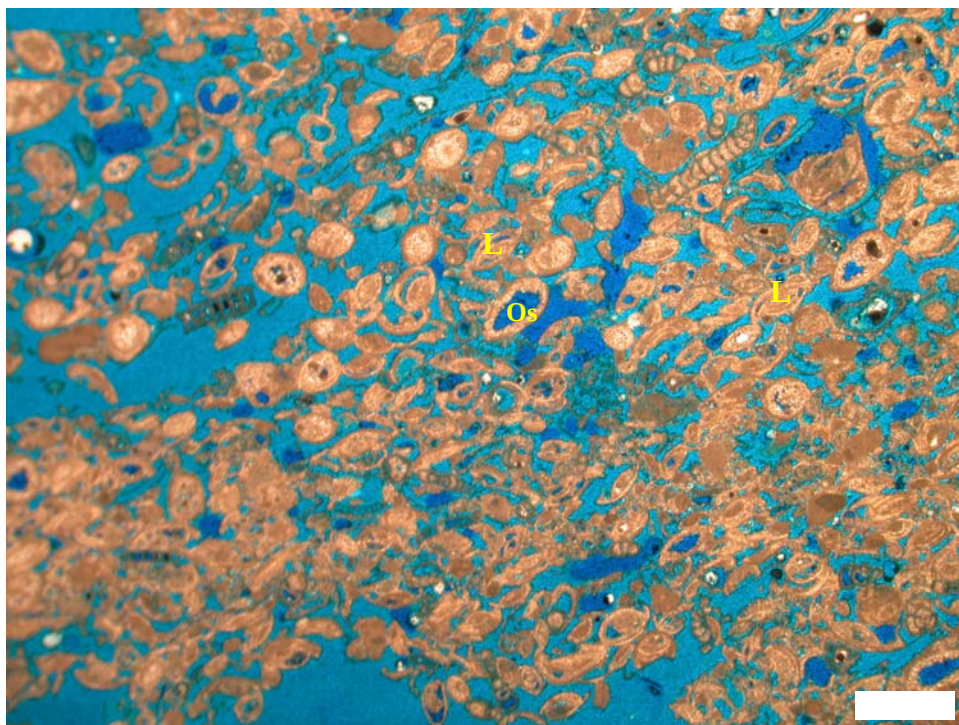


Figure 50. W-18778, 763-764. Mixed skeletal, grainstone with small foraminifera and peloids. Note layered appearance of grains due to packing differences. Miliolids (L) and ostracods (Os). Transmitted light. Scale is 1.0 mm.

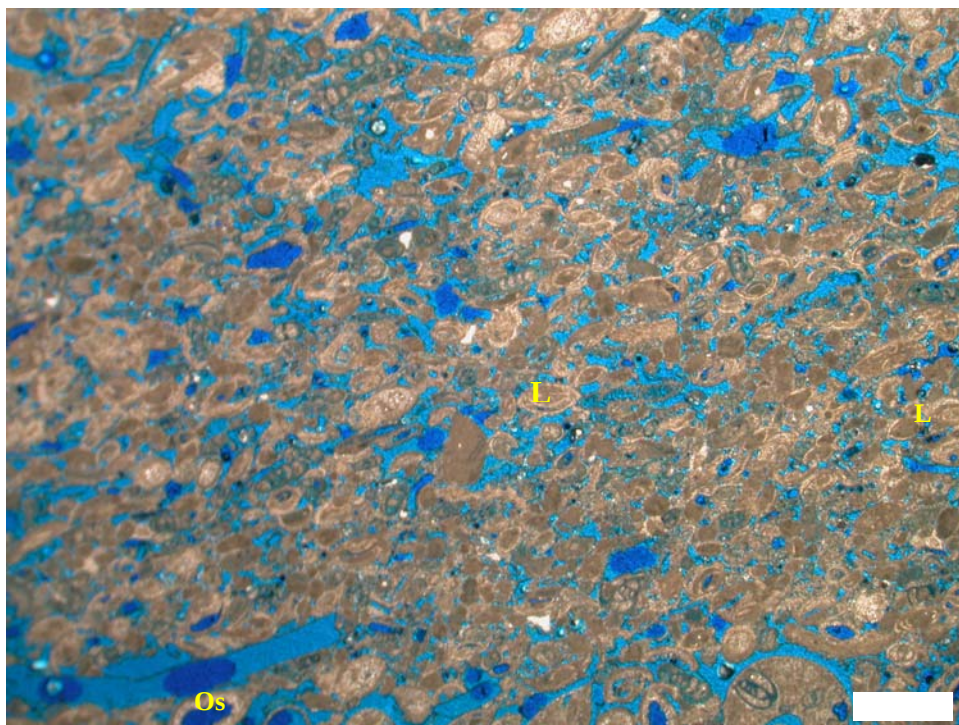


Figure 51. W-18778, 763-764. Mixed skeletal, grainstone with small foraminifera and peloids. This section of the slide is more densely packed than previous photo to show the layering due to packing differences. Miliolids (L) and ostracods (Os). Transmitted light. Scale is 1.0 mm.

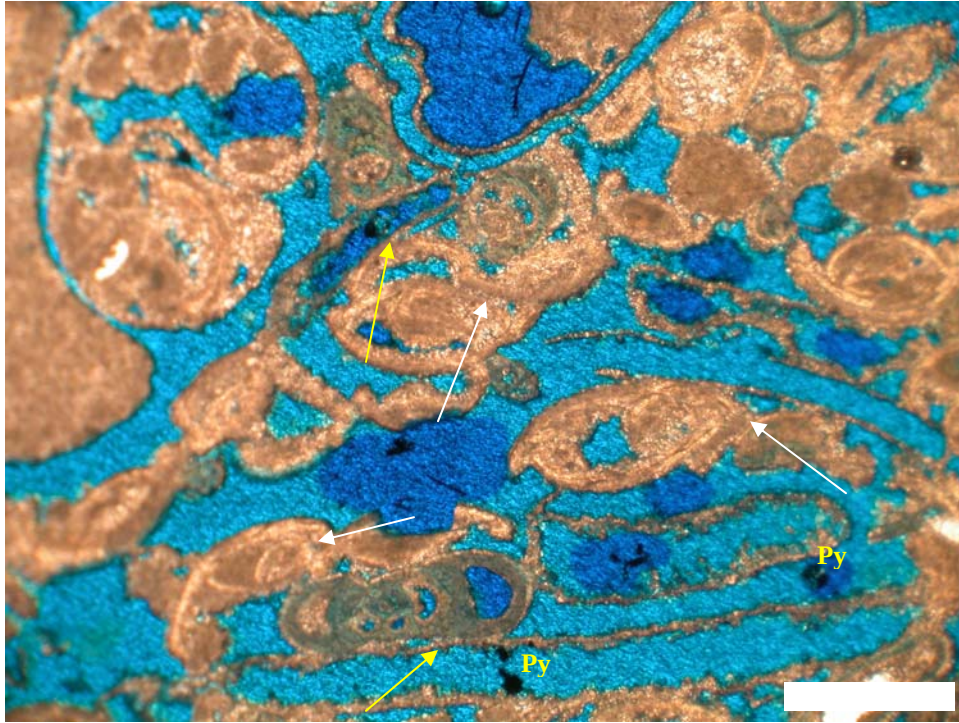


Figure 52. W-18778, 763-764. Mixed skeletal, grainstone with small foraminifera and peloids. Evidence that compaction occurred before the dissolution of the mollusk shells that formed the molds. Rims of molds remain relatively intact while the micritized grains show evidence of compaction. Compaction features include linear grain contacts (yellow arrows), grain to grain interpenetration (white arrows). Pyrite (Py) is present. Transmitted light. Scale is 0.5 mm.

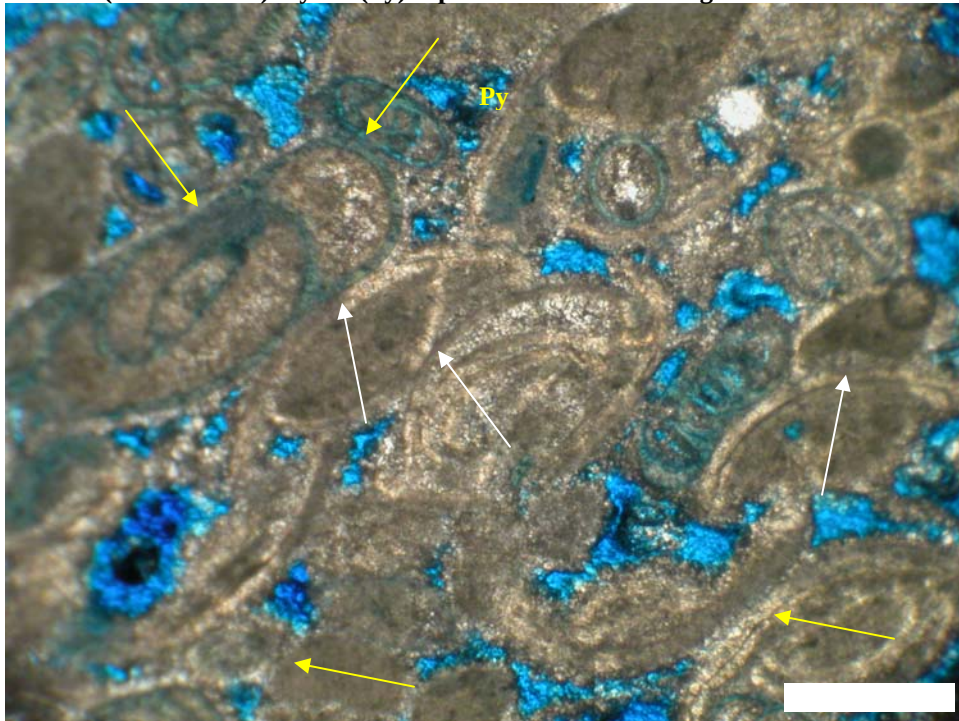


Figure 53. W-18778, 763-764. Mixed skeletal, grainstone with small foraminifera and peloids. Compaction features include linear grain contacts (yellow arrows), grain to grain interpenetration (white arrows). Pyrite (Py) is present. Transmitted light. Scale is 0.5 mm.

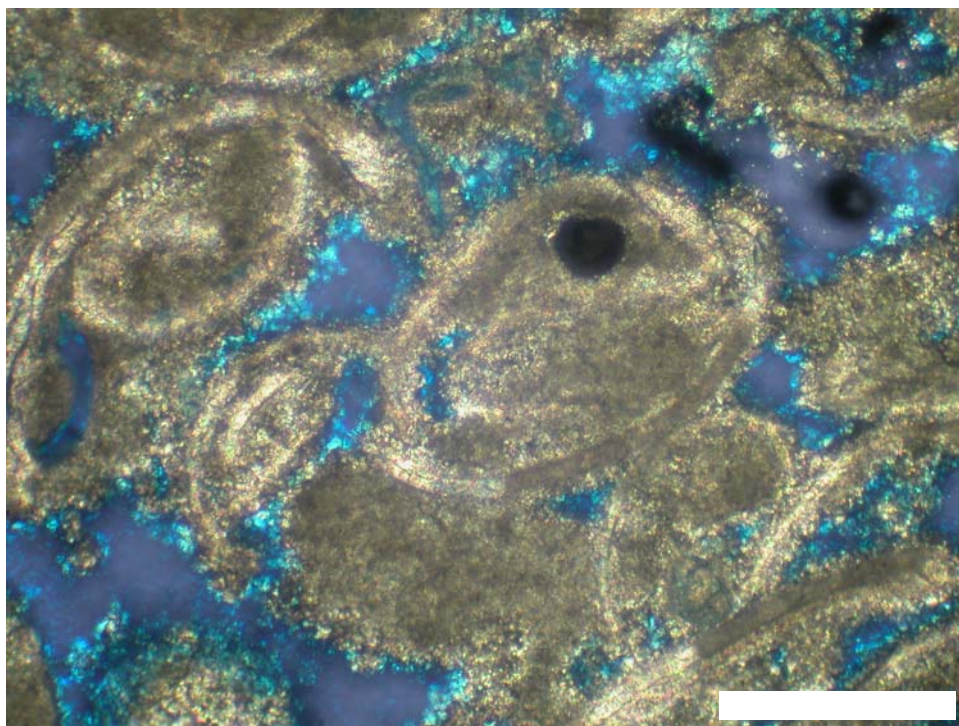


Figure 54. W-18778, 763-764. Mixed skeletal, grainstone with small micritized foraminifera and peloids. Microporosity is evident in the very fine grained light blue cement surrounding the grains and interparticle pore spaces. Cross-polarized light. Scale is 0.25 mm.

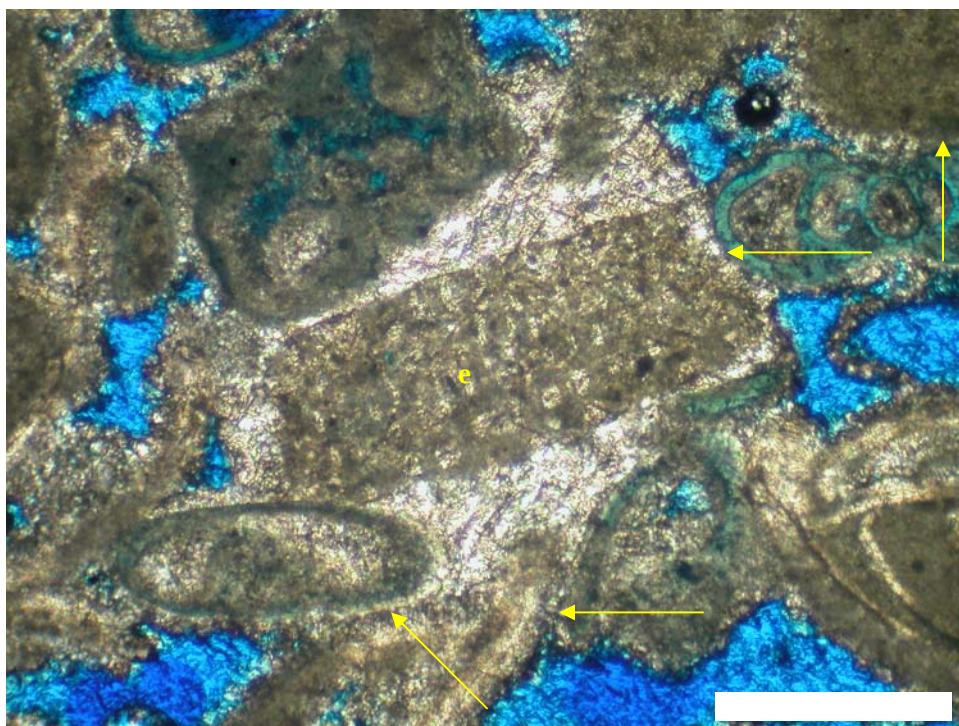


Figure 55. W-18778, 763-764. Mixed skeletal, grainstone with small foraminifera and peloids. Normal packing around echinoid (e) fragment preserved by syntaxial cement overgrowths on the echinoid; whole foraminifera exhibit close packing and linear grain contacts from compaction (arrows). Plane polarized light. Scale is 0.25 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18778

848-849 (Figures 56-61)

Lithostratigraphic Unit: Suwannee Limestone.

Lithology: Limestone - mixed skeletal, muddy wackestone with small foraminifera and peloids.

Porosity ~ 20%.

There are varied grain and mud densities throughout the section, some probably due to bioturbation. Sample is high-mud but appears layered with differing degrees of microporosity (Figures 56 and 57). Organics are present throughout this section. The layers appear as black specs in the matrix, alternating with mixed small foraminifera and as thin wispy laminae (Figures 57-61). Pyrite is also present but is very difficult to differentiate from the organics and probably occurs along with the organics. Peloids, intraclasts and a trace of quartz are also noted. A diverse assemblage of foraminifera, miliolids, ostracods, echinoids, coral and skeletal casts and molds are also present (Figures 57-60). Foraminifera and miliolids predominate in this sample. Many of the grains are micritized. Micritized rims are all that is left of some of the foraminifera, ostracods and coral (Figures 58 and 60). The sample appears to be minimally cemented but has a muddy micrite matrix with finely broken skeletal debris (Figures 56-61). There are fractures throughout the section (Figure 61) with evidence of infilling with organics in some places and calcite in others.

Dominant porosity types are microporosity and moldic. Microporosity is seen throughout the section and varies within the mud matrix of the section. Moldic porosity is present in some of the skeletal molds and the dissolved molds of mollusks and gastropods.

The depositional environment is likely a restricted lagoonal to subtidal environment. The abundance of mud and organics and intraclast suggest a tidal environment. The presence of miliolids, ostracods and gastropods indicate a restricted to shallow lagoonal environment (Hammes, 1992).

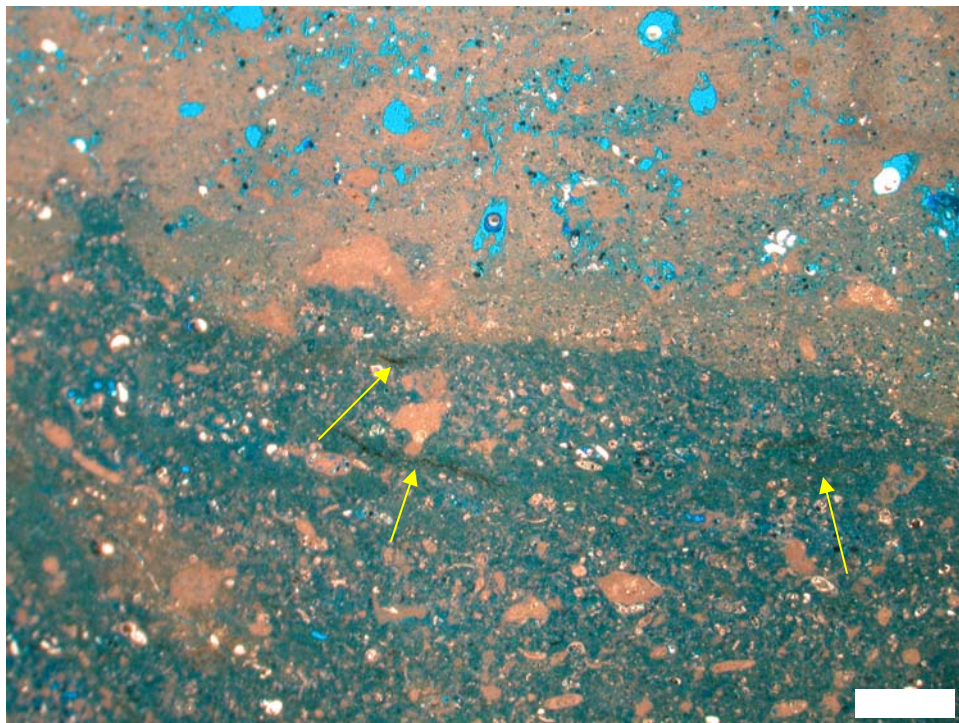


Figure 56. W-18778, 848-849. Mixed skeletal, muddy wackestone with small foraminifera and peloids. Note varied mud density and thin wispy laminae of organics (arrows). Transmitted light. Scale is 1.0 mm.

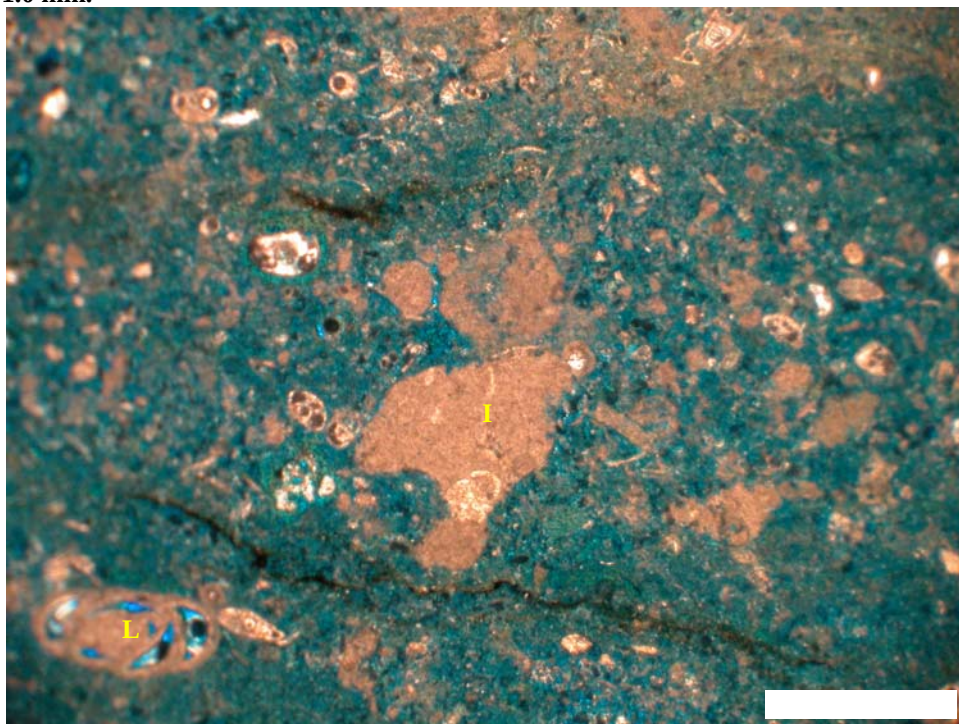


Figure 57. W-18778, 848-849. Mixed skeletal, muddy wackestone with small foraminifera and peloids. Close up of thin wispy laminae of organics along with scattered organics and/or pyrite. Intraclast (I) in center of picture. Miliolid (L) bottom left. Transmitted light. Scale is 1.0 mm.

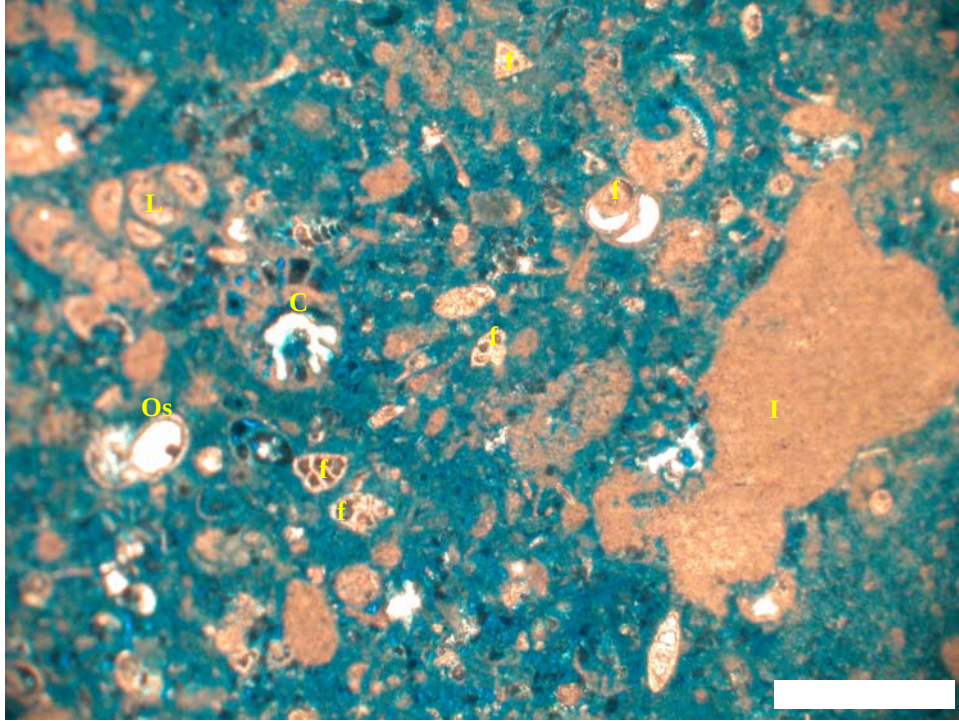


Figure 58. W-18778, 848-849. Mixed skeletal, muddy wackestone with small foraminifera and peloids. Section of slide exhibiting greater microporosity and mixed skeletal debris – foraminifera (f), ostracods (Os), miliolids (L), coral (C) and intraclast (I). Transmitted light. Scale is 2.0 mm.

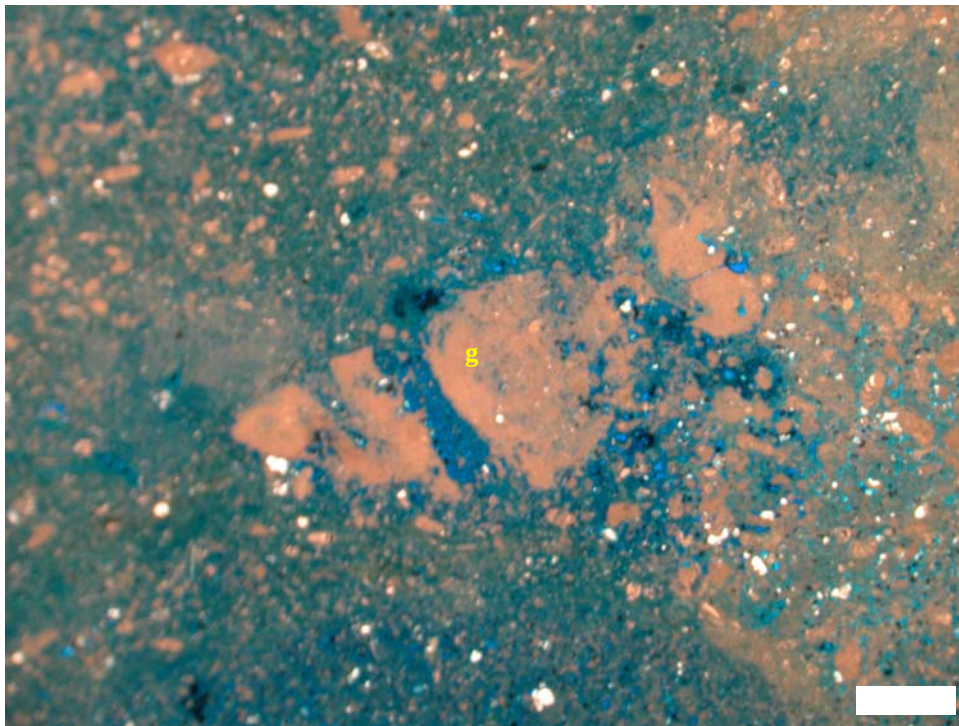


Figure 59. W-18778, 848-849. Mixed skeletal, muddy wackestone with small foraminifera and peloids. Gastropod (g) cast in center of photo. Shell material is dissolved and all that remains is the muddy cast. Transmitted light. Scale is 1.0 mm.

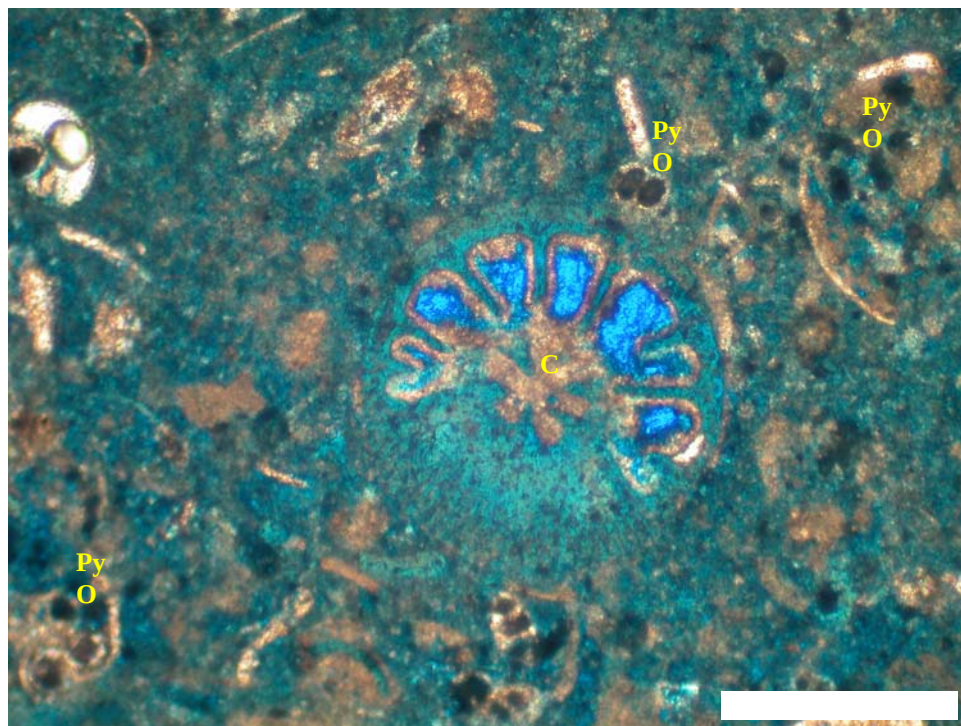


Figure 60. W-18778, 848-849. Mixed skeletal, muddy wackestone with small foraminifera and peloids. Mixed skeletal debris that is difficult to identify with the exception of coral (C), organics (O) and pyrite (Py). Plane polarized light. Scale is 0.25 mm.

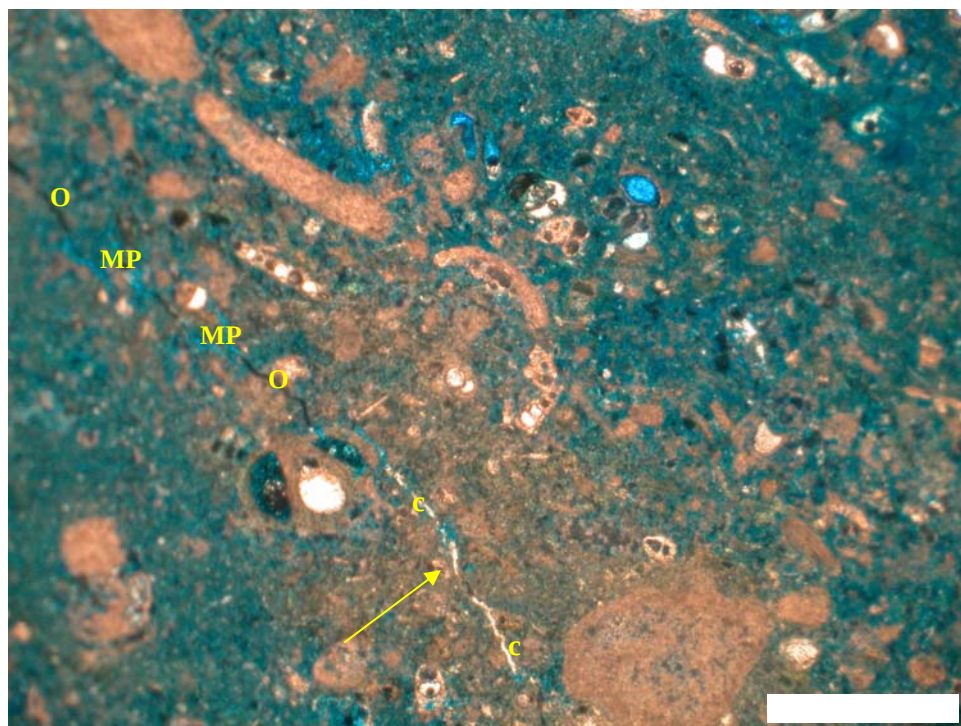


Figure 61. W-18778, 848-849. Mixed skeletal, muddy wackestone with small foraminifera and peloids. Fracture (arrow) filled in part with organics (O) and calcite (c); other parts exhibiting microporosity (MP). Transmitted light. Scale is 1.0 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18778

983-984 (Figures 62-67)

Lithostratigraphic Unit: Suwannee Limestone.

Lithology: Limestone - mixed skeletal, muddy, micritized packstone.

Porosity ~ 30-40%.

There are varied degrees of cementation and micrite in the matrix surrounding the larger skeletal molds, which give the appearance of layering within the section (Figure 62). Some of this is probably due to bioturbation. Another cause could be the dissolution of skeletal material leaving larger voids/molds which were less cemented and then slightly compacted permitting higher permeability and further dissolution. The sample is highly micritized and much of the structural detail is lost. Oncolites are common and, due to micritization, the structural detail is not always visible (Figures 62-64). Some of the larger mollusk and echinoid molds have a dark micritized rim slightly separated from the matrix. It appears that this rim could be organics, glauconite or possibly pyrite (Figure 65). Recrystallized echinoids and echinoid molds are common throughout the sample (Figures 66 and 67). Note the sparry calcite forming in the echinoid mold and interparticle pore spaces as seen under cross-polarized light (Figure 66). Allochems are a diverse assemblage of mollusk and gastropod molds, oncolites, echinoids, miliolids, small foraminifera, peloids and few ostracods. The sample is poorly sorted with a wide range of grain sizes and a highly moldic fabric. It shows evidence of compaction with numerous small fractures, some involving slight displacement. Also evident is the breakage of small foraminifera, miliolids and ostracods and rims of molds, all of which then accumulated in the moldic pore spaces (Budd, 2001) (Figure 62).

The dominant porosity type is moldic due to the highly moldic nature of the sample. Interparticle and microporosity are minor in occurrence.

The depositional environment is likely a semi-restricted to open marine lagoonal setting (Hammes, 1992). Oncolites, miliolids and ostracods occur in a more restricted quiet environment of a shallow lagoon while the echinoids and pelecypods reflect more open marine conditions (Hammes, 1992).

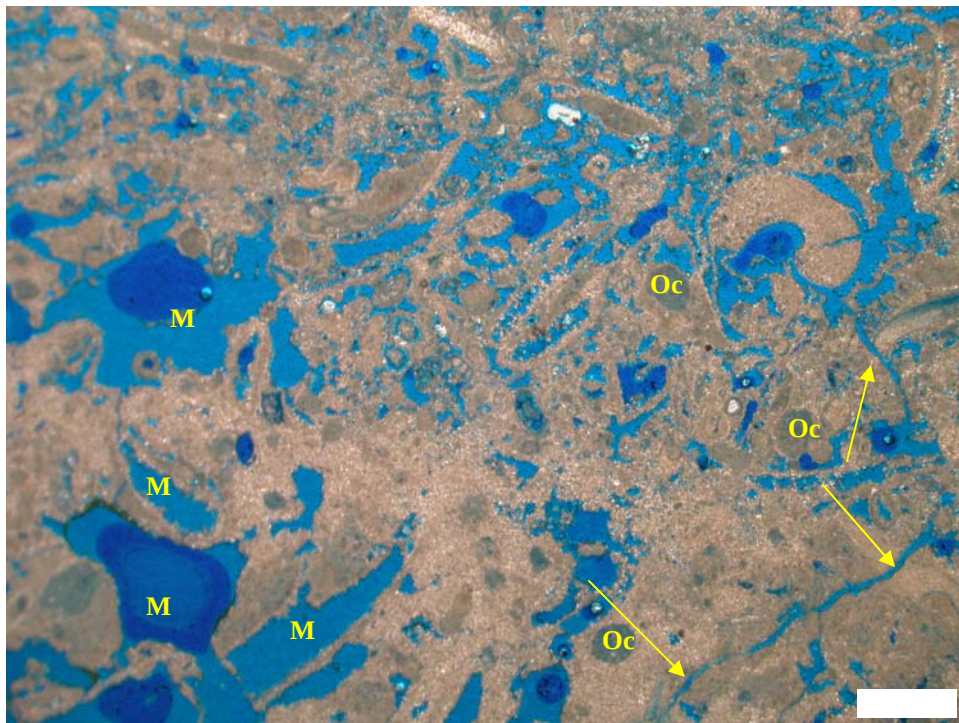


Figure 62. W-18778, 983-984. Mixed skeletal, muddy, micritized packstone. Note difference in matrix density from top to bottom of photo. Oncolites (Oc) and fracture (arrows) are evident as well as the moldic (M) nature of the sample. Transmitted light. Scale is 1.0 mm.

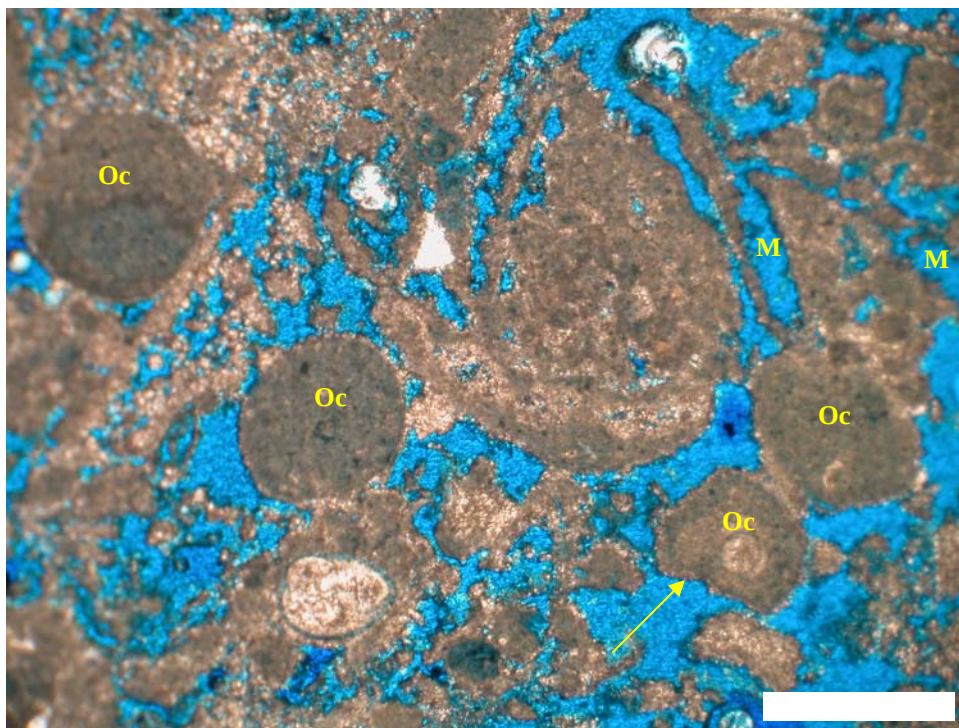


Figure 63. W-18778, 983-984. Mixed skeletal, muddy, micritized packstone. Micritized oncolites (Oc) and moldic (M) nature of sample, possible breakage or dissolution of one of the oncolites (arrow). Transmitted light. Scale is 1.0 mm.

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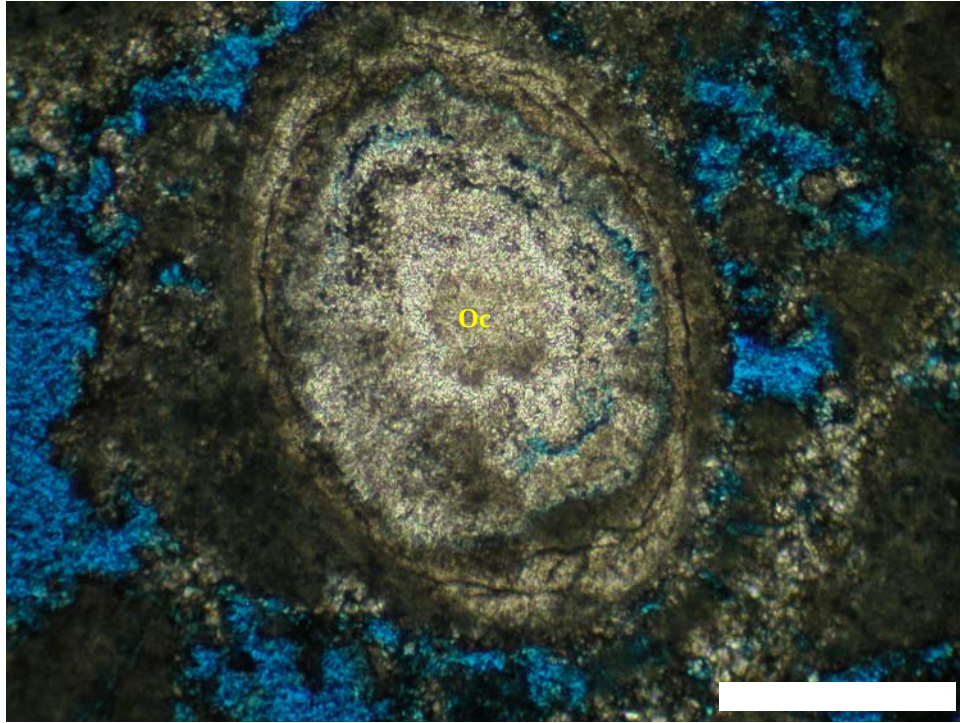


Figure 64. W-18778, 983-984. Mixed skeletal, muddy, micritized packstone. Micritized oncolite (Oc) showing some internal structure of concentric circles. Plane polarized light. Scale is 0.25 mm.

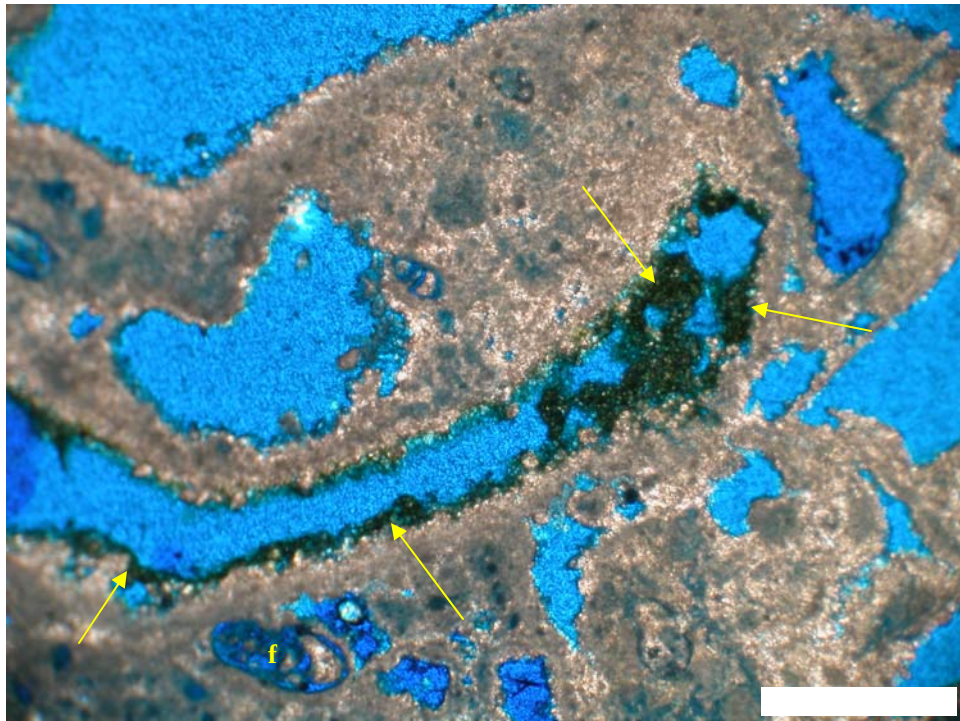


Figure 65. W-18778, 983-984. Mixed skeletal, muddy, micritized packstone. Dark micritized rim (arrows) in mold and partially filling mold. Possibly organics or glauconite. Foraminifera (f) in lower left. Transmitted light. Scale is 0.5 mm.

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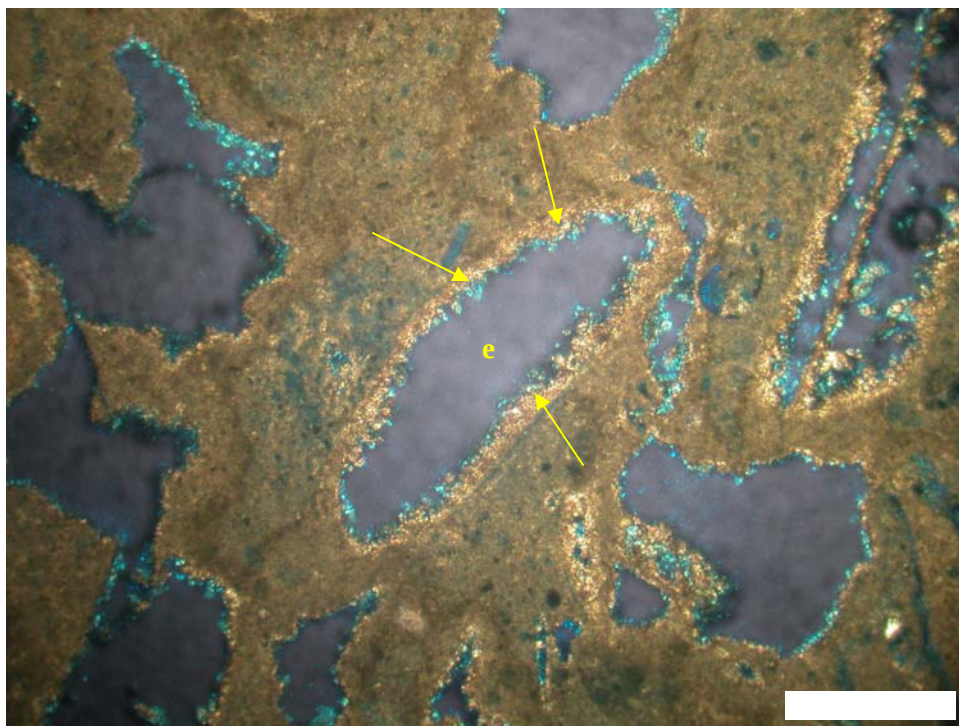


Figure 66. W-18778, 983-984. Mixed skeletal, muddy, micritized packstone. Echinoid (e) mold showing sparry calcite cement (arrows) lining the mold. Cross polarized light. Scale is 0.5 mm.

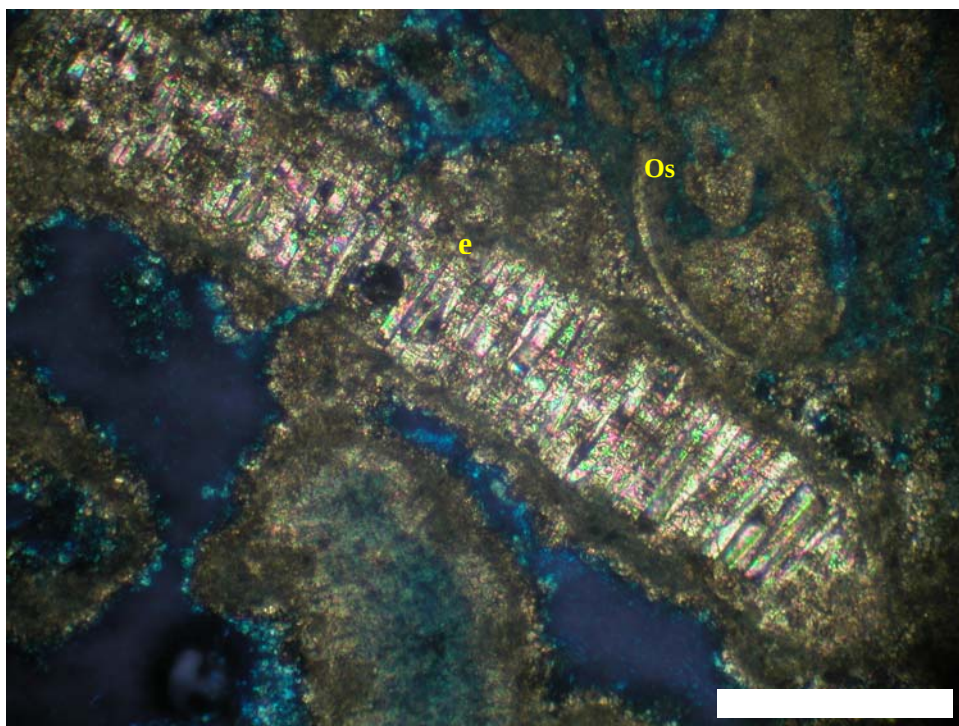


Figure 67. W-18778, 983-984. Mixed skeletal, muddy, micritized packstone. Recrystallized echinoid (e) fragment. Ostracod (Os) above echinoid fragment. Cross-polarized light. Scale is 0.25 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18778

995-996 (Figure 68-73)

Lithostratigraphic Unit: Suwannee Limestone.

Lithology: Limestone - highly micritized, foraminiferal, grainstone.

Porosity ~ 35%.

Most of the section consists of a grainstone. The exceptions are a muddy area surrounding the outline of a fossil mold (Figure 68) and a few other small muddy sections which are probably due to bioturbation. The area enclosed by the larger fossil mold is not as compacted as the area outside the mold (Figures 68-71). Some of the compaction possibly took place before dissolution of the shell material which formed the mold. Compaction is evident in other areas (Figures 72 and 73). There is linear grain contact (Figures 72 and 73). There is also grain breakage with minor displacement (Figures 70 and 71) and accumulations as collapsed squashed debris (Budd, 2002) (Figure 73). The sample is highly micritized obliterating much of the structural detail in the grains. Overall, the section is minimally cemented with some very fine-grained cement lining the interparticle pore spaces. Some intraparticle pore spaces are filled or partially filled with cement. Allochems consists of abundant miliolids and ostracods, in addition to molds and echinoids. Sample is moderately sorted and moldic. Scattered throughout the section are sparse intraclasts and peloids and very fine angular fragments that appear green-black in color and take a circular form (Figures 70-72). These circular forms may be an artifact of making the thin section. Preliminary microprobe data indicates they are some kind of aluminum silicate. Further study is warranted.

Dominant pore type is interparticle and intraparticle with slight microporosity in the few muddy areas.

Depositional environment is likely semi-restricted to open marine with a lagoonal influence. Miliolids, ostracods and gastropods occur in a restricted environment of a shallow lagoon, while the echinoids reflect a more open marine environment (Hammes, 1992).

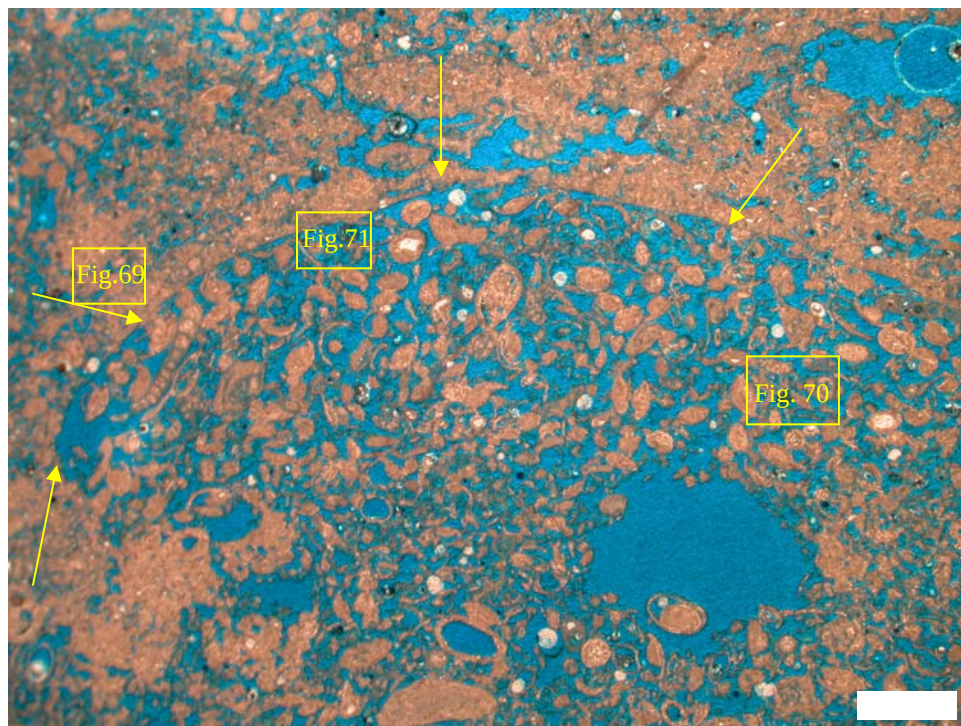


Figure 68. W-18778, 995-996. Highly micritized, foraminiferal, grainstone. Note sediment within the large mold (arrows) is very low-mud and less compacted than material outside the mold. Mud content immediately outside the mold is higher. Area in boxes shown below. Transmitted light. Scale is 1.0 mm.

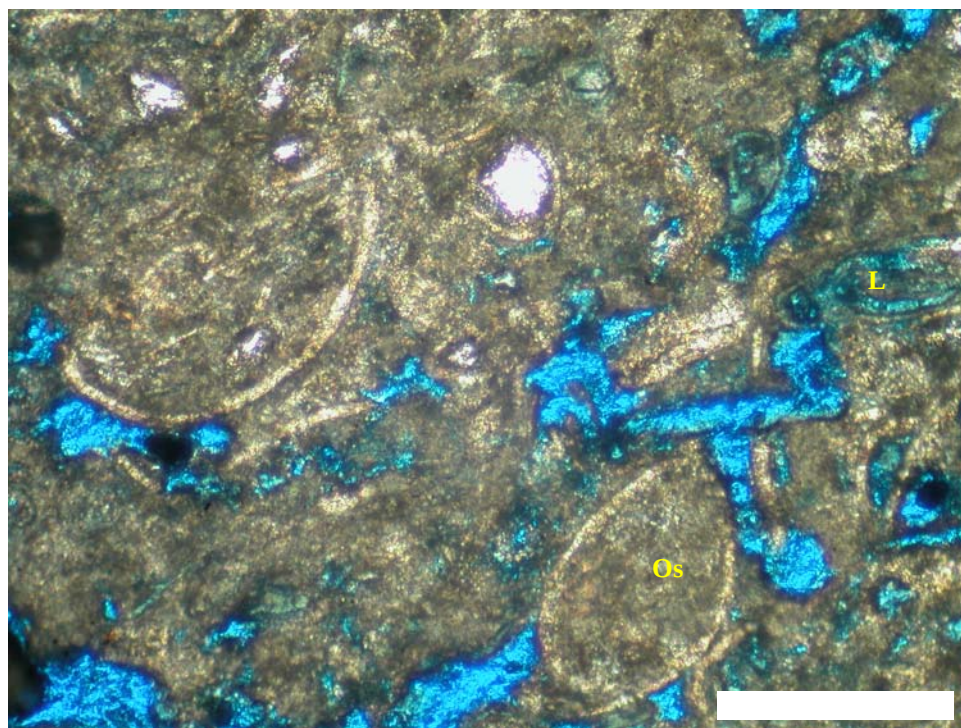


Figure 69. W-18778, 995-996. Highly micritized, foraminiferal, grainstone. Close up view showing cemented muddy material outside the large mold from the above photo. Many Ostracod (Os) fragments. Plane polarized light. Scale is 0.25 mm.

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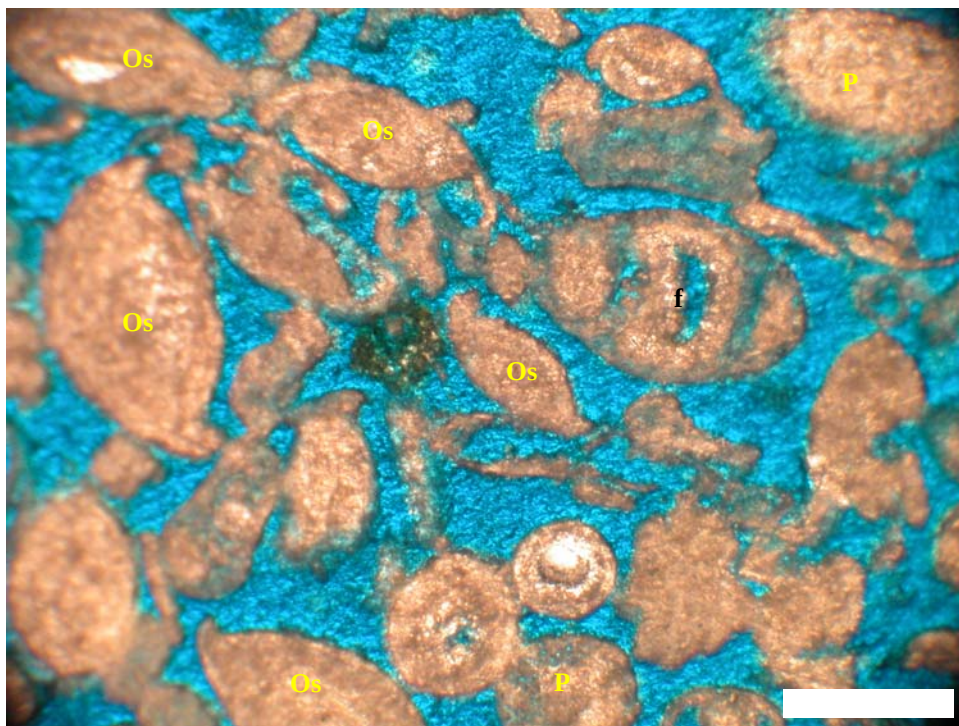


Figure 70. W-18778, 995-996. Highly micritized, foraminiferal, grainstone. Close up view showing normal packing of material inside the large mold (Figure 68). Ostracods (Os), foraminifer (f), and micritized peloids (P). Very fine crystalline green circular area is possibly an artifact of making the thin section. Transmitted light. Scale is 0.5 mm.



Figure 71. W-18778, 995-996. Highly micritized, foraminiferal, grainstone. Close up view showing edge (arrows) of the large mold (Figure 68). Inside the mold is very low-mud with some grain breakage and not much compaction. The very fine crystalline green-black circular area is possibly an artifact of making the thin section. Plane polarized light. Scale is 0.25 mm.

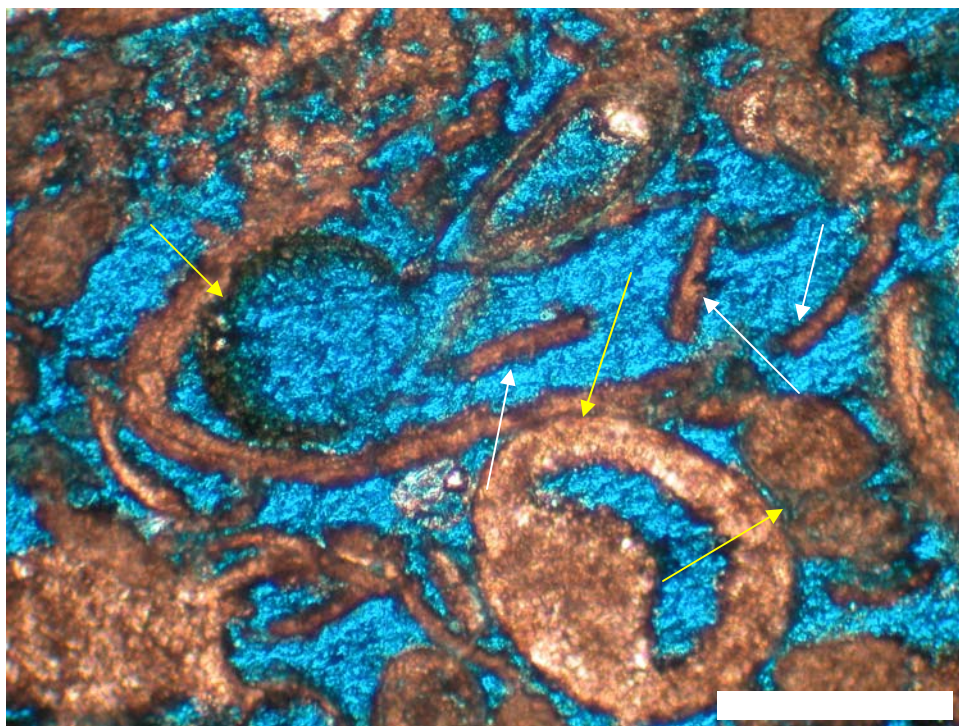


Figure 72. W-18778, 995-996. Highly micritized, foraminiferal, grainstone. Evidence of some compaction, grain-to-grain contact (yellow arrows) and broken grains (white arrows). Very fine crystalline green-black circular area is possibly an artifact of making the thin section. Plane polarized light. Scale is 0.25 mm.

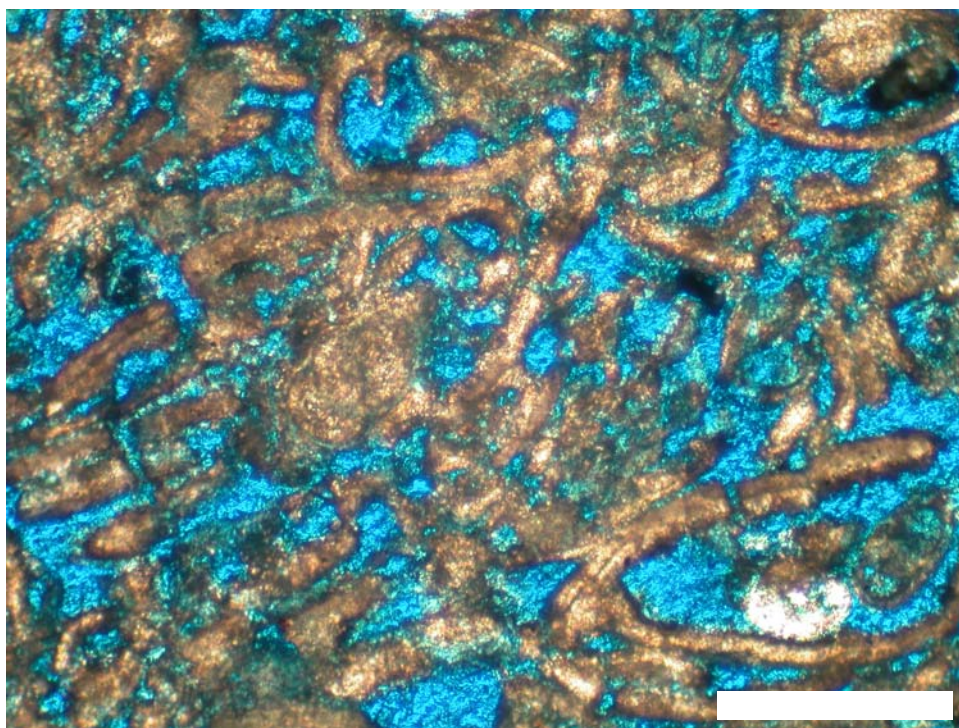


Figure 73. W-18778, 995-996. Highly micritized, foraminiferal, grainstone. Accumulation of compressed broken grains supports evidence of compaction. Plane polarized light. Scale is 0.25 mm.

FLORIDA GEOLOGICAL SURVEY

Core W-18778

1119-1120 (Figures 74-79)

Lithostratigraphic Unit: Suwannee Limestone.

Lithology: Limestone – micritized, high-mud wackestone with abundant echinoid fragments and algal material.

Porosity ~ 25%.

This is a muddy wackestone in which some of the mud-like material is actually algal material (Figure 74). Note the algal laminations in the middle of the photo and the round mud-like structure, which is also algal, in the bottom right (Figure 74). These may be some type of encrusting algae which are important in reef development (Scholle and Ulmer-Scholle, 1978). Also common are a different type of algae as shown in Figures 75 and 76. These are possibly some form of green algae. There is some evidence of compaction (Figures 75-78). There are many broken grains some with displacement. There is grain-to-grain penetration and linear grain contacts and grain breakage (Budd, 2002; Melzer, 2004); (Figures 76-78). The section is somewhat micritized with the internal structure of some grains no longer discernable. There is moderate cementation found as coarse, crystalline, syntaxial overgrowths on many of the echinoid fragments (Figures 76-77) and to a lesser degree, cementation in the interparticle pore spaces. There exists a diverse fauna assemblage of echinoids, algae, foraminifera, miliolids, bryozoa, and mollusks. (Figures 74-79). Echinoid fragments and spines are abundant. There is a trace of pyrite and glauconite and organics. The section is poorly sorted.

The dominant porosity type is microporosity along with interparticle porosity and minor intraparticle porosity.

The depositional environment is likely a deep lagoon, outer ramp shoal (Hammes, 1992). The deep lagoon environment is muddy and has an open marine fauna, which can be echinoid rich and muddy (Hammes, 1992). The shoal facies is composed of red algae and miliolids and can be intercalated with lagoonal and outer ramp facies (Hammes, 1992).

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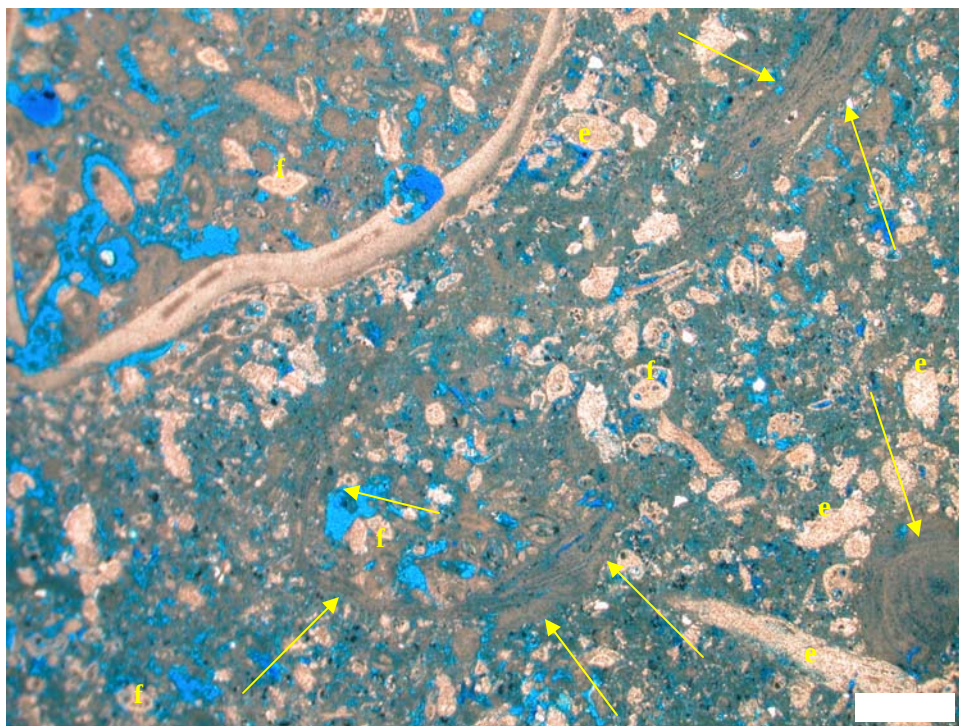


Figure 74. W-18778, 1119-1120. Micritized, high-mud wackestone. Abundant small foraminifera (f), echinoids (e) and algae laminations (arrows). Transmitted light. Scale is 1.0 mm.

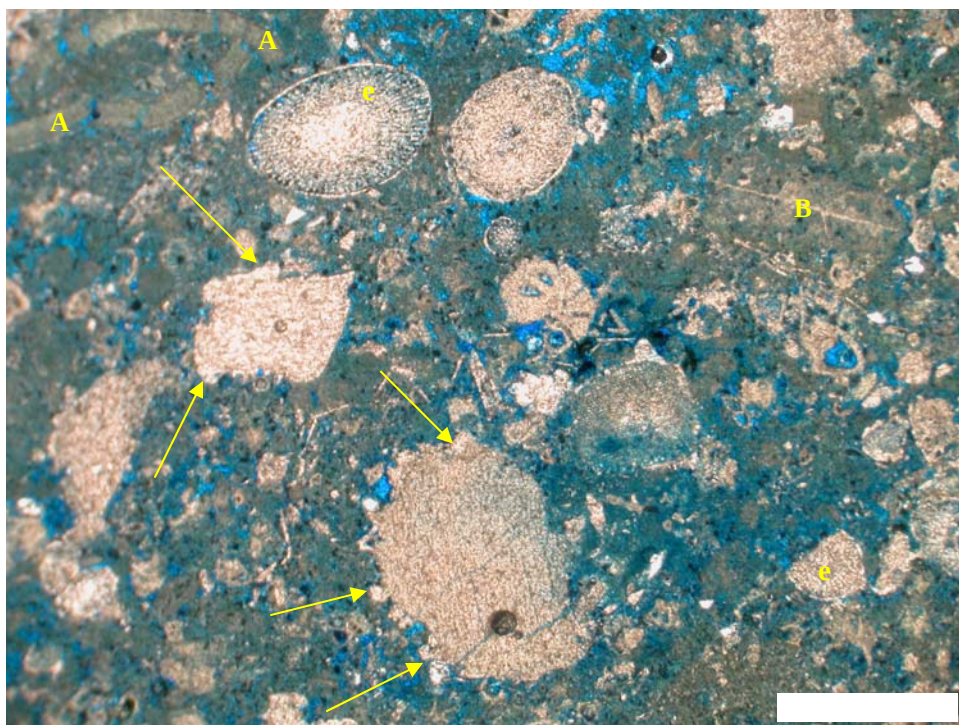


Figure 75. W-18778, 1119-1120. Micritized, high-mud wackestone. Echinoid fragments with syntaxial cement overgrowths (arrows), echinoid spine (e), algae (A) and bryozoan (B). Echinoid fragment in center bottom of photo is fractured and there is an abundance of small broken skeletal debris in the matrix. Transmitted light. Scale is 2.0 mm.

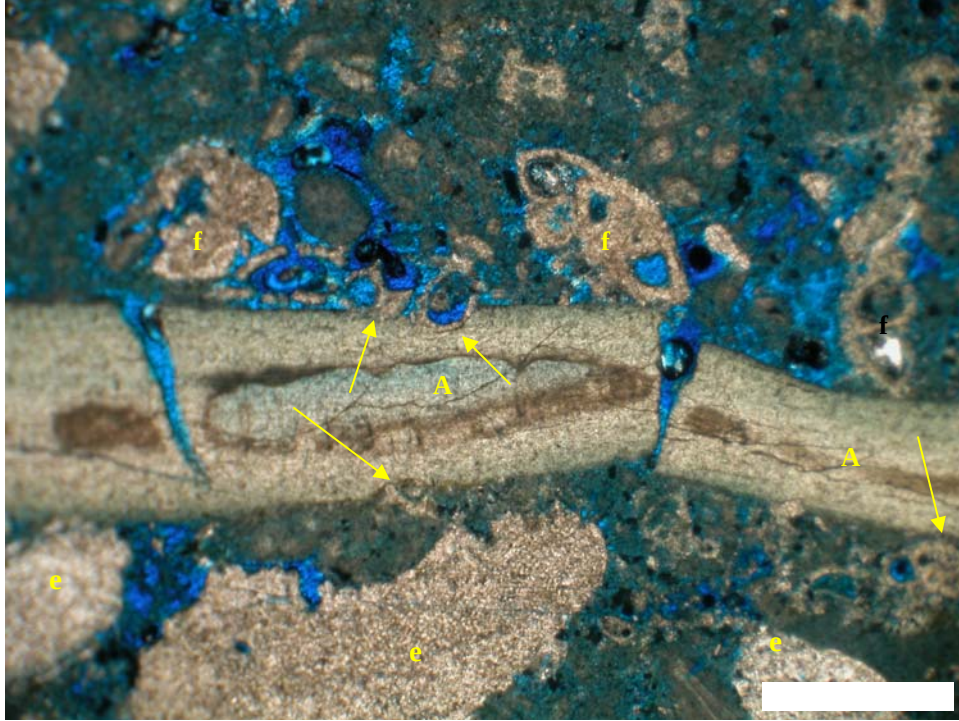


Figure 76. W-18778, 1119-1120. Micritized, high-mud wackestone. Some signs of compaction – broken foraminifera (f) and algal grains (A) and grain-to-grain penetration (arrows). Echinoid fragments (e). Transmitted light. Scale is 1.0 mm.

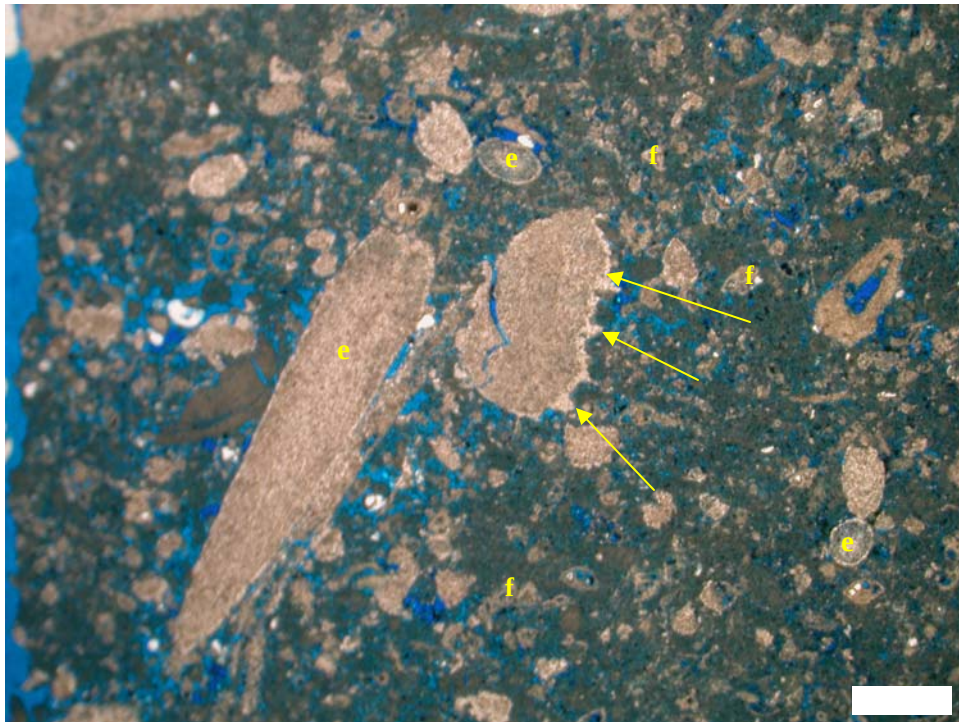


Figure 77. W-18778, 1119-1120. Micritized, high-mud wackestone. Echinoid spines (e) and broken echinoid fragment with syntaxial cement overgrowth (arrows), small foraminifera (f) and mixed skeletal debris. Transmitted light. Scale is 1.0 mm.

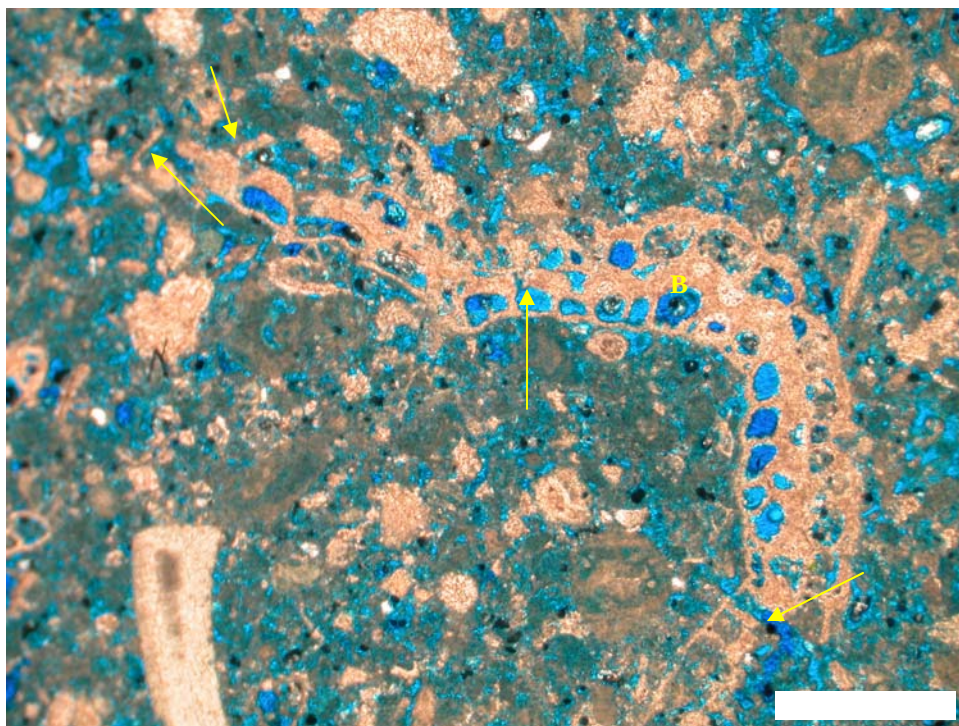


Figure 78. W-18778, 1119-1120. Micritized, high-mud wackestone. Bryozoan (B) showing breakage with slight displacement (arrows), slight compaction. Echinoid fragments and mixed skeletal debris. Transmitted light. Scale is 2.0 mm.

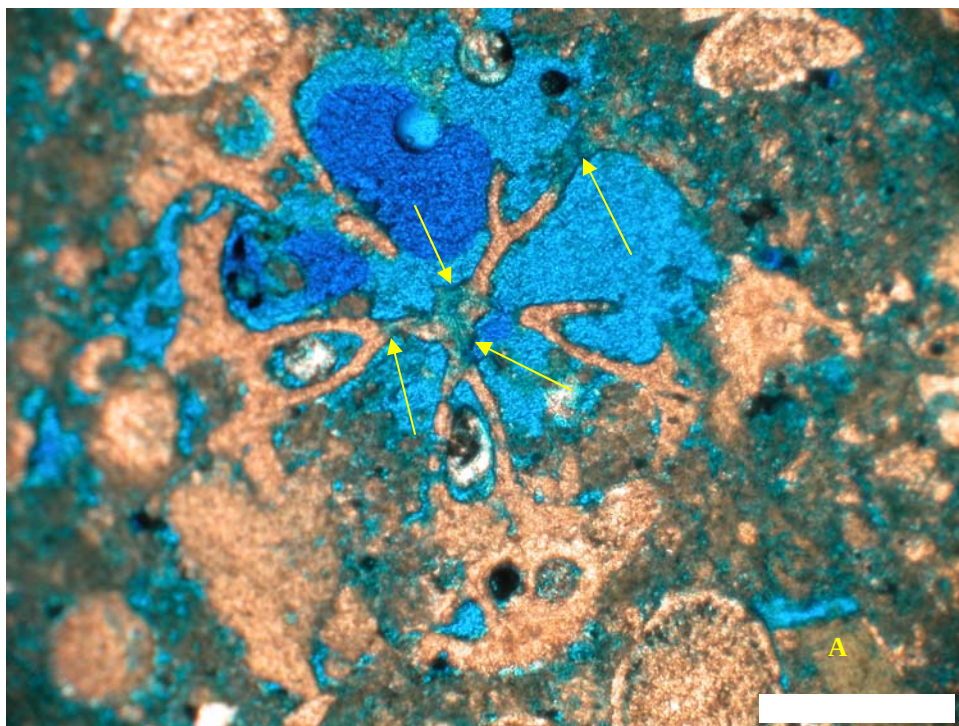


Figure 79. W-18778, 1119-1120. Micritized, high-mud wackestone. Bryozoan (?) with the micritized rim partially replaced with fine-grained cement showing microporosity (arrows) where the rim used to be. Algal fragment (A) is also present. Transmitted light. Scale is 0.5 mm.

Appendix 4.
Supplemental EPMA element maps and backscatter electron (BSE)
images.

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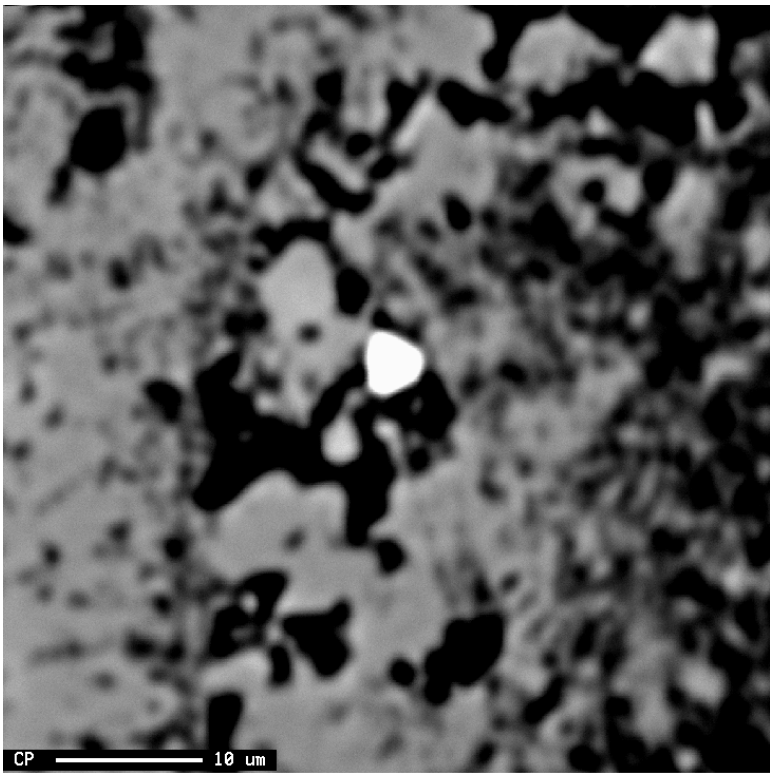


Figure 1. W-18278, 2140-2160' A BLS. BSE image of small pyrite from.

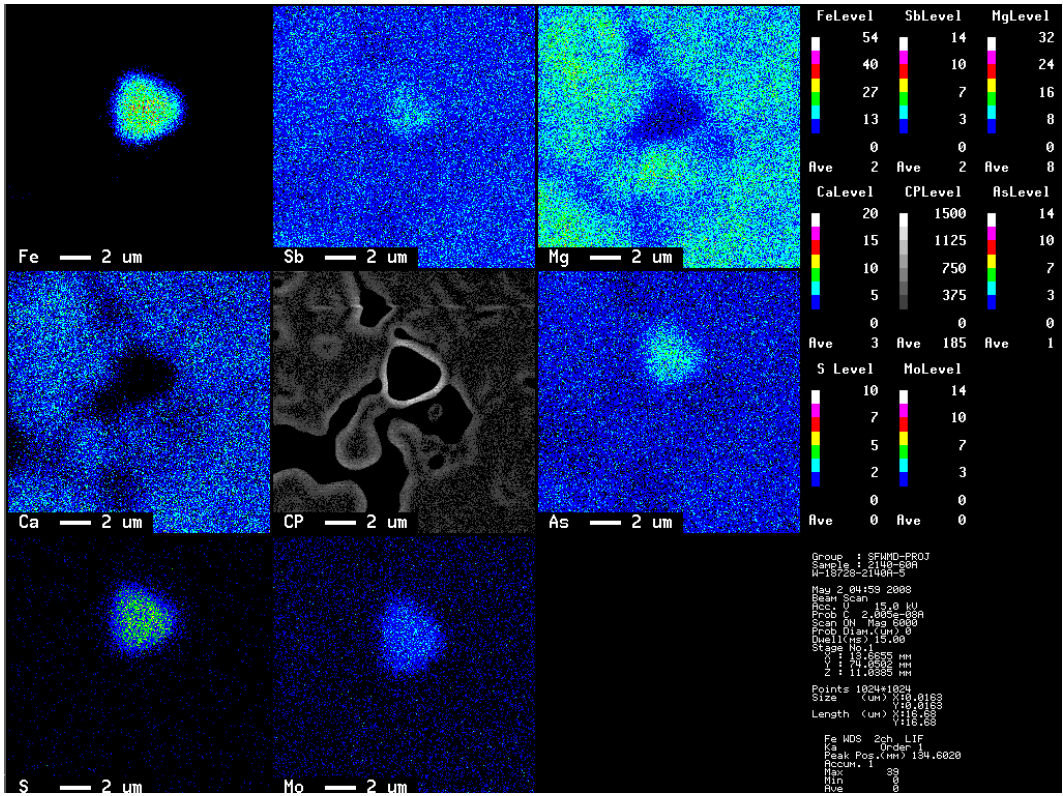


Figure 2. W-18278, 2140-2160' A BLS. Electron probe microanalysis (EPMA) element maps of pyrite seen in Figure 1. Note As and Mo.

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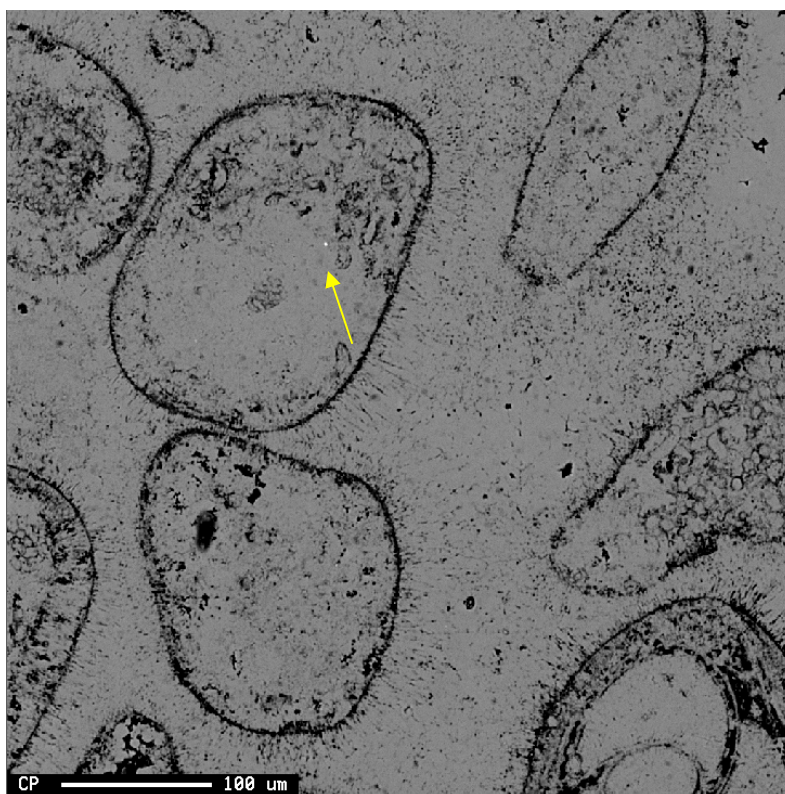


Figure 3. W-18728, 2140-2160' A BLS. BSE image of very small pyrite (arrow).

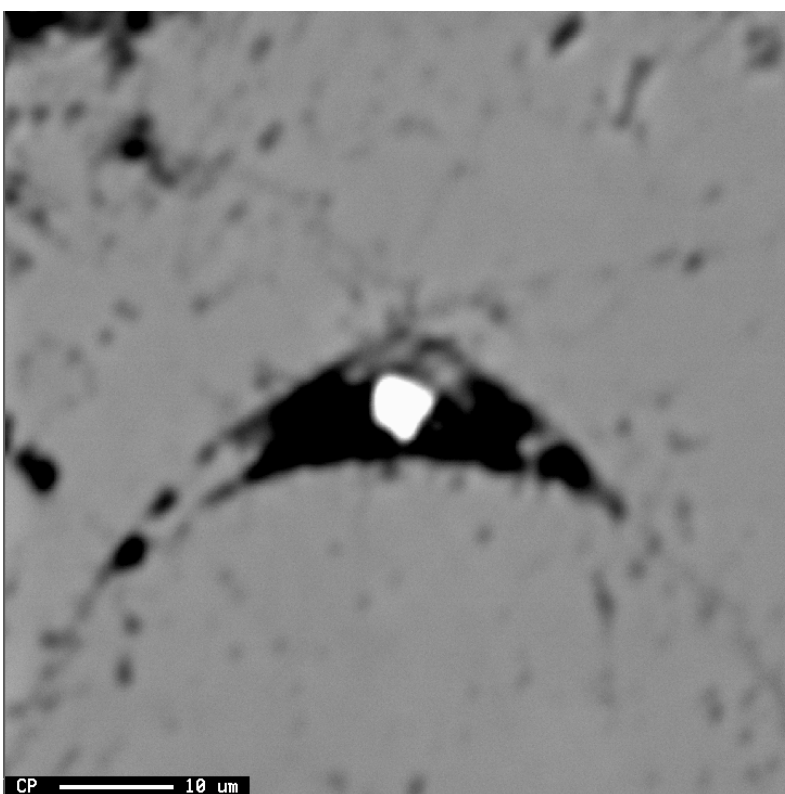


Figure 4. W-18728, 2140-2160' B BLS. Backscatter electron image (BSE) of zircon crystal.

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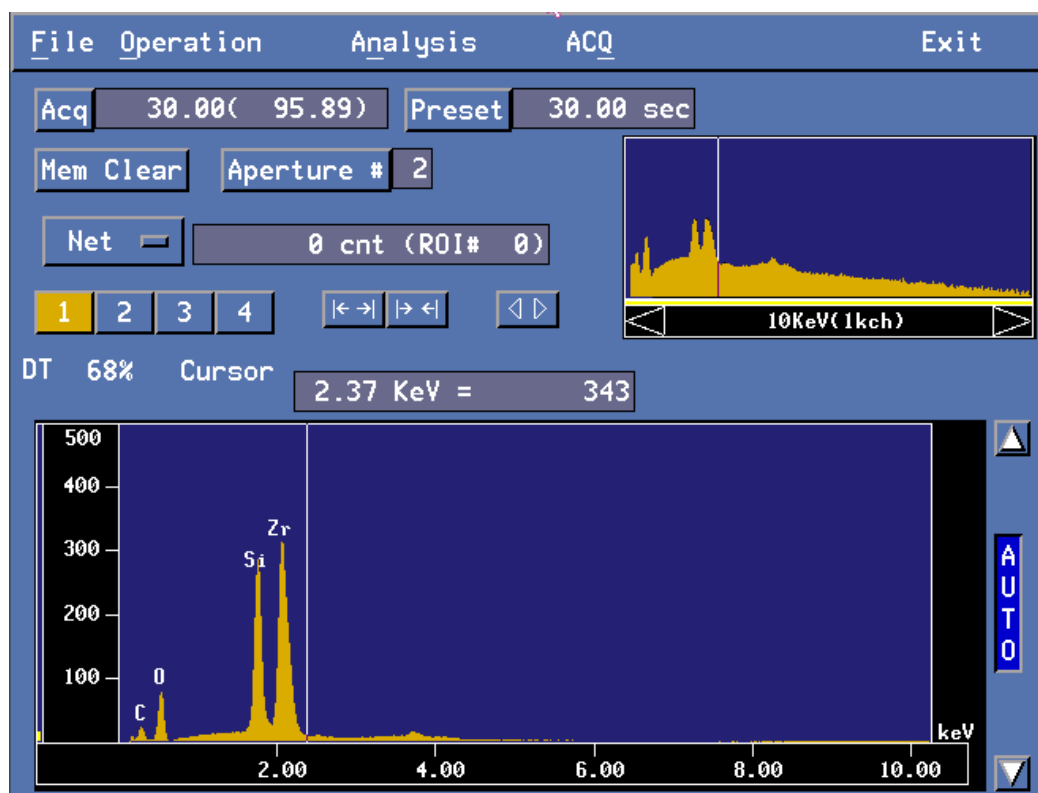


Figure 5. W-18728, 2140-2160' B BLS. Spectra for zircon (Figure 4).

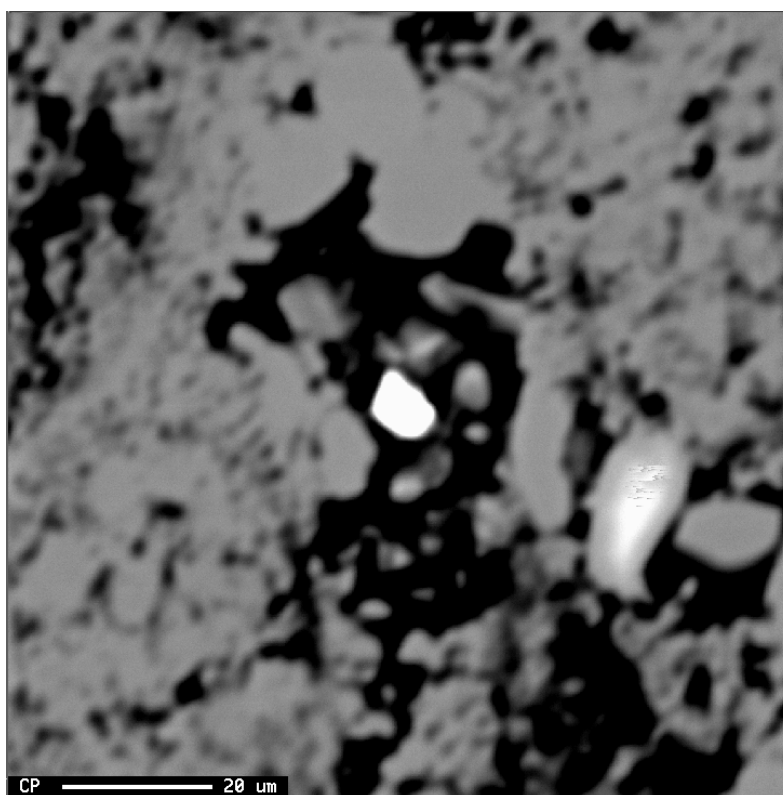


Figure 6. W-18728, 2140-2160' B BLS. BSE image Unknown mineral.

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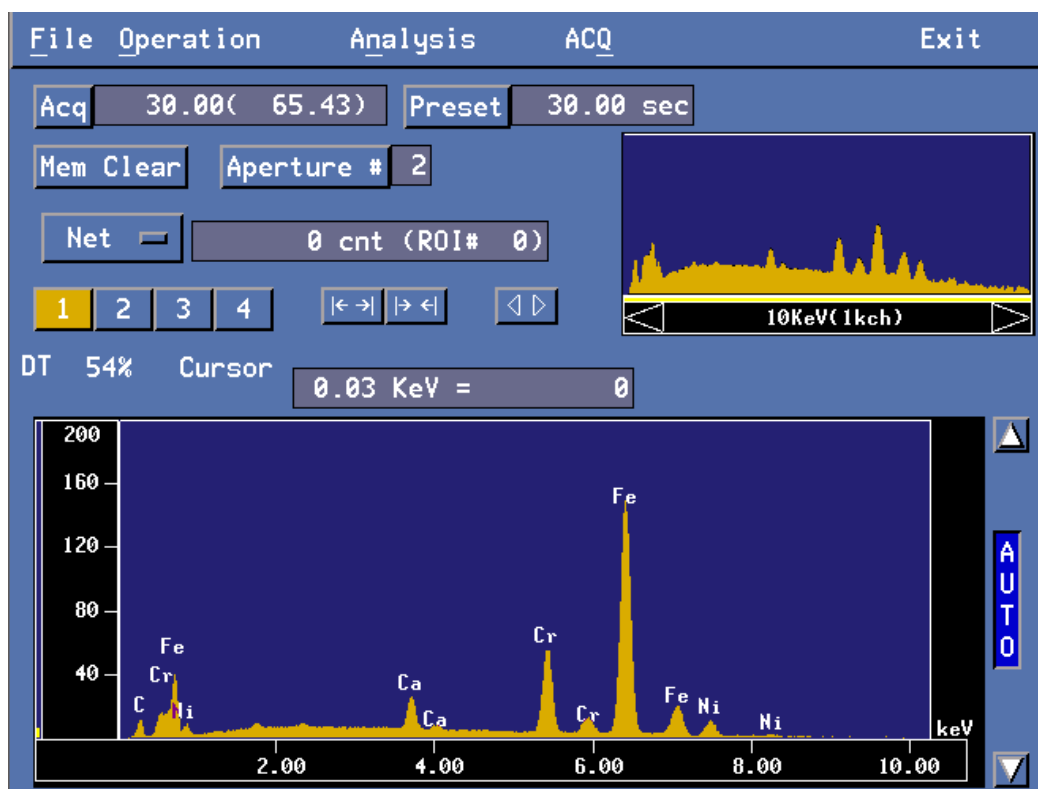


Figure 7. W-18728, 2140-2160' B BLS. Spectra for unknown mineral (Figure 6).

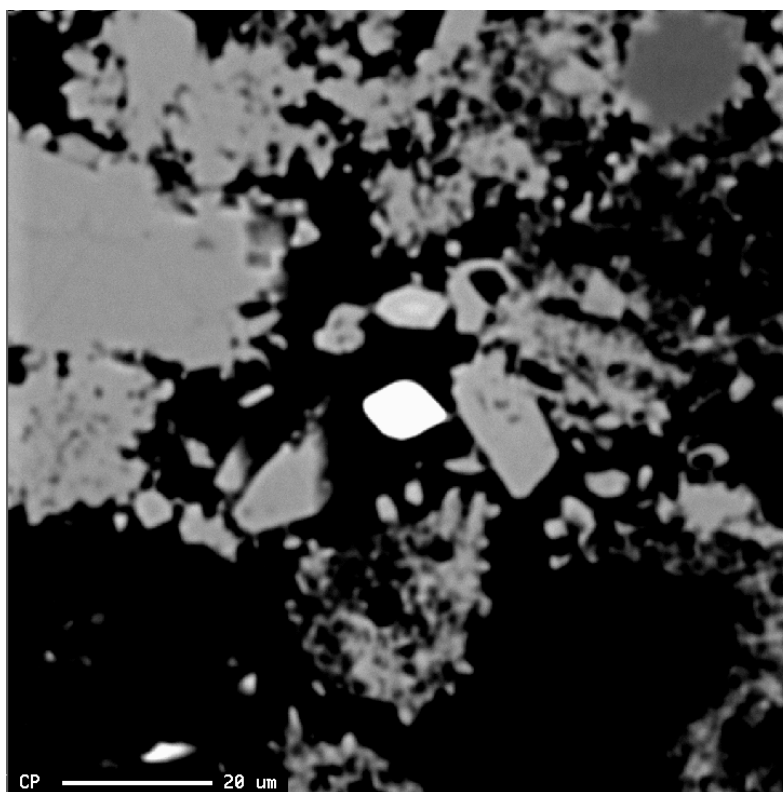


Figure 8. W-18776, 657-658' BLS. BSE image of euhedral pyrite.

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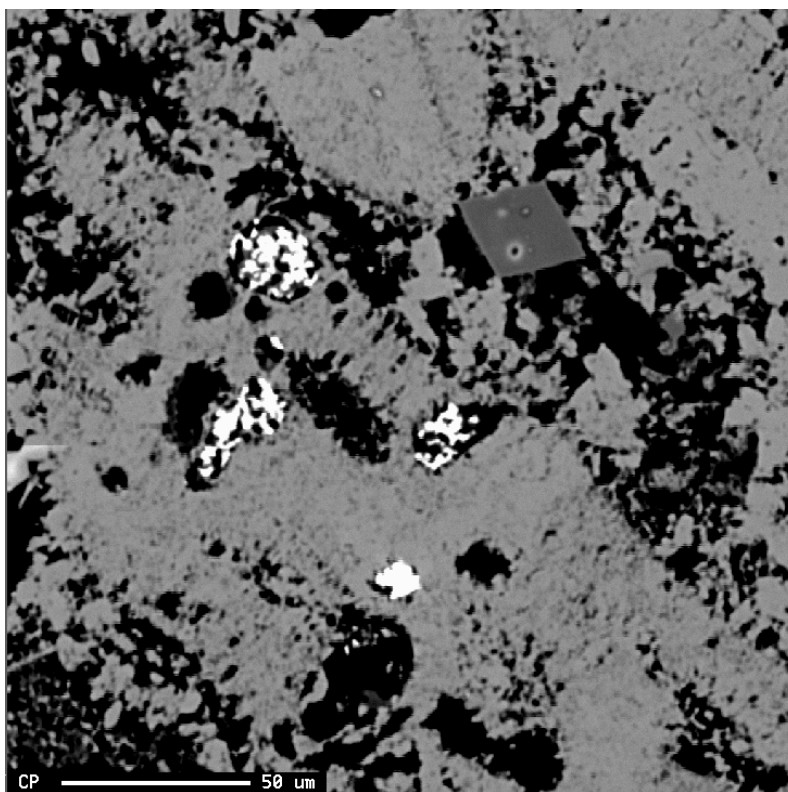


Figure 9. W-18776, 657-658' BLS. BSE image of pyrite in intragranular pore spaces of large foraminifera.

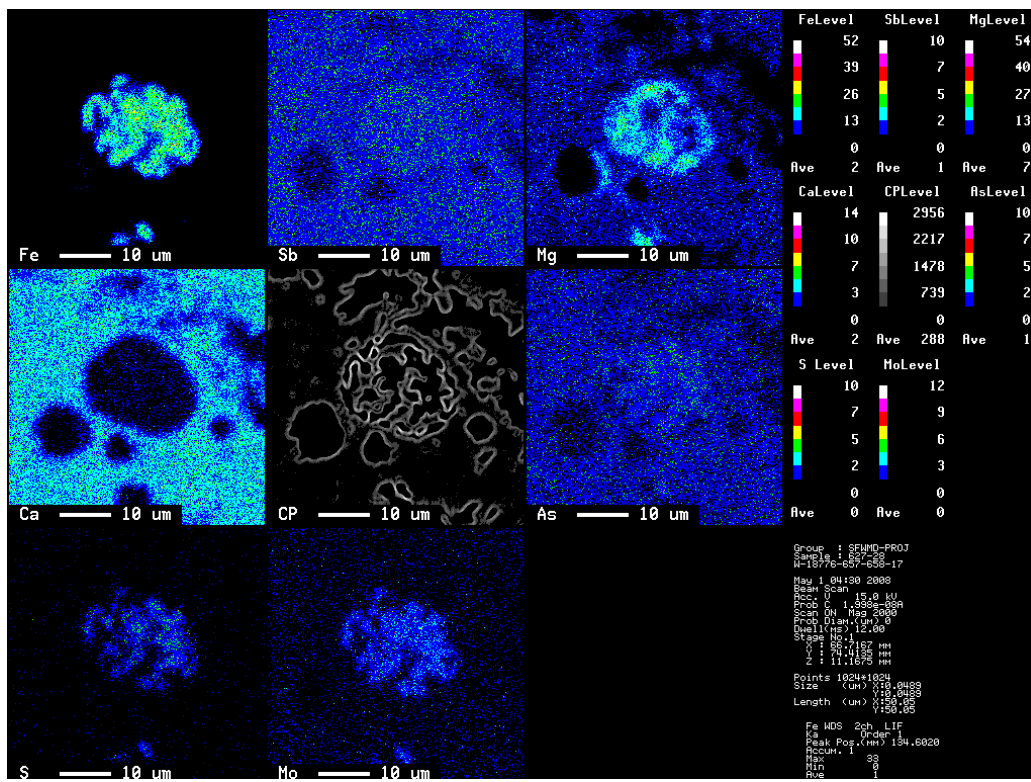


Figure 10. W-18776, 657-658' BLS. EPMA element maps of pyrite from Figure 9.

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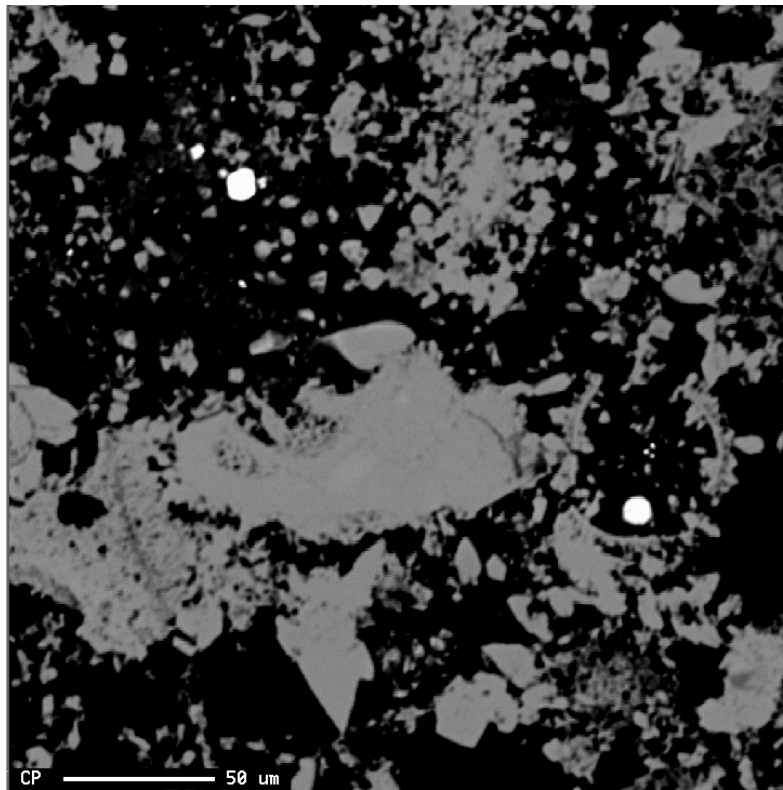


Figure 11. W-18776, 662-663' BLS. BSE image of pyrite framboids.

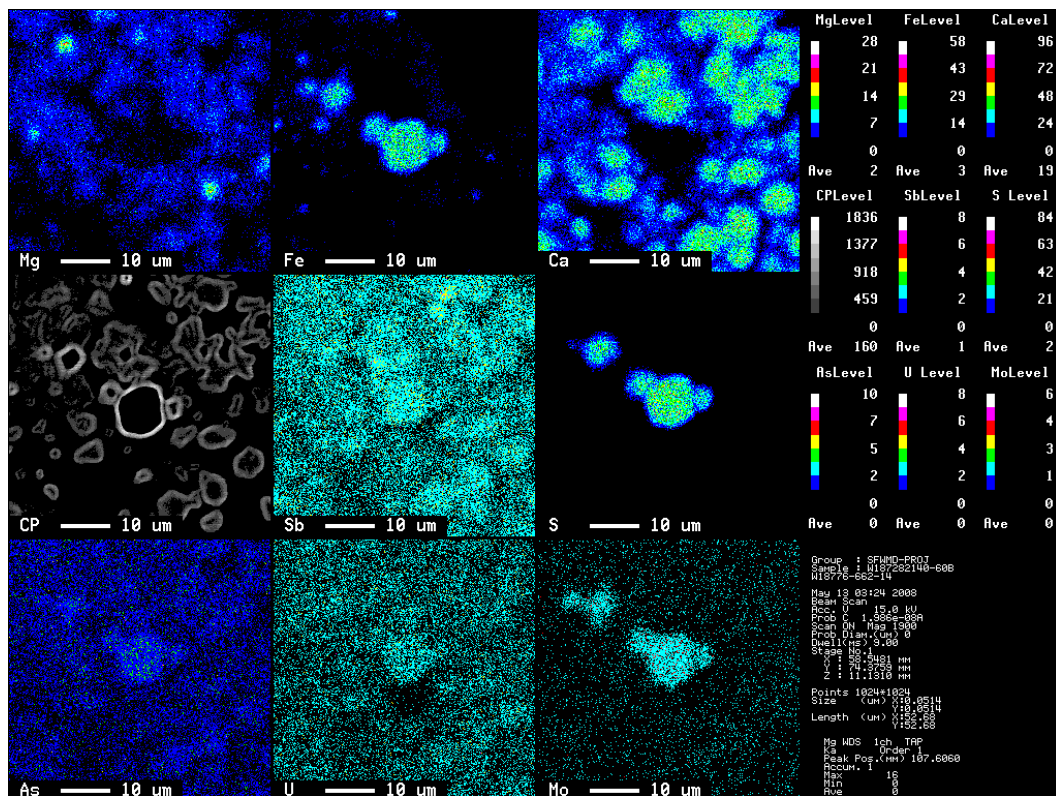


Figure 12. W-18776, 662-663' BLS. EPMA element maps of pyrite on top left side of Figure 11.

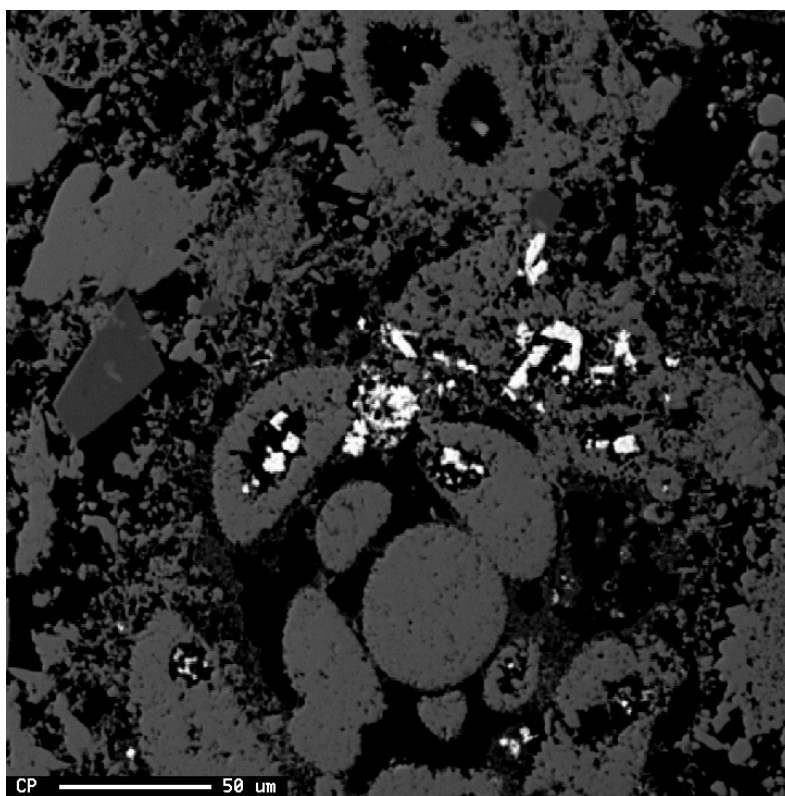


Figure 13. W-18776, 662-663' BLS. BSE image of pyrite.

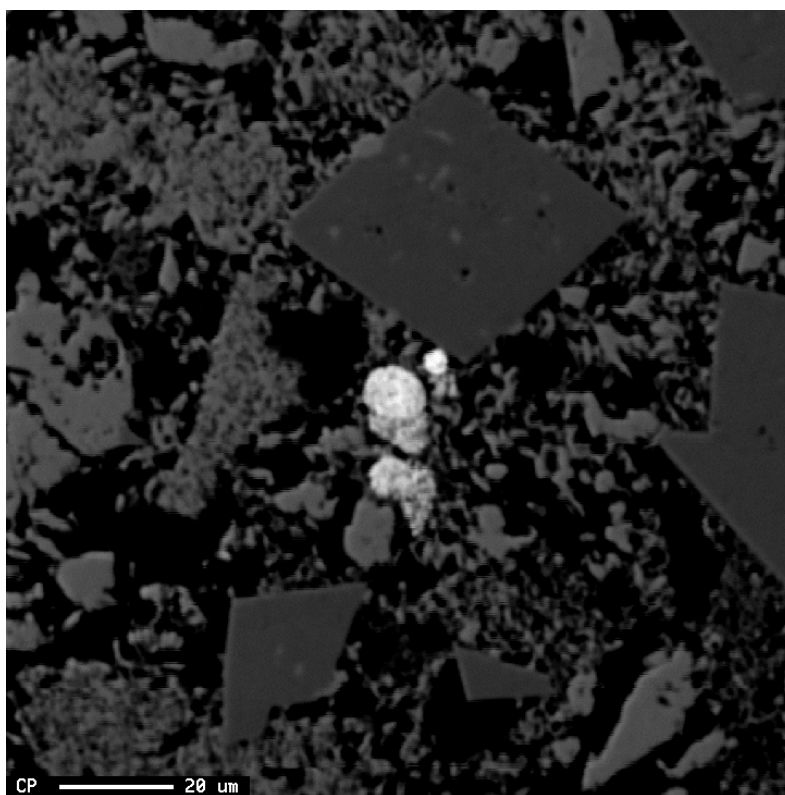


Figure 14. W-18776, 723-724' BLS. BSE image of pyrite and dolomite rhombs.

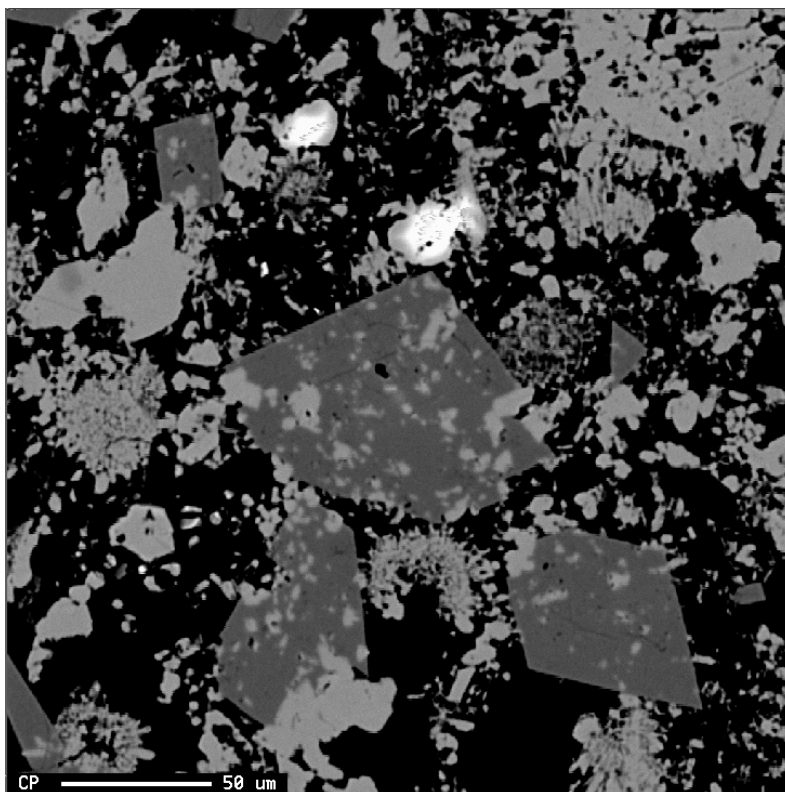


Figure 15. W-18776, 805-806' BLS. BSE image of mottled dolomite rhombs, indicates varying Mg content.

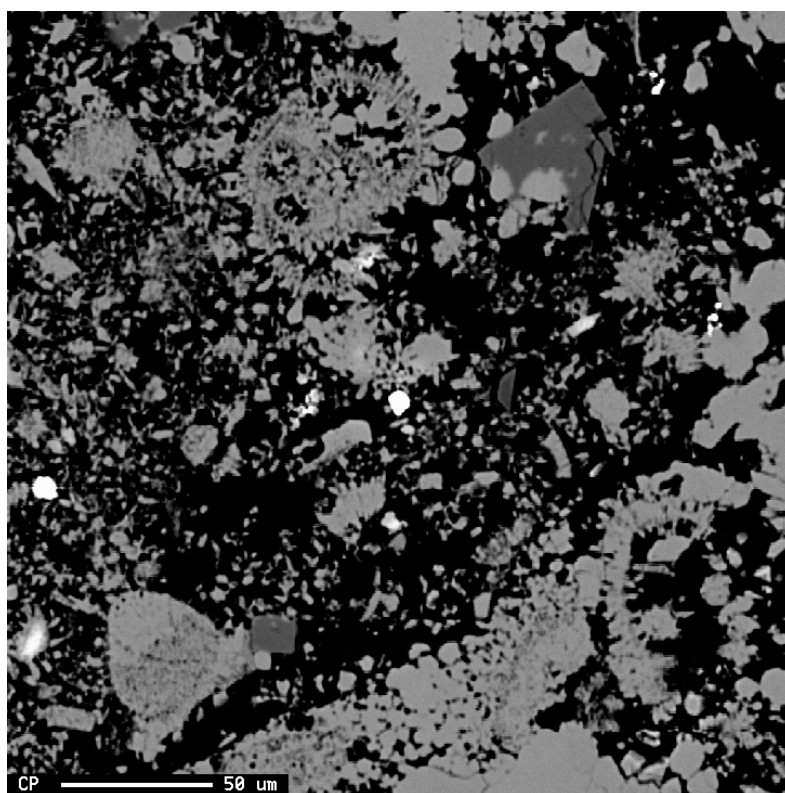


Figure 16. W-18776, 805-806' BLS. BSE image of scattered small pyrite framboids.

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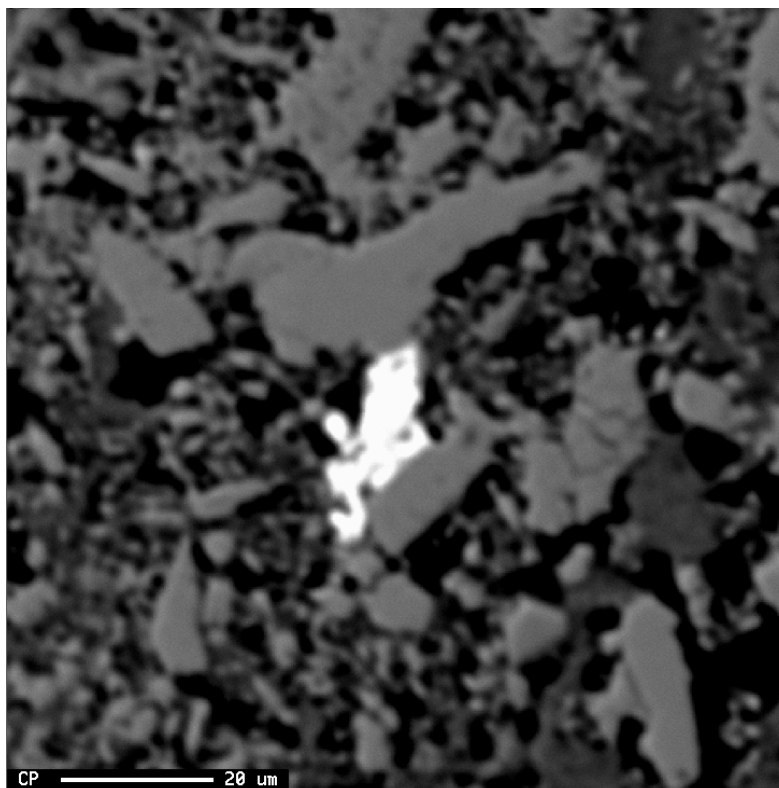


Figure 17. W-18776, 812-813' BLS. BSE image of celestite.

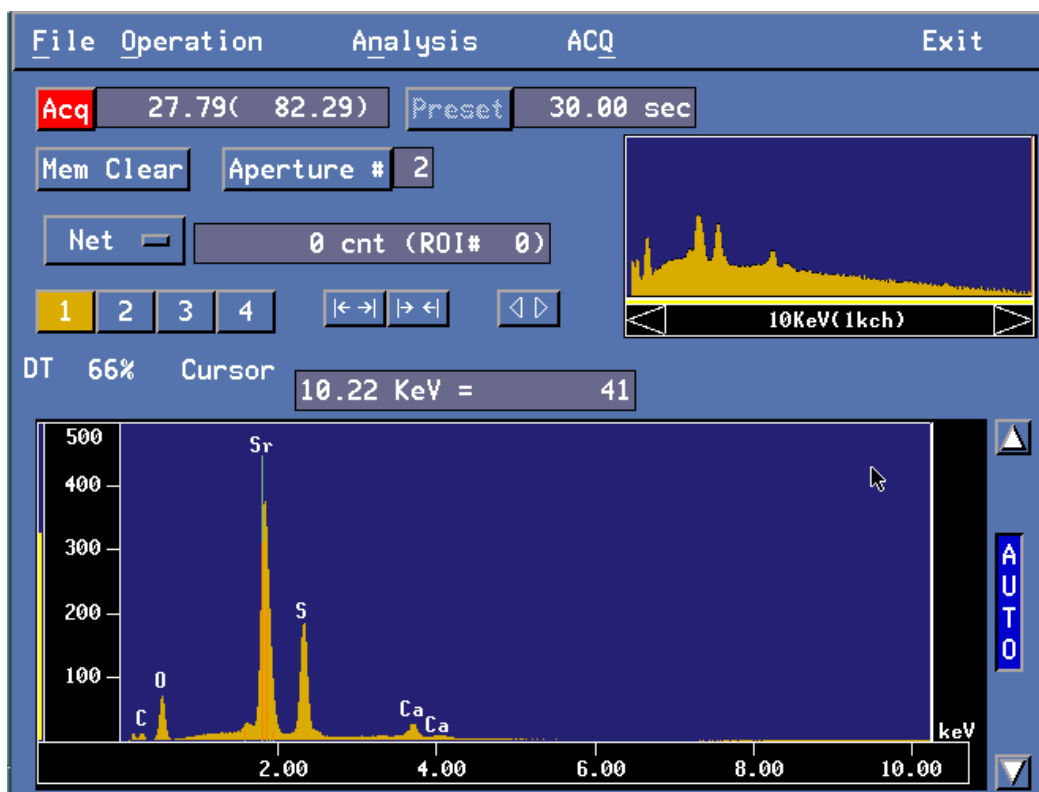


Figure 18. W-18776, 812-813' BLS. Spectra for above celestite (Figure 17).

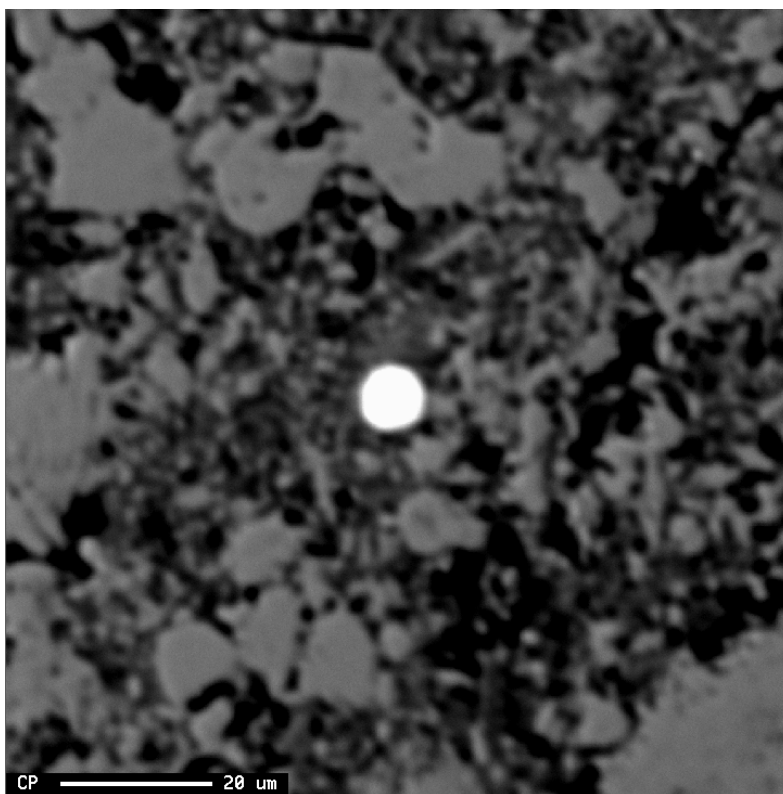


Figure 19. W-18776, 812-813' BLS. BSE image of pyrite framboid.

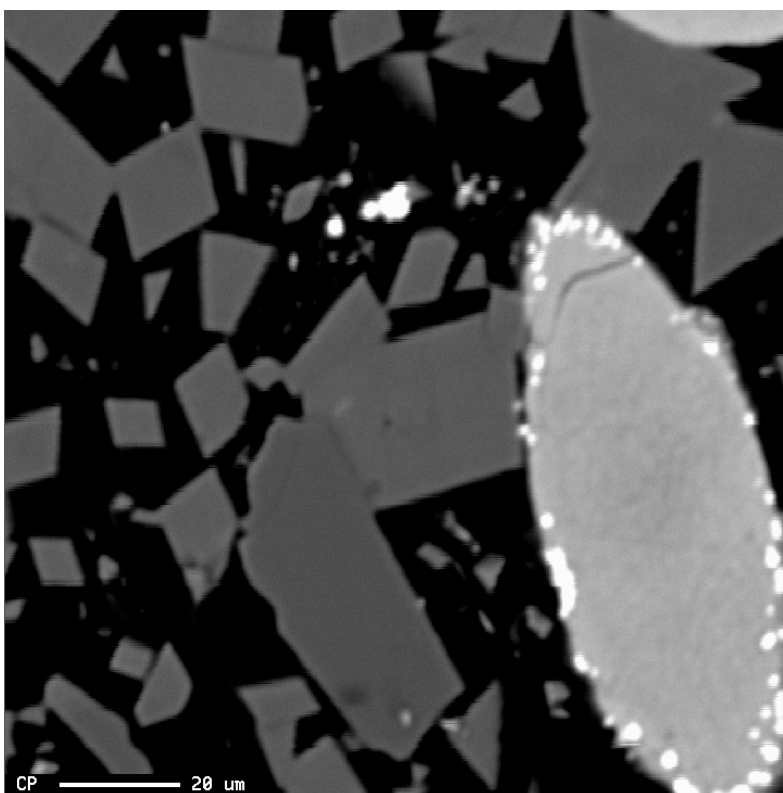


Figure 20. W-18778, 652-653' BLS. BSE image of phosphate grain with small pyrite framboids.

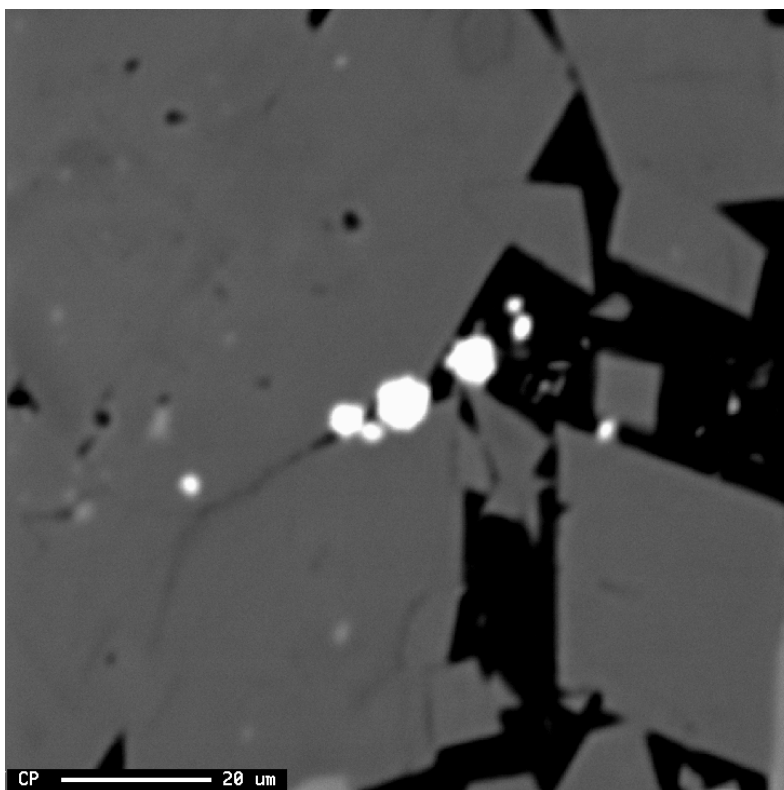


Figure 21. W-18778, 652-653' BLS. BSE image of pyrite framboids with dolomite.

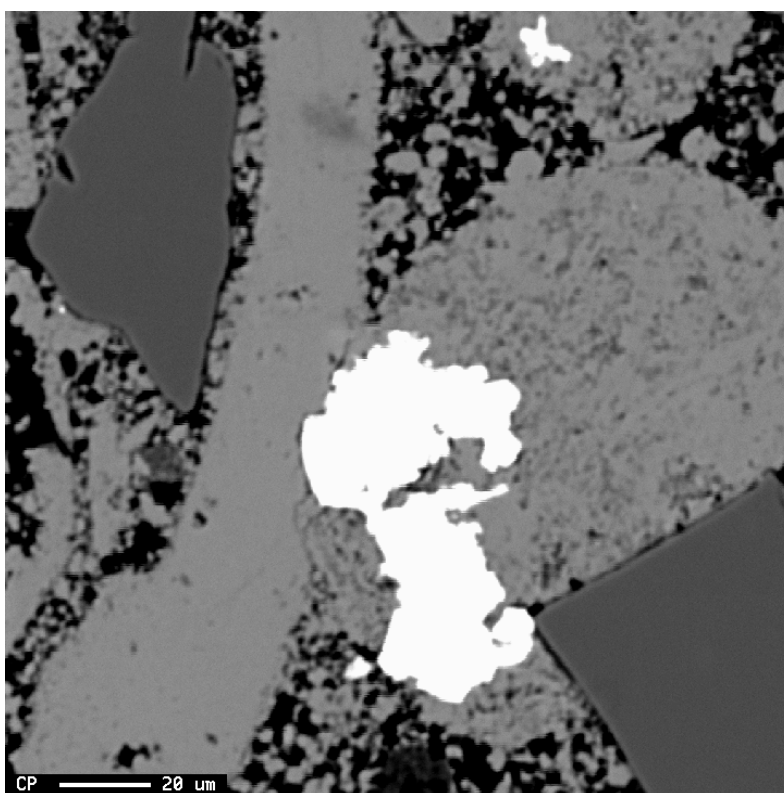


Figure 22. W-18778, 754-755' BLS. BSE image of large pyrite (bright), dolomite rhomb (lower right) and quartz grain (upper left) in limestone.

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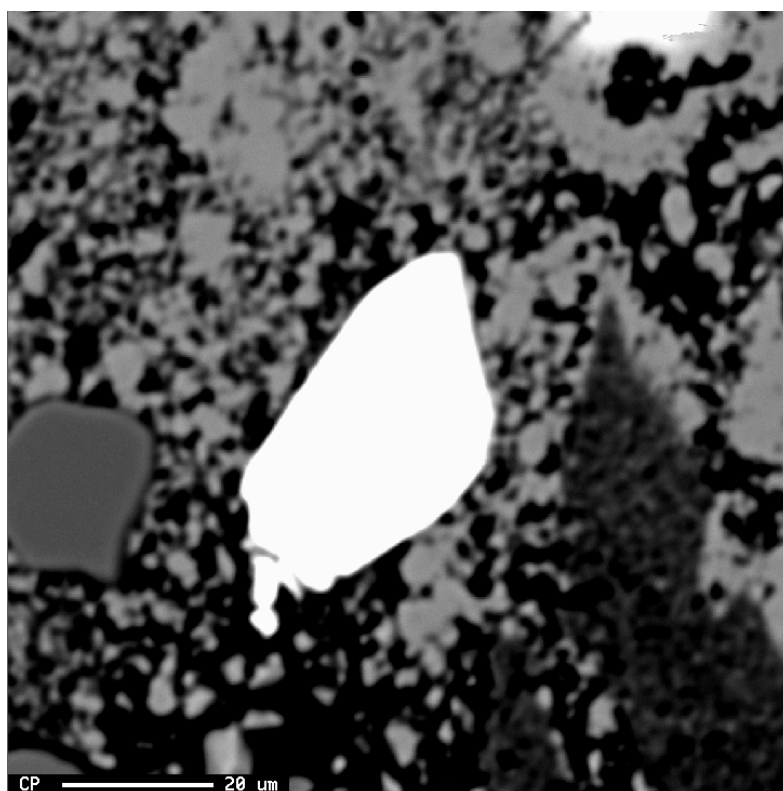


Figure 23. W-18778, 754-75' BLS. BSE image of zircon.

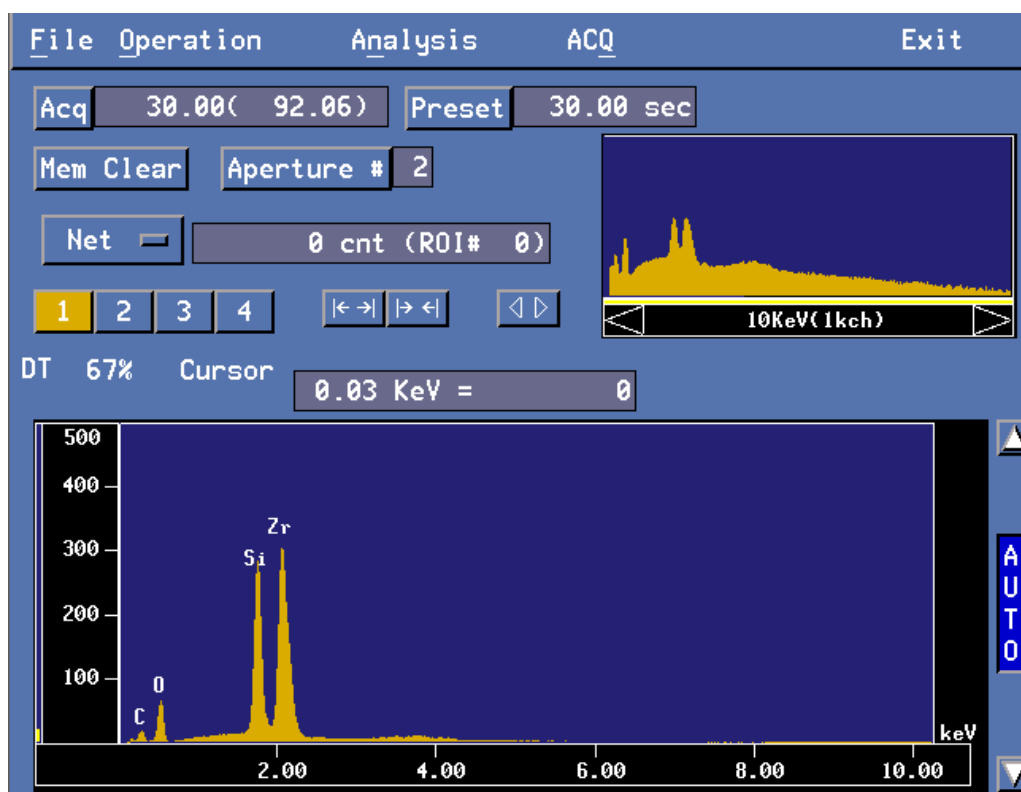


Figure 24. W-18778, 754-755' BLS. Spectra of zircon in Figure 23.

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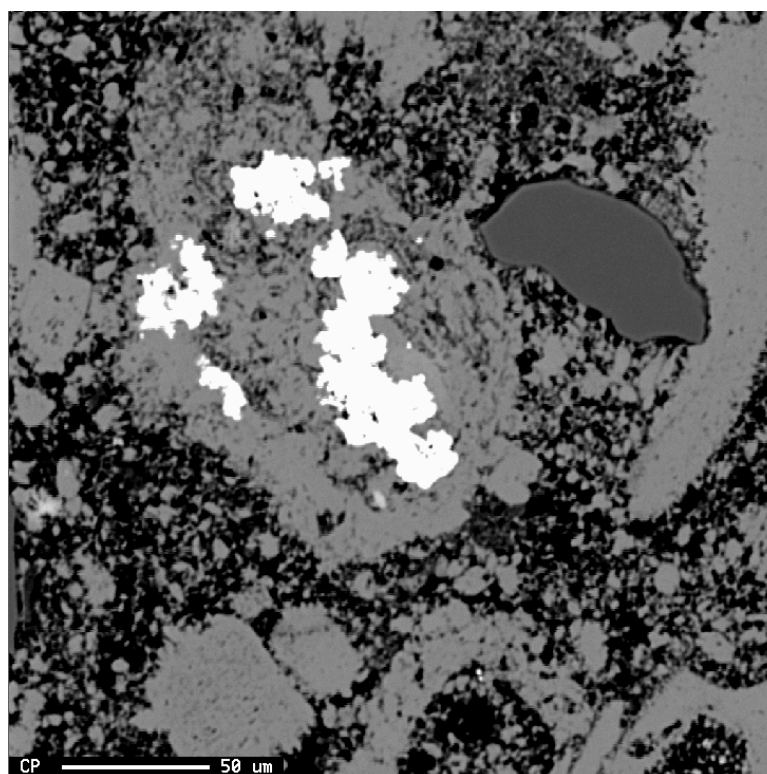


Figure 25. W-18778, 754-755' BLS. BSE image of pyrite clusters in foraminifera. Note darker gray quartz grain in top right corner.

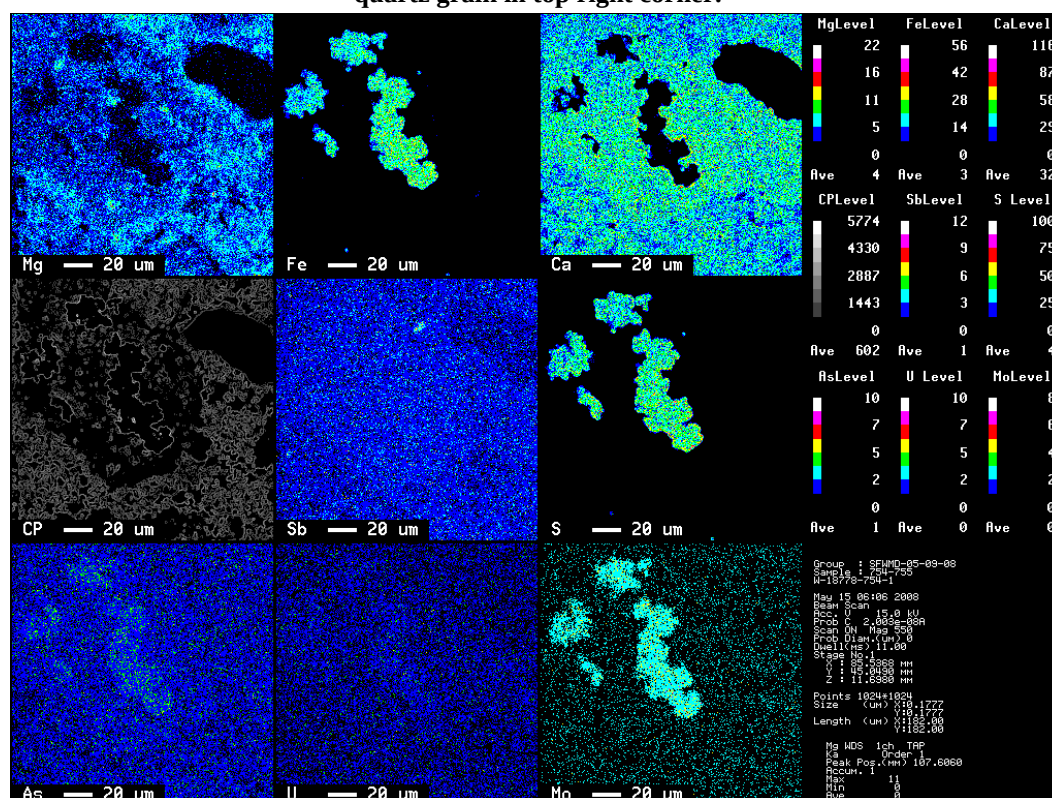


Figure 26. W-18778, 754-755' BLS. EPMA element maps of Figure 25 pyrite clusters. Note Mo and As maps.

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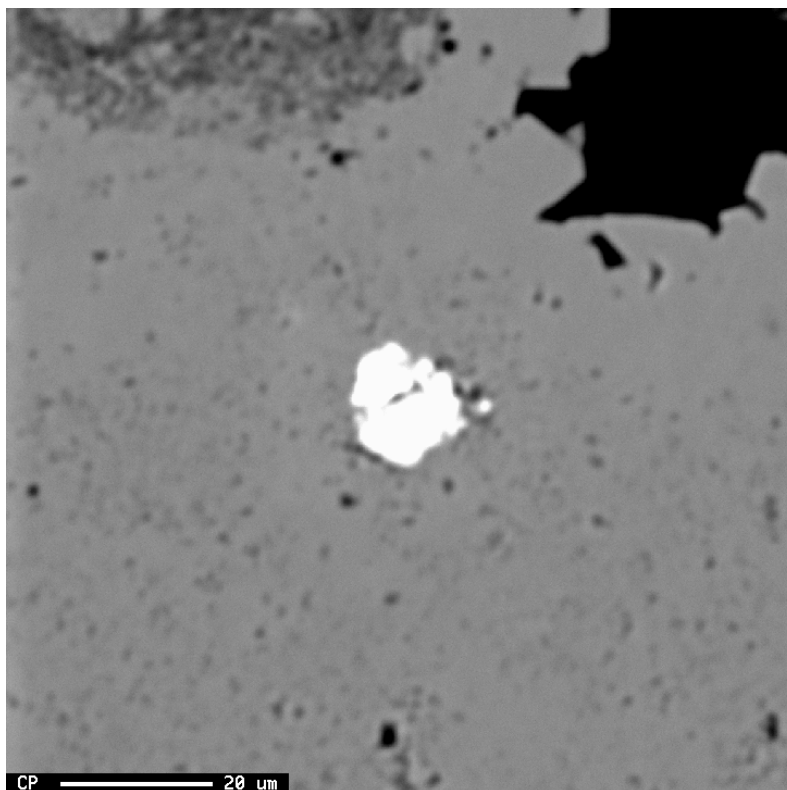


Figure 27. W-18778, 763-764' BLS. BSE image of ilmenite (?).

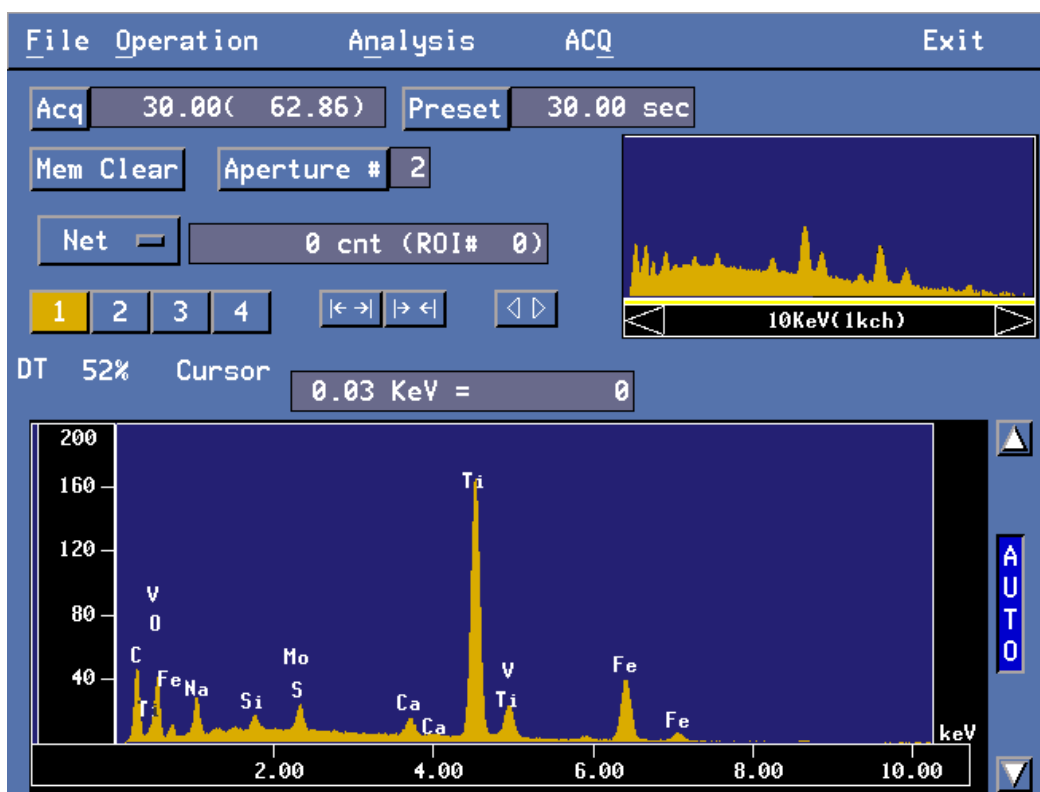


Figure 28. W-18778, 763-764' BLS. Spectra for ilmenite in Figure 27.

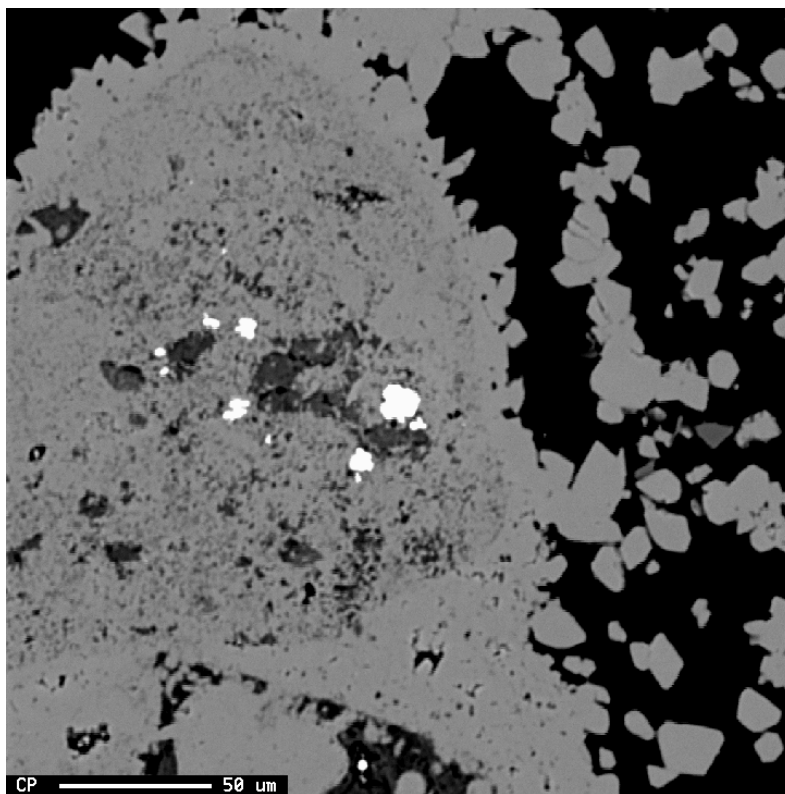


Figure 29. W-18778, 763-764' BLS. BSE image of pyrites.

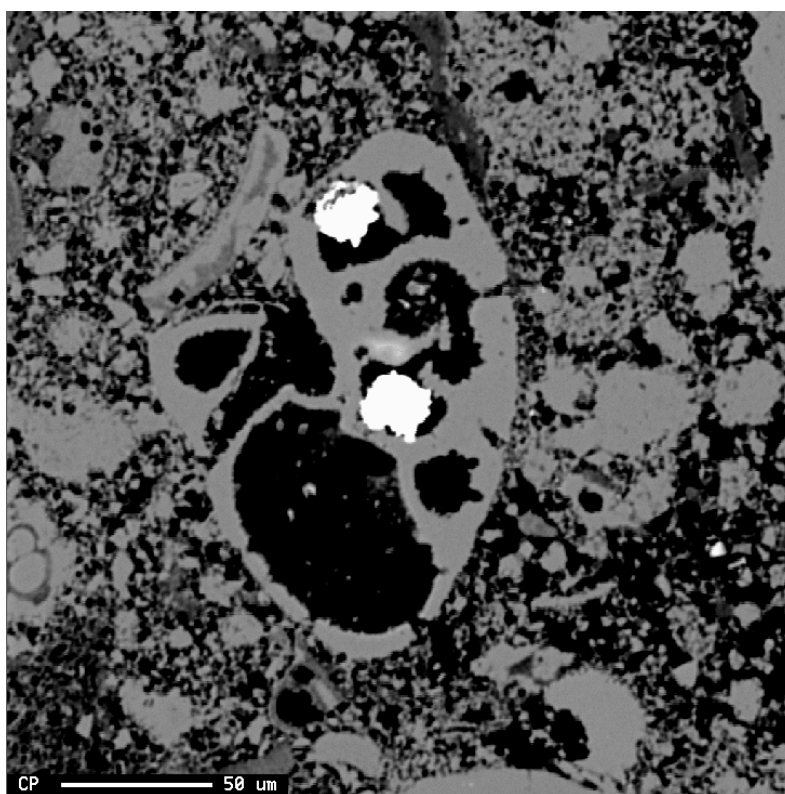


Figure 30. W-18778, 848-849' BLS. BSE image of pyrite framboids in foraminifera.

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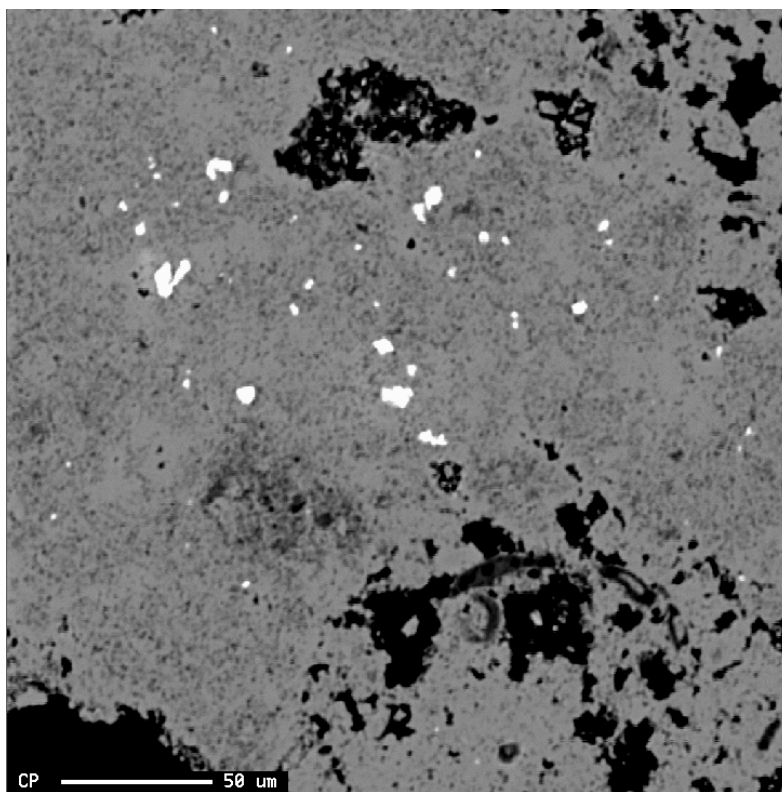


Figure 31. W-18778, 848-849' BLS. BSE image of scattered pyrite.

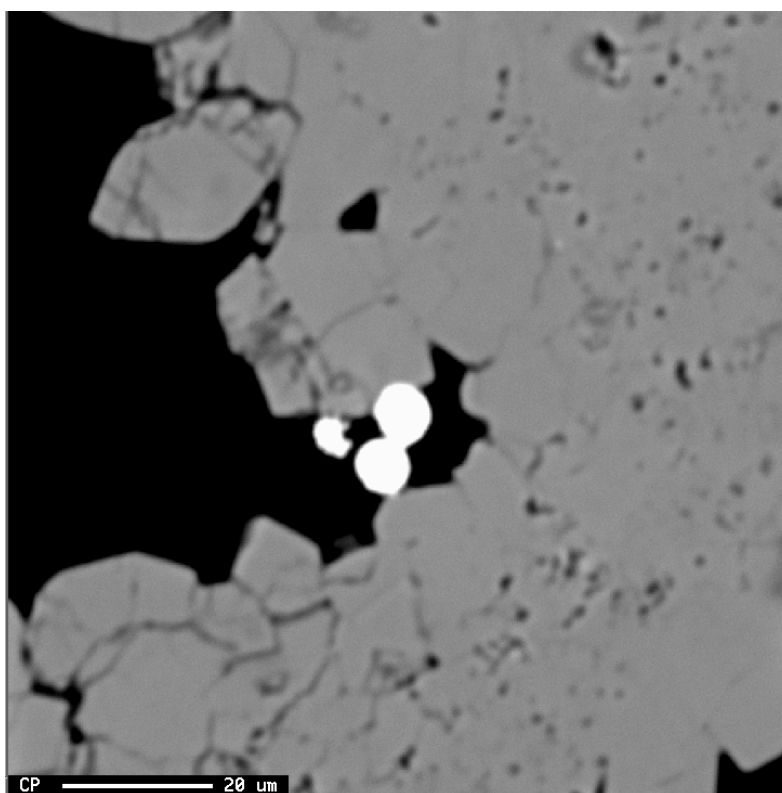


Figure 32. W-18778, 983-984' BLS. BSE image of pyrite framboids.

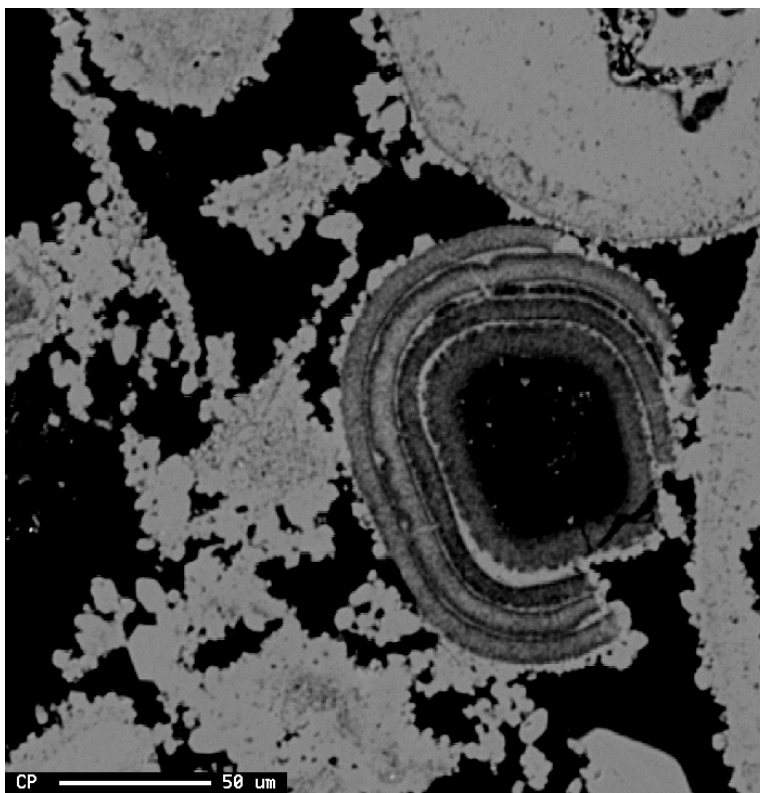


Figure 33. W-18778, 995-995' BLS. BSE image of ooid or pisoid?

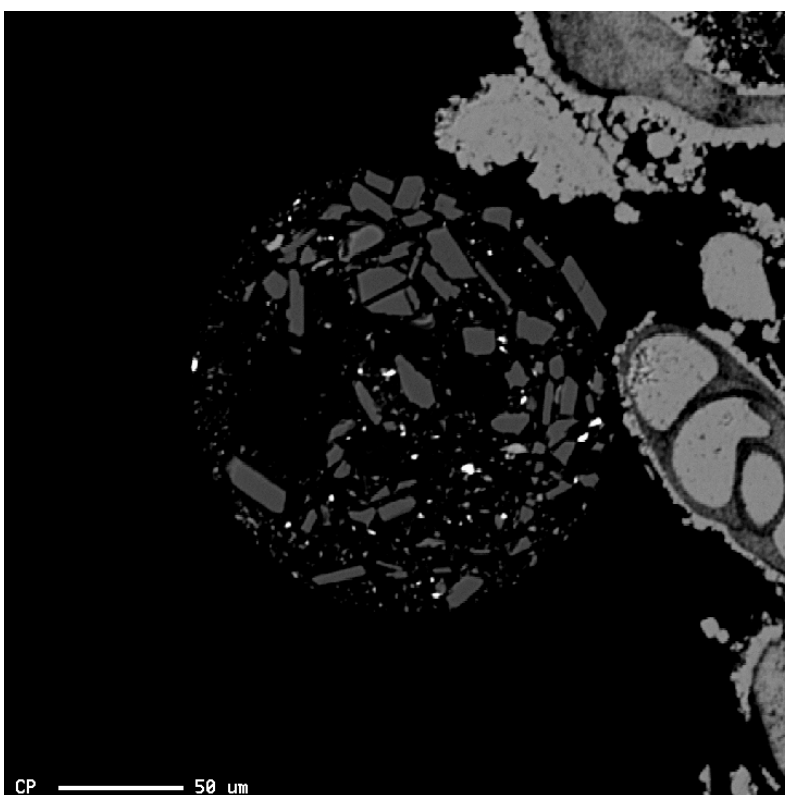


Figure 34. W-18778, 995-996' BLS. BSE image of spherical form comprised of angular fragments of Al and Si, bright spots are Fe (no S); further study is warranted.

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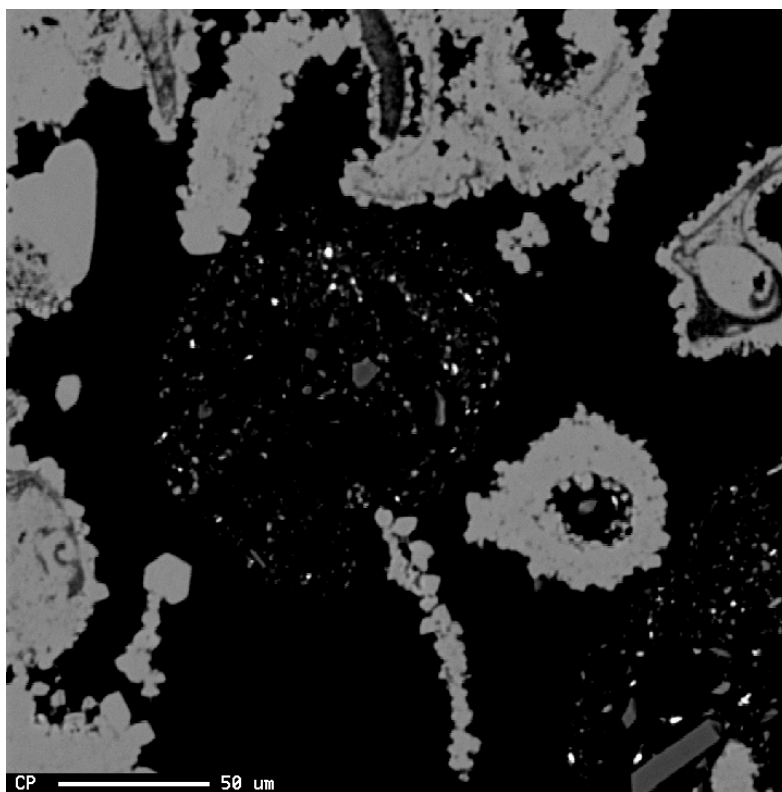


Figure 35. W-18778, 995-996' BLS. BSE image of same type of spherical form as seen in Figure 34.

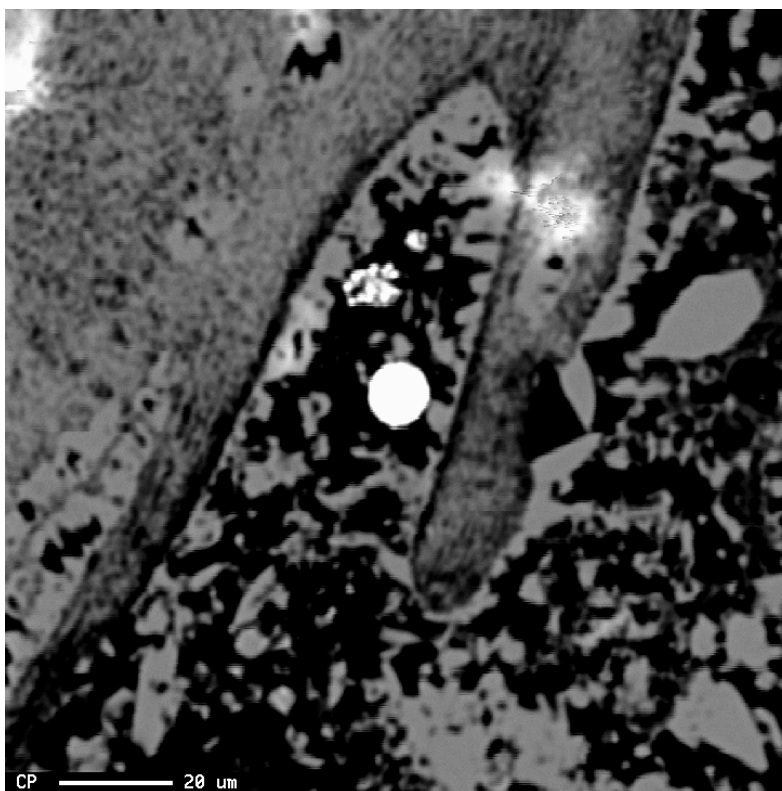


Figure 36. W-18778, 1119-1120' BLS. BSE image of pyrite framboid.

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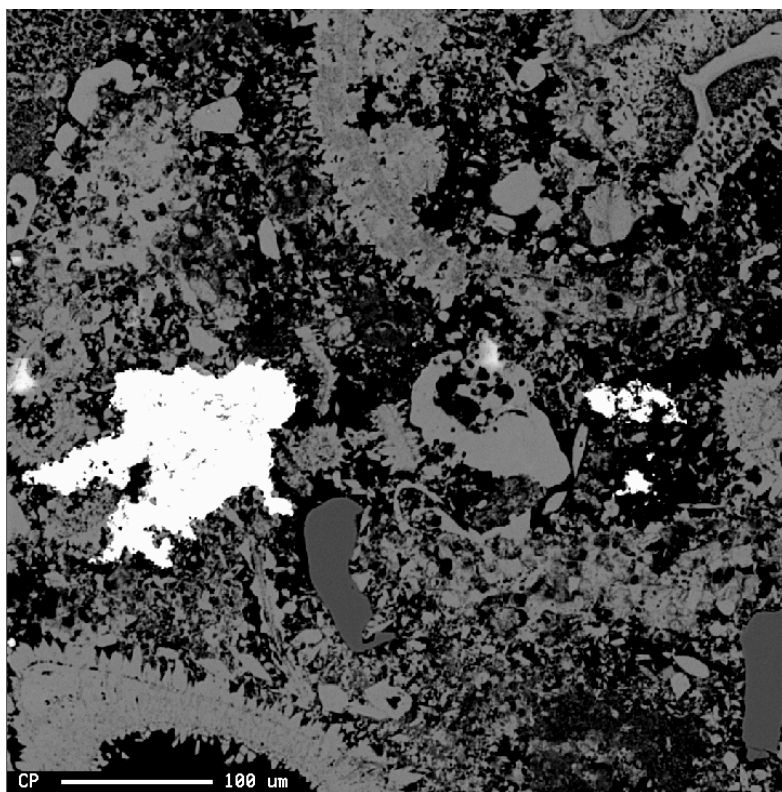


Figure 37. W-18778, 1119-1120' BLS. BSE image of pyrite.

Appendix 5.

Statistical summary of EPMA data.

Detection limit=0.02% (half detections used in calculations). **Statistical calculations include detects only.

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Pyrites									
	Fe	S	As	Mo	Sb	**As Detects			
Mean	45.10	46.90	0.19	0.58	0.06	0.25			
Standard Error	0.26	0.74	0.03	0.01	0.01	0.04			
Median	45.71	49.89	0.12	0.56	0.02	0.15			
Standard Deviation	2.83	7.99	0.32	0.14	0.08	0.35			
Minimum	32.22	20.10	0.01	0.34	0.01	0.03			
Maximum	49.82	54.68	2.17	1.61	0.52	2.17			
Count	117	117	117	117	117	91			
Carbonates									
	Mg	Fe	As	Ca	Mo	U	Sb	**As Detects	**Sb Detects
Mean	0.35	0.02	0.06	34.00	0.02	0.02	0.11	0.10	0.12
Standard Error	0.02	0.00	0.01	0.35	0.00	0.00	0.01	0.01	0.01
Median	0.34	0.01	0.03	35.49	0.01	0.01	0.10	0.08	0.11
Standard Deviation	0.16	0.02	0.08	4.81	0.01	0.03	0.08	0.09	0.08
Minimum	0.01	0.01	0.01	0.70	0.01	0.01	0.01	0.03	0.02
Maximum	0.86	0.14	0.60	38.46	0.07	0.12	0.60	0.60	0.60
Count	90	90	90	90	90	90	90	49	81
Dolomites									
	Mg	Fe	As	Ca	U	Sb	**As Detects	**Sb Detects	
Mean	9.53	0.02	0.04	22.85	0.03	0.09	0.06	0.09	
Standard Error	0.12	0.00	0.01	0.20	0.01	0.01	0.01	0.01	
Median	9.45	0.02	0.03	22.92	0.02	0.08	0.05	0.08	
Standard Deviation	0.52	0.02	0.03	0.88	0.03	0.05	0.02	0.04	
Minimum	8.34	0.01	0.01	20.10	0.01	0.01	0.03	0.04	
Maximum	10.41	0.06	0.09	24.28	0.10	0.18	0.09	0.18	
Count	20	20	20	20	20	20	11	18	

Appendix 6.

Electron probe microanalysis.

Detection limit is 200ppm=0.02% (below detection is shown as half detections and non-bold).

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Core ID (ft. BLS)	Percent	Mg	Fe	S	As	Ca	Mo	U	Sb	Total	Comment
<i>Calcites</i>											
W18728 2140-2160A		0.48	0.02	0.07	0.01	36.31	0.01	0.01	0.15	37.05	Carb
W18728 2140-2160A		0.86	0.01	0.08	0.01	36.94	0.01	0.02	0.09	38.05	Carb
W18728 2140-2160A		0.51	0.01	0.07	0.01	35.34	0.01	0.01	0.07	35.99	Carb
W18728 2140-2160A		0.47	0.01	0.06	0.01	35.77	0.04	0.01	0.11	36.45	Carb
W18728 2140-2160A		0.33	0.01	0.03	0.06	36.72	0.01	0.01	0.11	37.28	Carb
W18728 2140-2160A		0.47	0.02	0.05	0.10	36.69	0.01	0.01	0.13	37.48	Carb
W18728 2140-2160A		0.31	0.01	0.14	0.01	35.34	0.01	0.01	0.09	35.92	Carb
W18728 2140-2160A		0.44	0.01	0.04	0.04	33.24	0.01	0.01	0.14	33.95	Carb
W18728 2140-2160A		0.29	0.01	0.12	0.09	26.06	0.01	0.01	0.02	26.61	Carb
W18728 2140-2160A		0.34	0.04	0.05	0.01	34.59	0.01	0.01	0.03	35.07	Carb
W18728 2140-2160A		0.22	0.01	0.03	0.09	33.90	0.01	0.01	0.11	34.38	Carb
W18728 2140-2160B		0.30	0.05	0.01	0.01	33.62	0.01	0.01	0.04	34.03	Carb
W18728 2140-2160B		0.29	0.01	0.01	0.01	38.46	0.03	0.01	0.11	38.90	Carb
W18728 2140-2160B		0.38	0.01	0.05	0.10	30.40	0.01	0.01	0.08	31.02	Carb
W18728 2140-2160B		0.50	0.01	0.05	0.01	36.00	0.01	0.01	0.11	36.66	Carb
W18728 2140-2160B		0.14	0.01	0.01	0.05	30.33	0.01	0.05	0.08	30.69	Carb
W18728 2140-2160B		0.51	0.01	0.06	0.01	36.16	0.01	0.02	0.01	36.78	Carb
W18728 2140-2160B		0.59	0.01	0.06	0.10	35.73	0.01	0.07	0.08	36.65	Carb
W18776 657-658		0.41	0.01	0.01	0.04	31.15	0.01	0.01	0.16	31.78	Carb
W18776 657-658		0.30	0.01	0.01	0.01	36.65	0.01	0.12	0.05	37.13	Carb
W18776 657-658		0.44	0.01	0.01	0.01	36.65	0.01	0.07	0.37	37.57	Carb
W18776 662-663		0.44	0.01	0.03	0.01	35.03	0.05	0.01	0.10	35.66	Carb
W18776 662-663		0.44	0.03	0.01	0.12	34.36	0.01	0.01	0.21	35.21	Carb
W18776 662-663		0.28	0.04	0.04	0.01	38.01	0.01	0.01	0.11	38.51	Carb
W18776 662-663		0.43	0.03	0.02	0.01	33.03	0.01	0.01	0.13	33.68	Carb
W18776 662-663		0.17	0.03	0.36	0.11	36.42	0.07	0.12	0.12	37.42	Carb
W18776 662-663		0.37	0.01	0.01	0.07	31.84	0.01	0.03	0.03	32.37	Carb
W18776 723-724		0.49	0.01	0.02	0.01	33.55	0.01	0.01	0.22	34.28	Carb
W18776 723-724		0.58	0.01	0.04	0.01	37.63	0.01	0.04	0.18	38.47	Carb
W18776 723-724		0.32	0.03	0.01	0.09	32.32	0.01	0.01	0.16	32.94	Carb
W18776 723-724		0.34	0.01	0.01	0.01	31.69	0.01	0.01	0.08	32.14	Carb
W18776 805-806		0.54	0.01	0.04	0.06	35.29	0.01	0.01	0.12	36.07	Carb
W18776 805-806		0.40	0.02	0.02	0.03	38.06	0.01	0.08	0.10	38.74	Carb
W18776 805-806		0.45	0.02	0.01	0.01	36.07	0.04	0.09	0.09	36.76	Carb
W18776 805-806		0.29	0.01	0.01	0.01	34.02	0.02	0.02	0.16	34.52	Carb
W18776 812-813		0.54	0.01	0.07	0.04	30.58	0.02	0.01	0.12	31.39	Carb
W18776 812-813		0.48	0.01	0.05	0.10	34.69	0.01	0.01	0.08	35.44	Carb
W18776 812-813		0.55	0.01	0.13	0.03	30.86	0.01	0.05	0.10	31.73	Carb
W18776 812-813		0.73	0.01	0.08	0.01	34.80	0.01	0.06	0.01	35.67	Carb
W18776 812-813		0.65	0.01	0.09	0.07	35.44	0.01	0.01	0.07	36.36	Carb
W18776 812-813		0.62	0.01	0.11	0.01	33.33	0.01	0.01	0.15	34.22	Carb
W18778 754-755		0.19	0.14	0.04	0.05	36.54	0.01	0.01	0.09	37.07	Carb
W18778 754-755		0.38	0.08	0.18	0.01	35.28	0.01	0.04	0.11	36.07	Carb
W18778 754-755		0.11	0.03	0.02	0.03	37.27	0.03	0.01	0.60	38.12	Carb
W18778 754-755		0.37	0.02	0.05	0.08	32.21	0.01	0.05	0.13	32.95	Carb
W18778 754-755		0.11	0.03	0.06	0.01	36.15	0.01	0.01	0.01	36.35	Carb
W18778 754-755		0.20	0.01	0.04	0.10	38.20	0.01	0.01	0.13	38.71	Carb
W18778 763-764		0.23	0.01	0.08	0.01	26.16	0.01	0.06	0.15	26.71	Carb?
W18778 763-764		0.18	0.01	0.04	0.05	37.63	0.01	0.01	0.20	38.13	Carb
W18778 763-764		0.33	0.01	0.16	0.04	33.00	0.03	0.01	0.01	33.58	Carb
W18778 763-764		0.29	0.01	0.13	0.01	30.26	0.03	0.01	0.13	30.87	Carb
W18778 763-764		0.46	0.01	0.09	0.07	35.83	0.02	0.04	0.04	36.57	Carb
W18778 763-764		0.15	0.01	0.03	0.03	37.25	0.01	0.01	0.13	37.62	Carb
W18778 763-764		0.27	0.01	0.12	0.01	29.17	0.01	0.08	0.08	29.76	Carb
W18778 763-764		0.39	0.05	0.09	0.14	34.94	0.01	0.01	0.14	35.80	Carb
W18778 763-764		0.62	0.01	0.15	0.01	37.10	0.01	0.01	0.10	37.97	Carb
W18778 763-764		0.30	0.04	0.04	0.15	37.60	0.01	0.01	0.01	38.16	Carb
W18778 763-764		0.31	0.05	0.13	0.05	35.82	0.01	0.01	0.14	36.51	Carb
W18778 848-849		0.31	0.01	0.17	0.03	36.50	0.01	0.01	0.08	37.13	Carb
W18778 848-849		0.35	0.09	0.15	0.13	37.59	0.01	0.03	0.07	38.44	Carb
W18778 848-849		0.39	0.01	0.17	0.13	36.08	0.01	0.06	0.19	37.04	Carb

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Core ID (ft. BLS)	Percent	Mg	Fe	S	As	Ca	Mo	U	Sb	Total	Comment
W18778 848-849	0.34	0.04	0.15	0.13	37.27	0.01	0.01	0.01	0.01	37.95	Carb
W18778 848-849	0.32	0.01	0.13	0.04	37.06	0.01	0.01	0.24	0.01	37.85	Carb
W18778 848-849	0.40	0.01	0.15	0.08	36.73	0.01	0.01	0.14	0.01	37.53	Carb
W18778 848-849	0.31	0.03	0.15	0.01	35.93	0.01	0.04	0.16	0.01	36.62	Carb
W18778 848-849	0.30	0.01	0.16	0.27	37.14	0.01	0.04	0.01	0.01	37.95	Carb
W18778 983-984	0.24	0.01	0.10	0.22	30.81	0.01	0.01	0.08	0.01	31.49	Carb
W18778 983-984	0.14	0.01	0.12	0.17	37.72	0.03	0.01	0.14	0.01	38.36	Carb
W18778 983-984	0.18	0.01	0.08	0.23	38.15	0.03	0.01	0.08	0.01	38.78	Carb
W18778 983-984	0.11	0.07	0.11	0.01	33.21	0.01	0.01	0.09	0.01	33.60	Carb
W18778 983-984	0.32	0.01	0.12	0.05	30.51	0.03	0.01	0.09	0.01	31.15	Carb
W18778 983-984	0.05	0.01	0.09	0.01	37.45	0.02	0.02	0.16	0.01	37.83	Carb
W18778 983-984	0.29	0.01	0.09	0.01	36.68	0.01	0.01	0.05	0.01	37.13	Carb
W18778 983-984	0.06	0.01	0.15	0.01	35.67	0.02	0.01	0.10	0.01	35.99	Carb
W18778 995-996	0.38	0.02	0.08	0.01	36.47	0.01	0.09	0.13	0.01	37.20	Carb
W18778 995-996	0.33	0.01	0.11	0.01	35.43	0.01	0.01	0.18	0.01	36.07	Carb
W18778 995-996	0.18	0.01	0.08	0.03	25.77	0.01	0.03	0.03	0.01	26.14	Carb
W18778 995-996	0.22	0.01	0.14	0.60	33.24	0.03	0.04	0.18	0.01	34.53	Carb
W18778 995-996	0.20	0.04	0.09	0.13	25.07	0.01	0.01	0.07	0.01	25.61	Carb
W18778 995-996	0.12	0.02	0.10	0.04	36.76	0.01	0.01	0.11	0.01	37.17	Carb
W18778 995-996	0.16	0.01	0.06	0.01	24.16	0.01	0.03	0.05	0.01	24.49	Carb
W18778 995-996	0.22	0.01	0.09	0.01	29.56	0.01	0.03	0.18	0.01	30.12	Carb
W18778 1119-1120	0.43	0.01	0.06	0.03	31.24	0.03	0.01	0.12	0.01	31.92	Carb
W18778 1119-1120	0.46	0.02	0.05	0.01	29.62	0.04	0.07	0.09	0.01	30.37	Carb
W18778 1119-1120	0.45	0.01	0.04	0.01	35.94	0.02	0.01	0.13	0.01	36.61	Carb
W18778 1119-1120	0.68	0.01	0.03	0.01	35.98	0.04	0.01	0.01	0.01	36.74	Carb
W18778 1119-1120	0.36	0.01	0.06	0.13	30.39	0.01	0.01	0.06	0.01	31.03	Carb
W18778 1119-1120	0.51	0.01	0.03	0.06	36.41	0.01	0.01	0.06	0.01	37.11	Carb
W18778 1119-1120	0.41	0.01	0.06	0.21	35.53	0.01	0.02	0.06	0.01	36.32	Carb
Dolomites											
W18776 657-658	9.84	0.01	0.02	0.07	22.93	0.02	0.04	0.10	0.01	33.04	Dolo
W18776 657-658	9.85	0.01	0.03	0.01	22.85	0.01	0.07	0.07	0.01	32.89	Dolo
W18776 657-658	9.46	0.04	0.03	0.01	22.61	0.01	0.05	0.07	0.01	32.30	Dolo
W18776 662-663	10.41	0.06	0.02	0.01	24.13	0.03	0.04	0.01	0.01	34.70	Dolo
W18776 662-663	9.38	0.02	0.03	0.07	21.47	0.01	0.01	0.17	0.01	31.16	Dolo
W18776 662-663	9.44	0.01	0.03	0.01	22.91	0.02	0.01	0.13	0.01	32.56	Dolo
W18776 662-663	9.76	0.03	0.03	0.03	23.41	0.01	0.01	0.18	0.01	33.45	Dolo
W18776 723-724	10.24	0.01	0.01	0.05	22.88	0.01	0.01	0.08	0.01	33.29	Dolo
W18776 723-724	9.73	0.01	0.04	0.01	23.39	0.01	0.01	0.08	0.01	33.26	Dolo
W18776 723-724	9.35	0.01	0.03	0.05	22.98	0.01	0.06	0.01	0.01	32.50	Dolo
W18776 723-724	8.94	0.04	0.03	0.04	22.78	0.00	0.01	0.05	0.01	31.89	Dolo
W18776 723-724	9.29	0.04	0.03	0.01	22.65	0.01	0.03	0.08	0.01	32.13	Dolo
W18776 723-724	9.70	0.04	0.03	0.04	22.87	0.01	0.01	0.10	0.01	32.80	Dolo
W18776 805-806	8.82	0.01	0.04	0.01	23.11	0.01	0.03	0.12	0.01	32.12	Dolo
W18776 805-806	9.17	0.01	0.07	0.07	23.00	0.01	0.10	0.05	0.01	32.50	Dolo
W18776 805-806	9.09	0.03	0.10	0.07	23.29	0.01	0.01	0.14	0.01	32.74	Dolo -partial
W18776 805-806	10.33	0.03	0.01	0.05	22.23	0.01	0.03	0.04	0.01	32.74	Dolo
W18776 812-813	8.34	0.01	0.04	0.01	20.10	0.02	0.01	0.06	0.01	28.57	Dolo
W18778 652-653	9.97	0.01	0.04	0.01	24.28	0.01	0.01	0.08	0.01	34.37	Dolo
W18778 652-653	9.44	0.02	0.17	0.09	23.21	0.01	0.09	0.10	0.01	33.14	Dolo
Pyrites											
W18728 2140-2160A	0.02	44.22	49.09	1.04	1.01	0.48	0.01	0.01	0.01	95.96	Pyrite
W18728 2140-2160A	0.01	43.91	49.58	2.17	0.81	0.50	0.01	0.52	0.01	97.67	Pyrite
W18728 2140-2160A	0.01	43.71	49.81	1.88	1.06	0.52	0.03	0.42	0.01	97.58	Pyrite
W18728 2140-2160A	0.01	44.99	51.50	0.22	1.34	0.50	0.10	0.07	0.01	98.76	Pyrite
W18728 2140-2160A	0.24	47.65	24.26	0.36	1.30	0.65	0.01	0.19	0.01	74.70	Pyrite
W18728 2140-2160A	0.01	41.87	46.45	0.01	1.21	0.52	0.01	0.02	0.01	90.18	Pyrite
W18728 2140-2160A	0.03	41.31	48.12	0.37	2.60	0.37	0.01	0.09	0.01	92.94	Pyrite
W18728 2140-2160A	0.13	46.13	32.98	0.30	2.66	0.49	0.01	0.10	0.01	82.83	Pyrite
W18728 2140-2160B	0.84	42.89	22.68	0.30	4.23	0.49	0.01	0.09	0.01	71.56	Pyrite
W18776 657-658	0.24	44.67	35.82	0.37	1.14	0.84	0.01	0.08	0.01	83.22	Pyrite
W18776 657-658	0.01	46.60	52.99	0.01	1.74	0.56	0.07	0.01	0.01	102.03	Pyrite
W18776 657-658	0.01	45.71	52.75	0.01	0.61	0.49	0.02	0.09	0.01	99.67	Pyrite

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Core ID (ft. BLS)	Percent	Mg	Fe	S	As	Ca	Mo	U	Sb	Total	Comment
W18776 657-658		0.22	40.14	37.48	0.25	1.16	0.69	0.01	0.22	80.20	Pyrite
W18776 657-658		0.01	40.95	30.25	0.25	1.31	0.45	0.01	0.05	73.38	Pyrite
W18776 657-658		0.03	45.00	38.22	0.12	0.94	0.59	0.01	0.07	84.99	Pyrite
W18776 657-658		0.05	45.79	40.77	0.01	0.67	0.52	0.08	0.01	87.88	Pyrite
W18776 657-658		0.09	43.83	47.34	0.26	0.76	0.77	0.01	0.05	93.12	Pyrite
W18776 657-658		0.03	45.98	46.61	0.05	1.03	0.48	0.03	0.01	94.22	Pyrite
W18776 657-658		0.52	40.43	30.12	0.20	0.79	0.63	0.01	0.14	72.87	Pyrite
W18776 657-658		0.09	43.89	50.93	0.19	0.71	0.60	0.01	0.01	96.46	Pyrite
W18776 662-663		0.01	46.47	52.69	1.04	0.58	0.56	0.04	0.29	101.74	Pyrite
W18776 662-663		0.05	45.63	53.29	1.66	0.80	0.52	0.19	0.13	102.39	Pyrite
W18776 662-663		0.01	49.82	54.68	0.08	0.67	0.52	0.01	0.01	105.82	Pyrite
W18776 662-663		0.01	48.40	54.67	0.15	0.58	0.57	0.01	0.12	104.51	Pyrite
W18776 662-663		0.08	42.51	28.27	0.08	1.15	0.85	0.01	0.04	73.02	Pyrite
W18776 662-663		0.05	47.39	47.31	0.27	0.95	0.55	0.01	0.01	96.55	Pyrite
W18776 662-663		0.01	47.46	54.29	0.19	0.46	0.62	0.01	0.01	103.05	Pyrite
W18776 662-663		0.01	47.87	53.48	0.01	0.51	0.54	0.01	0.01	102.41	Pyrite
W18776 662-663		0.01	48.06	54.21	0.01	0.54	0.51	0.02	0.01	103.37	Pyrite
W18776 723-724		0.01	46.98	20.10	0.19	0.27	0.62	0.01	0.17	68.37	Pyrite
W18776 723-724		0.01	46.88	53.01	0.05	0.62	0.56	0.11	0.03	101.29	Pyrite
W18776 723-724		0.01	48.53	52.84	0.10	0.89	0.50	0.12	0.10	103.12	Pyrite
W18776 723-724		0.04	46.57	49.89	0.01	0.62	0.61	0.01	0.09	97.84	Pyrite
W18776 723-724		0.52	45.31	33.99	0.27	2.46	0.41	0.01	0.01	83.00	Pyrite
W18776 723-724		0.05	44.69	50.21	0.12	0.73	0.47	0.01	0.01	96.27	Pyrite
W18776 723-724		0.05	47.10	43.47	0.03	0.92	0.63	0.01	0.01	92.31	Pyrite
W18776 723-724		0.01	48.23	53.35	0.08	0.52	0.54	0.15	0.01	102.88	Pyrite
W18776 723-724		0.36	44.60	30.49	0.26	1.06	0.43	0.01	0.10	77.34	Pyrite
W18776 723-724		0.25	44.71	34.41	0.14	1.07	0.52	0.01	0.09	81.22	Pyrite
W18776 805-806		0.01	42.86	51.06	0.10	0.66	0.70	0.01	0.01	95.41	Pyrite
W18776 805-806		0.01	46.09	52.01	0.09	0.67	0.59	0.01	0.01	99.47	Pyrite
W18776 805-806		0.01	42.15	50.88	0.06	1.03	0.69	0.01	0.01	94.85	Pyrite
W18776 805-806		0.01	46.90	52.96	0.01	0.67	0.53	0.01	0.01	101.06	Pyrite
W18776 805-806		0.01	47.51	52.57	0.04	0.65	0.60	0.08	0.01	101.46	Pyrite
W18776 805-806		0.01	45.90	52.57	0.01	0.46	0.52	0.01	0.03	99.50	Pyrite
W18776 812-813		0.09	43.01	39.28	0.25	1.41	0.61	0.01	0.05	84.74	Pyrite
W18776 812-813		0.04	40.98	41.47	0.23	2.06	0.69	0.01	0.01	85.51	Pyrite
W18776 812-813		0.10	41.67	46.55	0.01	2.37	0.57	0.01	0.01	91.27	Pyrite
W18776 812-813		0.12	40.55	26.36	0.30	0.89	0.66	0.07	0.01	69.00	Pyrite
W18776 812-813		0.05	39.59	46.36	0.12	1.35	0.50	0.01	0.05	88.02	Pyrite
W18776 812-813		0.03	43.80	49.81	0.13	1.32	0.58	0.03	0.01	95.71	Pyrite
W18776 812-813		0.13	39.59	37.53	0.13	2.43	0.65	0.11	0.03	80.62	Pyrite
W18776 812-813		0.02	44.68	48.97	0.10	0.58	0.66	0.01	0.01	95.03	Pyrite
W18776 812-813		0.01	41.97	49.71	0.13	0.81	0.60	0.01	0.01	93.27	Pyrite
W18776 812-813		0.04	44.21	49.89	0.01	0.81	0.52	0.01	0.08	95.59	Pyrite
W18776 812-813		0.06	40.85	46.93	0.03	0.77	0.51	0.01	0.03	89.19	Pyrite
W18776 812-813		0.03	39.14	43.01	0.10	0.83	0.50	0.02	0.17	83.83	Pyrite
W18778 652-653		0.02	43.90	51.29	0.04	0.51	0.63	0.01	0.05	96.47	Pyrite
W18778 652-653		0.06	44.35	52.42	0.06	0.75	0.59	0.01	0.01	98.25	Pyrite
W18778 652-653		0.04	44.55	50.23	0.11	0.61	0.65	0.01	0.19	96.39	Pyrite
W18778 652-653		0.04	44.12	50.55	0.01	0.61	0.65	0.01	0.01	95.97	Pyrite
W18778 652-653		0.01	44.64	51.82	0.07	0.35	0.60	0.03	0.01	97.53	Pyrite
W18778 652-653		0.28	41.71	45.77	0.25	0.65	0.55	0.01	0.03	89.27	Pyrite
W18778 652-653		0.01	46.65	53.96	0.13	0.39	0.61	0.01	0.01	101.77	Pyrite
W18778 652-653		0.01	43.93	49.73	0.09	1.05	0.60	0.01	0.01	95.45	Pyrite
W18778 652-653		0.03	43.74	51.31	0.14	0.37	0.63	0.01	0.01	96.24	Pyrite
W18778 754-755		0.01	46.92	52.18	0.16	0.70	0.65	0.03	0.01	100.67	Pyrite
W18778 754-755		0.01	46.71	51.76	0.09	1.35	0.76	0.05	0.03	100.79	Pyrite
W18778 754-755		0.05	44.45	49.04	0.01	2.25	0.55	0.01	0.11	96.45	Pyrite
W18778 754-755		0.02	46.04	51.97	0.31	0.60	0.63	0.01	0.19	99.80	Pyrite
W18778 754-755		0.04	44.22	45.01	0.01	3.15	0.53	0.01	0.11	93.04	Pyrite
W18778 754-755		0.04	42.79	43.43	0.21	3.03	0.48	0.01	0.08	90.09	Pyrite
W18778 754-755		0.06	46.79	51.38	0.15	0.34	0.62	0.01	0.01	99.37	Pyrite
W18778 754-755		0.01	45.08	48.14	0.27	1.67	0.62	0.01	0.03	95.84	Pyrite

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Core ID (ft. BLS)	Percent	Mg	Fe	S	As	Ca	Mo	U	Sb	Total	Comment
W18778 754-755	0.01	46.35	51.32	0.15	0.91	0.66	0.03	0.01	0.01	99.45	Pyrite
W18778 754-755	0.03	49.15	54.33	0.18	0.10	0.57	0.01	0.05	0.05	104.43	Pyrite
W18778 754-755	0.01	45.82	52.34	0.01	0.52	0.51	0.04	0.01	0.01	99.25	Pyrite
W18778 763-764	0.09	47.90	34.25	0.18	1.63	0.59	0.01	0.12	0.12	84.78	Pyrite
W18778 763-764	0.01	47.02	52.79	0.01	0.54	0.66	0.01	0.01	0.01	101.04	Pyrite
W18778 763-764	0.01	45.56	49.70	0.23	2.13	0.48	0.01	0.20	0.20	98.33	Pyrite
W18778 763-764	0.01	47.50	52.72	0.01	0.72	0.58	0.01	0.01	0.01	101.57	Pyrite
W18778 763-764	0.07	49.15	34.58	0.26	1.51	0.68	0.08	0.01	0.01	86.36	Pyrite
W18778 763-764	0.11	49.15	38.24	0.33	1.26	0.77	0.04	0.01	0.01	89.94	Pyrite
W18778 763-764	0.13	48.90	37.12	0.24	1.96	0.69	0.01	0.03	0.03	89.10	Pyrite
W18778 763-764	0.08	47.67	39.56	0.13	1.21	0.64	0.01	0.01	0.01	89.32	Pyrite
W18778 848-849	0.01	48.14	53.18	0.01	0.51	0.51	0.01	0.01	0.01	102.36	Pyrite
W18778 848-849	0.03	44.15	48.62	0.19	2.70	0.55	0.01	0.01	0.01	96.26	Pyrite
W18778 848-849	0.07	47.38	41.17	0.48	1.21	0.79	0.01	0.12	0.12	91.27	Pyrite
W18778 848-849	0.01	47.02	52.43	0.10	0.83	0.55	0.01	0.01	0.01	100.95	Pyrite
W18778 848-849	0.06	44.33	46.00	0.48	3.54	0.62	0.01	0.07	0.07	95.15	Pyrite
W18778 848-849	0.01	47.38	53.27	0.22	0.54	0.56	0.01	0.01	0.01	102.01	Pyrite
W18778 848-849	0.01	43.37	46.12	0.05	1.38	0.50	0.01	0.01	0.01	91.62	Pyrite
W18778 848-849	0.01	47.33	52.42	0.18	0.24	0.58	0.01	0.01	0.01	100.77	Pyrite
W18778 848-849	0.02	47.46	49.30	0.24	0.53	0.53	0.05	0.03	0.03	98.20	Pyrite
W18778 848-849	0.01	41.04	51.87	0.12	0.57	0.49	0.01	0.08	0.08	94.20	Pyrite
W18778 848-849	0.01	48.48	53.20	0.03	0.33	0.41	0.01	0.01	0.01	102.46	Pyrite
W18778 983-984	0.01	45.72	52.98	0.01	0.55	0.56	0.08	0.01	0.01	99.90	Pyrite
W18778 983-984	0.01	49.07	54.19	0.01	0.37	0.51	0.05	0.02	0.02	104.21	Pyrite
W18778 983-984	0.01	46.40	52.92	0.01	0.39	0.56	0.01	0.01	0.01	100.29	Pyrite
W18778 983-984	0.01	47.39	52.77	0.09	0.41	0.47	0.04	0.07	0.07	101.26	Pyrite
W18778 983-984	0.01	47.83	52.80	0.18	0.67	0.50	0.12	0.01	0.01	102.14	Pyrite
W18778 983-984	0.01	47.37	54.23	0.09	0.52	0.50	0.01	0.03	0.03	102.75	Pyrite
W18778 983-984	0.01	47.17	51.90	0.10	0.56	0.59	0.01	0.01	0.01	100.33	Pyrite
W18778 983-984	0.01	47.97	53.80	0.07	0.31	0.53	0.01	0.04	0.04	102.75	Pyrite
W18778 995-996	0.01	42.05	44.04	0.05	1.28	0.46	0.03	0.07	0.07	88.01	Pyrite
W18778 995-996	0.01	48.41	53.53	0.01	0.63	0.56	0.01	0.01	0.01	103.13	Pyrite
W18778 995-996	0.01	42.64	47.89	0.01	1.51	0.48	0.01	0.01	0.01	92.57	Pyrite
W18778 995-996	0.01	46.83	53.66	0.06	0.58	0.52	0.04	0.01	0.01	101.71	Pyrite
W18778 995-996	0.01	47.16	52.48	0.01	0.56	0.49	0.02	0.01	0.01	100.75	Pyrite
W18778 995-996	0.01	47.53	51.66	0.01	0.35	0.51	0.01	0.12	0.12	100.17	Pyrite
W18778 1119-1120	0.05	42.02	44.67	0.05	2.75	0.50	0.03	0.01	0.01	90.10	Pyrite
W18778 1119-1120	0.04	42.87	47.69	0.04	0.64	1.61	0.01	0.10	0.10	93.01	Pyrite
W18778 1119-1120	0.01	38.77	47.81	0.15	0.51	1.26	0.08	0.11	0.11	88.73	Pyrite
W18778 1119-1120	0.01	46.90	52.20	0.01	0.57	0.57	0.06	0.01	0.01	100.34	Pyrite
W18778 1119-1120	0.08	44.23	38.24	0.22	1.09	0.57	0.01	0.01	0.01	84.44	Pyrite
W18778 1119-1120	0.01	46.57	52.37	0.40	0.27	0.66	0.03	0.19	0.19	100.52	Pyrite
<i>Other</i>											
W18776 657-653	0.01	0.01	0.01	0.01	0.01	0.63	0.03	0.01	0.01	0.71	Unknown
W18778 652-653	0.01	0.03	0.03	0.03	BDL	0.01	0.01	0.65	0.78	0.78	K, Al, Si
W18778 652-653	0.01	0.05	0.01	0.01	0.03	0.01	0.01	0.01	0.14	0.14	QTZ
W18778 652-653	0.01	0.01	0.15	0.04	5.37	0.01	0.01	0.05	5.62	5.62	phosphate
W18778 763-764	0.22	0.01	0.06	0.09	22.29	0.01	0.01	0.09	22.79	22.79	Organics?
W18778 763-764	0.17	19.73	0.33	0.03	1.05	0.01	0.06	0.16	21.54	21.54	Ti, Fe

Appendix 7.

Whole rock geochemical analysis (BDL=below detection limit).

See list of abbreviations and acronyms for analysis methods.

***A=Avon Park Formation, O=Ocala Limestone, S=Suwannee Limestone, H=Hawthorn Group.**

FLORIDA GEOLOGICAL SURVEY

Analyte Symbol	Depth_min	Depth_max	Formation*	County	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	LOI	Total
Unit Symbol	ft BLS	ft BLS			%	%	%	%	%	%	%	%	%	%	%	%
Detection Limit					0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01	0.01	0.01
Analysis Method					FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP
W-18728	2140	2160A	A	Palm Beach	0.15	0.02	0.03	BDL	0.9	56.01	0.17	0.06	BDL	BDL	43.59	100.9
W-18728	2140	2160B	A	Palm Beach	0.13	0.02	0.02	BDL	0.89	56.13	0.15	BDL	BDL	BDL	43.64	101
W-18776	657	658	O	Okeechobee	0.36	0.11	0.07	0.002	1.16	55.98	0.03	0.1	BDL	0.02	42.92	100.7
W-18776	662	663	O	Okeechobee	0.46	0.13	0.05	0.002	1.24	55.41	0.02	0.08	BDL	0.03	42.9	100.3
W-18776	723	724	O	Okeechobee	0.36	0.12	0.04	BDL	1.83	54.45	0.02	0.08	BDL	BDL	43.67	100.6
W-18776	805	806	A	Okeechobee	0.66	0.2	0.12	0.004	6.06	48.69	0.03	0.07	0.006	0.03	43.66	99.53
W-18776	812	813	A	Okeechobee	2.92	0.96	0.19	0.004	1.5	50.18	0.11	0.34	0.013	0.05	42.34	98.61
W-18778	652	653	H	LEE	18.28	2.16	0.38	0.008	14.17	26.43	0.55	0.45	0.144	2.38	33.86	98.82
W-18778	754	755	H	LEE	15.95	1.41	0.29	0.004	0.91	44.83	0.19	0.34	0.087	0.29	35.66	99.95
W-18778	763	764	S	LEE	0.69	0.06	0.03	0.002	0.51	55.81	0.07	BDL	BDL	0.05	43.18	100.3
W-18778	848	849	S	LEE	1.05	0.29	0.08	BDL	0.5	54.86	0.07	0.01	0.007	BDL	43.07	99.95
W-18778	983	984	S	LEE	0.35	0.07	0.03	BDL	0.32	56.47	0.05	BDL	BDL	0.01	43.4	100.7
W-18778	995	996	S	LEE	0.39	0.05	0.02	BDL	0.48	56.25	0.07	BDL	BDL	0.01	43.41	100.6
W-18778	1119	1120	S	LEE	0.5	0.03	0.02	BDL	0.96	55.12	0.08	BDL	BDL	0.03	43.55	100.2

Analyte Symbol	Depth_min	Depth_max	Formation*	County	Au	Ag	As	Ba	Be	Bi	Br	Cd	Co	Cr	Cs	Cu
Unit Symbol	ft BLS	ft BLS			ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Detection Limit					1	0.5	1	1	1	0.1	0.5	0.5	0.1	0.5	0.1	1
Analysis Method					INAA	TD-ICP	INAA	FUS-ICP	FUS-ICP	FUS-MS	INAA	TD-ICP	INAA	INAA	FUS-MS	TD-ICP
W-18728	2140	2160A	A	Palm Beach	BDL	BDL	BDL	16	BDL	BDL	6.6	BDL	BDL	12.8	BDL	2
W-18728	2140	2160B	A	Palm Beach	BDL	0.6	BDL	16	BDL	BDL	5.5	BDL	BDL	13	BDL	2
W-18776	657	658	O	Okeechobee	BDL	0.6	2	40	BDL	BDL	2.6	BDL	0.3	9.3	BDL	11
W-18776	662	663	O	Okeechobee	BDL	0.6	2	11	BDL	BDL	1.8	BDL	0.3	11.7	BDL	9
W-18776	723	724	O	Okeechobee	BDL	0.6	BDL	10	BDL	BDL	1.8	BDL	BDL	5.2	BDL	6
W-18776	805	806	A	Okeechobee	BDL	BDL	BDL	12	BDL	BDL	2.3	BDL	0.8	11.3	BDL	7
W-18776	812	813	A	Okeechobee	BDL	1.1	3	61	BDL	BDL	2.7	BDL	0.9	8.3	0.1	8
W-18778	652	653	H	LEE	BDL	0.6	2	100	BDL	BDL	2.1	BDL	1.2	36.1	0.2	1
W-18778	754	755	H	LEE	BDL	0.7	1	73	BDL	BDL	1.6	BDL	0.9	20.2	0.3	2
W-18778	763	764	S	LEE	BDL	0.8	BDL	11	BDL	BDL	1.1	BDL	BDL	5.9	BDL	2
W-18778	848	849	S	LEE	BDL	BDL	1	13	BDL	BDL	2.6	BDL	BDL	5.5	0.1	1
W-18778	983	984	S	LEE	BDL	BDL	BDL	8	BDL	BDL	2.5	BDL	0.6	5.7	BDL	3
W-18778	995	996	S	LEE	BDL	0.7	BDL	10	BDL	BDL	2.2	BDL	BDL	BDL	BDL	1
W-18778	1119	1120	S	LEE	BDL	0.6	1	9	BDL	BDL	2.5	BDL	BDL	9.4	BDL	1

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Analyte Symbol	Depth_min	Depth_max	Formation*	County	Ga	Ge	Hf	Hg	In	Ir	Mo	Nb	Ni	Pb	Rb	S	Sb
Unit Symbol	ft BLS	ft BLS			ppm	ppm	ppm	ppb	ppm	ppb	ppm	ppm	ppm	ppm	ppm	%	ppm
Detection Limit					1	0.5	0.1	5	0.1	1	2	0.2	1	5	2	0.001	0.1
Analysis Method					FUS-MS	FUS-MS	FUS-MS	Hg-FIMS	FUS-MS	INAA	FUS-MS	FUS-MS	TD-ICP	TD-ICP	FUS-MS	TD-ICP	INAA
W-18728	2140	2160A	A	Palm Beach	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.2	1	BDL	BDL	0.102	BDL
W-18728	2140	2160B	A	Palm Beach	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1	BDL	BDL	0.087	BDL
W-18776	657	658	O	Okeechobee	BDL	BDL	BDL	BDL	BDL	BDL	6	BDL	4	BDL	BDL	0.093	0.2
W-18776	662	663	O	Okeechobee	BDL	BDL	0.1	BDL	BDL	BDL	4	BDL	3	BDL	BDL	0.086	0.2
W-18776	723	724	O	Okeechobee	BDL	BDL	BDL	BDL	BDL	1	8	BDL	4	BDL	BDL	0.12	0.2
W-18776	805	806	A	Okeechobee	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4	BDL	BDL	0.072	0.2
W-18776	812	813	A	Okeechobee	BDL	BDL	0.2	BDL	BDL	BDL	10	0.8	8	BDL	3	0.314	0.4
W-18778	652	653	H	LEE	3	BDL	6.8	BDL	BDL	BDL	BDL	2.5	3	BDL	10	0.297	BDL
W-18778	754	755	H	LEE	2	BDL	2.3	BDL	BDL	BDL	BDL	1.5	4	BDL	9	0.159	0.2
W-18778	763	764	S	LEE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.3	2	BDL	2	0.111	BDL
W-18778	848	849	S	LEE	BDL	BDL	0.2	5	BDL	BDL	BDL	0.3	3	BDL	2	0.16	BDL
W-18778	983	984	S	LEE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3	BDL	BDL	0.15	0.1
W-18778	995	996	S	LEE	BDL	BDL	0.1	BDL	BDL	BDL	BDL	BDL	3	BDL	BDL	0.141	BDL
W-18778	1119	1120	S	LEE	BDL	BDL	0.2	BDL	BDL	BDL	5	BDL	4	BDL	BDL	0.103	0.2

Analyte Symbol	Depth_min	Depth_max	Formation*	County	Sc	Se	Sn	Sr	Ta	Th	U	V	W	Y	Zn	Zr	La
Unit Symbol	ft BLS	ft BLS			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Detection Limit					0.01	0.5	1	2	0.1	0.05	0.05	5	1	1	1	1	0.05
Analysis Method					INAA	INAA	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	INAA	FUS-ICP	TD-ICP	FUS-MS	FUS-MS
W-18728	2140	2160A	A	Palm Beach	0.12	BDL	BDL	439	BDL	0.23	1.47	BDL	BDL	2	6	2	0.82
W-18728	2140	2160B	A	Palm Beach	0.14	BDL	BDL	495	BDL	0.06	1.23	BDL	BDL	BDL	2	1	0.37
W-18776	657	658	O	Okeechobee	0.18	BDL	BDL	523	BDL	0.34	1.62	9	BDL	4	7	3	1.37
W-18776	662	663	O	Okeechobee	0.17	BDL	BDL	517	BDL	0.55	1.96	10	BDL	4	6	3	1.66
W-18776	723	724	O	Okeechobee	0.12	BDL	BDL	536	BDL	0.09	2.39	10	BDL	BDL	3	2	0.29
W-18776	805	806	A	Okeechobee	0.44	BDL	BDL	490	BDL	0.22	1.84	13	BDL	3	5	3	1.29
W-18776	812	813	A	Okeechobee	0.38	BDL	BDL	930	BDL	0.7	2.01	32	BDL	1	4	7	1.34
W-18778	652	653	H	LEE	2.04	BDL	BDL	591	0.2	4.13	5.7	25	BDL	26	12	275	19.5
W-18778	754	755	H	LEE	0.97	BDL	BDL	579	0.1	1.45	4.6	23	BDL	6	7	92	6.28
W-18778	763	764	S	LEE	0.12	BDL	BDL	734	0.1	0.14	5.94	15	BDL	BDL	5	2	0.93
W-18778	848	849	S	LEE	0.23	BDL	BDL	487	BDL	0.37	3.24	11	BDL	1	2	5	1.23
W-18778	983	984	S	LEE	0.06	BDL	BDL	410	BDL	0.11	4.58	11	BDL	BDL	BDL	1	0.5
W-18778	995	996	S	LEE	0.07	BDL	BDL	629	BDL	0.08	4.37	15	BDL	BDL	2	4	0.37
W-18778	1119	1120	S	LEE	0.08	BDL	BDL	489	BDL	0.13	9.77	25	BDL	BDL	4	7	0.67

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Analyte Symbol	Depth_min	Depth_max	Formation*	County	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tl	Tm
Unit Symbol	ft BLS	ft BLS			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Detection Limit					0.1	0.02	0.05	0.01	0.005	0.02	0.01	0.02	0.01	0.01	0.05	0.005
Analysis Method					FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
W-18728	2140	2160A	A	Palm Beach	1	0.14	0.55	0.11	0.014	0.11	0.02	0.14	0.03	0.1	BDL	0.014
W-18728	2140	2160B	A	Palm Beach	0.3	0.08	0.3	0.07	0.009	0.09	0.02	0.12	0.03	0.08	BDL	0.012
W-18776	657	658	O	Okeechobee	1.1	0.29	1.17	0.26	0.045	0.34	0.06	0.42	0.09	0.27	BDL	0.039
W-18776	662	663	O	Okeechobee	1.7	0.36	1.44	0.31	0.045	0.35	0.07	0.45	0.1	0.29	BDL	0.042
W-18776	723	724	O	Okeechobee	0.5	0.07	0.27	0.06	BDL	0.04	BDL	0.06	0.01	0.04	0.07	0.005
W-18776	805	806	A	Okeechobee	0.9	0.28	1.14	0.26	0.061	0.34	0.06	0.42	0.09	0.27	BDL	0.04
W-18776	812	813	A	Okeechobee	2.6	0.31	1.15	0.2	0.03	0.13	0.02	0.15	0.03	0.1	0.1	0.015
W-18778	652	653	H	LEE	29.9	4.56	16	3.24	0.692	3.31	0.55	3.29	0.69	2.09	0.11	0.302
W-18778	754	755	H	LEE	10.9	1.53	5.24	1.07	0.226	0.94	0.15	0.85	0.18	0.5	BDL	0.071
W-18778	763	764	S	LEE	1.3	0.19	0.66	0.14	0.021	0.14	0.03	0.16	0.03	0.1	BDL	0.017
W-18778	848	849	S	LEE	2.2	0.29	0.95	0.19	0.04	0.2	0.03	0.21	0.04	0.12	BDL	0.018
W-18778	983	984	S	LEE	0.8	0.11	0.34	0.06	0.011	0.07	BDL	0.07	0.02	0.04	BDL	BDL
W-18778	995	996	S	LEE	0.5	0.09	0.28	0.05	0.013	0.07	BDL	0.06	0.01	0.04	BDL	BDL
W-18778	1119	1120	S	LEE	0.7	0.14	0.49	0.09	0.024	0.12	0.02	0.15	0.04	0.12	BDL	0.017

Analyte Symbol	Depth_min	Depth_max	Formation*	County	Yb	Lu	Mass	C-Total	C-Graph	C-Organ	CO2	Total S	SO4
Unit Symbol	ft BLS	ft BLS			ppm	ppm	g	%	%	%	%	%	%
Detection Limit					0.01	0.002		0.01	0.05	0.05	0.01	0.01	0.3
Analysis Method					FUS-MS	FUS-MS	INAA	IR	IR	IR	COUL	IR	IR
W-18728	2140	2160A	A	Palm Beach	0.09	0.014	1.344	11.7	BDL	0.05	44.3	0.1	0.3
W-18728	2140	2160B	A	Palm Beach	0.07	0.011	1.04	11.6	BDL	BDL	44.2	0.09	0.3
W-18776	657	658	O	Okeechobee	0.24	0.034	1.276	11.6	BDL	BDL	44.2	0.09	0.3
W-18776	662	663	O	Okeechobee	0.26	0.038	1.349	11.6	BDL	0.13	44.2	0.08	0.3
W-18776	723	724	O	Okeechobee	0.03	0.003	1.082	11.5	BDL	BDL	44.4	0.11	0.3
W-18776	805	806	A	Okeechobee	0.24	0.036	1.118	11.5	BDL	0.16	45.2	0.05	BDL
W-18776	812	813	A	Okeechobee	0.1	0.016	1.091	11.9	0.07	0.47	41.6	0.29	0.6
W-18778	652	653	H	LEE	1.91	0.295	1.346	8.78	BDL	BDL	32.8	0.27	0.7
W-18778	754	755	H	LEE	0.44	0.065	1.084	9.4	BDL	BDL	35.6	0.11	BDL
W-18778	763	764	S	LEE	0.1	0.015	1.447	11.9	BDL	BDL	44.4	0.1	BDL
W-18778	848	849	S	LEE	0.11	0.018	1.291	11.5	BDL	BDL	43.7	0.14	BDL
W-18778	983	984	S	LEE	0.03	0.003	1.16	11.6	BDL	BDL	44.7	0.13	BDL
W-18778	995	996	S	LEE	0.04	0.004	1.353	11.8	BDL	BDL	44.3	0.12	BDL
W-18778	1119	1120	S	LEE	0.1	0.015	1.24	11.8	BDL	0.05	44.3	0.08	BDL

Appendix 8.

Lithogeochemical statistics for selected constituents from CERP study (Arthur et al., 2007) and project results by lithostratigraphic unit.

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Hawthorn Group																					
					SiO2	Fe2O3 (T)	Na2O	K2O	P2O5	TOTAL	GRAPHITIC	ORGANIC	CO2	S	S(SO4)	As	Mo	Sb	Hg	U	
					n=142	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppb	ppm	
CERP Study	Statistics				Mean	11.23	0.30	0.23	0.24	1.10	9.89	0.03	0.13	35.63	0.15	0.36	3.44	3.05	0.37	12.71	11.24
					Median	5.30	0.17	0.17	0.14	0.53	10.75	0.03	0.03	38.50	0.11	0.27	2.00	1.00	0.30	2.50	7.58
					Std. Dev.	13.58	0.36	0.25	0.30	1.38	2.22	0.02	0.17	8.21	0.15	0.31	4.31	4.98	0.34	63.79	12.38
					Minimum	0.12	0.01	0.01	0.01	0.01	1.43	0.03	0.03	2.12	0.02	0.03	0.50	1.00	0.05	2.50	1.12
					Maximum	66.83	2.14	2.11	2.32	7.69	13.10	0.25	0.75	44.90	0.94	1.67	33.00	40.00	2.00	657.00	90.50
Present Study	Sample ID	Depth_min	Depth_max	County																	
	W-18778	652	653	LEE	18.28	0.38	0.55	0.45	2.38	8.78	BDL	BDL	32.8	0.27	0.7	2	BDL	BDL	BDL	5.7	
	W-18778	754	755	LEE	15.95	0.29	0.19	0.34	0.29	9.4	BDL	BDL	35.6	0.11	BDL	1	BDL	0.2	BDL	4.6	
Suwannee Limestone																					
					SiO2	Fe2O3 (T)	Na2O	K2O	P2O5	TOTAL	GRAPHITIC	ORGANIC	CO2	S	S(SO4)	As	Mo	Sb	Hg	U	
					n=61	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppb	ppm	
CERP Study	Statistics				Mean	7.57	0.11	0.09	0.09	0.17	10.71	0.03	0.10	39.09	0.08	0.20	1.58	2.46	0.20	23.98	4.04
					Median	2.44	0.10	0.08	0.07	0.05	11.20	0.03	0.03	40.90	0.08	0.22	1.00	1.00	0.17	7.00	3.62
					Std. Dev.	12.06	0.09	0.06	0.09	0.24	1.57	0.00	0.15	5.59	0.03	0.16	1.27	2.21	0.18	36.06	2.09
					Minimum	0.09	0.01	0.01	0.01	0.01	4.73	0.02	0.03	17.30	0.02	0.03	0.50	1.00	0.05	2.50	0.89
					Maximum	56.39	0.59	0.21	0.33	1.07	13.50	0.04	0.58	45.00	0.15	0.53	6.00	9.00	0.80	171.00	11.90
Present Study	Sample ID	Depth_min	Depth_max	County																	
	W-18778	763	764	LEE	0.69	0.03	0.07	BDL	0.05	11.9	BDL	BDL	44.4	0.1	BDL	BDL	BDL	BDL	BDL	5.94	
	W-18778	848	849	LEE	1.05	0.08	0.07	0.01	BDL	11.5	BDL	BDL	43.7	0.14	BDL	1	BDL	BDL	5	3.24	
	W-18778	983	984	LEE	0.35	0.03	0.05	BDL	0.01	11.6	BDL	BDL	44.7	0.13	BDL	BDL	BDL	0.1	BDL	4.58	
	W-18778	995	996	LEE	0.39	0.02	0.07	BDL	0.01	11.8	BDL	BDL	44.3	0.12	BDL	BDL	BDL	BDL	BDL	4.37	
	W-18778	1119	1120	LEE	0.5	0.02	0.08	BDL	0.03	11.8	BDL	0.05	44.3	0.08	BDL	1	5	0.2	BDL	9.77	

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Ocala Limestone																									
					SiO ₂	Fe ₂ O ₃ (T)	Na ₂ O	K ₂ O	P ₂ O ₅	TOTAL	GRAPHITIC	ORGANIC	CO ₂	S	S(SO ₄)	As	Mo	Sb	Hg	U					
CERP Study	Statistics	n = 58			%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppb	ppm					
		Mean			0.95	0.09	0.08	0.10	0.03	12.09	0.03	0.14	42.84	0.09	0.15	1.98	4.77	0.22	15.07	2.77					
		Median			0.60	0.07	0.06	0.06	0.03	11.70	0.03	0.09	43.01	0.08	0.07	1.00	1.00	0.16	2.50	2.39					
		Std. Dev.			1.30	0.10	0.07	0.14	0.02	1.97	0.01	0.16	1.58	0.04	0.17	3.11	17.00	0.30	46.84	1.48					
		Minimum			0.11	0.01	0.01	0.01	0.01	10.69	0.02	0.03	38.50	0.02	0.01	0.50	1.00	0.05	2.50	1.18					
		Maximum			8.91	0.68	0.33	0.93	0.15	25.80	0.10	0.62	47.44	0.26	0.62	23.00	130.00	2.00	334.00	7.74					
Present Study	Sample ID	Depth_min	Depth_max	County																					
	W-18776	657	658	Okeechobee	0.36	0.07	0.03	0.1	0.02	11.6	BDL	BDL	44.2	0.09	0.3	2	6	0.2	BDL	1.62					
	W-18776	662	663	Okeechobee	0.46	0.05	0.02	0.08	0.03	11.6	BDL	0.13	44.2	0.08	0.3	2	4	0.2	BDL	1.96					
	W-18776	723	724	Okeechobee	0.36	0.04	0.02	0.08	BDL	11.5	BDL	BDL	44.4	0.11	0.3	BDL	8	0.2	BDL	2.39					
Avon Park Formation																									
					SiO ₂	Fe ₂ O ₃ (T)	Na ₂ O	K ₂ O	P ₂ O ₅	TOTAL	GRAPHITIC	ORGANIC	CO ₂	S	S(SO ₄)	As	Mo	Sb	Hg	U					
CERP Study	Statistics	n=41			%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppb	ppm					
		Mean			0.44	0.05	0.08	0.05	0.01	11.99	0.04	0.22	42.84	0.17	0.26	2.69	12.95	0.31	13.16	4.24					
		Median			0.29	0.04	0.08	0.04	0.01	11.97	0.03	0.22	43.10	0.11	0.24	2.00	8.00	0.17	2.50	4.03					
		Std. Dev.			0.39	0.05	0.03	0.04	0.05	0.46	0.04	0.18	2.65	0.26	0.21	2.59	20.04	0.39	21.26	1.72					
		Minimum			0.01	0.01	0.03	0.01	0.01	10.77	0.01	0.03	30.79	0.01	0.03	0.50	1.00	0.05	2.50	1.51					
		Maximum			1.87	0.21	0.16	0.18	0.33	12.80	0.20	0.75	46.70	1.71	0.72	10.40	122.00	1.96	110.00	10.50					
Present Study	Sample ID	Depth_min	Depth_max	County																					
	W-18728	2140	2160A	Palm Beach	0.15	0.03	0.17	0.06	BDL	11.7	BDL	0.05	44.3	0.1	0.3	BDL	BDL	BDL	BDL	1.47					
	W-18728	2140	2160B	Palm Beach	0.13	0.02	0.15	BDL	BDL	11.6	BDL	BDL	44.2	0.09	0.3	BDL	BDL	BDL	BDL	1.23					
	W-18776	805	806	Okeechobee	0.66	0.12	0.03	0.07	0.03	11.5	BDL	0.16	45.2	0.05	BDL	BDL	BDL	0.2	BDL	1.84					
	W-18776	812	813	Okeechobee	2.92	0.19	0.11	0.34	0.05	11.9	0.07	0.47	41.6	0.29	0.6	3	10	0.4	BDL	2.01					