Chemical Rocks

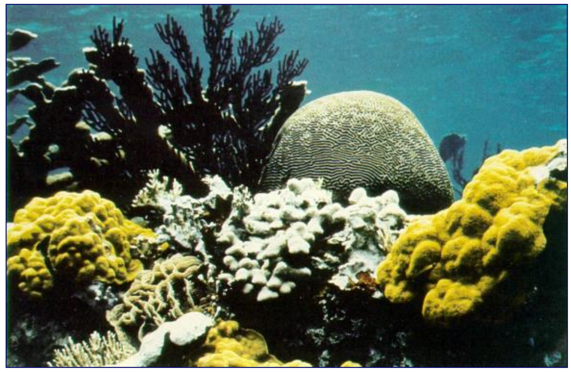
Two Main Types:

Carbonates (both biochemical and inorganic precipitates)

- Limestones
- Dolostones

Evaporites (all are precipitates)

- Halite
- Gypsum/Anhydrite



Carbonate Rocks

Why do we study carbonate rocks?

Comprise only ~ 20% global sedimentary rocks, BUT

~ 50% of global hydrocarbon reserves (plus most of the world's largest potable water aquifers)

Also common host rock for Mississippi Valley Type lead-zinc deposits

Useful for understanding Earth history because:

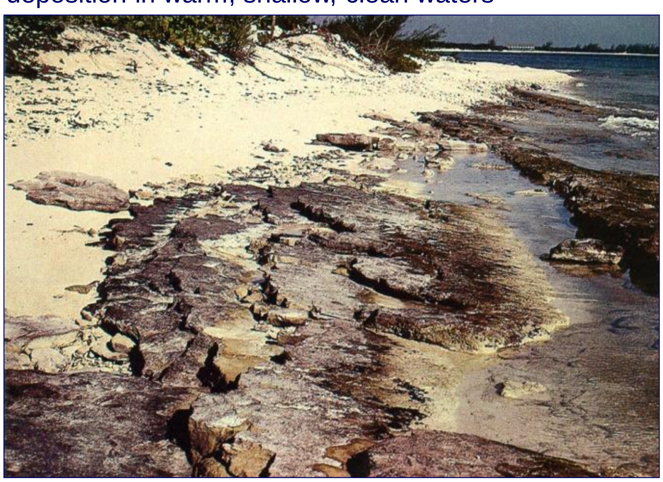
- Composed largely of skeletal organisms
- Grains form in equilibrium with surrounding seawater (therefore incorporate stable isotopes and fluid inclusions)
- Extremely sensitive to climatic and eustatic variations

Carbonate Rocks

Modern Carbonate Settings

Carbonate Rocks

- Carbonates capable of syndepositional cement (not predictable properties during burial compaction)
- *Most* deposition in warm, shallow, clean waters



Recent, Marine Cemented Foreshore Strata - “Beachrock”, Grand Cayman Island

Inden & Moore, 1983 (AAPG Memoir 33)

Carbonate Rocks

Composed primarily of skeletal remains of extinct and extant calcareous organisms

Most carbonate sediments formed *in situ*, in warm, clear, shallow marine environments

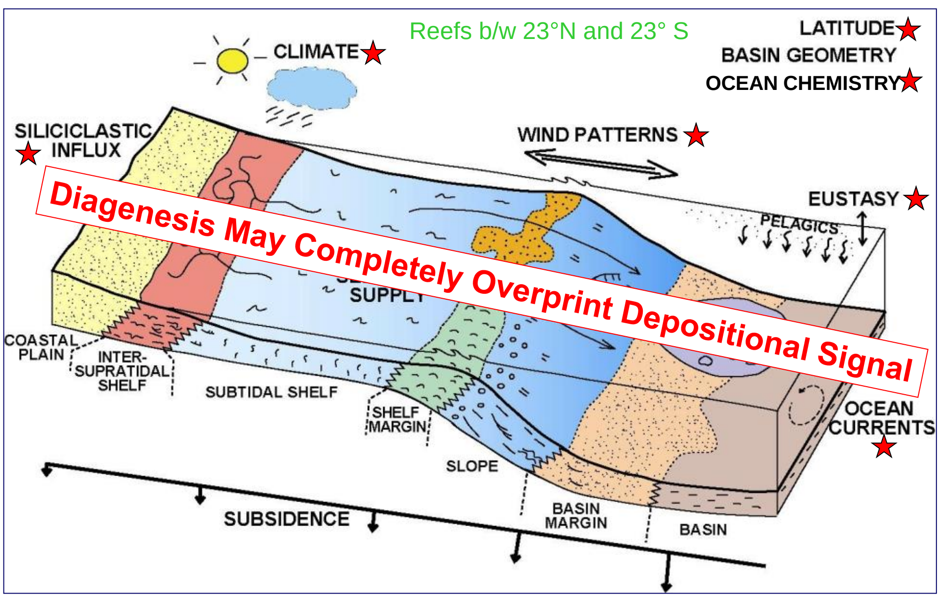
Sedimentation is strongly influenced by environmental factors, such as:

- Temperature
- Water Depth / Light
- Nutrient Supply
- Salinity
- Turbulence / Energy Conditions
- Water Clarity / Light

Also important in paleontology and ichnology (*i.e.*, affect all life)

Size and sorting of sediment influenced by both biological processes and physical transport

Controls on Carbonate Deposition



Carbonate Rock Properties: Lithology

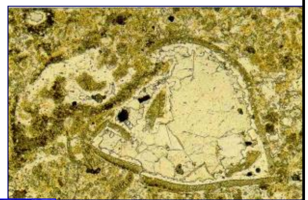
Limestone (Calcite, High-Mg Calcite, Aragonite: $CaCO_3$)

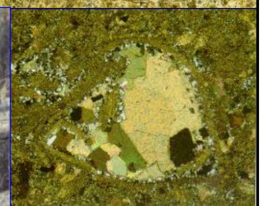
Dolostone (Dolomite: $CaMg(CO_3)_2$)

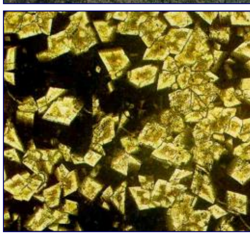
Mixed (Dolomitic Limestone; Calcareous Dolostone)

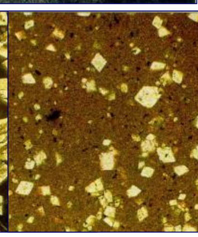
Gypsum ($CaSO_4 \cdot 2H_2O$)

Anhydrite ($CaSO_4$)









NB: most workers use “dolomite” for both the mineral name AND the rock name as opposed to dolostone.

Principal Controls on Carbonate Sedimentation

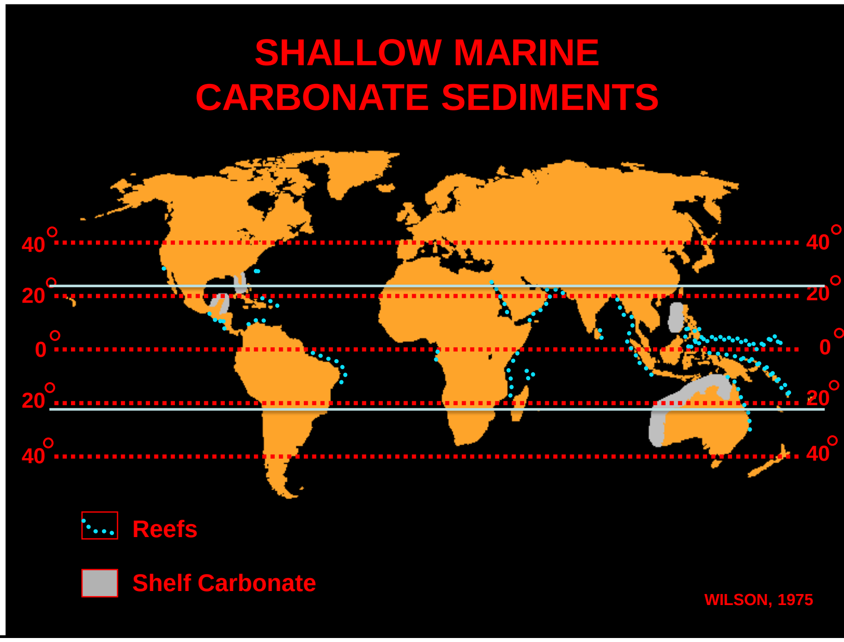
Water Temperature

- Major control on distribution of calcite- and aragonite-secreting organisms
- Most modern deposition occurs within 30º of the equator
- Skeletal and reef assemblages vary with latitude (water temperature)

Water Depth

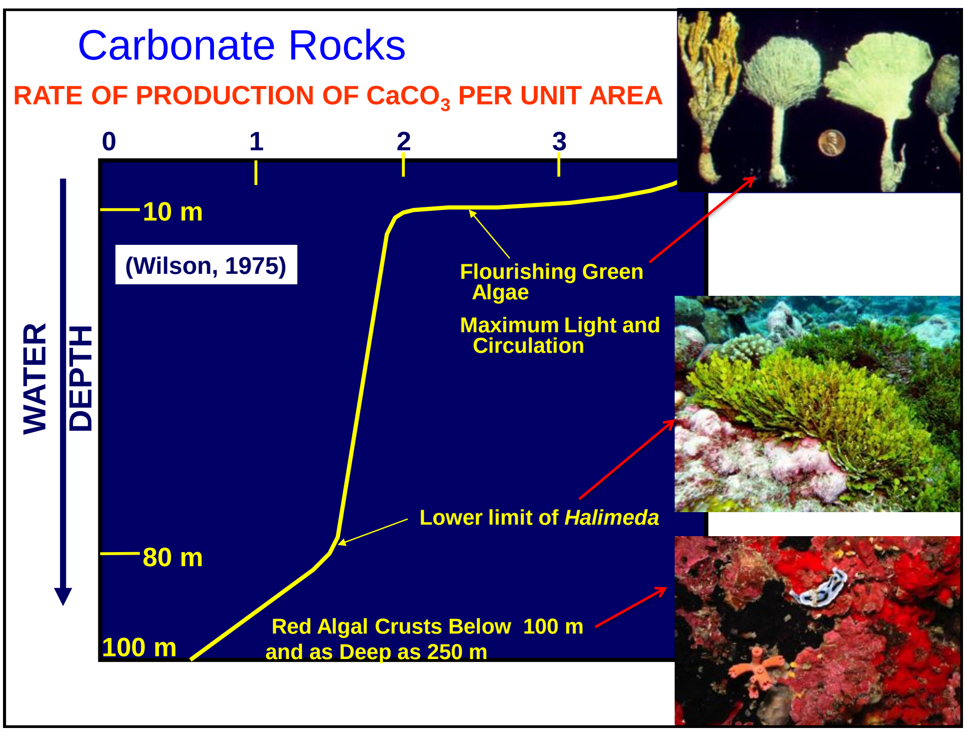
- Sedimentation rates decrease rapidly with increasing water depth (a function of light penetration through water column)
- Most productivity occurs in less than 20 m of water (both warmer & with more light)
- Proxy for relative sea level changes through time

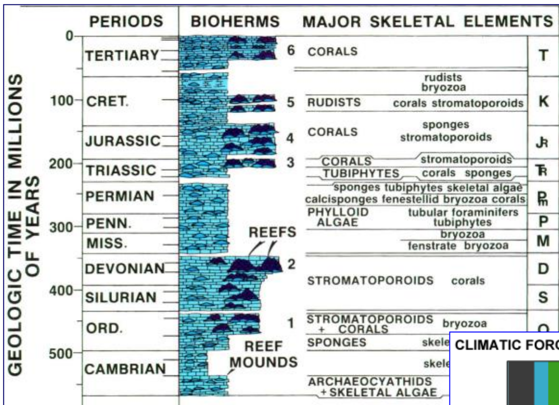
Carbonate Rock Properties: Latitude



Carbonate Rocks

RATE OF PRODUCTION OF $CaCO_3$ PER UNIT AREA

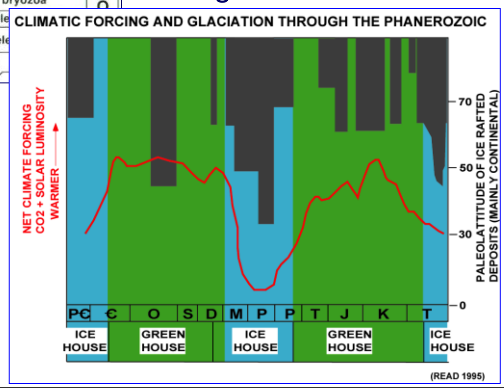




Carbonate Rocks

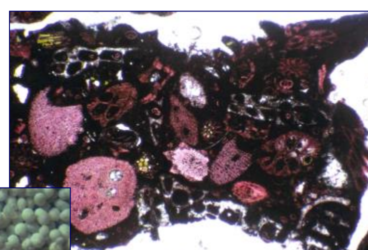
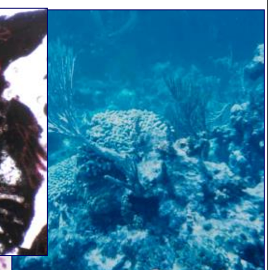
Climate has served to control carbonate distributions (ice-house *vs*. greenhouse). Arid carbonates also differ from those in humid settings.

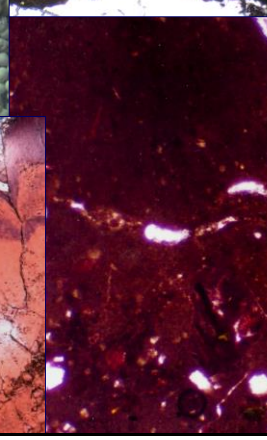
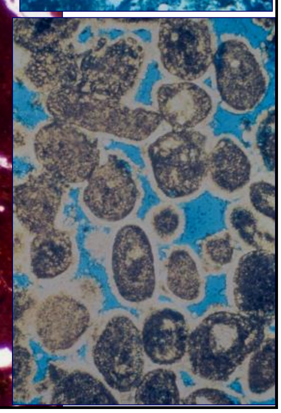
Carbonate rocks are both lithological and paleontological entities. Animals have evolved through time so that rock characters also have changed.



Carbonate Rocks

Skeletal grains
Non-skeletal grains
Lime mud
Cement

Carbonate Framework Grains

Carbonate framework grains are separated in two main ways.

1) Are the grains skeletal or "inorganic" (though this is not always consistent - e.g., is a fecal pellet "inorganic"?).

2) Are the framework elements in place (*in situ*) or have they been transported (*i.e.*, the equivalent of grains or clasts).

Allochems are grains that have been transported.

Biolithic elements are those that have grown in place (*in situ*) and have not been transported.

Carbonate Framework Grains: Skeletal Material

Skeletal elements are based on whether they are in place or are grains that have been transported

Allochems (bioclastic) (Transported)

Biolithic: (*In situ*)

Grain expressions are highly variable (differentiation based on particle orientation). However, biolithic grains are always skeletal.

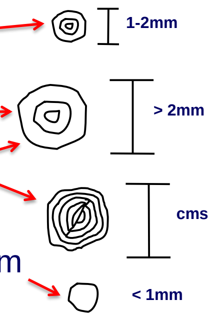
Difficult to ID if fragmented or altered. Hard to prove in hand specimen; challenging in core. Better in outcrop expression.

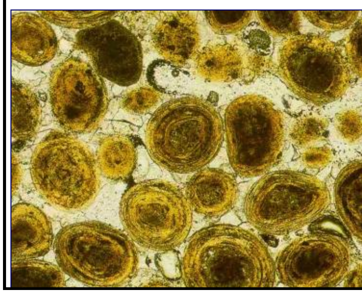
Allochems are a mixture of benthic and pelagic fossil material.

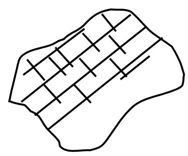
Grain types associated with depositional environments have changed with time and paleogeography

Allochemical Carbonate Grain Types: Non-Skeletal

- **Ooids:** concentric layers, < 2 mm
- **Pisoids:** concentric layers, > 2 mm
- **Oncoids:** algal, concentric layers, > 2 mm
- **Peloids:** micro- or cryptocrystalline allochem
- **Pellets:** micrite (microcrystalline) grains, < 1 mm
- **Intraclasts/Lithoclasts** (equivalent to rip-ups)



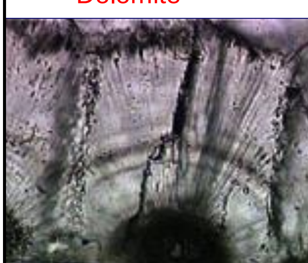


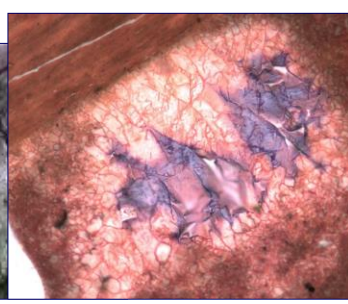


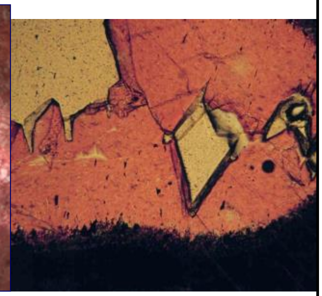
Carbonate Rocks

Carbonate Cements

- Crystalline fraction produced *via* precipitation or recrystallization
- Types:
  - Microspar (4-15 μm): Commonly *via* micrite recrystallization
    Commonly rim grains
  - Microspar (15-60 μm): mainly precipitated cement
  - Macrospar (> 60 μm): Secondary mosaic void-filling (calcite)
  - Aragonite: Needle-like fibrous crystals (early)
  - High-Mg Calcite: 'Roman spear' crystals
  - Dolomite



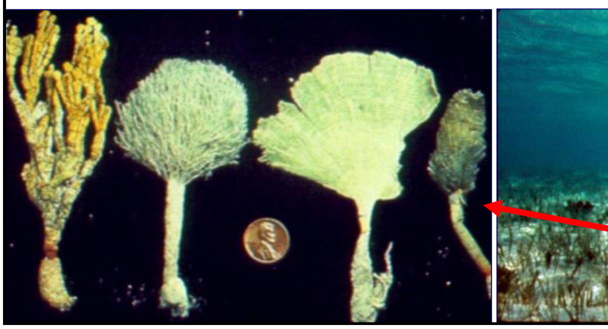




Carbonate Rocks

Lime Mud (Micrite)

- Comparable to matrix of clastics (same problems)
- Generally microcrystalline calcite
- Origin debated:
    - Disaggregation of calcareous algae
    - Inorganic precipitation (whitings)
- Modern muds consist of aragonite needles (alters to calcite)



Carbonate Rock Classification

Very different from siliciclastics, so must employ a very different approach to classification:

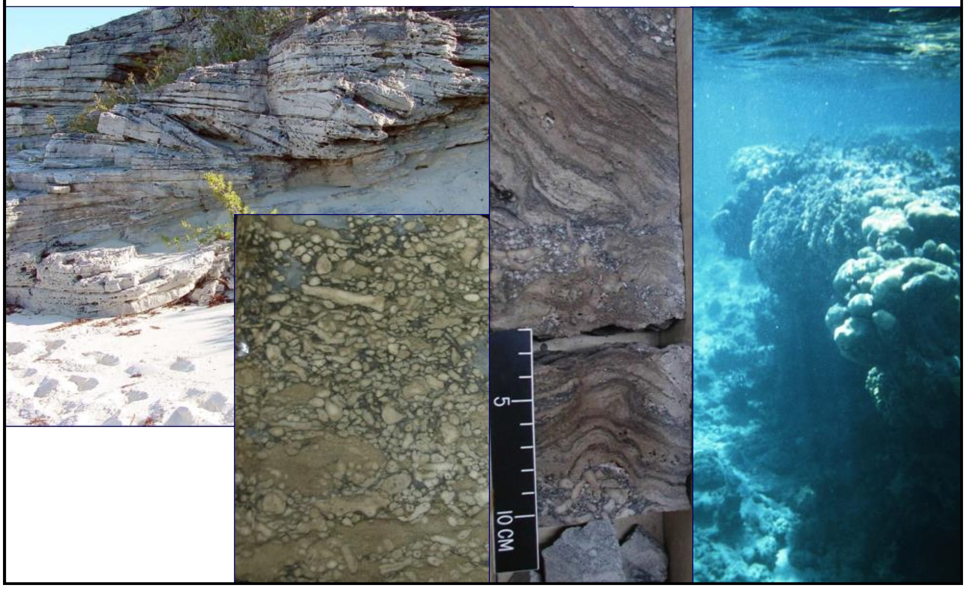
- Essentially consists entirely of intrabasinal material
- Texture is critical (grain size, sorting; grain relations)
- Fabric is also critical (framework *vs*. matrix support)
- QFL type diagrams do not work

Schemes do not incorporate non-biological carbonate materials (*e.g*., travertine, tufa, caliche)

Must include both detrital (allochem) and *in situ* (biolithic) fabrics

Carbonate Rock Classification

Detrital (allochemic) fabrics *vs*. *in situ* (biolithic) Fabrics



Carbonate Rock Description: Basic Rock Properties

- Lithology
- Colour
- Depositional Texture
- Grain Type(s) and Matrix
- Grain Size and Shape
- Sedimentary Structures
- Porosity
- Pore Type

Scholle, et al., 1983

Carbonate Rock Classification

Dunham's Classification System (1962):

Presence or absence of mud

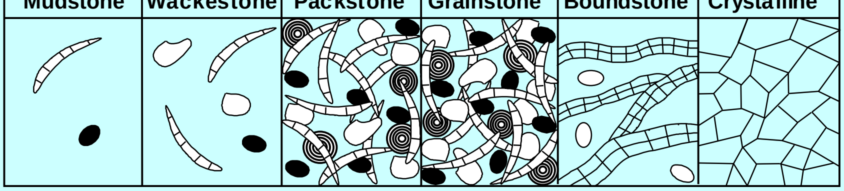
Packing or abundance of grains (grain- *vs*. mud-supported)

Biologic control on sedimentation

- Easy to remember
- Descriptive
- Better suited for field observations
- Typically hints at depositional conditions – relations are related to depositional energy.

Carbonate Rock Classification

<table>
<tr><td colspan="5">Depositional Texture Recognizable</td><td rowspan="5">Depositional Texture Not Recognizable</td></tr>
<tr><td colspan="4">Original Components Not Bound Together During Deposition</td><td rowspan="4">Original Components Bound Together</td></tr>
<tr><td colspan="3">Contains Carbonate Mud</td><td rowspan="3">Lacks Mud Grain-supported</td></tr>
<tr><td colspan="2">Mud-supported</td><td rowspan="2">Grain-supported</td></tr>
<tr><td><10% Grains</td><td>>10% Grains</td></tr>
<tr><td>Mudstone</td><td>Wackestone</td><td>Packstone</td><td>Grainstone</td><td>Boundstone</td><td>Crystalline</td></tr>
</table>



DUNHAM'S (1962) CLASSIFICATION FOR CARBONATE ROCKS

Modified Dunham Scheme to accommodate Biolithites

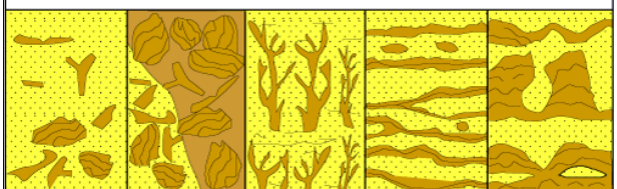
Allochthonous: concerned with original constituents that were once biolithic but have been resedimented.

Floatstone ~ = matrix-supported carbonate conglomerate

Rudstone ~ = clast-supported carbonate conglomerate

Dunham term boundstone expanded to include autochthonous textural/fabric types: bafflestone and framestone.

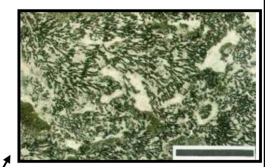
Allochthonous		Autochthonous		
Original components not bound organically at deposition		Original components bound organically at deposition		
>10%grains>2mm				
Matrix supported	Supported by >2mm component	By organisms that act as baffles	By organisms that encrust and bind	By organisms that build a rigid framework
Floatstone	Rudstone	Bafflestone	Bindstone	Framestone



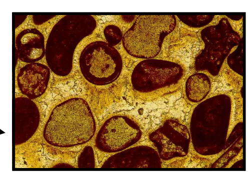
Textural classification of reef limestones after Embry & Klovan (1971) and James (1984)

Dunham (1962) Classification

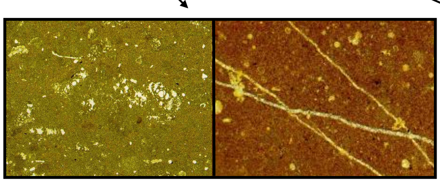
Original components not organically bound together during deposition				Components organically bound during deposition
Contains carbonate mud			No carbonate mud	
Mud-supported		Grain-supported		
<10% allochems	>10% allochems			
MUDSTONE	WACKESTONE	PACKSTONE	GRAINSTONE	BOUNDSTONE

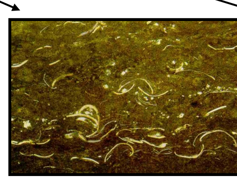


Schoelle, et al., 1985 (fig. 85)



Adams, et al., 1998 (fig. 201)



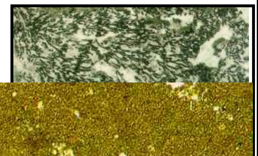


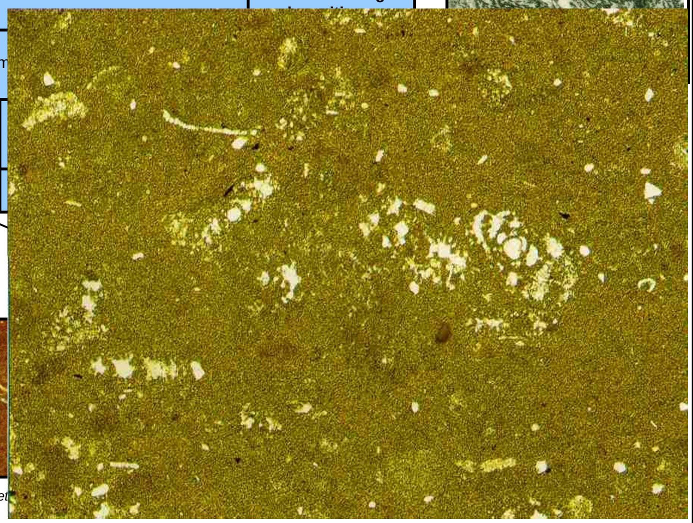
Adams, et al., 1998 (figs. 116, 235)

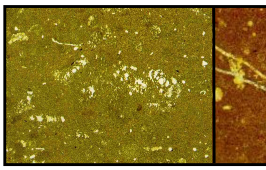
Adams, et al., 1998 (fig. 127)

Dunham (1962) Classification

Original components not organically bound together during deposition			Components organically bound during ...
Contains carbonate m...			
Mud-supported			
<10% allochems	>10% allochems		
MUDSTONE	WACKESTONE		





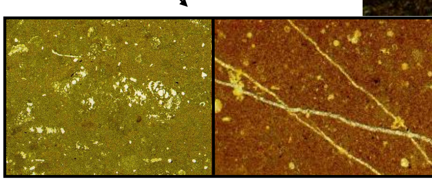


Lime mudstone

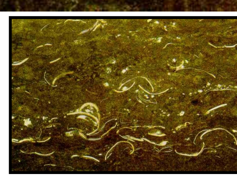
Adams, et...

Dunham (1962) Classification

Original components not organically bound t... during deposition		
Contains carbonate mud		
Mud-supported		Grain...
<10% allochems	>10% allochems	
MUDSTONE	WACKESTONE	PACKSTONE



Adams, et al., 1998 (figs. 116, 235)



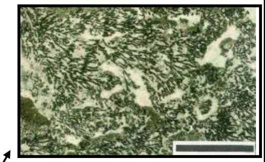
Wackestone

Adams, et al., 1998 (fig. 127)

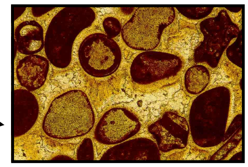
Dunham (1962) Classification

Original components not organically bound together during deposition	Components organically bound during deposition

Packstone



Schoelle, et al., 1985 (fig. 85)

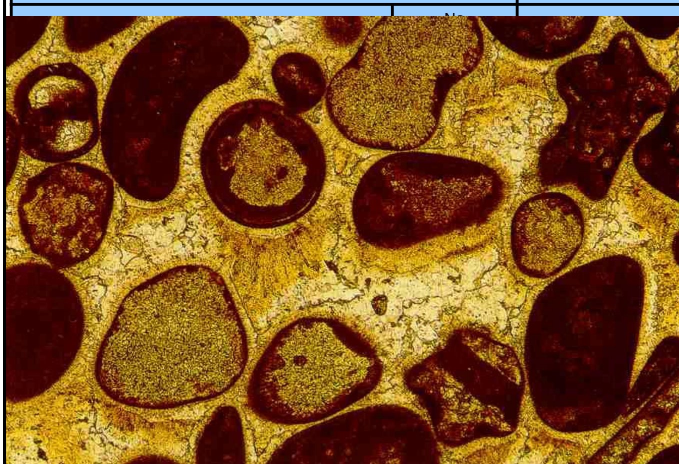


Adams, et al., 1998 (fig. 201)

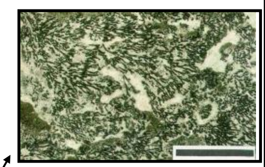
Adams, et al., 1998 (fig. 127)

Dunham (1962) Classification

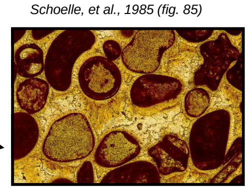
Original components not organically bound together during deposition	Components organically bound during deposition



Grainstone



Schoelle, et al., 1985 (fig. 85)

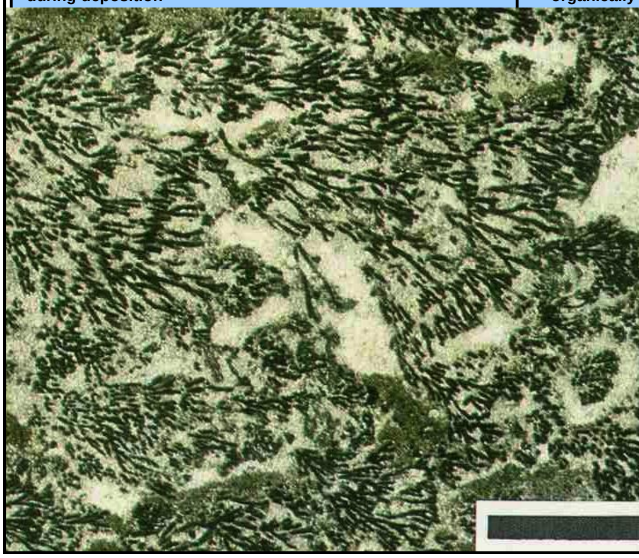


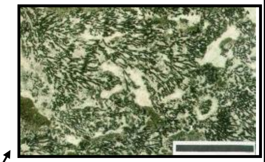
Adams, et al., 1998 (fig. 201)

Adams, et al., 1998 (fig. 127)

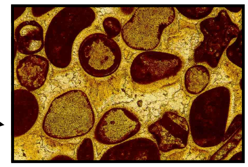
Dunham (1962) Classification

Original components not organically bound together during deposition	Components organically ...g





Schoelle, et al., 1985 (fig. 85)



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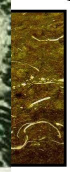
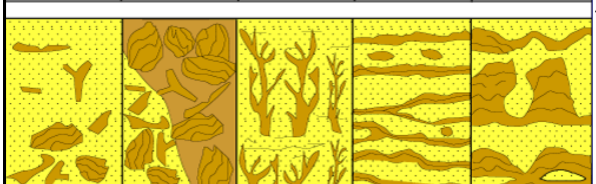


Adams, et al., 1998 (fig. 127)

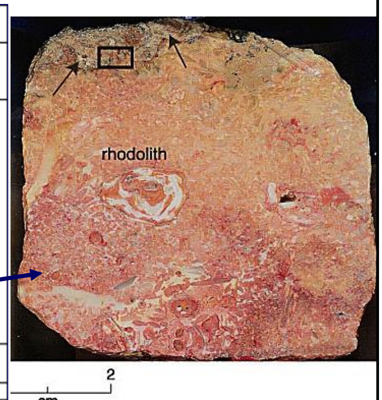
Boundstone

Modified Dunham Classification

Allochthonous		Autochthonous		
Original components not bound organically at deposition		Original components bound organically at deposition		
>10%grains>2mm				
Matrix supported	Supported by >2mm component	By organisms that act as baffles	By organisms that encrust and bind	By organisms that build a rigid framework
Floatstone	Rudstone	Bafflestone	Bindstone	Framestone



Textural classification of reef limestones after Embry & Klovan (1971) and James (1984)

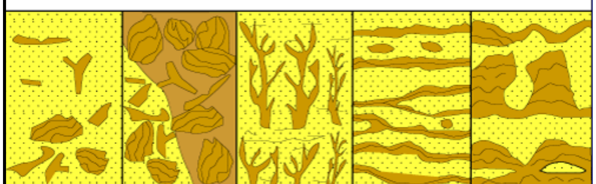


Rhodolith (benthic red algae) floatstone overlain by wackestone

Floatstone

Modified Dunham Classification

Allochthonous		Autochthonous		
Original components not bound organically at deposition		Original components bound organically at deposition		
>10%grains>2mm				
Matrix supported	Supported by >2mm component	By organisms that act as baffles	By organisms that encrust and bind	By organisms that build a rigid framework
Floatstone	Rudstone	Bafflestone	Bindstone	Framestone

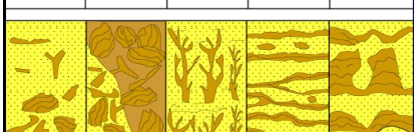


Textural classification of reef limestones after Embry & Klovan (1971) and James (1984)

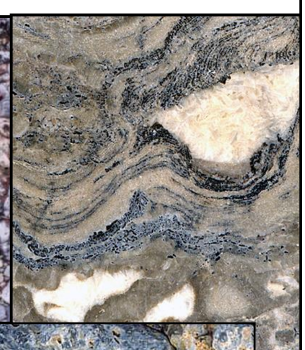
Rudstone

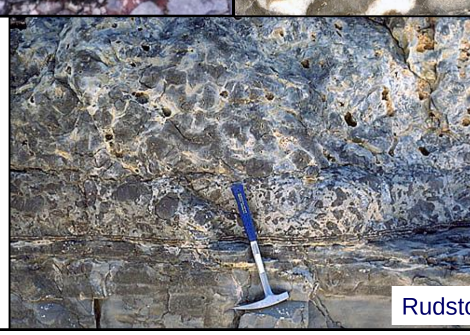
Modified Dunham Classification

Allochthonous		Autochtl		
Original components not bound organically at deposition		Original compone organically at de		
>10%grains>2mm				
Matrix supported	Supported by >2mm component	By organisms that act as baffles	By organisms that encrust and bind	By organisms that build a rigid framework
Floatstone	Rudstone	Bafflestone	Bindstone	Framestone



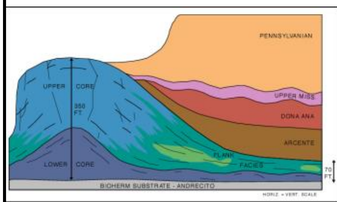
Textural classification of reef limestones after Embry & Klovan (1971) and James (1984)



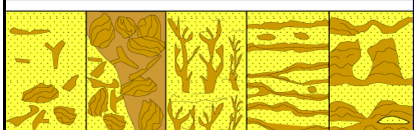


Rudstone

Modified Dunham Classification



Allochthonous		Autochthonous		
Original components not bound organically at deposition		Original components bound organically at deposition		
>10%grains>2mm				
Matrix supported	Supported by >2mm component	By organisms that act as baffles	By organisms that encrust and bind	By organisms that build a rigid framework
Floatstone	Rudstone	Bafflestone	Bindstone	Framestone



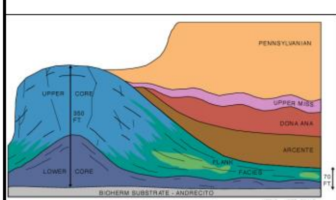
Textural classification of reef limestones after Embry & Klovan (1971) and James (1984)

Crinoidal bafflestone and typical Waulsortian bioherms (mud mound with no obvious framemaker)

Serpulid worm burrow bafflestone

Bafflestone

Modified Dunham Classification



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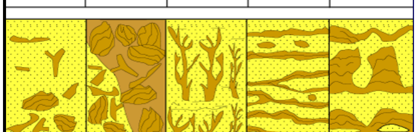
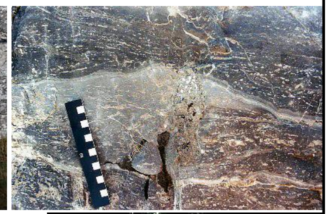


Textural classification of reef limestones after Embry & Klovan (1971) and James (1984)

Archaeocyathid bafflestone, Cambrian

Modified Dunham Classification



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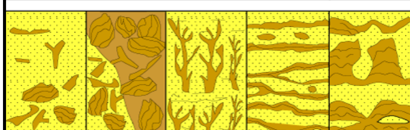
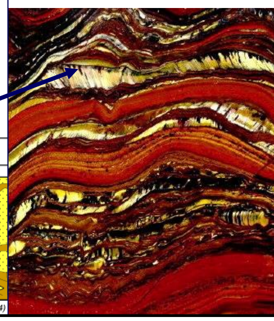


Textural classification of reef limestones after Embry & Klovan (1971) and James (1984)

Encrusted Bioherms: Bindstones; Examples are Stromatolitic (Algal)



Modified Dunham Classification

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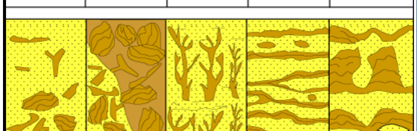

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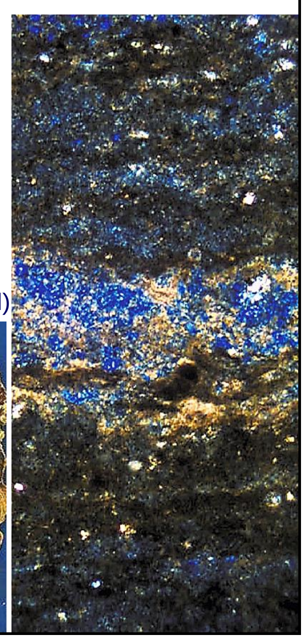

Modified Dunham Classification

Original components not bound organically at deposition		Original components bound organically at deposition		
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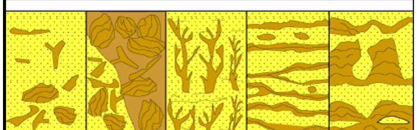
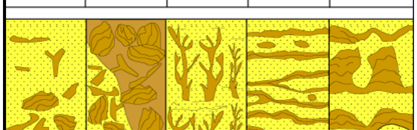


Textural classification of reef limestones after Embry & Klovan (1971) and James (1984)

Rigid Bioherms: Framestones; Examples are Branching Corals and Stromatoporoids

Modified Dunham Classification

Original components not bound organically at deposition		Origi orga		
>10%grains>2mm				
Matrix supported	Supported by >2mm component	By organisms that act as baffles	organisms that encrust and bind	organisms that build a rigid framework
Floatstone	Rudstone	Bafflestone	Bindstone	Framestone



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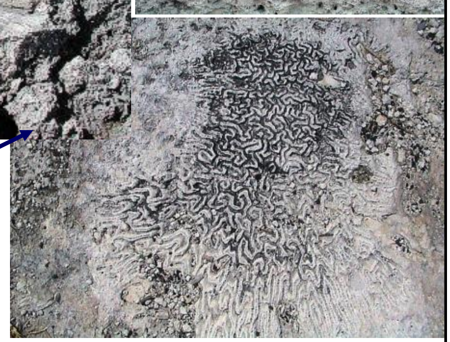


Rigid Bioherms: Framestones; Examples are Branching Corals

Carbonate Rock Classification . . .

Folk's Classification System (1962):

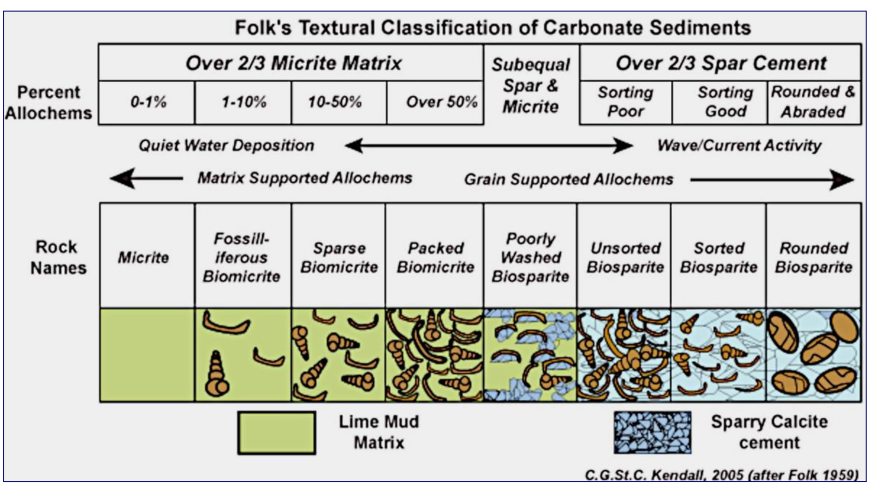
- More complex than Dunham, but also textural
- 4 basic material components:
  Allochems (detrital carbonate grains)
  Carbonate mud (micrite)
  Crystalline calcite (sparite)
  In situ reef rock (biolithite)

Rock names based on:

- % Allochem (by type)
- Allochem *vs*. matrix
- Sparry cement *vs*. micrite

-- Makes for very long, complex names that often require thin section petrographic analyses to discern.

Folk's Classification System (1962)

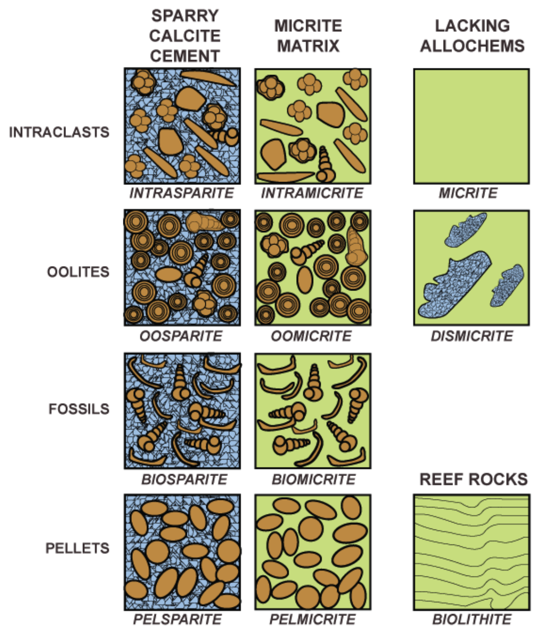


Terminology used *if* allochems are fossil fragments!

Folk's Classification System (1962)

Rock names are strongly controlled by dominant grain type, in addition to the importance of cement *vs*. matrix.

Hence similar rocks characterized by ooids *vs*. fossil fragments *vs*. fecal pellets derive different names



Components of Carbonate Rocks

Siliciclastics and Evaporites in Carbonate Settings

Clastics:

Common Associations:

interbedded within shallow-water carbonate deposits filling basins adjacent to carbonate buildups

Main Controls on Mixed Carbonate-Clastic Deposition:

cyclic and reciprocal sedimentation

autocyclic changes in sediment supply

Evaporites:

Gypsum, Anhydrite, and Halite common in carbonates

Common Associations:

interbedded with tidal flat or sabkha deposits

basin-restricted wedges

Main Controls on Evaporite Deposition:

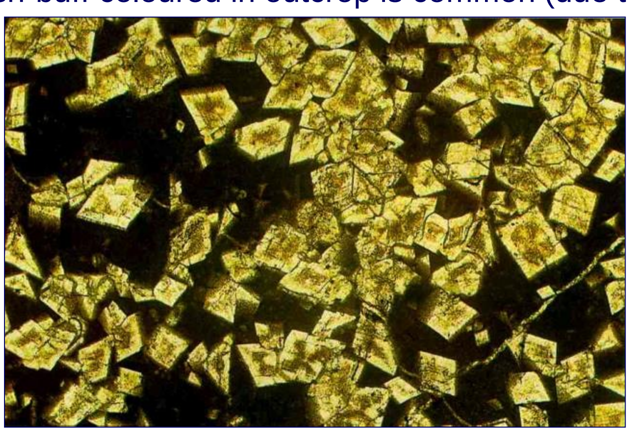
sea level and climate

basin geometry and circulation

Dolostone/Dolomite

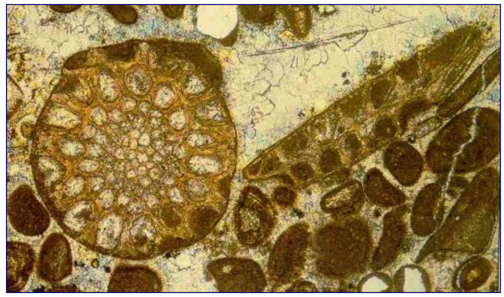
Mg ions replace Ca ions in the crystal lattice

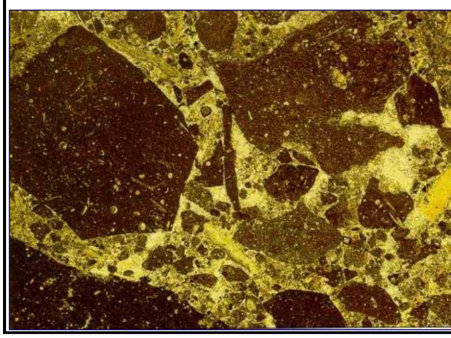
- Less reactive to acid (need > 10% or warm HCl to react)
- More stable in burial conditions
- Commonly disrupts and/or replaces primary calcite fabrics
- Yellowish-buff coloured in outcrop is common (due to Fe)

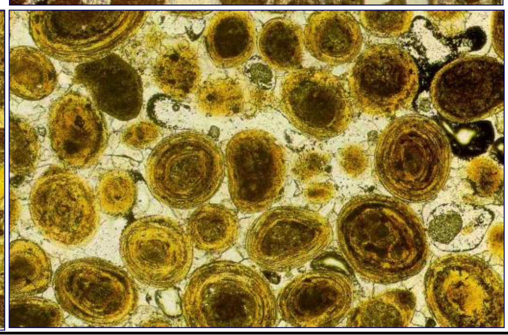


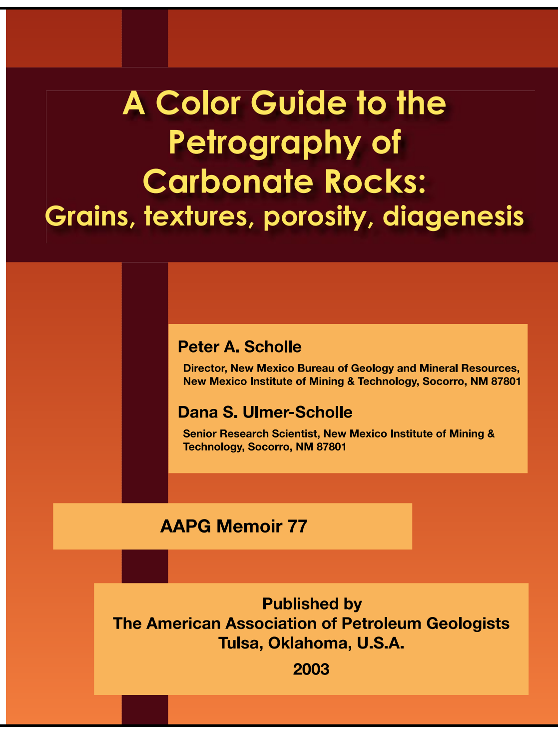
Carbonate Grain Types and Matrix

Fossils/Skeletal Grains
Ooids/Coated Grains
Pellets
Intraclasts/Lithoclasts
Peloids
Lime Mud



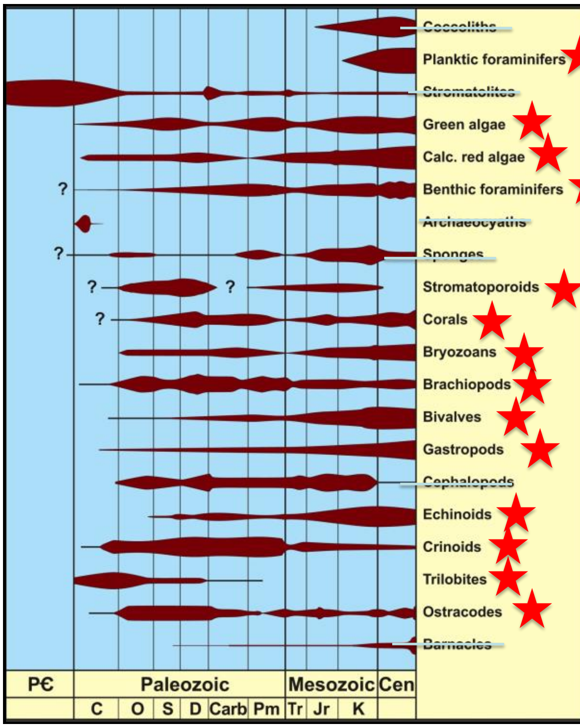






Many images and material sourced from this book.

A must-have if you want to pursue Sedimentary Petrology or Carbonate Sedimentology!



Fossil Groups Through Time

Common fossil groups encountered in carbonate rocks as allochems and/or biolithic elements.

★ = Need to be able to identify these groups for thin sections and hand specimens in the lab

CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ________ ROCK NAME ________

Megascopic Description

Colour (Fresh): ________ Colour (Weathered): ________ Sample Quality: ________

Crystal Size: ________ Particle Size: (Max-Min; Ave.): ________

Particle/Matrix: (grain- or matrix-supported) ________

Hand Specimen Description: ________

Thin Section Description

Allochem%: ________ Micrite Matrix%: ________ Sparite (Cement)%: ________

Particle/Matrix: (grain- or matrix-supported) ________ Micritized Grain Margins: ________

Allochemical Particle Types:

Bioclastic Fragments: (Size and %)

- Corals: ________
- Brachiopods: ________
- Bivalves: ________
- Gastropods: ________
- Bryozoans: ________
- Echinoderms: ________
- Ostracodes: ________
- Calcareous Green Algae: ________
- Calcareous Red Algae: ________
- Foraminifera: ________
- Radiolarians: ________
- Stromatoporoids: ________
- Oncoids: ________

Inorganic Allochems: (Size and %)

- Ooids: ________
- Peloids: ________
- Pisoids: ________
- Intraclasts: ________
- Aggregate Grains: ________
- Lithoclasts: ________
- OTHERS: ________

Fabric(s), Packing and Structure(s): ________

Diagenesis

Matrix Type(s) and %: ________

Cement Type(s) and %: ________

Other Authigenic Minerals: ________

Compactional Data: ________

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ________

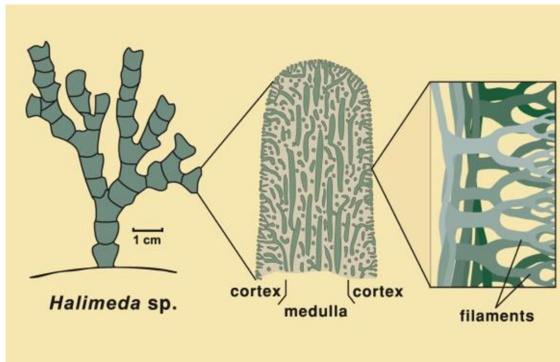
Porosity%: ________

Neomorphism and Diagenetic History: ________

Representative Thin Section Description: ________

Green Algae — *Halimeda*: Cretaceous to Recent
Family Codiaceae: Ordovician to Recent

- **Aragonite (typically replaced). True of all green algae**
- 'Spaghetti noodle' interior fabric
- Major source of carbonate mud.



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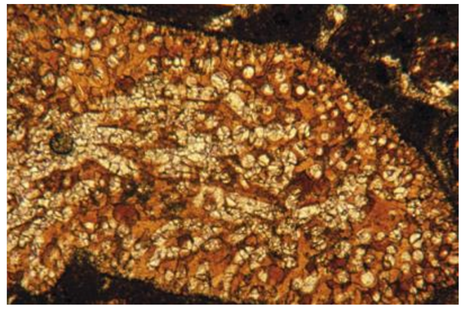
Family Codiaceae: Ordovician to Recent

- **Aragonite (typically replaced). True of all green algae**
- 'Spaghetti noodle' interior fabric
- Major source of carbonate mud.

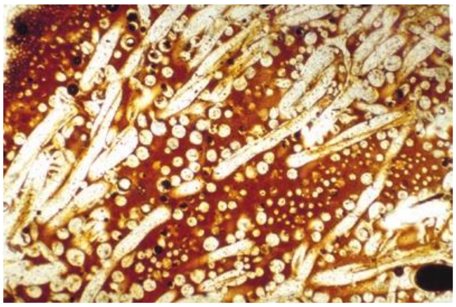
Transverse section
PPL, ~2.4 mm

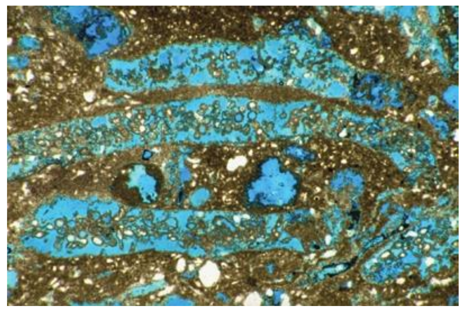
Halimeda

Halimeda, Pleistocene
PPL, horizontal: 14 mm



Halimeda, Recent Sediments
PPL, horizontal: 2 mm

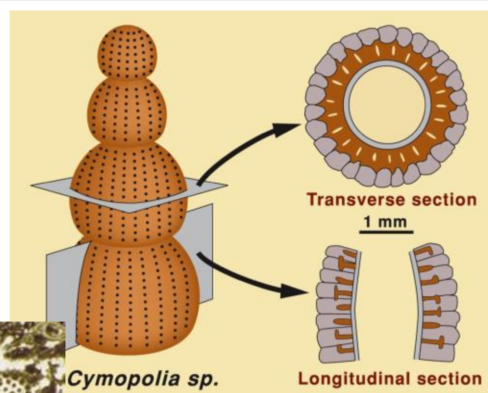


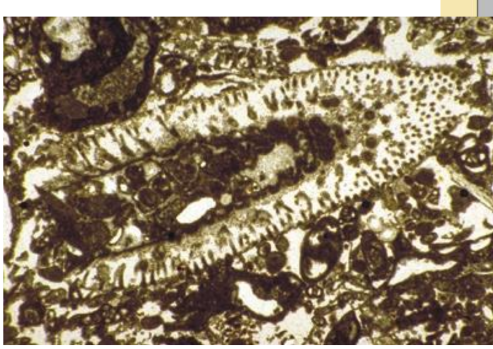


Halimeda, Miocene
PPL, horizontal: 5 mm

Green Algae –
Dasycladacea

- Resemble ‘flowers’
- **Aragonite** = poor preservation of internal microstructure





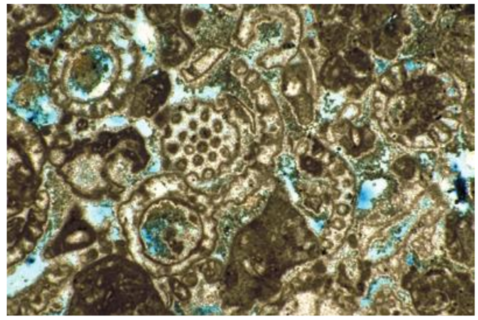
Dasyclaydacean algae, Oligocene
PPL, horizontal: 5 mm

Cambrian to Recent

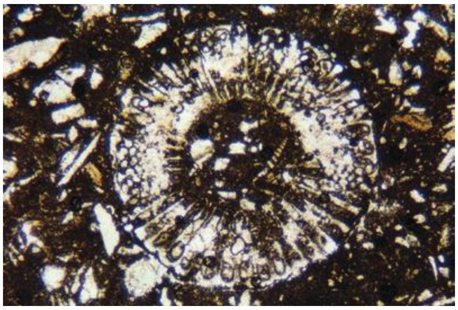
Disarticulates into spherical grains upon death

Dasycladacea

Dasyclaydacean algae, Upper Permian
PPL, horizontal: 5.8 mm



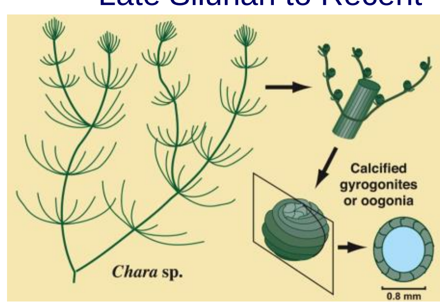
Dasyclaydacean algae, Cretaceous
PPL, horizontal: 5.5 mm



Dasyclaydacean algae, Ordovician
PPL, horizontal: 23 mm

Green Algae – Charophytes

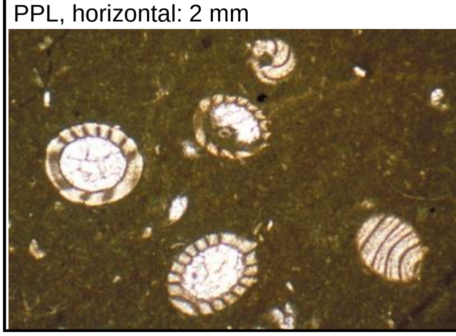
Late Silurian to Recent



- Resemble ‘flowers’
- Stalks and pelagic reproductive bodies (charophytes)

Low-Mg Calcite or **Aragonite**

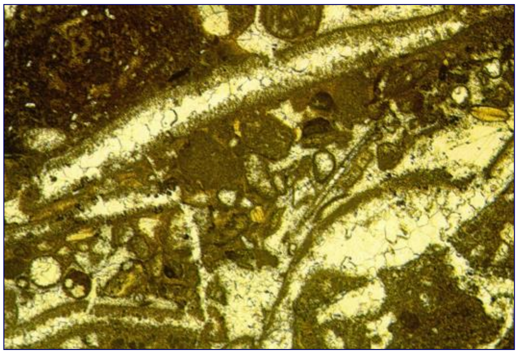
Charophyte, Upper Jurassic
PPL, horizontal: 2 mm

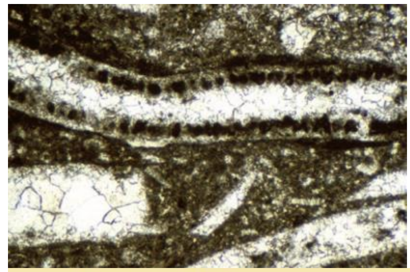


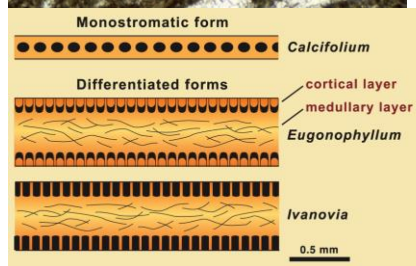
Charophyte, Lower Cretaceous
PPL, horizontal: 2.1 mm

Green Algae – Phylloid

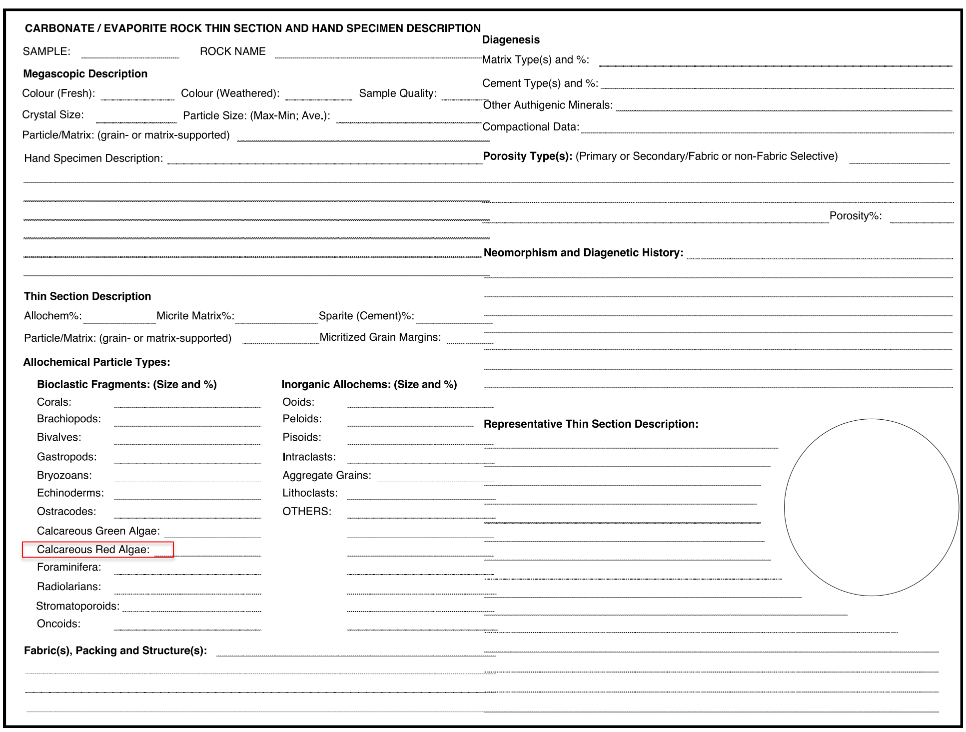
Upper Pennsylvanian
PPL, horizontal: 2.4 mm







- Pennsylvanian to Late Permian
- Common Carboniferous grain producer
- **Aragonite**, so typically leached to resemble 'potato chips'
  - May look similar to bivalve pieces, but grain shape more irregular



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Ooids: ______
Peloids: ______
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Aggregate Grains: ______
Lithoclasts: ______
OTHERS: ______

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Compactional Data: ______

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ______

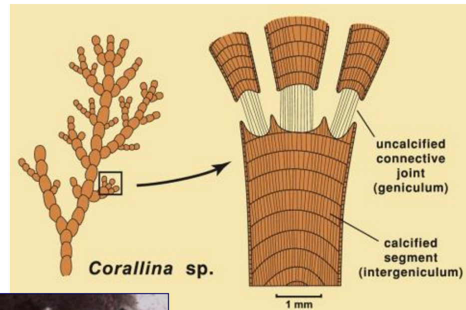
Porosity%: ______

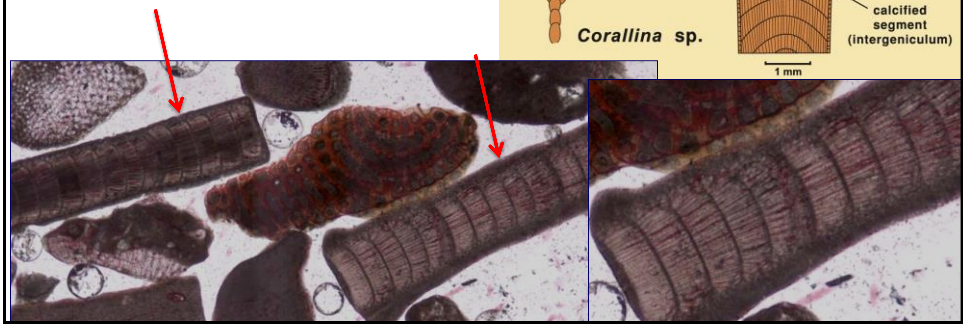
Neomorphism and Diagenetic History: ______

Representative Thin Section Description: ______

Skeletal Grains - Red Algae Cambrian to Recent

- Stacked 'columns' – Identified by very fine latticework, boxwork or network structure
- Well-preserved because precipitated as **calcite**
- Larger depth range (low light tolerant)





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Other Authigenic Minerals: ______
Compactional Data: ______

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ______

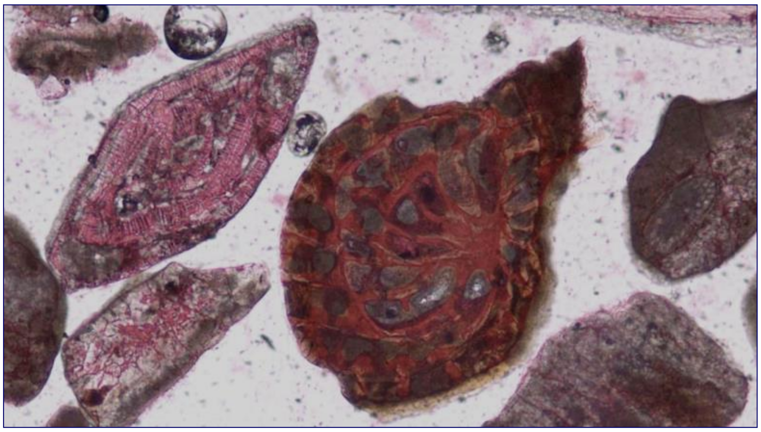
Porosity%: ______

Neomorphism and Diagenetic History: ______

Representative Thin Section Description: ______

Benthic Foraminifera Cambrian to Recent

- Single celled, commonly resemble small “snail-like” shapes.
- Typically 0.1 to 1 mm. Can grow to a few cm long
- Key biostratigraphic indicators
- Many have **calcite tests**, so well preserved

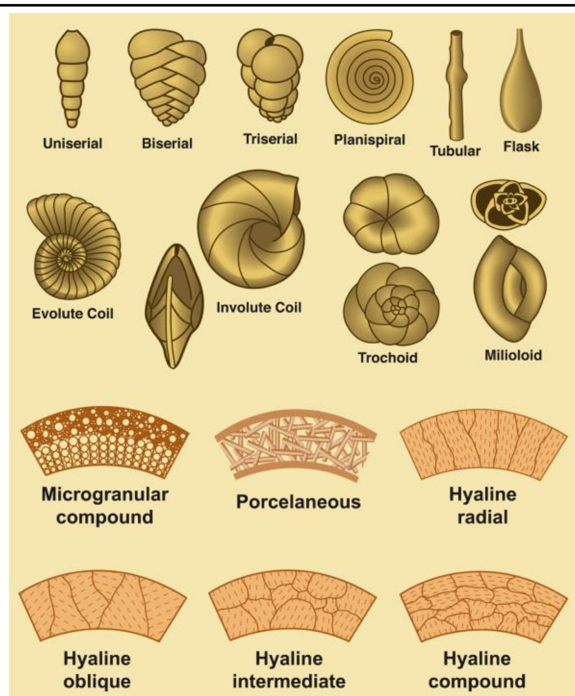


Benthic Foraminifera

Common test shapes

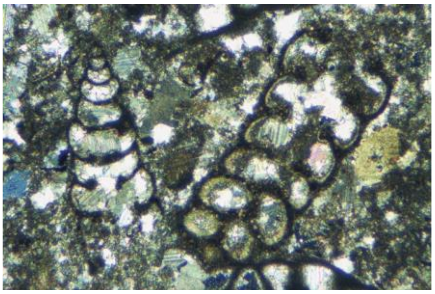
Can also get agglutinated forms (made of carbonate sand, quartz sand or mud

Main calcareous wall structures

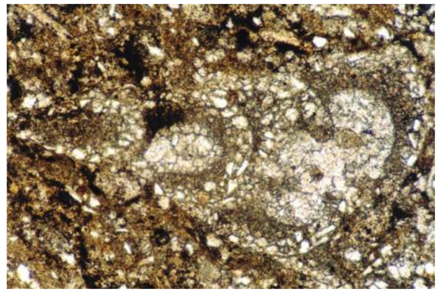


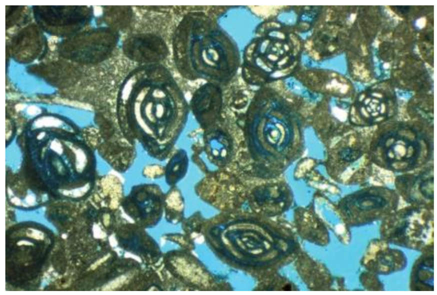
Benthic Foraminifera

Biserial foram, Mid. Pennsylvanian
XPL, horizontal: 2.2 mm



Agglutinated foram, Upper Cretaceous
PPL, horizontal: 0.9 mm

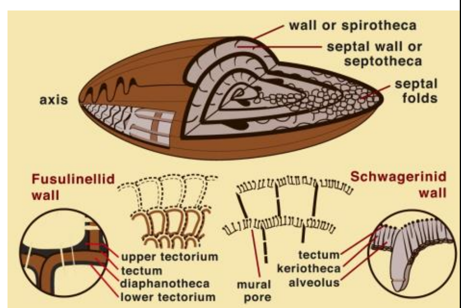


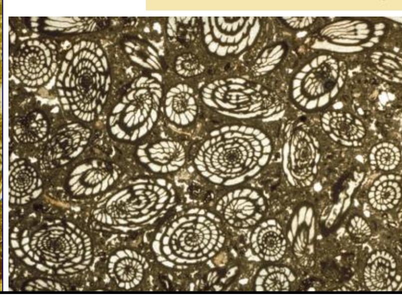


Miliolid foram, Eocene
PPL, horizontal: 5.1 mm

Foraminifera – Fusilinids Late Paleozoic

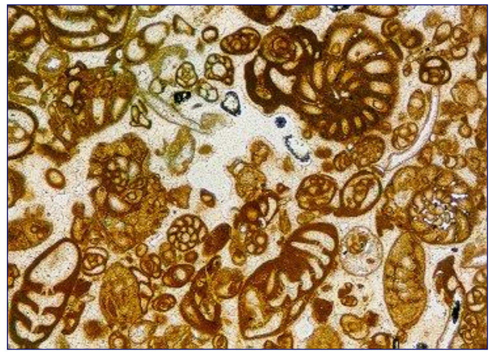
Large benthic forams. Commonly visible with naked eye

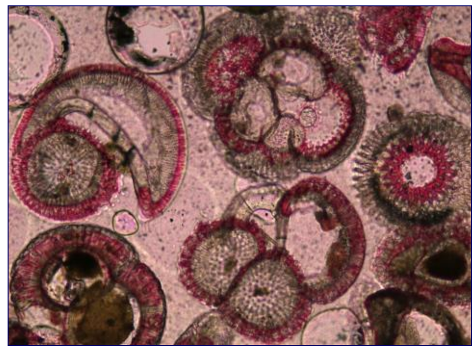




Fusilinid, Upper Pennsylvanian
PPL, 16 mm

Planktonic Foraminifera





Late Jurassic to Recent

- Much smaller (0.02 - 0.2 mm)
- **Calcite Tests**
- Delicate forms (pelagic)

CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ____ ROCK NAME ____

Megascopic Description

Colour (Fresh): ____ Colour (Weathered): ____ Sample Quality: ____

Crystal Size: ____ Particle Size: (Max-Min; Ave.): ____

Particle/Matrix: (grain- or matrix-supported) ____

Hand Specimen Description: ____

Thin Section Description

Allochem%: ____ Micrite Matrix%: ____ Sparite (Cement)%: ____

Particle/Matrix: (grain- or matrix-supported) ____ Micritized Grain Margins: ____

Allochemical Particle Types:

Bioclastic Fragments: (Size and %)

Corals: ____
Brachiopods: ____
Bivalves: ____
Gastropods: ____
Bryozoans: ____
Echinoderms: ____
Ostracodes: ____
Calcareous Green Algae: ____
Calcareous Red Algae: ____
Foraminifera: ____
Radiolarians: ____
Stromatoporoids: ____
Oncoids: ____

Inorganic Allochems: (Size and %)

Ooids: ____
Peloids: ____
Pisoids: ____
Intraclasts: ____
Aggregate Grains: ____
Lithoclasts: ____
OTHERS: ____

Fabric(s), Packing and Structure(s): ____

Diagenesis

Matrix Type(s) and %: ____

Cement Type(s) and %: ____

Other Authigenic Minerals: ____

Compactional Data: ____

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ____

Porosity%: ____

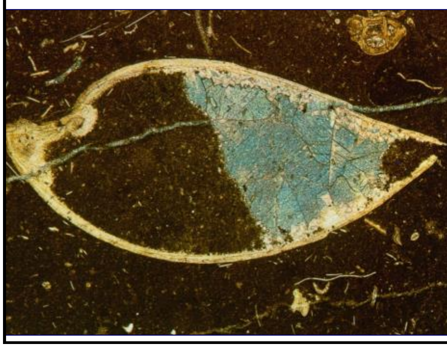
Neomorphism and Diagenetic History: ____

Representative Thin Section Description: ____

Brachiopods

Cambrian to Recent

- Irregular, fibrous structure
- Punctate or impunctate
- Thin, **calcite** shells
- Corrugated or spiny margin
- Spines in Late Paleozoic



Brachiopods

5 types of shell microstructure:

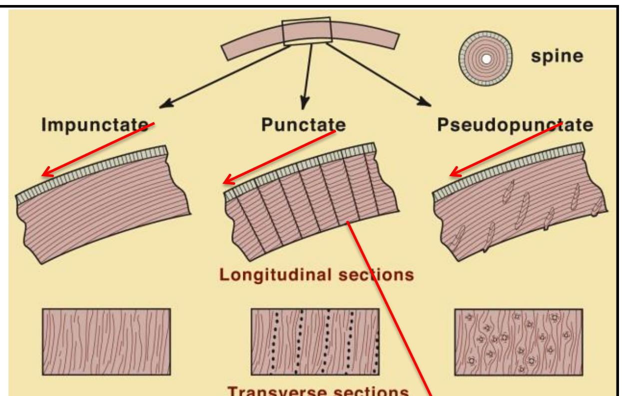
Laminar

Punctate

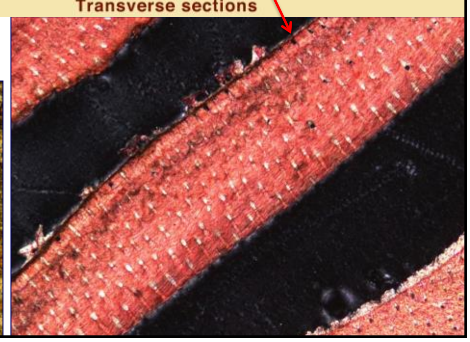
Impunctate

Pseudopunctate

Tabular

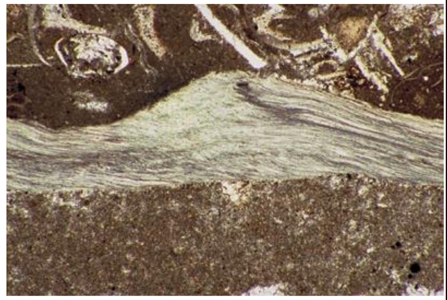


Low-angle fibrous microstructure

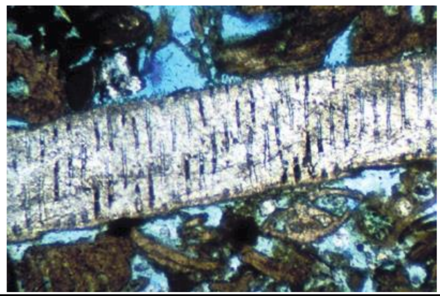


Brachiopods

Upper Mississipian, PPL, horizontal: 2.1 mm
Micrite coated brachiopod shells & crinoid ossicles. Two shell layers, fibrous microstructure, punctuate and impunctuate



Upper Ordovician, PPL, hztl: 3.0 mm
Thick second layer. Low-angle, fibrous microstructure, signif. Shell thickness change



Miocene, PPL, horizontal: 2.0 mm
Punctuate shell & fibrous wall structure

CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ______ ROCK NAME ______

Megascopic Description

Colour (Fresh): ______ Colour (Weathered): ______ Sample Quality: ______

Crystal Size: ______ Particle Size: (Max-Min; Ave.): ______

Particle/Matrix: (grain- or matrix-supported) ______

Hand Specimen Description: ______

Thin Section Description

Allochem%: ______ Micrite Matrix%: ______ Sparite (Cement)%: ______

Particle/Matrix: (grain- or matrix-supported) ______ Micritized Grain Margins: ______

Allochemical Particle Types:

Bioclastic Fragments: (Size and %)

Corals: ______
Brachiopods: ______
Bivalves: ______
Gastropods: ______
Bryozoans: ______
Echinoderms: ______
Ostracodes: ______
Calcareous Green Algae: ______
Calcareous Red Algae: ______
Foraminifera: ______
Radiolarians: ______
Stromatoporoids: ______
Oncoids: ______

Inorganic Allochems: (Size and %)

Ooids: ______
Peloids: ______
Pisoids: ______
Intraclasts: ______
Aggregate Grains: ______
Lithoclasts: ______
OTHERS: ______

Fabric(s), Packing and Structure(s): ______

Diagenesis

Matrix Type(s) and %: ______

Cement Type(s) and %: ______

Other Authigenic Minerals: ______

Compactional Data: ______

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ______

Porosity%: ______

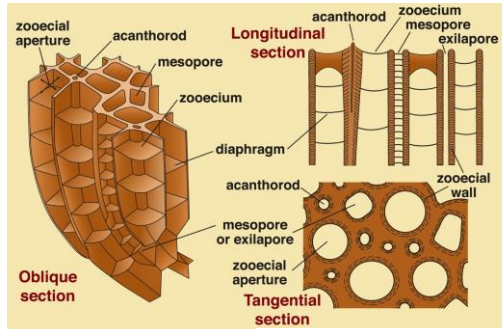
Neomorphism and Diagenetic History: ______

Representative Thin Section Description:

Bryozoa

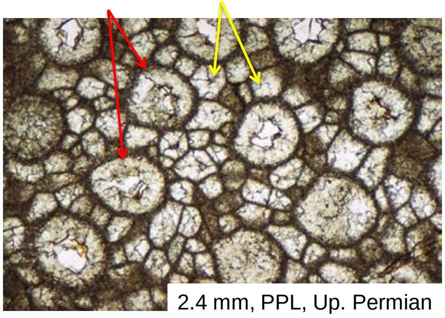
Early Ordovician to Recent

- Well-organized structure
- Small holes (zooecia), commonly cement filled filled with micrite.
- Branching, encrusting forms common
- Fibrous wall structure



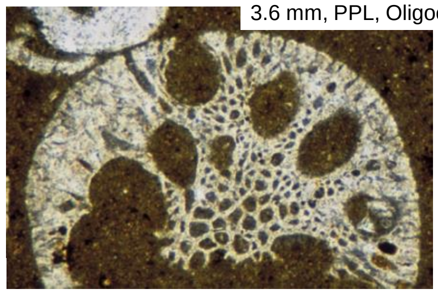
Zooecia

pores



2.4 mm, PPL, Up. Permian

Cyclostome bryozoan: 3.6 mm, PPL, Oligocene



Bryozoa

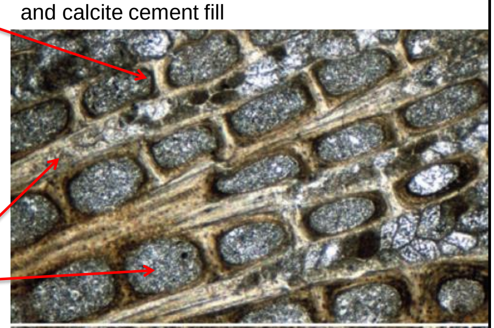
- Mostly composed of **calcite,** so microstructure commonly preserved.
- Colonial, few mm's to cm's
- Individual zooecia < 1mm

Fenestrate bryozoan: 1.65 mm, PPL, Mid. Mississippian. Note: laminated wall structure and calcite cement fill

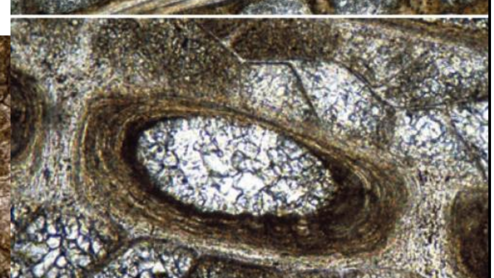
Dissepiments

Wall structure

Fenestrule



Treptostome bryozoan: 8.0 mm, PPL, Upper Ordovician

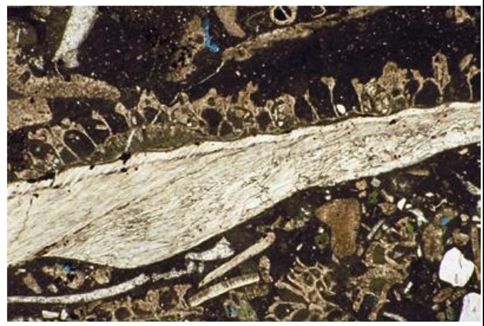


Same slide as above: 0.65 mm. Note: laminated structure and slight crenulations

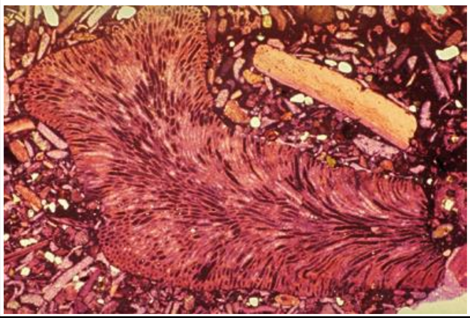
Bryozoa

Cheliostome bryozoan: 1.6 mm, PPL, Oligocene

Encrusting Cheliostome bryozoan on brachiopod shell: 6.0 mm, PPL, Oligocene



Cyclostome bryozoan: 5.1 mm, PPL, Oligocene



CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ______ ROCK NAME ______

Megascopic Description

Colour (Fresh): ______ Colour (Weathered): ______ Sample Quality: ______

Crystal Size: ______ Particle Size: (Max-Min; Ave.): ______

Particle/Matrix: (grain- or matrix-supported) ______

Hand Specimen Description: ______

Thin Section Description

Allochem%: ______ Micrite Matrix%: ______ Sparite (Cement)%: ______

Particle/Matrix: (grain- or matrix-supported) ______ Micritized Grain Margins: ______

Allochemical Particle Types:

Bioclastic Fragments: (Size and %)

Corals: ______
Brachiopods: ______
Bivalves: ______
Gastropods: ______
Bryozoans: ______
Echinoderms: ______
Ostracodes: ______
Calcareous Green Algae: ______
Calcareous Red Algae: ______
Foraminifera: ______
Radiolarians: ______
Stromatoporoids: ______
Oncoids: ______

Inorganic Allochems: (Size and %)

Ooids: ______
Peloids: ______
Pisoids: ______
Intraclasts: ______
Aggregate Grains: ______
Lithoclasts: ______
OTHERS: ______

Fabric(s), Packing and Structure(s): ______

Diagenesis

Matrix Type(s) and %: ______

Cement Type(s) and %: ______

Other Authigenic Minerals: ______

Compactional Data: ______

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ______

Porosity%: ______

Neomorphism and Diagenetic History: ______

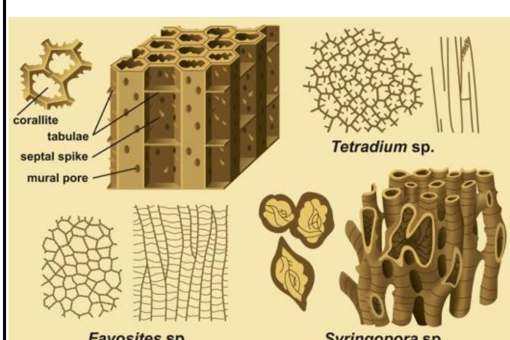
Representative Thin Section Description: ______

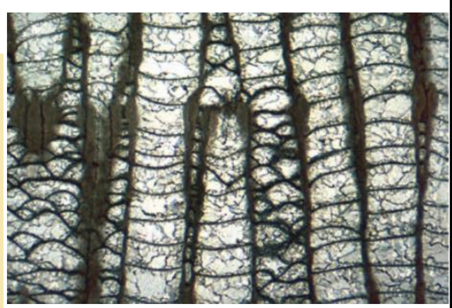
Corals

- Much larger ‘holes’ (corallites), separated by septa
- Modern Schleractinians (Triassic to Recent) are **aragonitic**, commonly leached, recrystallized and without microstructure.
- Paleozoic corals: Tabulata and Rugosa – **calcitic**, so commonly preserve wall structure.

Tabulate Corals Early Ordovician to Late Permian

- **Calcite**
- Colonial: corallites (0.2-5 mm). Colonies mms to 4m in diameter
- Horizontal tabulae prominent. Small septa or lacks septa
- Fuzzy, fibrous wall structure
- Differentiated from Bryozoa by larger living chambers, tabulae and septa





Tabulate coral: 7.5 mm, PPL, Upper Ordovician.

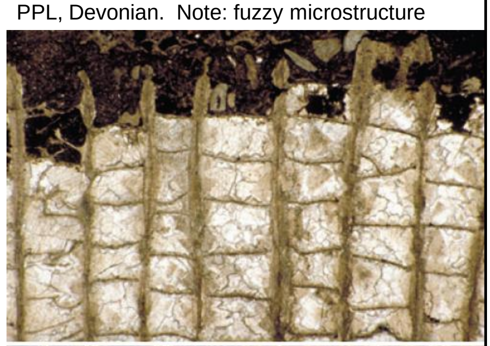
Coral

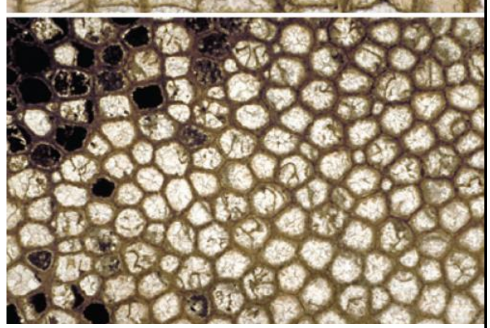
Fuzzy microstructure – perpendicular to septa & coral wall

Tabulate Corals

- **Calcite**
- Colonial: corallites (0.2-5 mm). Colonies mms to 4m in diameter.
- Horizontal tabulae prominent. Small septa or lack septa.
- Fuzzy, fibrous wall structure.
- Differentiated from Bryozoa by larger living chambers, tabulae and septa.

Tabulate Coral (longitudinal section): 5 mm, PPL, Devonian. Note: fuzzy microstructure

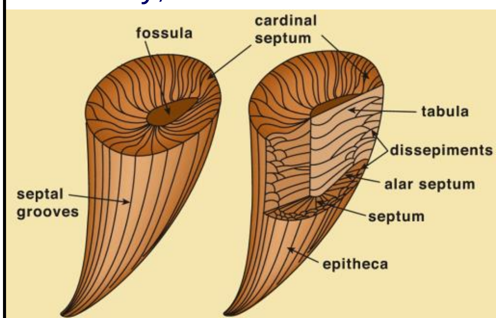


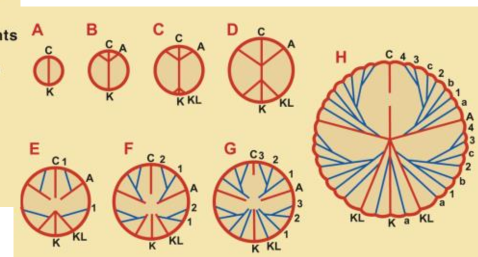


Same slide, transverse section: 12.5 mm.

Rugose Corals Middle Ordovician to Late Permian

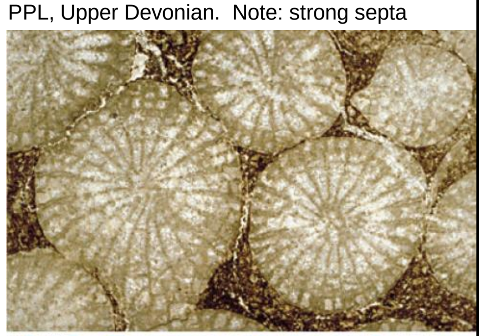
- **Calcite**
- Solitary (2/3): cm to dm, horn-shaped; or Colonial (1/3): cm to m, irregular branching or massive
- Well-developed septa, poorly developed tabulae. Bilaterally symmetrical
- Fuzzy, fibrous wall structure

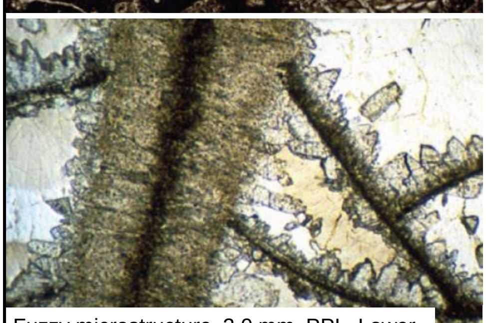




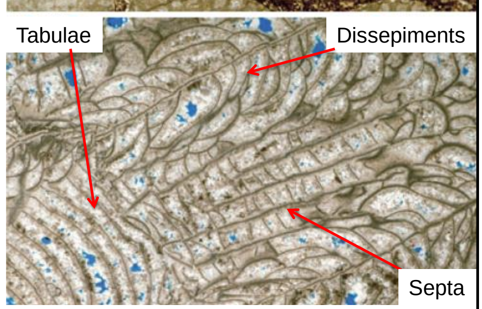
Rugose Coral (longitudinal section): 16 mm, PPL, Carboniferous.

Colonial Rugose (transverse section): 16 mm, PPL, Upper Devonian. Note: strong septa





Fuzzy microstructure, 2.0 mm, PPL, Lower Permian.



Colonial Rugose with complex structure: 14.5 mm, PPL, Lower Permian

CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ________ ROCK NAME ________

Megascopic Description

Colour (Fresh): ________ Colour (Weathered): ________ Sample Quality: ________

Crystal Size: ________ Particle Size: (Max-Min; Ave.): ________

Particle/Matrix: (grain- or matrix-supported) ________

Hand Specimen Description: ________

Thin Section Description

Allochem%: ________ Micrite Matrix%: ________ Sparite (Cement)%: ________

Particle/Matrix: (grain- or matrix-supported) ________ Micritized Grain Margins: ________

Allochemical Particle Types:

Bioclastic Fragments: (Size and %)

Corals: ________
Brachiopods: ________
Bivalves: ________
Gastropods: ________
Bryozoans: ________
Echinoderms: ________
Ostracodes: ________
Calcareous Green Algae: ________
Calcareous Red Algae: ________
Foraminifera: ________
Radiolarians: ________
Stromatoporoids: ________
Oncoids: ________

Inorganic Allochems: (Size and %)

Ooids: ________
Peloids: ________
Pisoids: ________
Intraclasts: ________
Aggregate Grains: ________
Lithoclasts: ________
OTHERS: ________

Fabric(s), Packing and Structure(s): ________

Diagenesis

Matrix Type(s) and %: ________

Cement Type(s) and %: ________

Other Authigenic Minerals: ________

Compactional Data: ________

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ________

Porosity%: ________

Neomorphism and Diagenetic History: ________

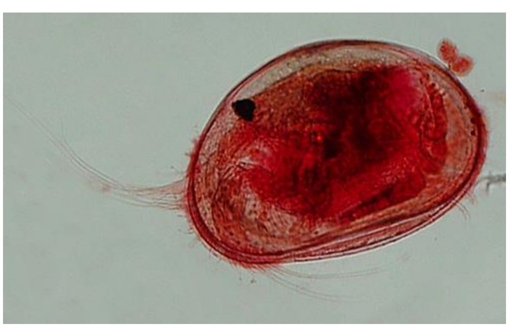
Representative Thin Section Description: ________

Ostracodes

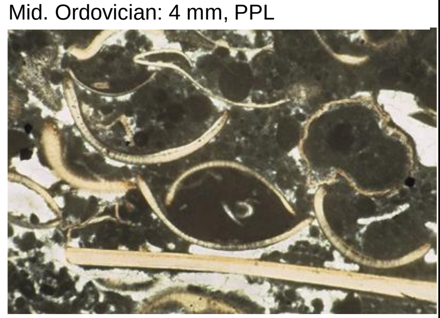
Cambrian to Recent

- Small (1 to 2 mm, max. 40 mm), very thin shells of an arthropod.
- Crystal growth normal to shell = sweeping extinction
- **Calcite** and slightly phosphatic, so well-preserved

Upper Permian: 1.6 mm, PPL Note: geopetal structure



Mid. Ordovician: 4 mm, PPL



CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ________ ROCK NAME ________

Megascopic Description

Colour (Fresh): ________ Colour (Weathered): ________ Sample Quality: ________

Crystal Size: ________ Particle Size: (Max-Min; Ave.): ________

Particle/Matrix: (grain- or matrix-supported) ________

Hand Specimen Description: ________

Thin Section Description

Allochem%: ________ Micrite Matrix%: ________ Sparite (Cement)%: ________

Particle/Matrix: (grain- or matrix-supported) ________ Micritized Grain Margins: ________

Allochemical Particle Types:

Bioclastic Fragments: (Size and %)

- Corals:
- Brachiopods:
- Bivalves:
- Gastropods:
- Bryozoans:
- Echinoderms:
- Ostracodes:
- Calcareous Green Algae:
- Calcareous Red Algae:
- Foraminifera:
- Radiolarians:
- Stromatoporoids:
- Oncoids:

Inorganic Allochems: (Size and %)

- Ooids:
- Peloids:
- Pisoids:
- Intraclasts:
- Aggregate Grains:
- Lithoclasts:
- OTHERS:

Fabric(s), Packing and Structure(s): ________

Diagenesis

Matrix Type(s) and %: ________

Cement Type(s) and %: ________

Other Authigenic Minerals: ________

Compactional Data: ________

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ________

Porosity%: ________

Neomorphism and Diagenetic History: ________

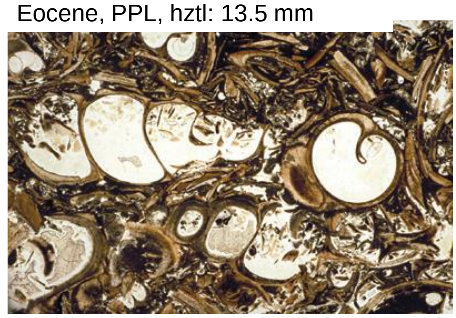
Representative Thin Section Description: ________

Gastropod

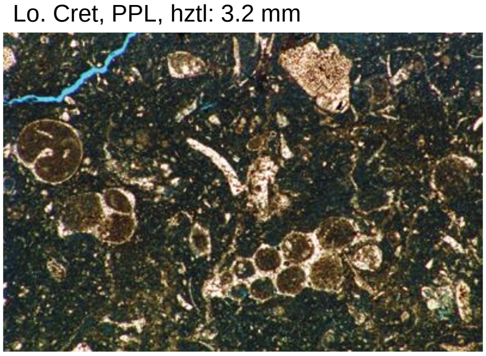
Cambrian to Recent

- Complex shell microstructures
- Mm to cm
- **Aragonitic**,so typically leached (no microstructure preserved).
- Generally recrystallized.

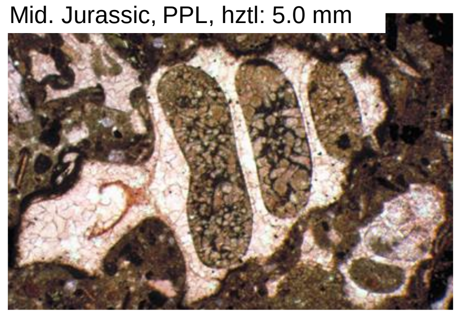
Eocene, PPL, hztl: 13.5 mm



Lo. Cret, PPL, hztl: 3.2 mm



Mid. Jurassic, PPL, hztl: 5.0 mm



CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ______ ROCK NAME ______

Megascopic Description

Colour (Fresh): ______ Colour (Weathered): ______ Sample Quality: ______

Crystal Size: ______ Particle Size: (Max-Min; Ave.): ______

Particle/Matrix: (grain- or matrix-supported) ______

Hand Specimen Description: ______

Thin Section Description

Allochem%: ______ Micrite Matrix%: ______ Sparite (Cement)%: ______

Particle/Matrix: (grain- or matrix-supported) ______ Micritized Grain Margins: ______

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Bioclastic Fragments: (Size and %)

Corals: ______
Brachiopods: ______
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Bryozoans: ______
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Oncoids: ______

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Ooids: ______
Peloids: ______
Pisoids: ______
Intraclasts: ______
Aggregate Grains: ______
Lithoclasts: ______
OTHERS: ______

Fabric(s), Packing and Structure(s): ______

Diagenesis

Matrix Type(s) and %: ______

Cement Type(s) and %: ______

Other Authigenic Minerals: ______

Compactional Data: ______

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ______

Porosity%: ______

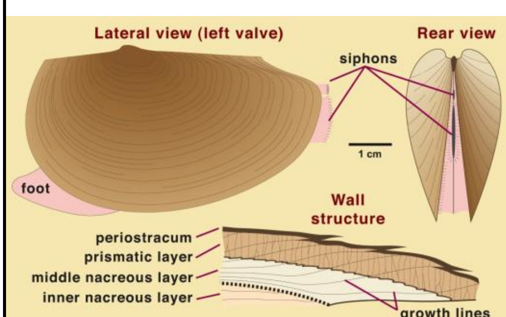
Neomorphism and Diagenetic History: ______

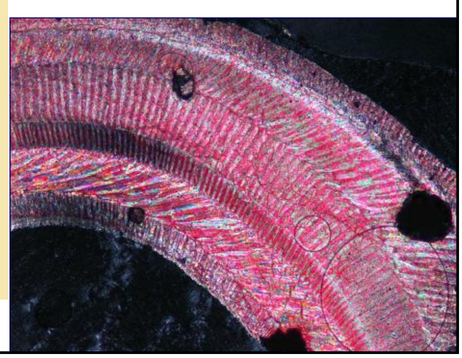
Representative Thin Section Description: ______

Bivalves (Pelecypods)

Cambrian to Recent

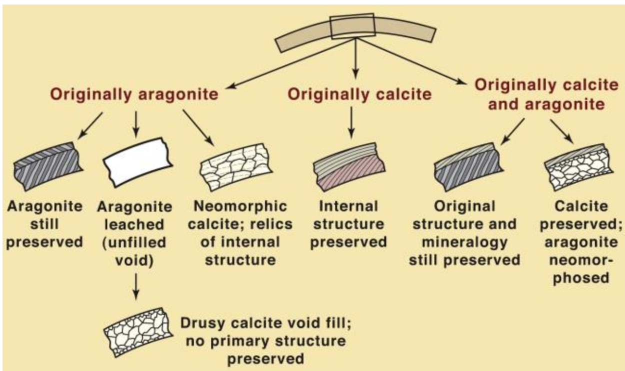
- Complex shell microstructures (many varieties) – inner lamellar and outer prismatic layers
- **Aragonite** or calcite; most aragonite.
- *Commonly recrystallized or leached*. Fossil examples typically lack preserved wall microstructure.

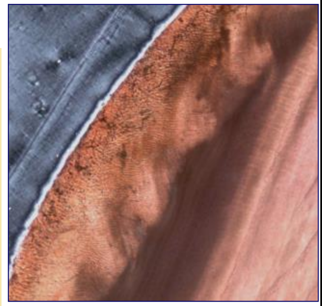




Bivalves (Pelecypods) Cambrian to Recent

- Complex shell microstructures (many varieties) – inner lamellar and outer prismatic layers
- **Aragonite** or calcite; most aragonite.
- *Commonly recrystallized or leached*. Fossil examples typically lack preserved wall microstructure.





Bivalves (Pelecypods)

How to Identify Bivalves in thin section:

- Bivalve microstructure is typically replaced or recrystallized
- Bigger than Ostracodes (similar shell structure) though not generally phosphatic.
- Gently curving shell that tapers towards the front, and thickens towards the hinge.
- Multiple, complex shell structure if preserved.

Mid. Triassic, PPL, hztl: 7.0 mm

Lo. Cret., PPL, hztl: 2.0 mm

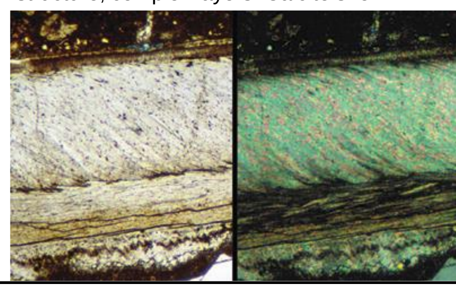
Bivalves (Pelecypods)

How to Identify Bivalves in thin section:

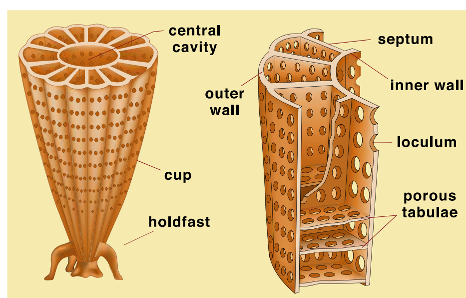
- Bivalve microstructure is typically replaced or recrystallized
- Bigger than Ostracodes (similar shell structure) though not generally phosphatic.
- Gently curving shell that tapers towards the front, and thickens towards the hinge.
- Multiple, complex shell structure if preserved.

Cretaceous – rudist bivalve, PPL, hztl: 8.0 mm. Aragonite inner and calcite outer layer

Oligocene, PPL/XPL, hztl: 1.0 mm. Foliated structure, complex layers. Calcite shell



Archaeocyaths



Calcareous fossils common in the Lower Cambrian and **extinct by the end of the Cambrian**

Calcite

Large. 10-25 mm in diameter and 50 mm high (large specimens to 150 mm)

Lo. Cambrian, PPL hztl: 16 mm

CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ____ ROCK NAME ____

Megascopic Description

Colour (Fresh): ____ Colour (Weathered): ____ Sample Quality: ____

Crystal Size: ____ Particle Size: (Max-Min; Ave.): ____

Particle/Matrix: (grain- or matrix-supported) ____

Hand Specimen Description: ____

Thin Section Description

Allochem%: ____ Micrite Matrix%: ____ Sparite (Cement)%: ____

Particle/Matrix: (grain- or matrix-supported) ____ Micritized Grain Margins: ____

Allochemical Particle Types:

Bioclastic Fragments: (Size and %)

Corals:
Brachiopods:
Bivalves:
Gastropods:
Bryozoans:
Echinoderms:
Ostracodes:
Calcareous Green Algae:
Calcareous Red Algae:
Foraminifera:
Radiolarians:
Stromatoporoids:
Oncoids:

Inorganic Allochems: (Size and %)

Ooids:
Peloids:
Pisoids:
Intraclasts:
Aggregate Grains:
Lithoclasts:
OTHERS:

Fabric(s), Packing and Structure(s): ____

Diagenesis

Matrix Type(s) and %: ____

Cement Type(s) and %: ____

Other Authigenic Minerals: ____

Compactional Data: ____

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ____

Porosity%: ____

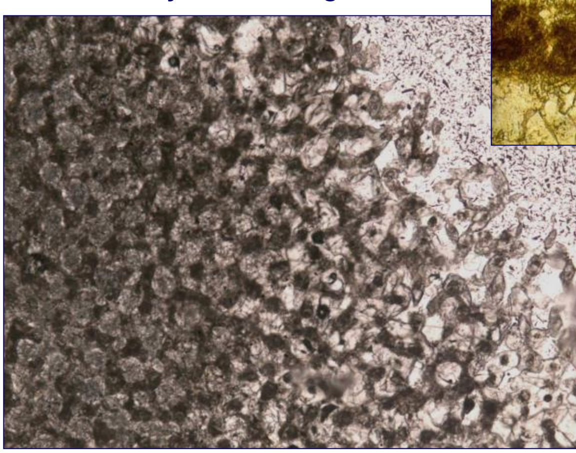
Neomorphism and Diagenetic History: ____

Representative Thin Section Description: ____

Calcareous Demosponges (Stromatoporoids)

PreCambrian to Recent

- Irregular microstructure
- May find spicules (but rare)
- Commonly encrusting forms



Spicules are hard to tell from pillars; arguments persist as to whether they had siliceous spicules replaced by calcite or calcareous spicules. Some say no spicules at all.

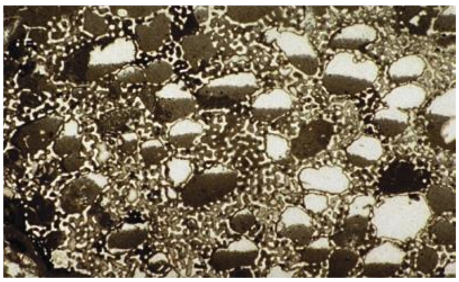
Calcareous Sponges (excl. Stromatoporoids)
PreCambrian to Recent

Very hard to differentiate from Stromatoporoids. If spicules observed, then it's a sponge (incl. with Stroms)

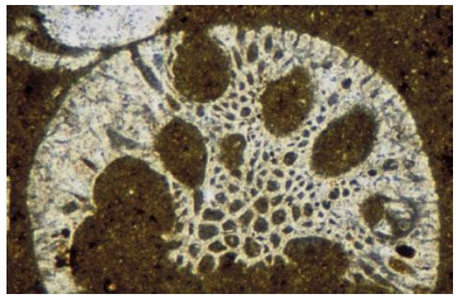
Differ from bryozoa in that they lack fibrous microstructure and less organized

Differ from corals in that they lack clear organization obvious in corals

Calcareous sponge, Up. Permian, PPL, hztl: 8.0 mm



Cyclostome bryozoan: 3.6 mm, PPL, Oligocene



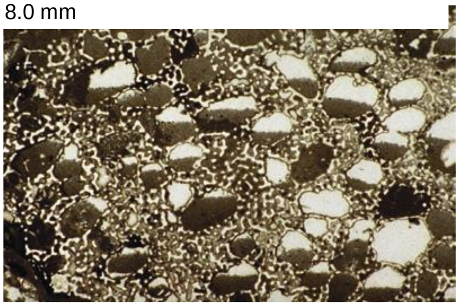
Calcareous Sponges (excl. Stromatoporoids)
PreCambrian to Recent

Very hard to differentiate from Stromatoporoids. If spicules observed, then it's a sponge (included with Stroms)

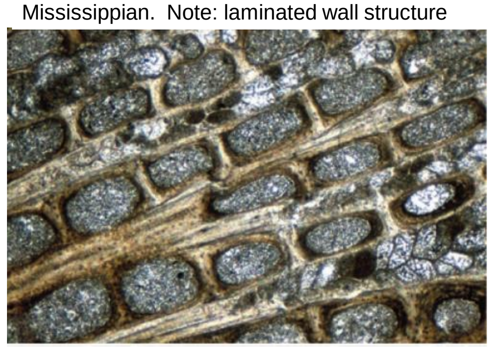
Differ from bryozoa in that they lack fibrous microstructure and are less well organized

Differ from corals in that they lack clear organization obvious in corals

Calcareous sponge, Up. Permian, PPL, hztl: 8.0 mm



Fenestrate bryozoan: 1.65 mm, PPL, Mid. Mississippian. Note: laminated wall structure



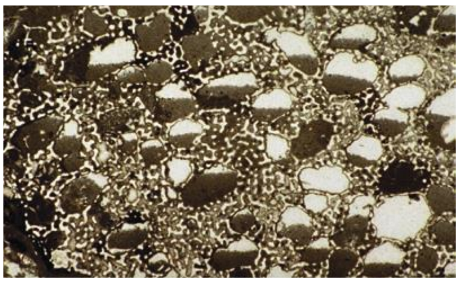
Calcareous Sponges (excl. Stromatoporoids)
PreCambrian to Recent

Very hard to differentiate from Stromatoporoids. If spicules observed, then it's a sponge (included with Stroms)

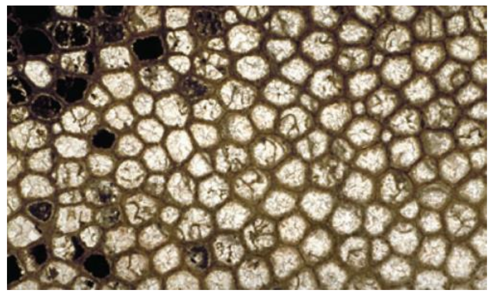
Differ from bryozoa in that they lack fibrous microstructure and are less well organized

Differ from corals in that they lack clear organization obvious in corals

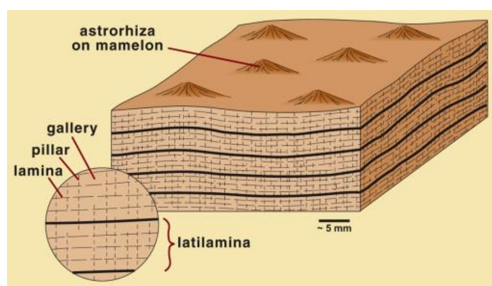
Calcareous sponge, Up. Permian, PPL, hztl: 8.0 mm



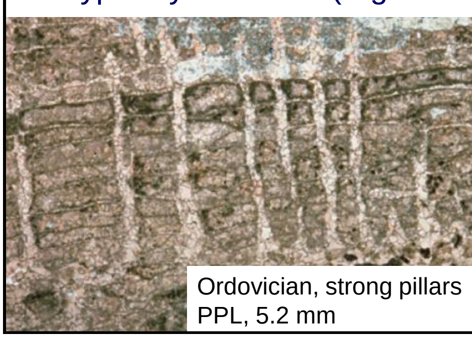
Tabulate Coral (tranverse section): 12.5 mm, PPL, Devonian.



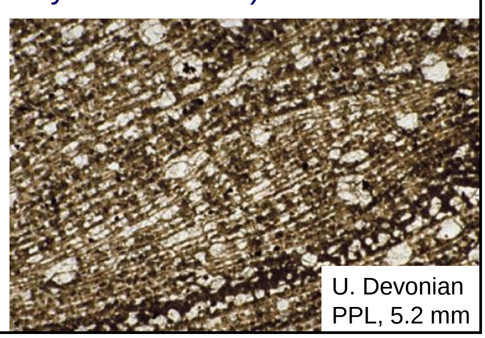
Stromatoporoids E. Ordovician to Cretaceous



- Extremely common from Ordovician to Devonian
- Lattice-work of vertical pillars and horizontal laminae
- Primarily **calcite**
- Typically brownish (organics in crystal structure)



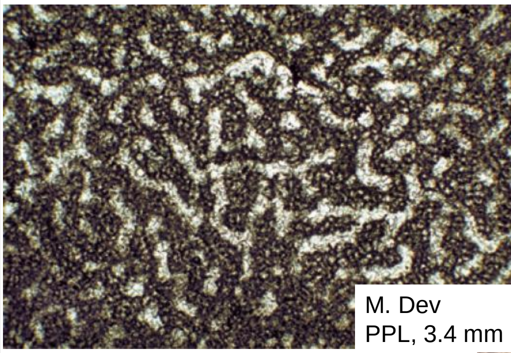
Ordovician, strong pillars
PPL, 5.2 mm



U. Devonian
PPL, 5.2 mm

Stromatoporoids

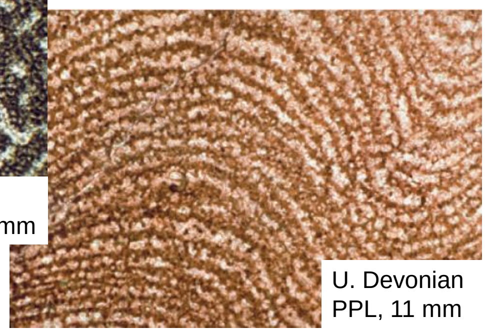
- < 1 cm to > 1m
- Massive, sheet-like, encrusting forms, or globular and branching, finger-like forms (depending on energy level).



M. Dev
PPL, 3.4 mm

Can look very similar to calcified sponges in transverse view

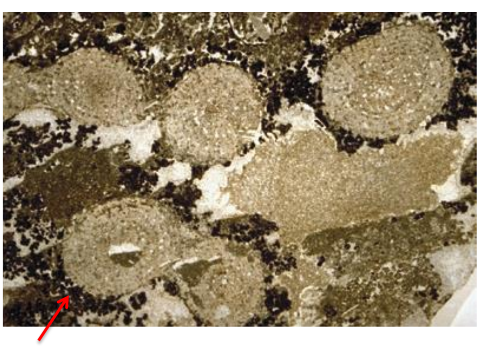
Boxwork appearance in cross-sectional view



U. Devonian
PPL, 11 mm

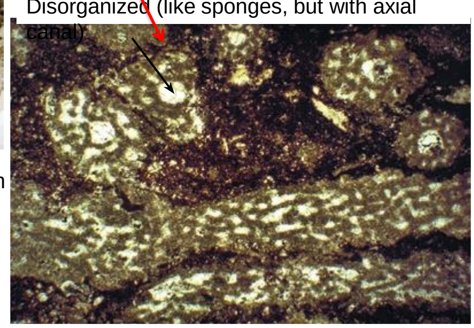
Stromatoporoids

Stromatoporoid, Up. Devonian, PPL, hztl: 9.0 mm
Well developed pillars and laminae



Stromatoporoid, Up. Devonian, PPL, hztl: 23.0 mm
Well-developed chambers in cross-sections of finger-like stromatoporoids.

Amphipora, Up. Devonian, PPL, hztl: 11.0 mm
Disorganized (like sponges, but with axial canal)



Trilobites: Arthropoda

Cambrian to Late Permian

Phosphatic, giving **sweeping extinction**

Shepherd's crook shapes

Calcitic/Apatitic (rarely leached)

May have small perforations in Carapace.

CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ____ ROCK NAME ____

Megascopic Description

Colour (Fresh): ____ Colour (Weathered): ____ Sample Quality: ____

Crystal Size: ____ Particle Size: (Max-Min; Ave.): ____

Particle/Matrix: (grain- or matrix-supported) ____

Hand Specimen Description: ____

Thin Section Description

Allochem%: ____ Micrite Matrix%: ____ Sparite (Cement)%: ____

Particle/Matrix: (grain- or matrix-supported) ____ Micritized Grain Margins: ____

Allochemical Particle Types:

Bioclastic Fragments: (Size and %)

Corals: ____
Brachiopods: ____
Bivalves: ____
Gastropods: ____
Bryozoans: ____
Echinoderms: ____
Ostracodes: ____
Calcareous Green Algae: ____
Calcareous Red Algae: ____
Foraminifera: ____
Radiolarians: ____
Stromatoporoids: ____
Oncoids: ____

Inorganic Allochems: (Size and %)

Ooids: ____
Peloids: ____
Pisoids: ____
Intraclasts: ____
Aggregate Grains: ____
Lithoclasts: ____
OTHERS: ____

Fabric(s), Packing and Structure(s): ____

Diagenesis

Matrix Type(s) and %: ____

Cement Type(s) and %: ____

Other Authigenic Minerals: ____

Compactional Data: ____

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ____

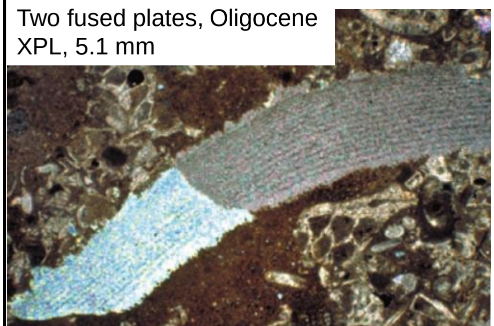
Porosity%: ____

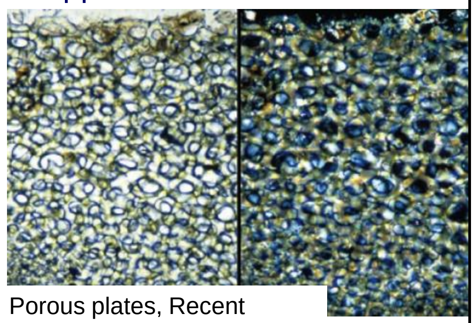
Neomorphism and Diagenetic History: ____

Representative Thin Section Description: ____

Echinoderms – Echinoids Late Ordovician to Recent

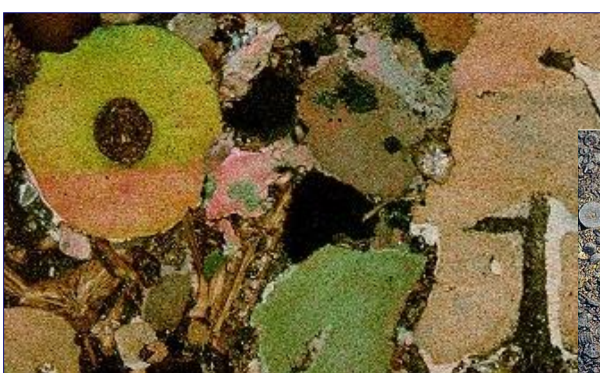
- **Calcite**, very stable. Plates < 30 mm. Animals 1 to 10 cm
- Each plate/ spine grows as a single crystal (optical continuity) = **uniform extinction for entire plate.**
- Very common syntaxial calcite overgrowths
- Fine, honeycomb perforations, commonly filled with microspar or micrite gives a “checkerboard” appearance under XPL

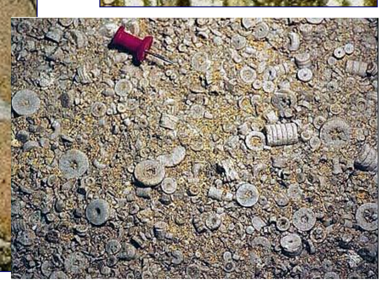

Two fused plates, Oligocene
XPL, 5.1 mm


Porous plates, Recent
PPL/XPL, 3.2 mm

Echinoderms – Crinoids Early Cambrian to Recent

Calcite, very stable
Grow as single crystals (optical continuity);
uniform extinction for each plate
Very common syntaxial calcite overgrowths
Plates perforated. “Starry night” appearance.





CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ______ ROCK NAME ______

Megascopic Description

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Particle/Matrix: (grain- or matrix-supported) ______

Hand Specimen Description: ______

Thin Section Description

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Bioclastic Fragments: (Size and %)

Corals: ______
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Bivalves: ______
Gastropods: ______
Bryozoans: ______
Echinoderms: ______
Ostracodes: ______
Calcareous Green Algae: ______
Calcareous Red Algae: ______
Foraminifera: ______
Radiolarians: ______
Stromatoporoids: ______
Oncoids: ______

Inorganic Allochems: (Size and %)

Ooids: ______
Peloids: ______
Pisoids: ______
Intraclasts: ______
Aggregate Grains: ______
Lithoclasts: ______
OTHERS: ______

Fabric(s), Packing and Structure(s): ______

Diagenesis

Matrix Type(s) and %: ______

Cement Type(s) and %: ______

Other Authigenic Minerals: ______

Compactional Data: ______

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ______

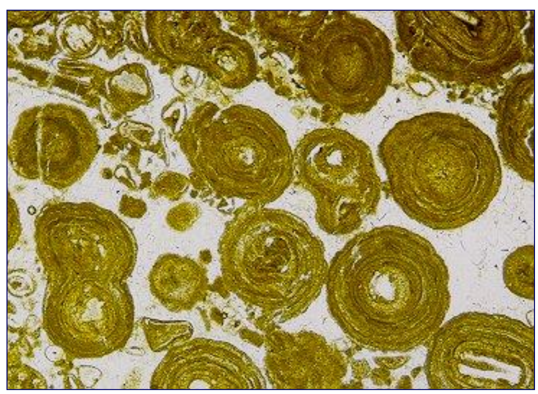
Porosity%: ______

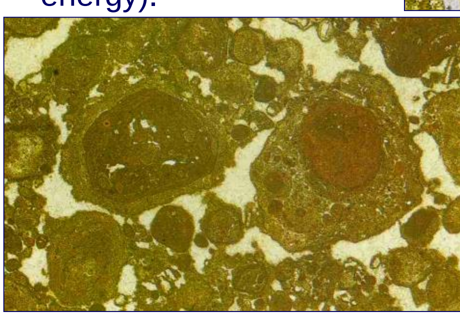
Neomorphism and Diagenetic History: ______

Representative Thin Section Description: ______

Oncoids

- Grains with irregular concentric laminae.
- Resemble pisoids (size and shape).
- Algal 'blobs' that roll around in subtidal env.(generally low energy).





CARBONATE / EVAPORITE ROCK THIN SECTION AND HAND SPECIMEN DESCRIPTION

SAMPLE: ______ ROCK NAME ______

Megascopic Description

Colour (Fresh): ______ Colour (Weathered): ______ Sample Quality: ______

Crystal Size: ______ Particle Size: (Max-Min; Ave.): ______

Particle/Matrix: (grain- or matrix-supported) ______

Hand Specimen Description: ______

Thin Section Description

Allochem%: ______ Micrite Matrix%: ______ Sparite (Cement)%: ______

Particle/Matrix: (grain- or matrix-supported) ______ Micritized Grain Margins: ______

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Bioclastic Fragments: (Size and %)

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Stromatoporoids: ______
Oncoids: ______

Inorganic Allochems: (Size and %)

Ooids: ______
Peloids: ______
Pisoids: ______
Intraclasts: ______
Aggregate Grains: ______
Lithoclasts: ______
OTHERS: ______

Fabric(s), Packing and Structure(s): ______

Diagenesis

Matrix Type(s) and %: ______

Cement Type(s) and %: ______

Other Authigenic Minerals: ______

Compactional Data: ______

Porosity Type(s): (Primary or Secondary/Fabric or non-Fabric Selective) ______

Porosity%: ______

Neomorphism and Diagenetic History: ______

Representative Thin Section Description: ______

Carbonate Grain Types – Non-Skeletal Grains

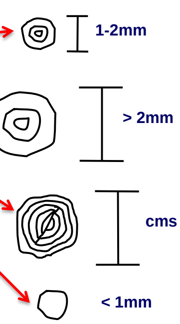
Ooids: concentric layers, < 2mm

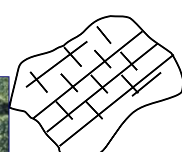
Pisoids: concentric layers, > 2mm

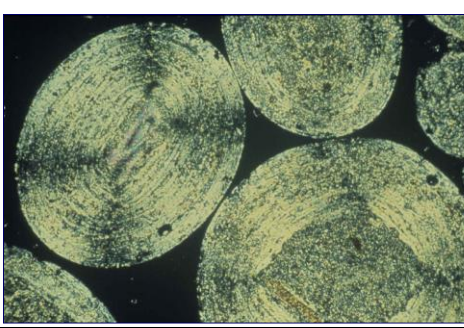
Peloids: micro- or cryptocrystalline allochem

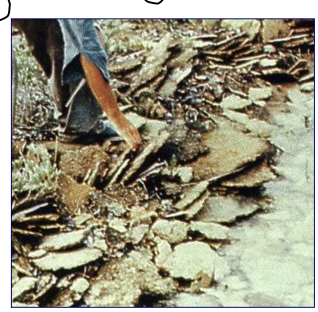
Pellets: micrite (microcrystalline) ball, < 1 mm

Intraclasts/Lithoclasts



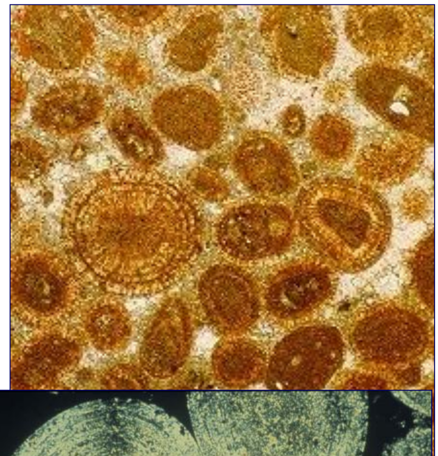
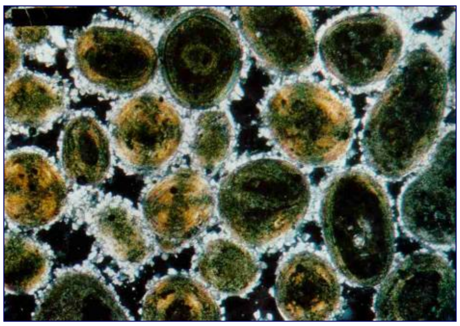
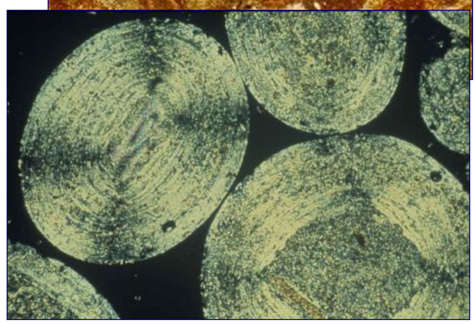






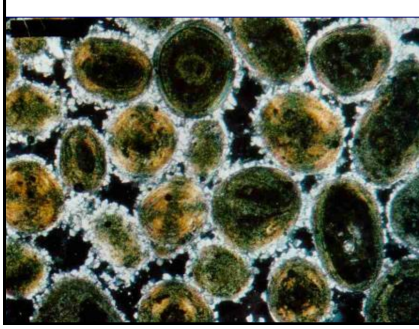
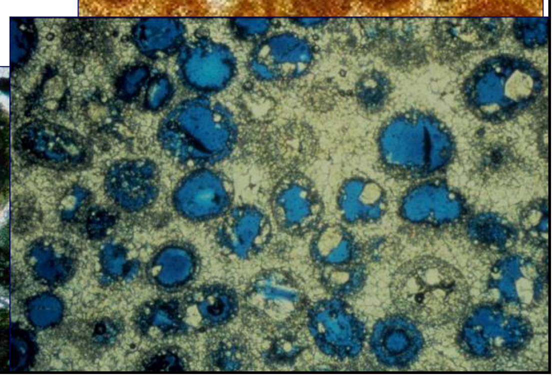
Ooids

Sand-sized
Sub-spherical
Non-biochemical
Concentric or radial growth
Calcite or aragonite*
Mostly warm, shallow, and/or hypersaline, agitated water

Ooids

Sand-sized
Sub-spherical
Non-biochemical
Concentric or radial growth
Calcite or aragonite*
Mostly warm, shallow, and/or hypersaline, agitated water

Pisoids

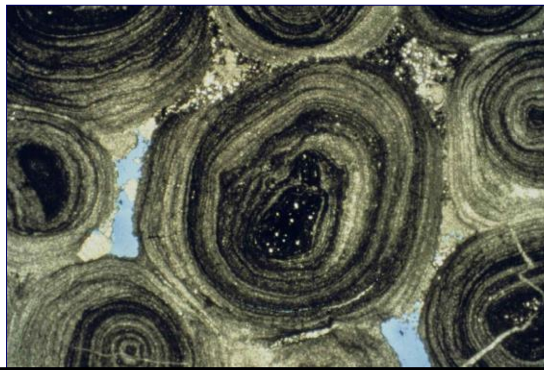
~Greater than sand-sized ooids (> 2 mm)

Sub-spherical

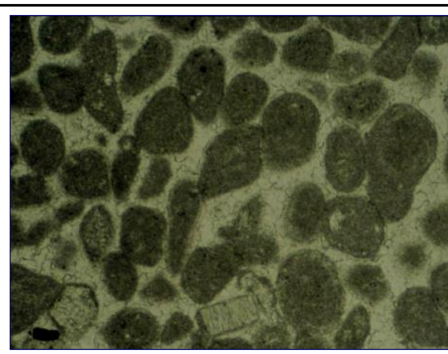
Non-biochemical

Concentric or radial growth

Commonly form in non-marine (groundwater)



Peloids



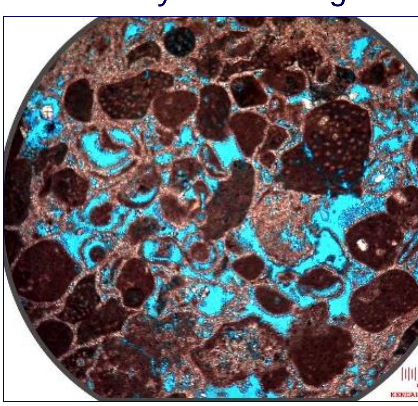
Grains of indeterminate origin

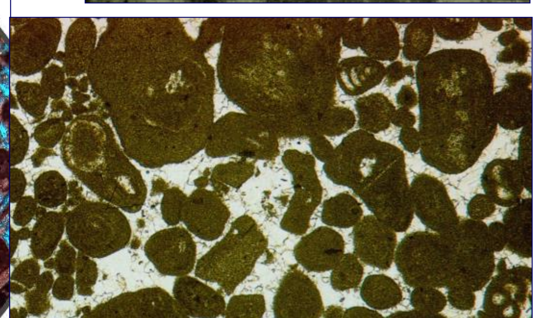
Typically rounded

May be coated with micrite rim

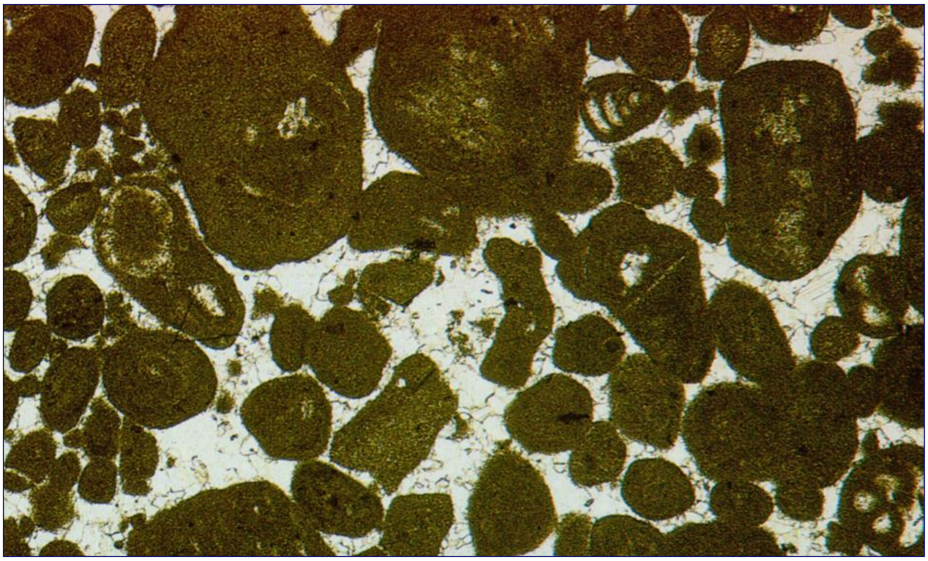
Difficult to ID if compacted

Commonly of fecal origin



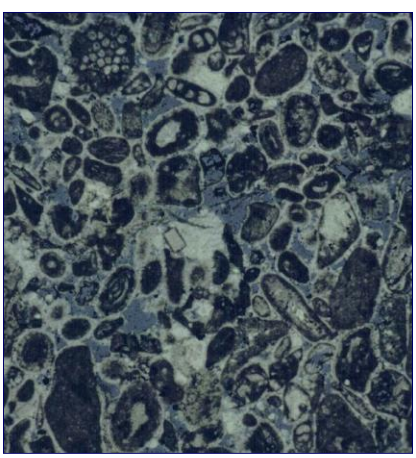


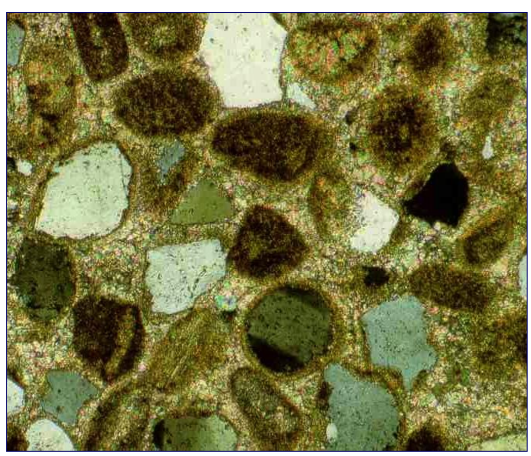
Peloids



Coated Grains

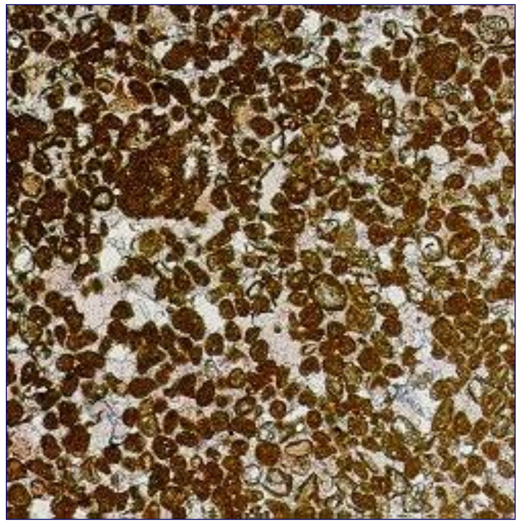
May resemble ooids, but commonly with a sinlge thin micrite coating on allochem core (cortoid). Generally endolithic boring algae causes the micrite coating.

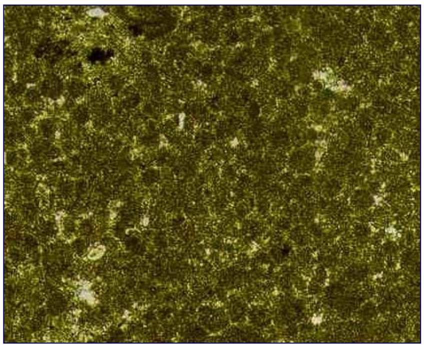




Pellets

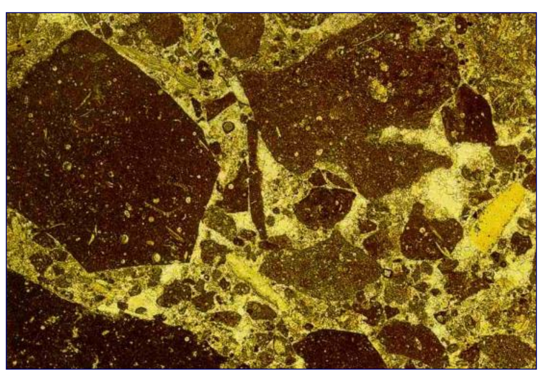
Rounded grains
Micrite-rich
Fine to very fine sand size
Well-sorted
Likely fecal origin
Texture resembles the
'feel of matchbook'





Intraclasts / Aggregates

Rip-ups of weakly lithified material
Typically lime mudstone
Common in tidal settings
Includes 'grapestones' and other aggregate grains.



Lithoclasts

Fragments of consolidated material

Commonly associated with storm deposits

Variety of lithologies possible

Both intrabasinal and extrabasinal