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Petrographic characteristics of the updip middle Eocene Carbonate-Clastic Microfacies – Savannah River Site, South Carolina

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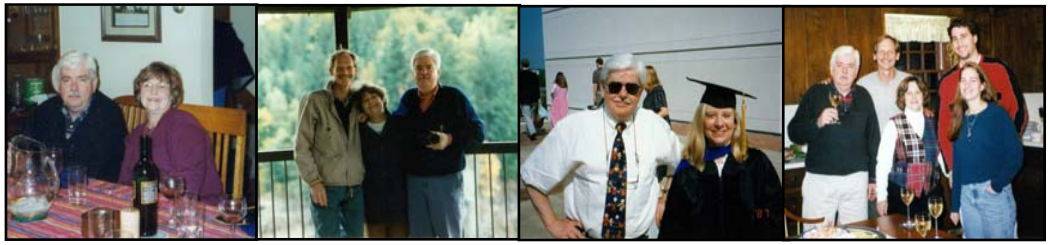
Savannah River National Laboratory

March 24th, 2011



SRNL-STI-2011-00169

Acknowledgements


WV
VA
KY
NC
TN
SC
MS
AL
GA
FL
SC
GA
Savannah
River
Fall
Line
Columbia
Aiken
Augusta
Upper Atlantic Coastal Plain
Lower Atlantic Coastal Plain
Savannah
River Site
Atlantic Ocean

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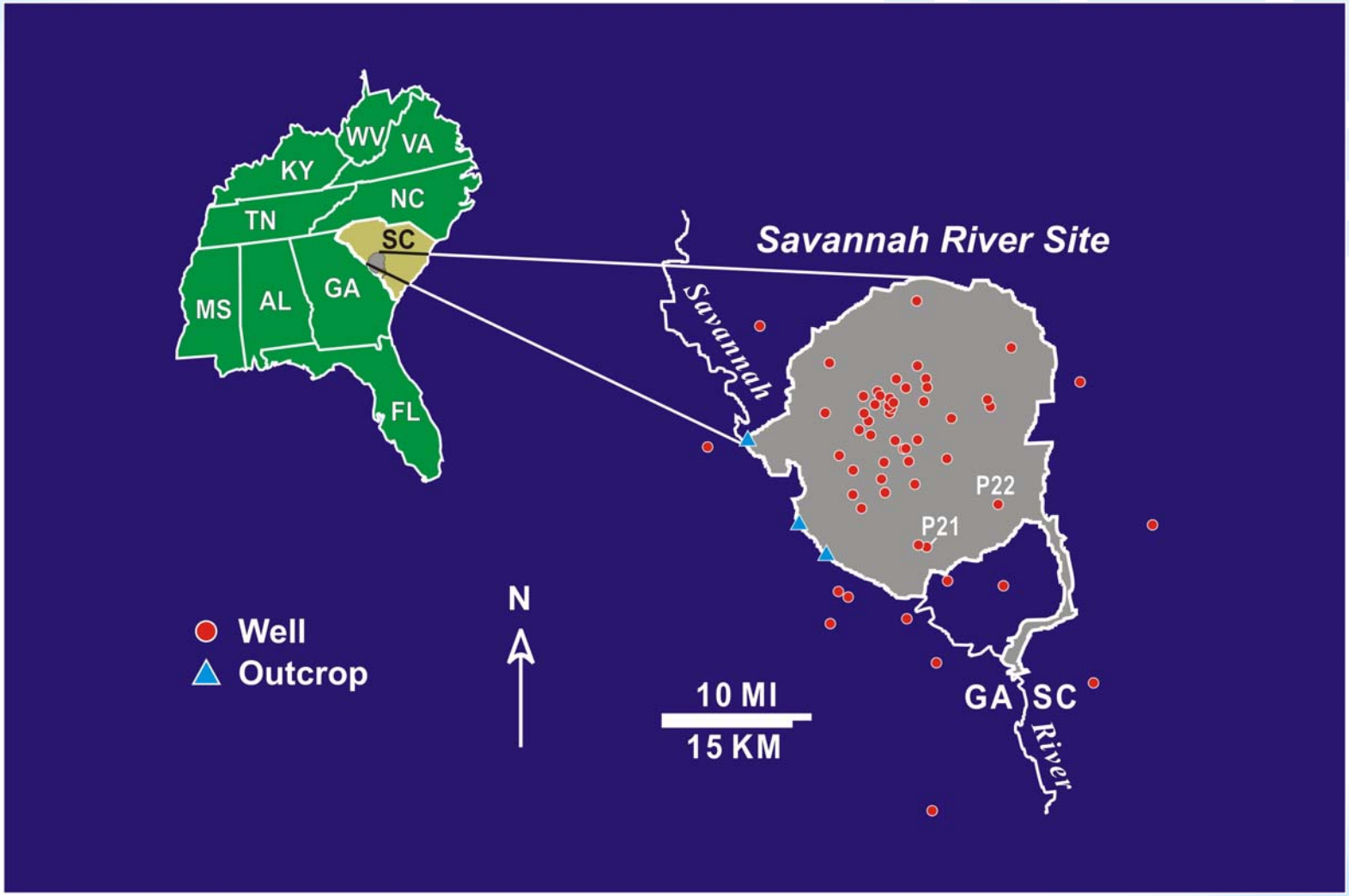
WV
VA
KY
NC
TN
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MS
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Savannah River Site
Savannah
P22
P21
Well
Outcrop
N
10 MI
15 KM
GA
SC
River

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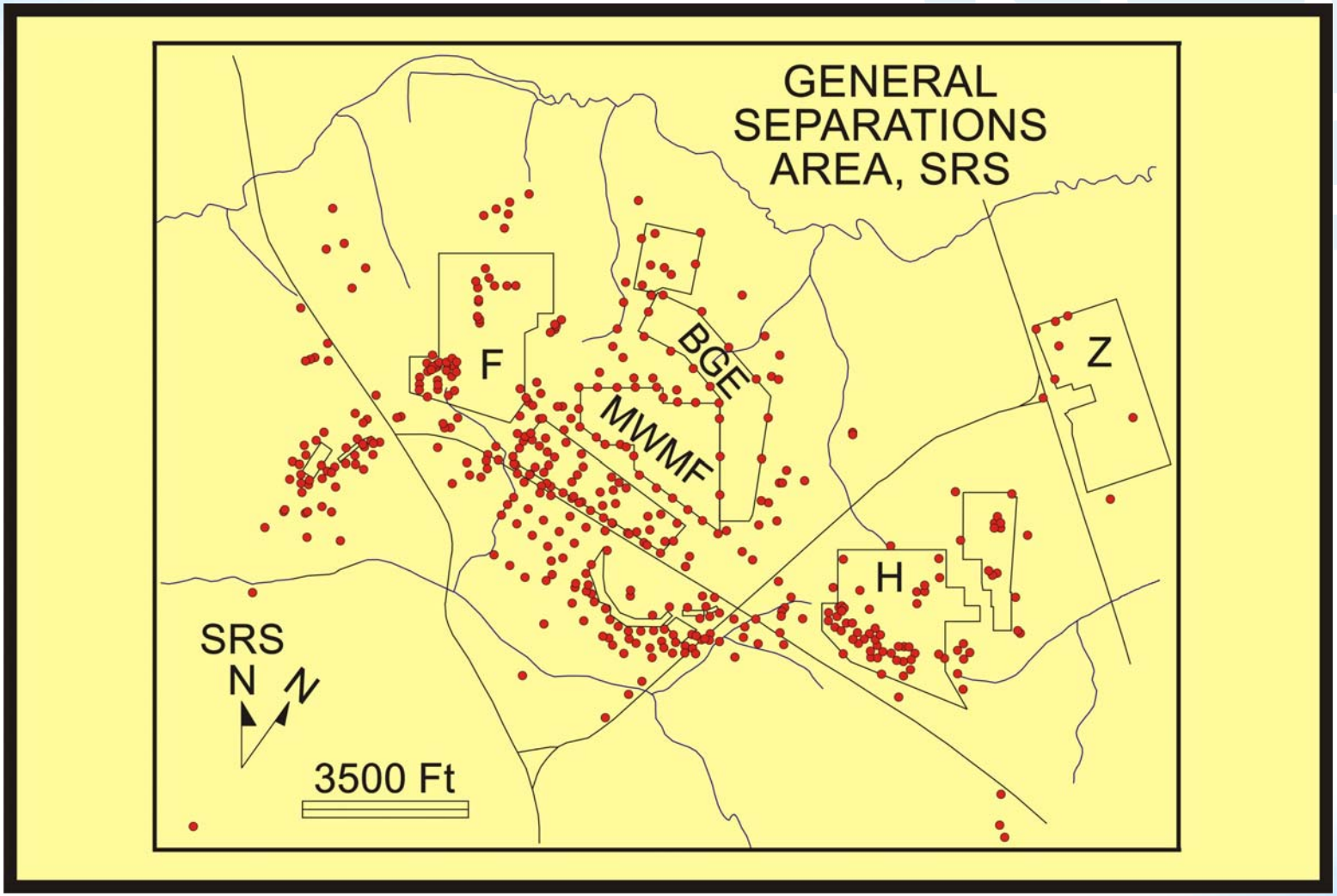

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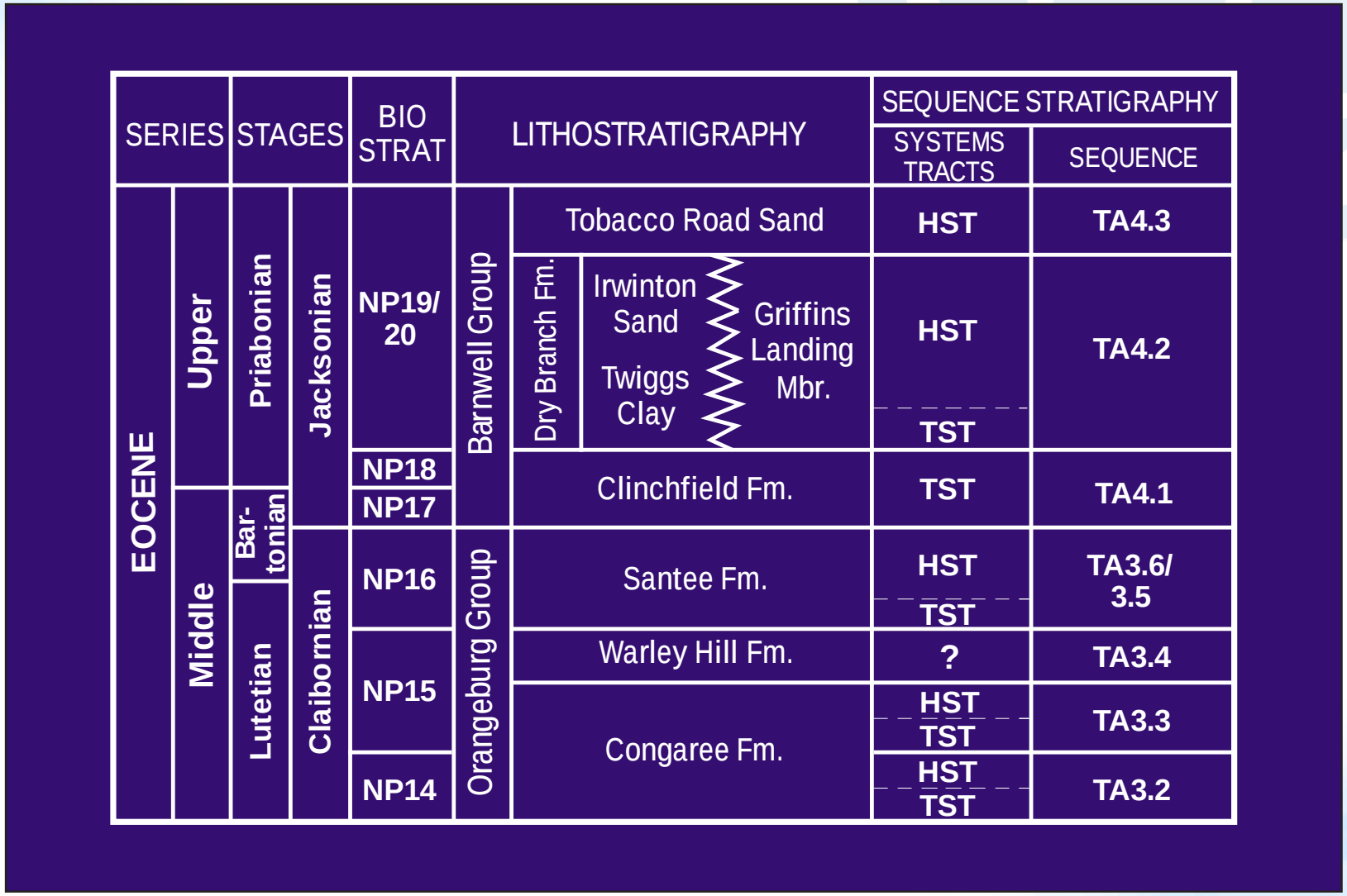
Data and Methods

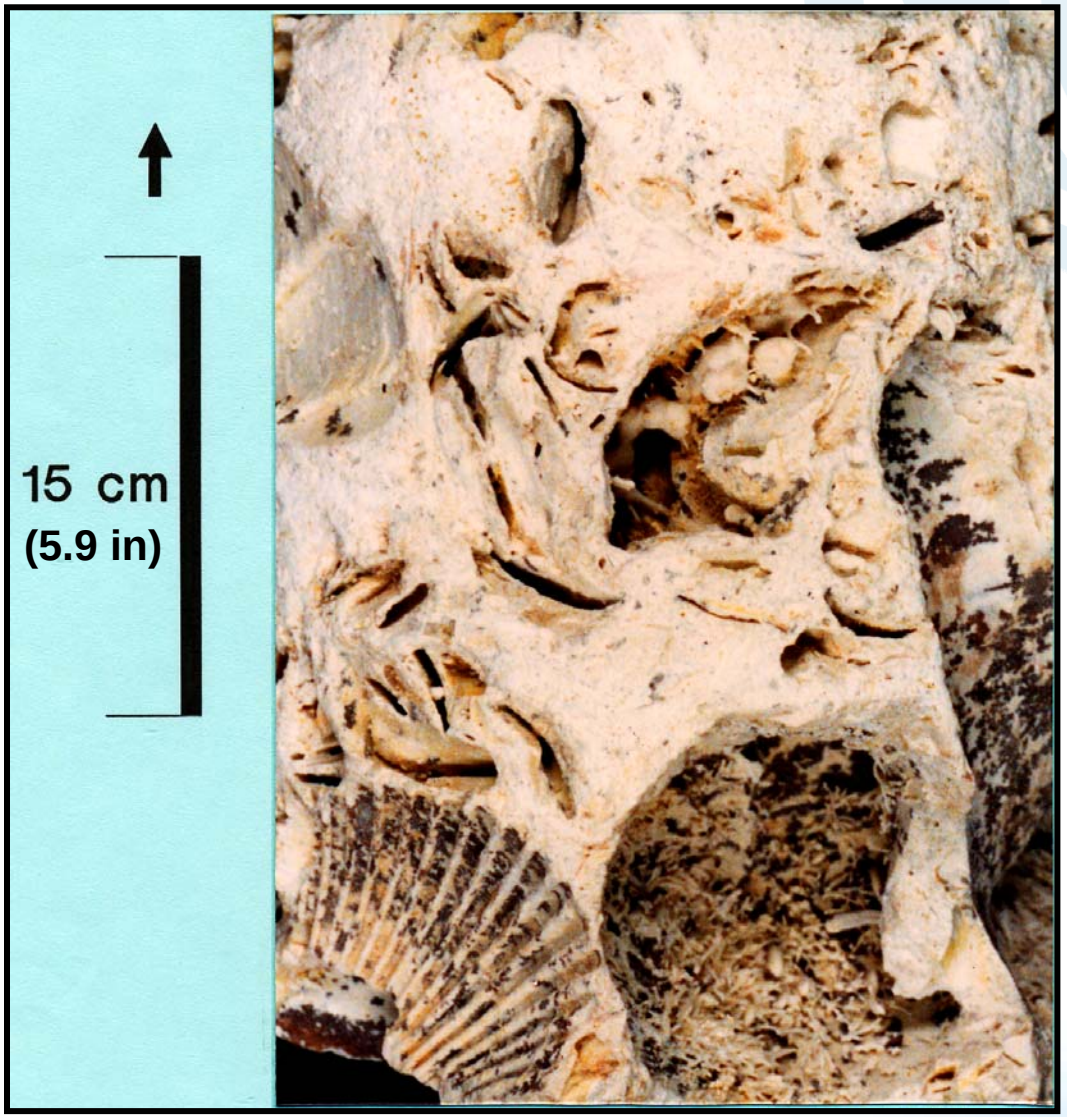
- **90 boreholes with lithologic and geophysical data**
- **Methods**
  - thin section examination,
  - insoluble residue analysis,
  - SEM
- **Lithofacies Methods**
- **Computer Generated Mapping**


SERIES
STAGES
BIO STRAT
LITHOSTRATIGRAPHY
SEQUENCE STRATIGRAPHY
SYSTEMS TRACTS
SEQUENCE
EOCENE
Upper
Middle
Priabonian
Bar-tonian
Lutetian
Jacksonian
Claibornian
NP19/ 20
NP18
NP17
NP16
NP15
NP14
Barnwell Group
Orangeburg Group
Tobacco Road Sand
Dry Branch Fm.
Irwinton Sand
Twiggs Clay
Griffins Landing Mbr.
Clinchfield Fm.
Santee Fm.
Warley Hill Fm.
Congaree Fm.
HST
TST
TA4.3
TA4.2
TA4.1
TA3.6/ 3.5
?
TA3.4
TA3.3
TA3.2

Five mixed carbonate-terrigenous lithofacies

- **Quartz sand**
- **Calcareous quartz sand**
- **Sandy carbonate**
- **Muddy carbonate**
- **Transitional - sandy, muddy carbonate to a calcareous sandy mud**

Packstone: BGO 9AA



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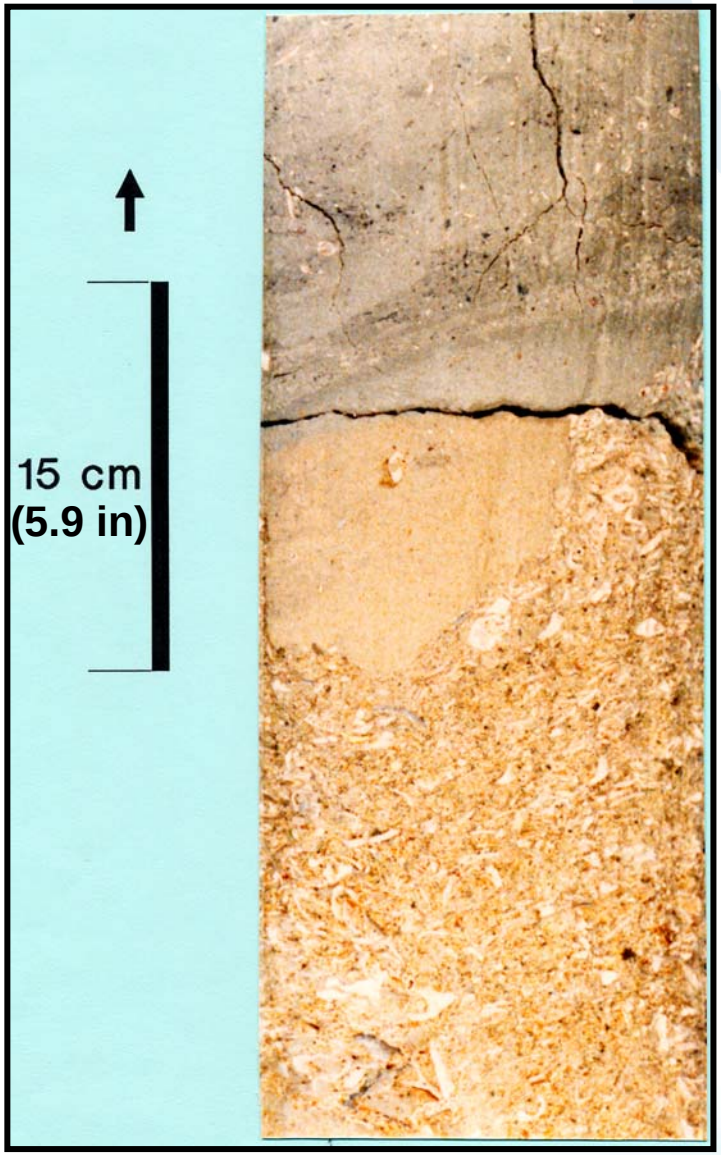
Sandy Packstone/Mudstone Contact: BGO 9AA



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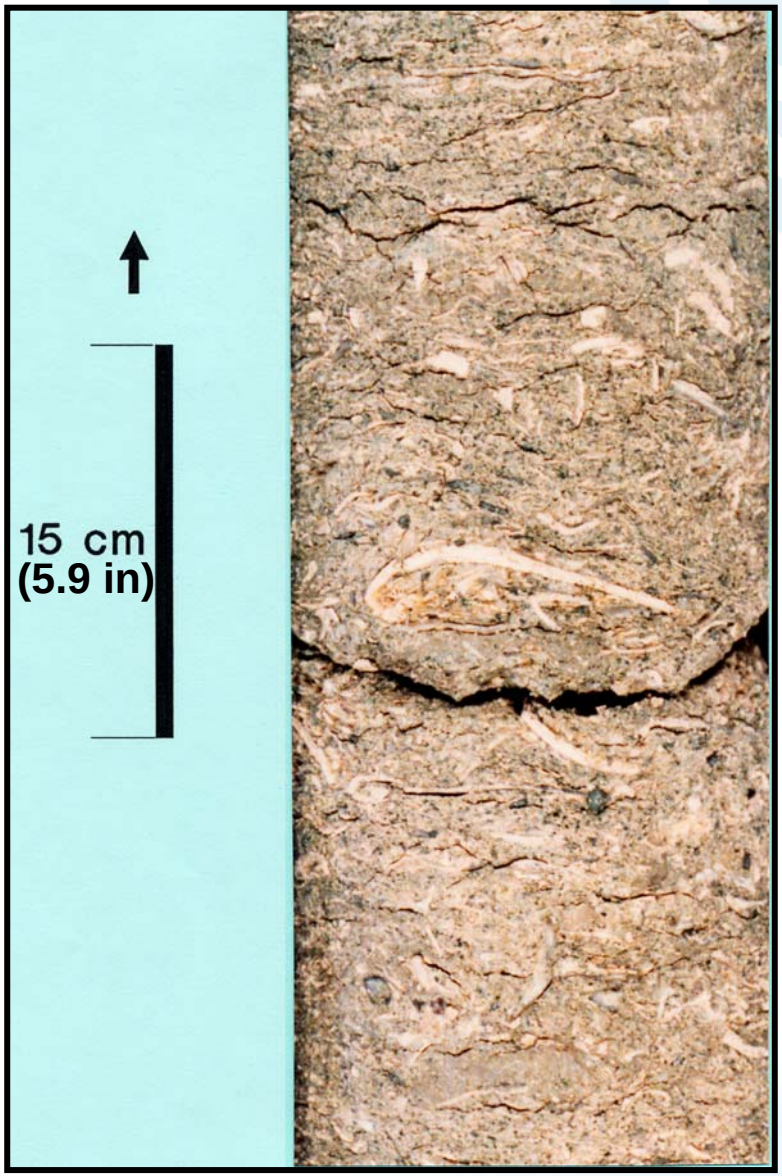
Sandy Wackestone: BGO 9AA



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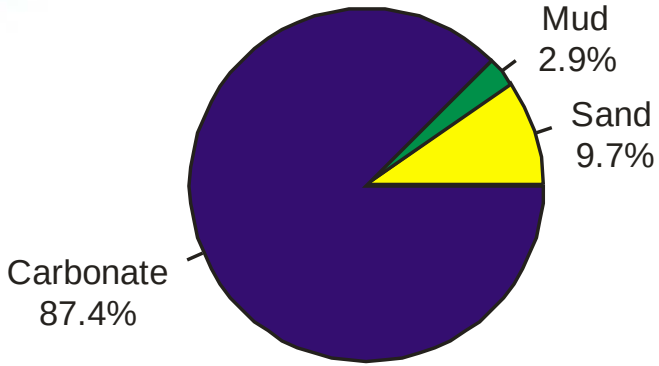
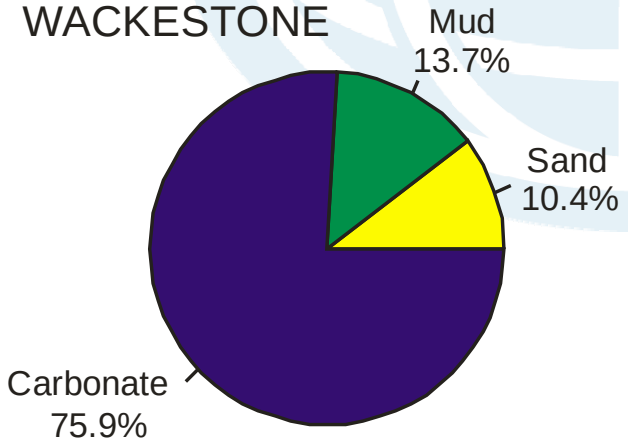
% Sand, Mud, and Carbonate

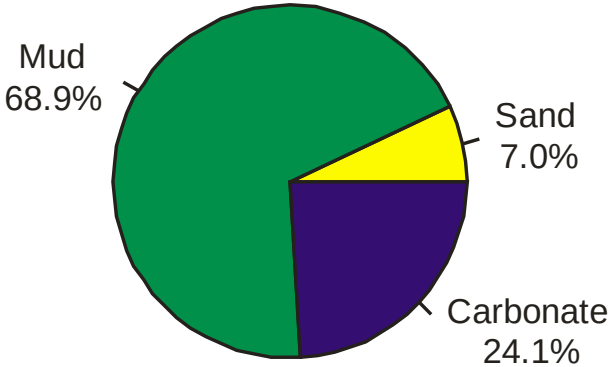
GRAINSTONE



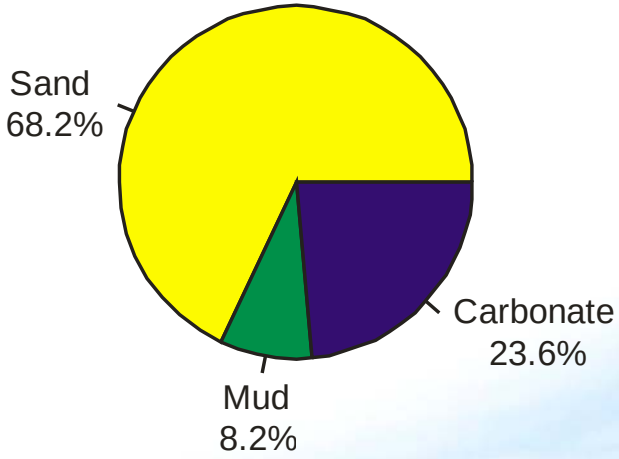
WACKESTONE



TERRIGENOUS MUD



QUARTZ SAND



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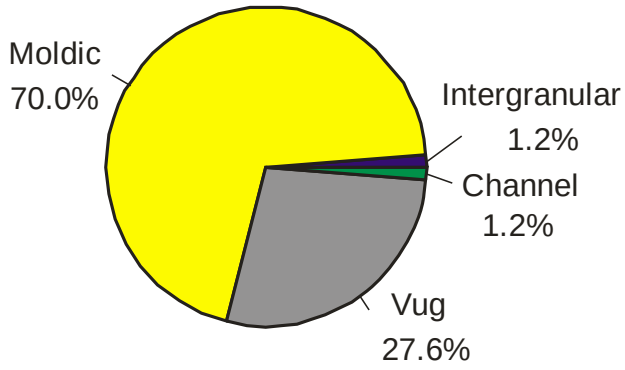
Porosity Types

GRAINSTONE



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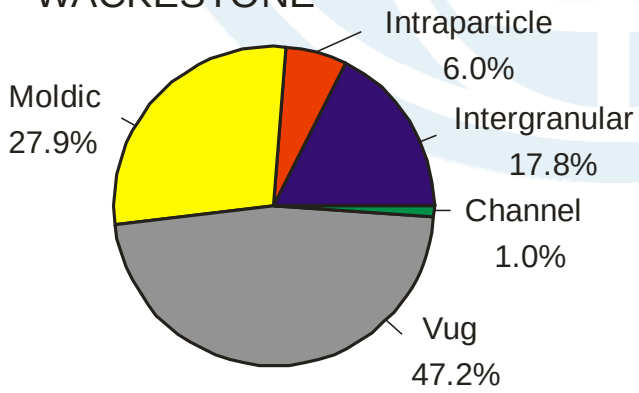
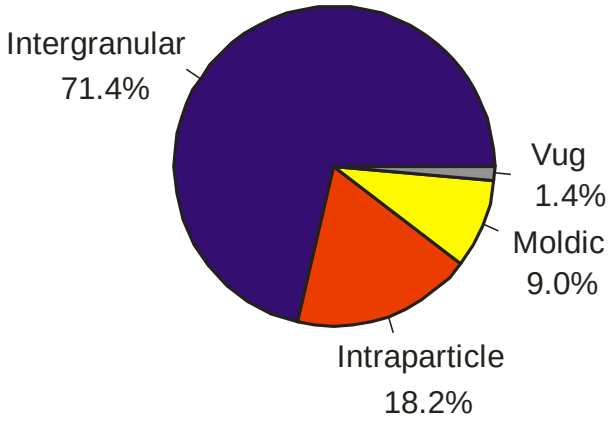
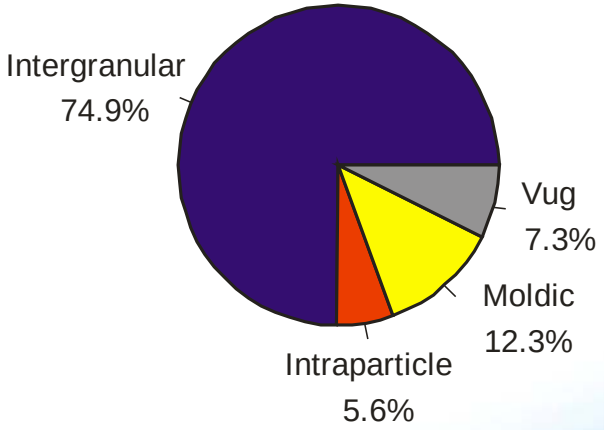


TERRIGENOUS MUD



QUARTZ SAND



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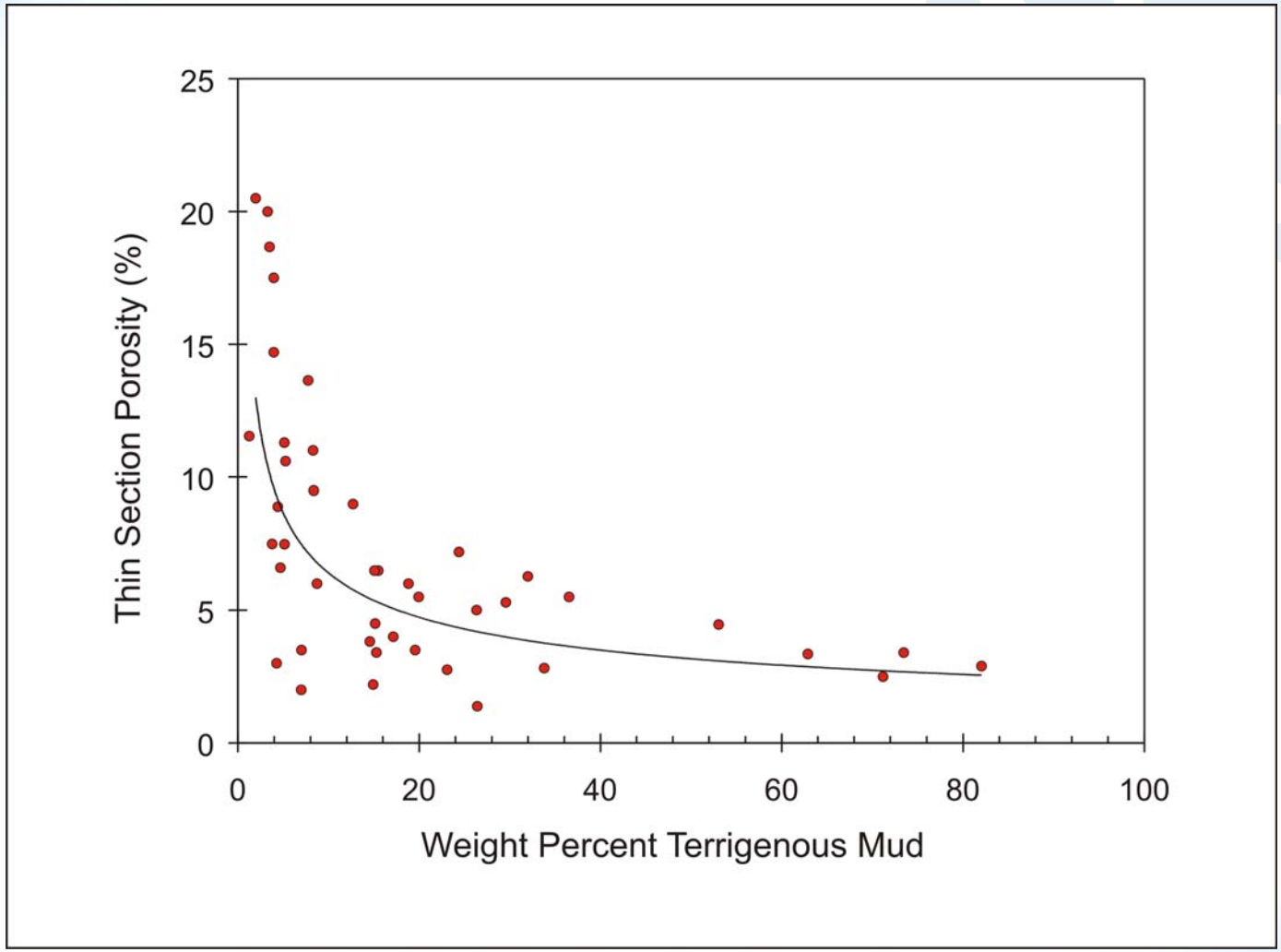
Thin Section Porosity (%)
25
20
15
10
5
0
0
20
40
60
80
100
Weight Percent Terrigenous Mud

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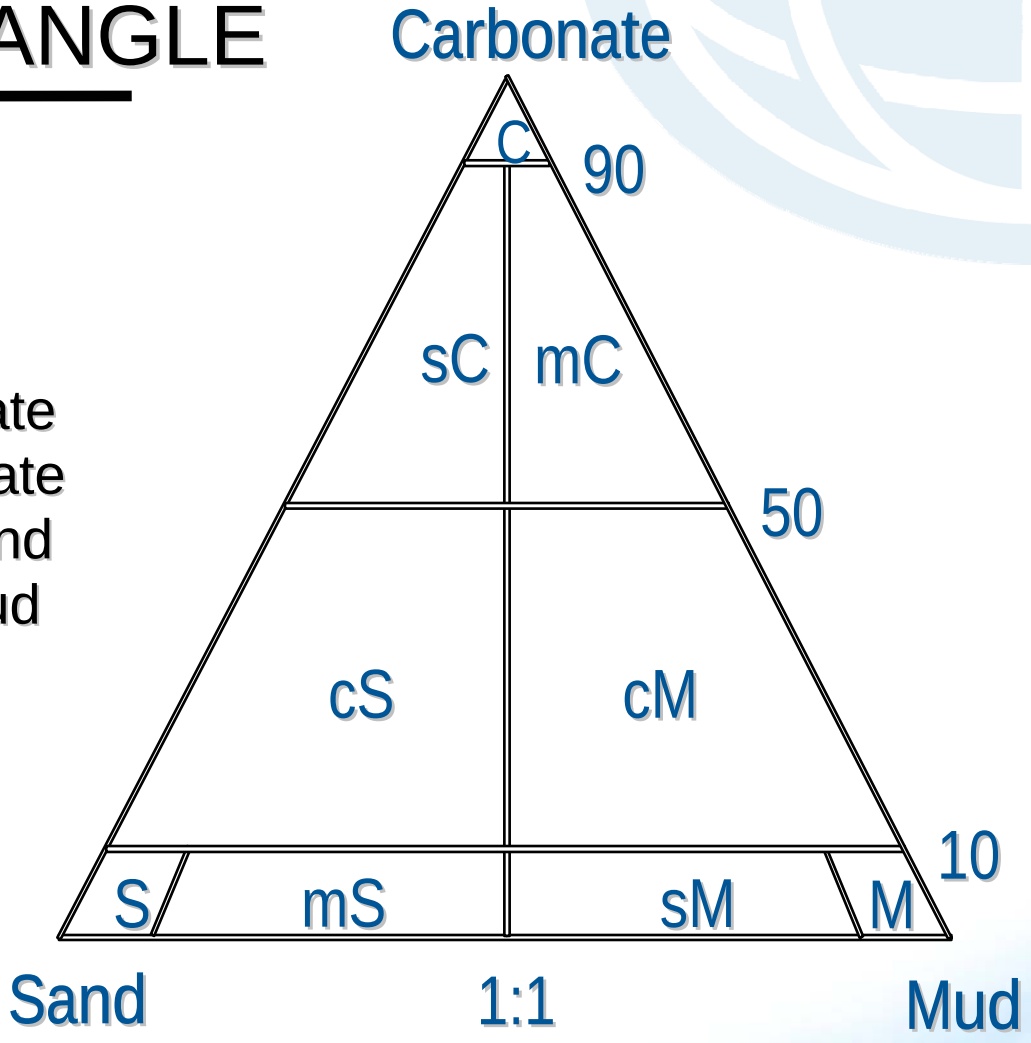
FACIES TRIANGLE

Key

C	Carbonate
sC	Sandy carbonate
mC	Muddy carbonate
cS	Calcareous sand
cM	Calcareous mud
S	Sand
mS	Muddy sand
sM	Sandy mud
M	Mud



Lindholm (1987)

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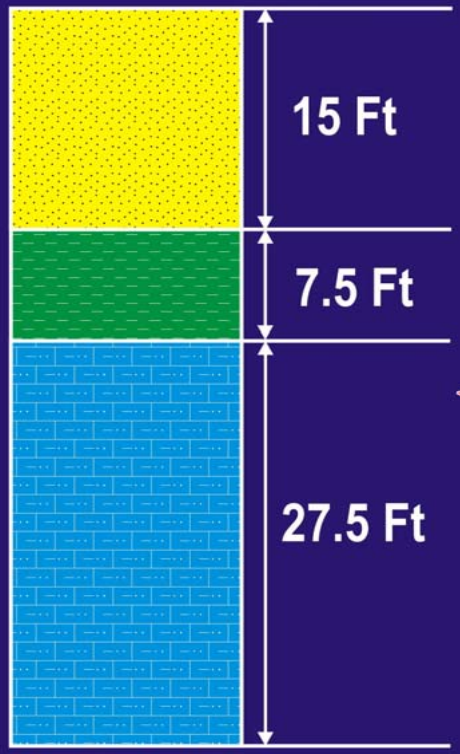
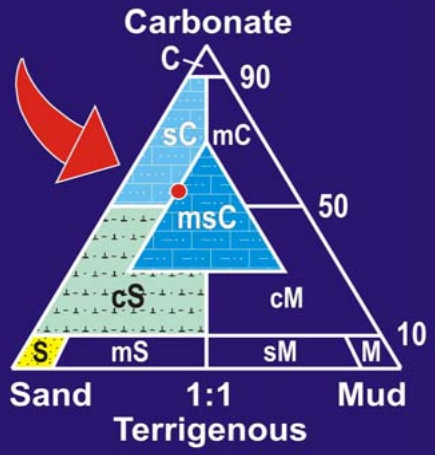
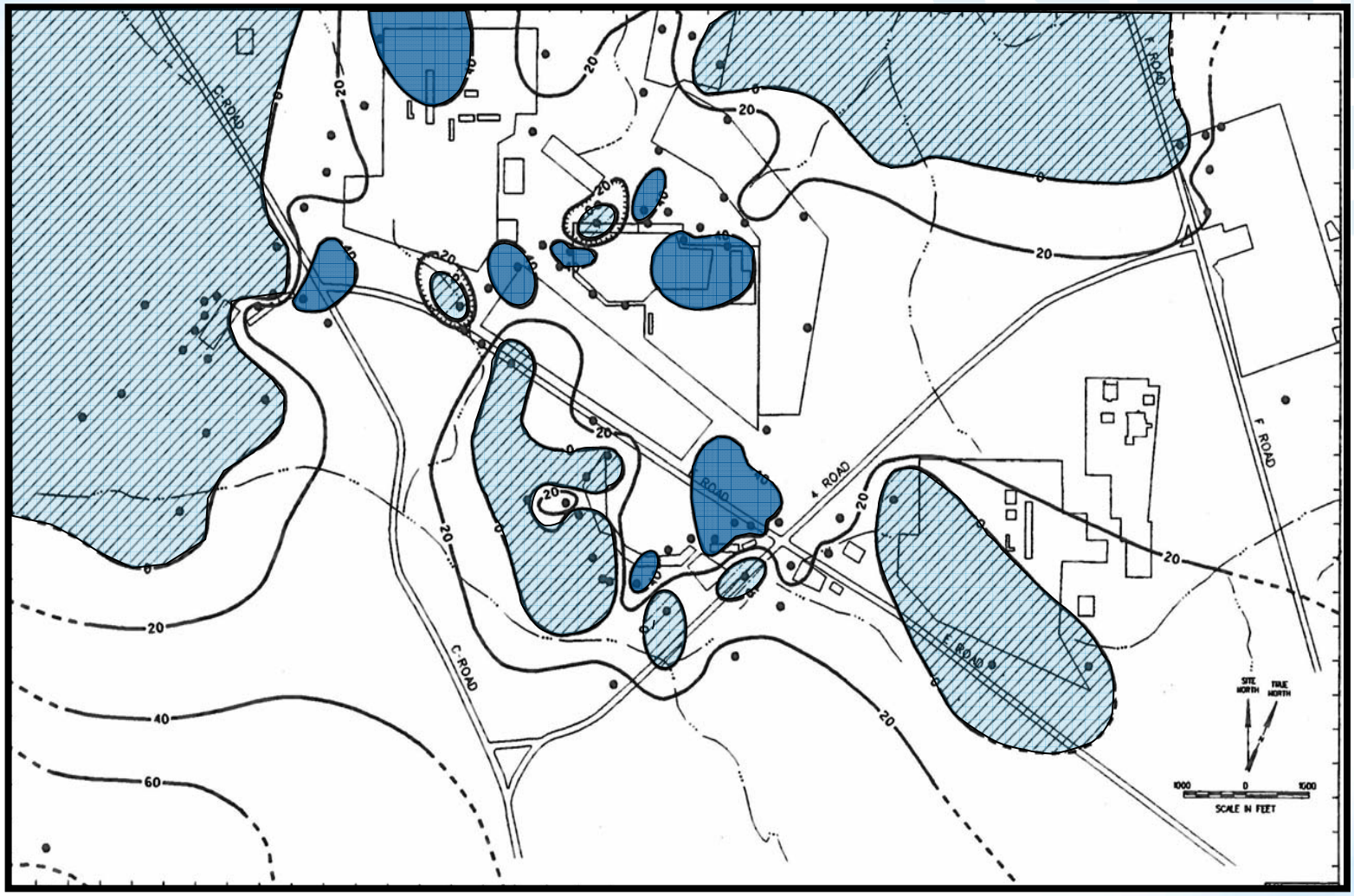
LITHOFACIES METHODS



Sand	15.0 Ft	15.0/50 x 100	30%
Mud	7.5 Ft	7.5/50 x 100	15%
Carbonate	27.5 Ft	27.5/50 x 100	55%
Total	50.0 Ft		100%



Middle Eocene Carbonate %



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10 Petrographic Microfacies

- **Quartz Sand**
- **Calcareous Quartz Sand**
- **Quartz-rich Skeletal Calcareous Mud**
- **Skeletal Wackestone**
- **Quartz-rich Skeletal Wackestone**
- **Skeletal Packstone**
- **Quartz-rich Skeletal Packstone**
- **Quartz-rich Glauconitic Skeletal Wackestone**
- **Quartz-rich Glauconitic Skeletal Packstone**
- **Sandy Skeletal Grainstone**

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Diagenetic Pathways

Marine Phreatic

- **Grain Micritization**
- **Radially fibrous cementation**

Freshwater Phreatic

- **Inversion of high-Mg calcite to low-Mg calcite**
- **Dissolution of aragonitic allochems**
- **Formation of moldic porosity**
- **Calcite cement**
- **Neomorphism of micrite to microspar and pseudospar**
- **Precipitation of opal-CT lepispheres**
- **Replacement of mollusk shells by chalcedony**
- **Precipitation of zeolites within secondary moldic pores**

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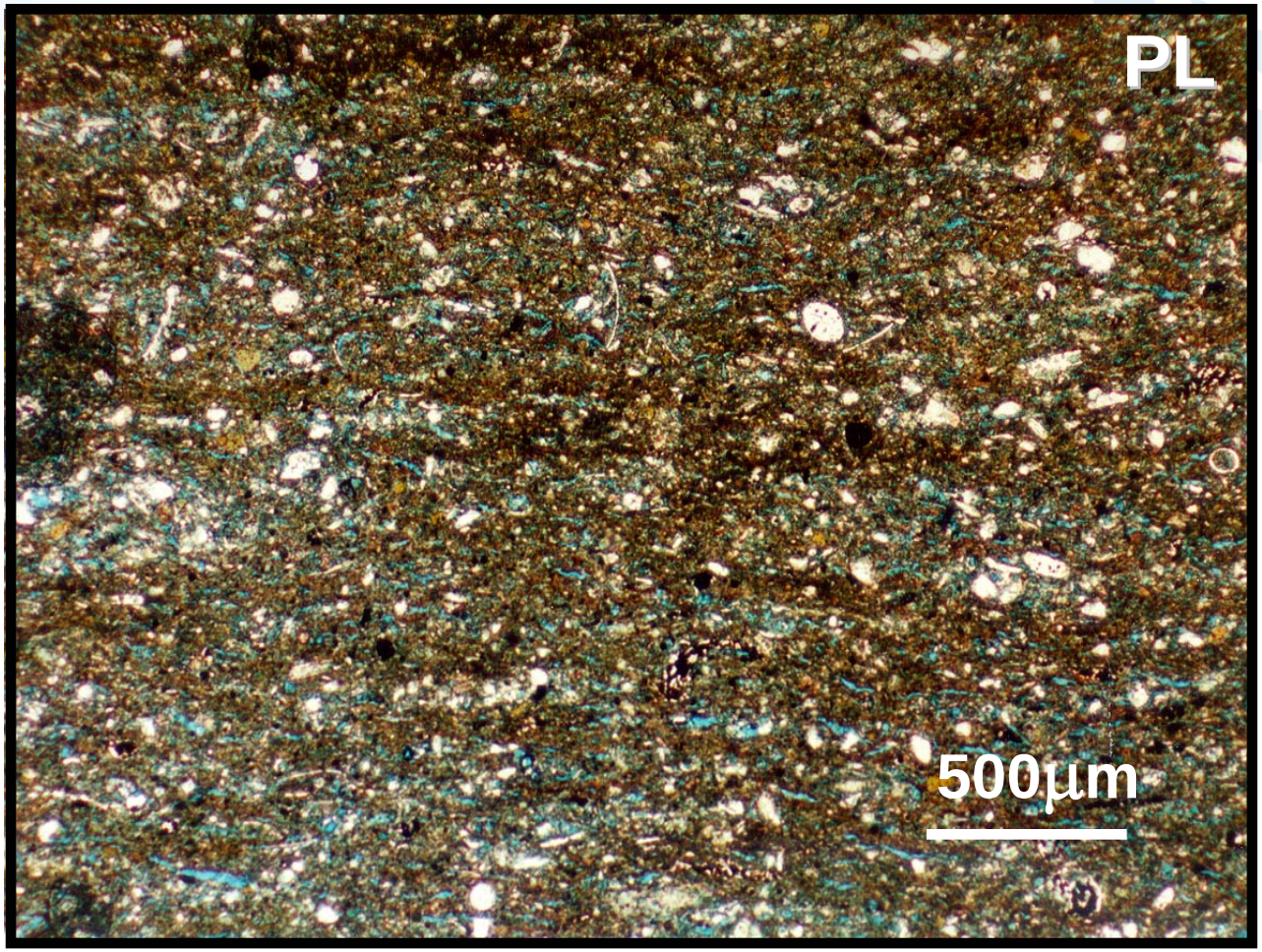
QUARTZ-RICH SKELETAL MUDSTONE



CPC-1

45 meters

(148 Feet)

ϕ = 12.3%

K = 2 mD

73% Mud

23% Sand

4% Carb.

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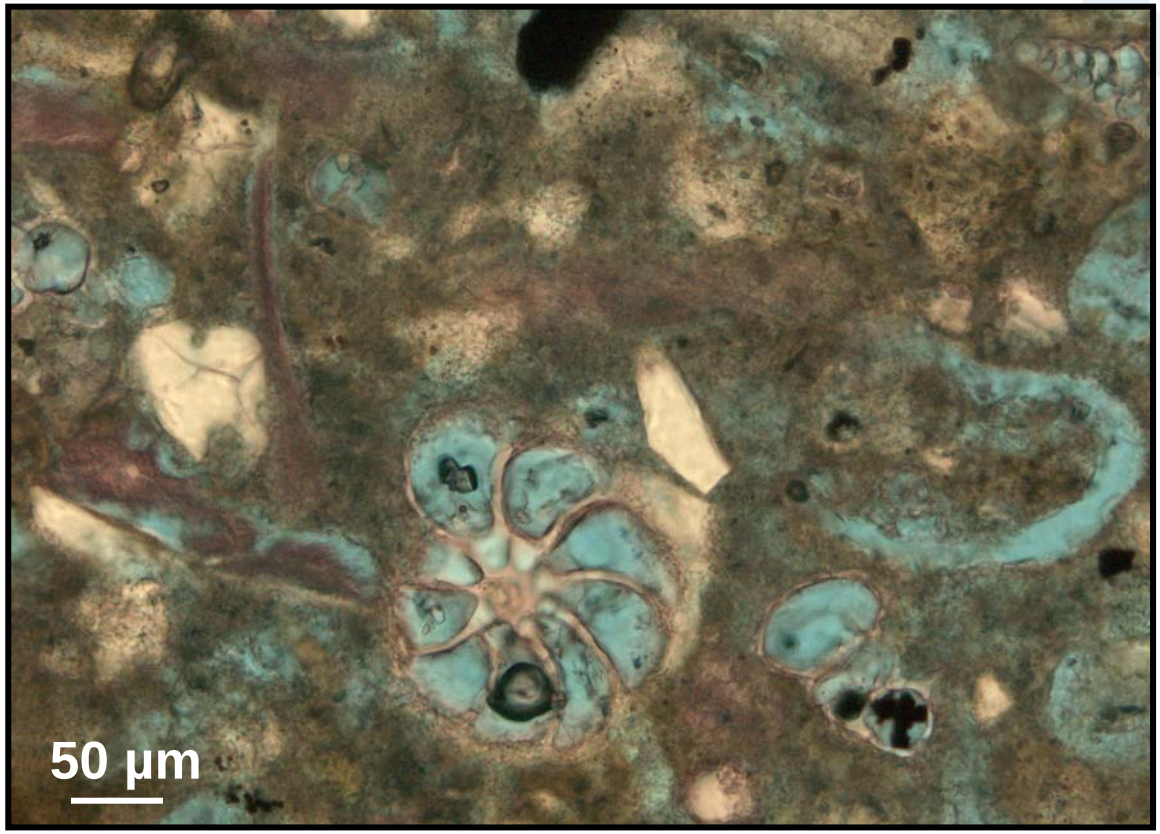
QUARTZ-RICH SKELETAL WACKESTONE



HSB-TB

45 meters

(149 Feet)

12% Mud

14% Sand

74% Carb.

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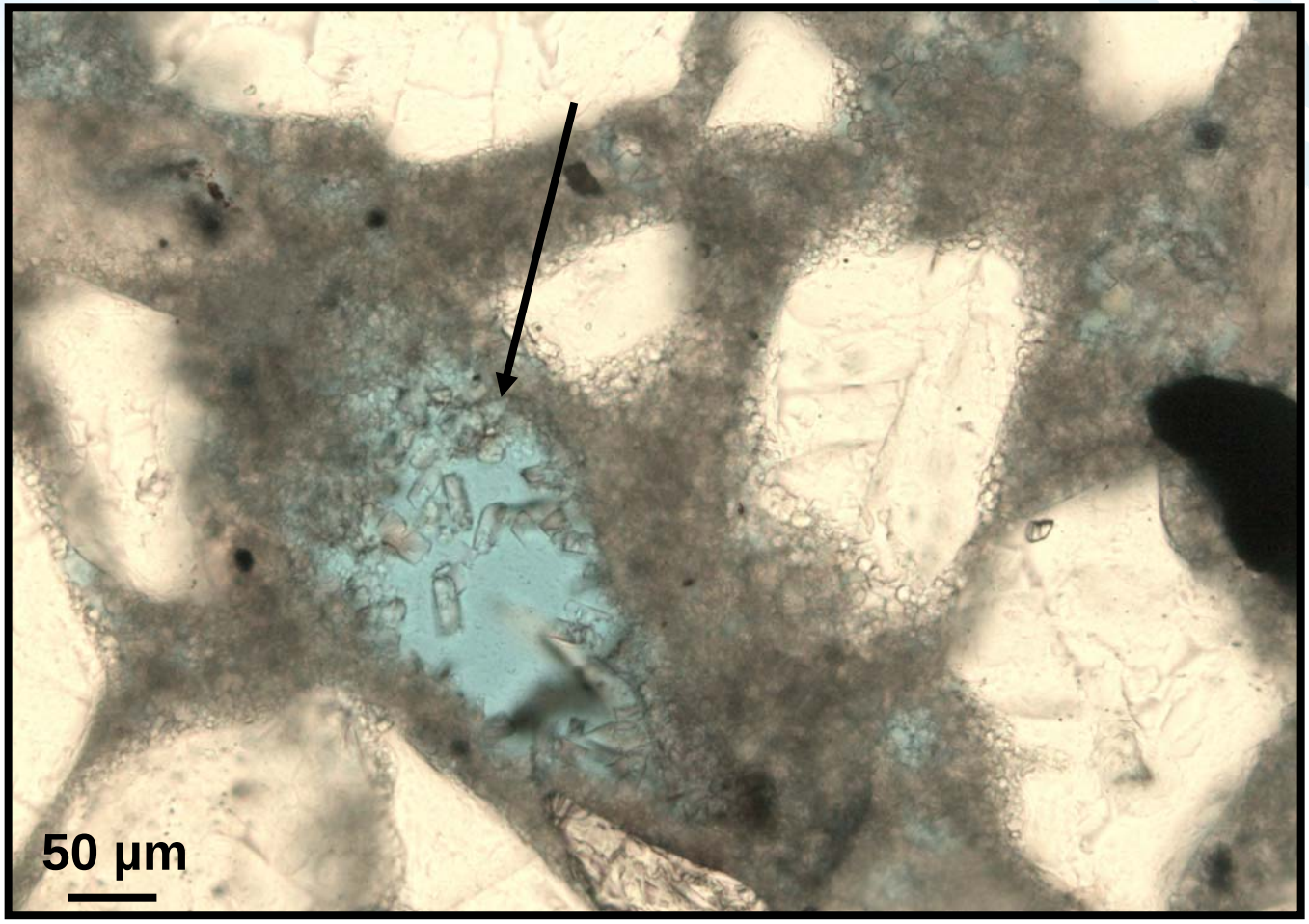
Zeolites in moldic porosity - *Clinoptinolite*



HSB-TB

36 meters

(117 Feet)

7% Mud

52% Sand

41% Carb.

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Ostracod preserved with fibrous calcite cement

HSB TB 47 meters
(153 feet)

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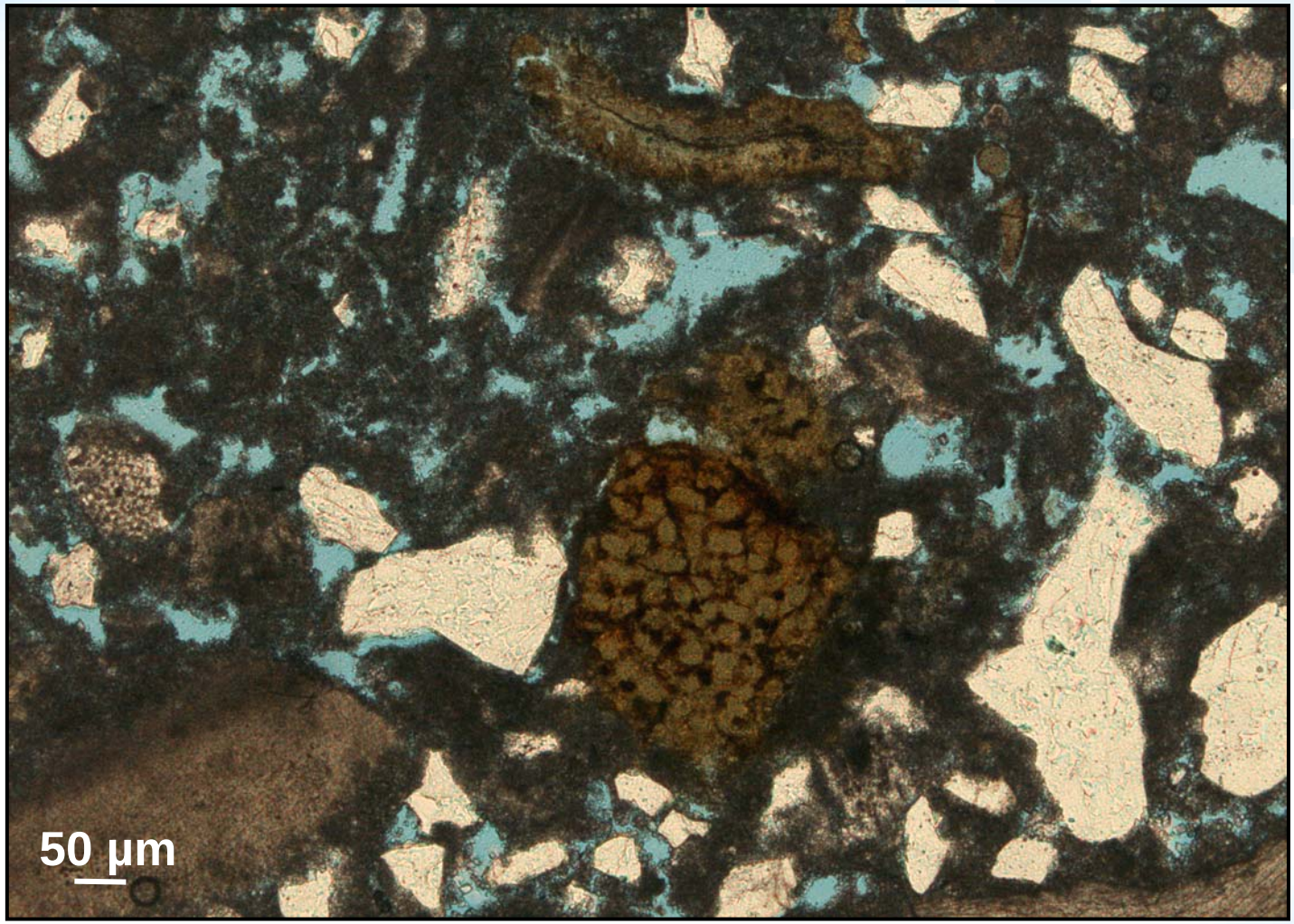
Glauconitic Grains in a Quartz Rich Mud



HSB TB 41 meters
(134 feet)

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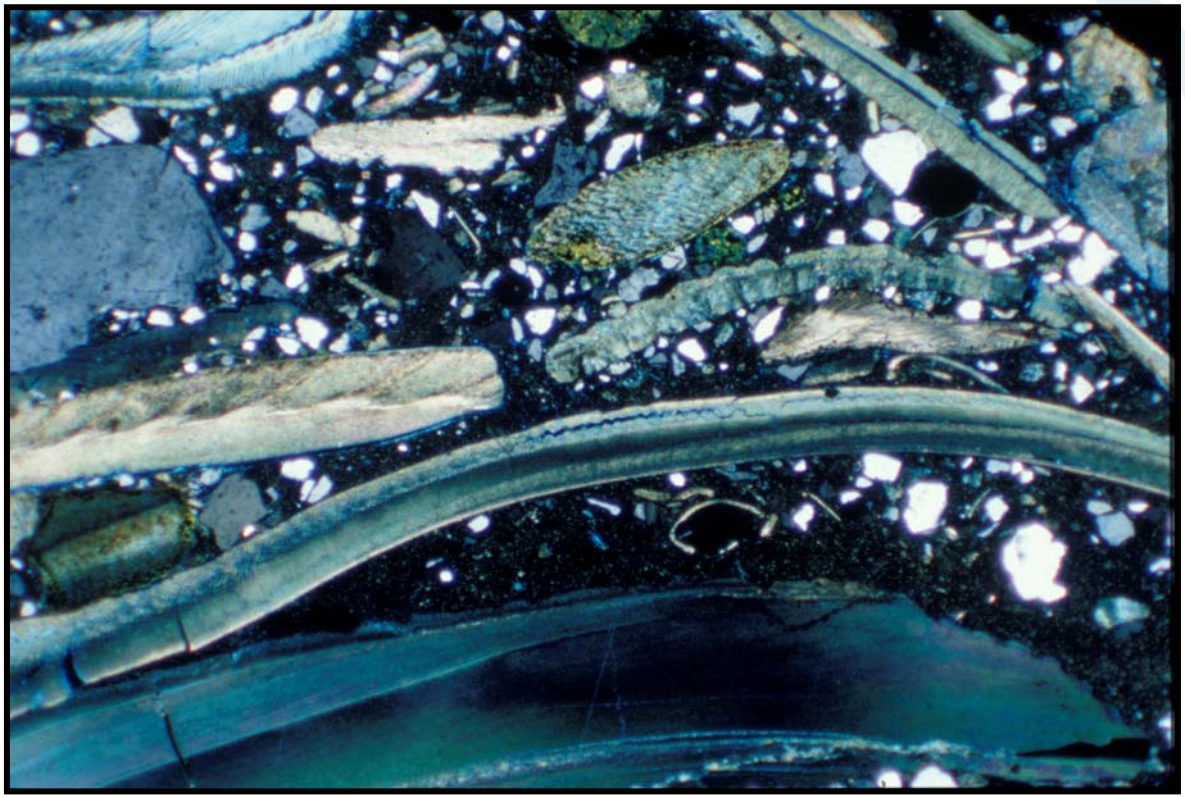
Replacement of pelcypods with chalcedony



XN 2.5X

BGO-9AA

45 meters

(149 Feet)

59% Mud

15% Sand

26% Carb.

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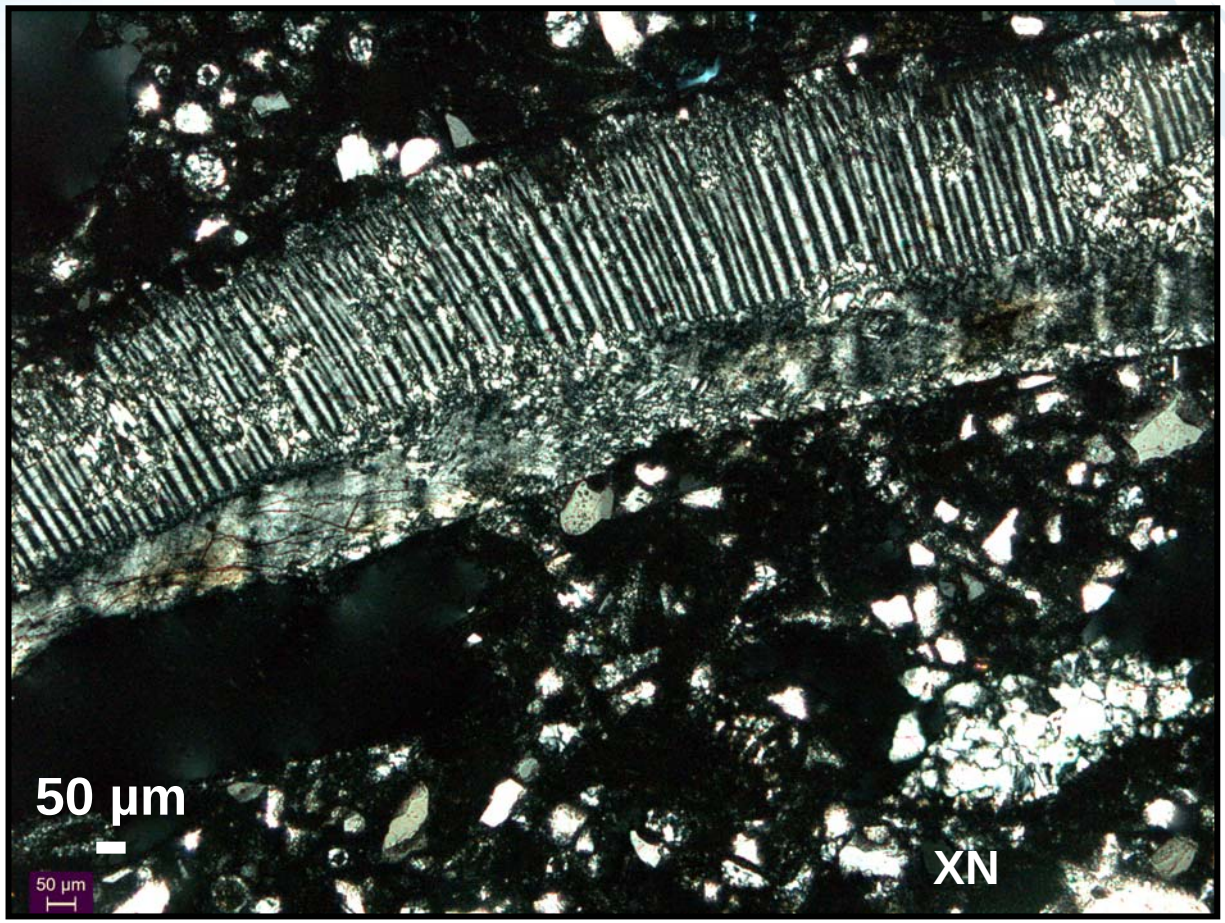
Close up of chalcedony replacement



BGX-2B

45 meters

(155 Feet)

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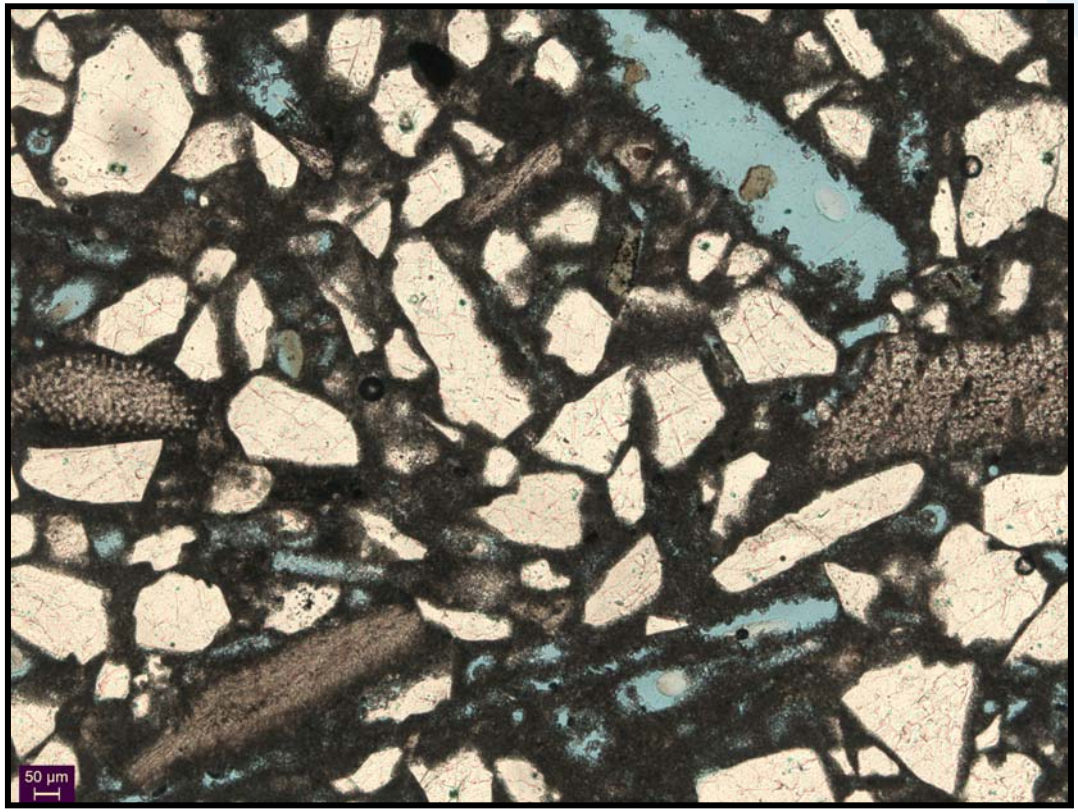
SKELETAL QUARTZ SAND



HSB-TB

36 meters

(117 Feet)

6% Mud

53% Sand

41% Carb.

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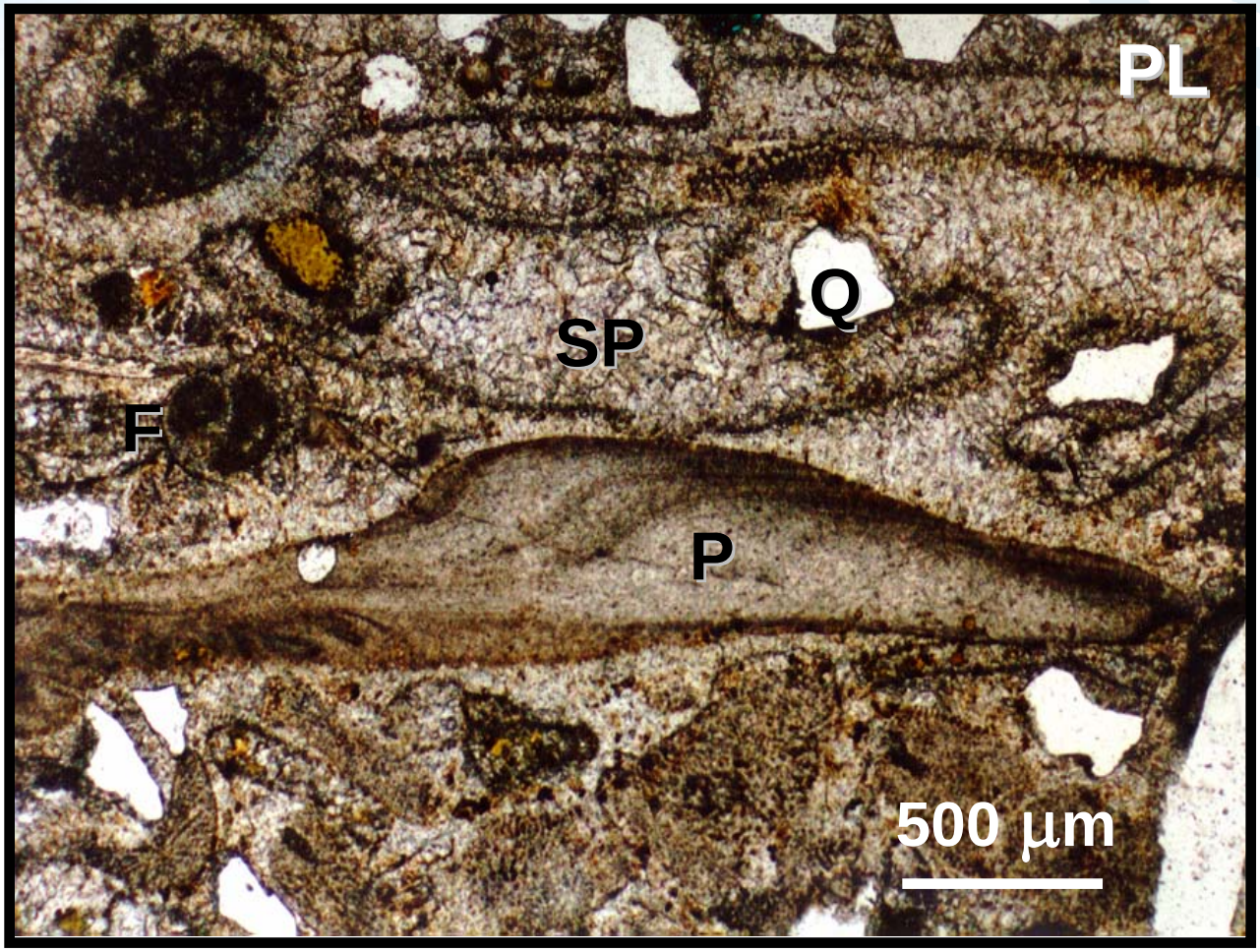
PELECYPOD GRAINSTONE



P-21

47 meters

(153 Feet)

ϕ = 2.4%

K = <0.1

mD

85% Carb.

12% Sand

3% Mud

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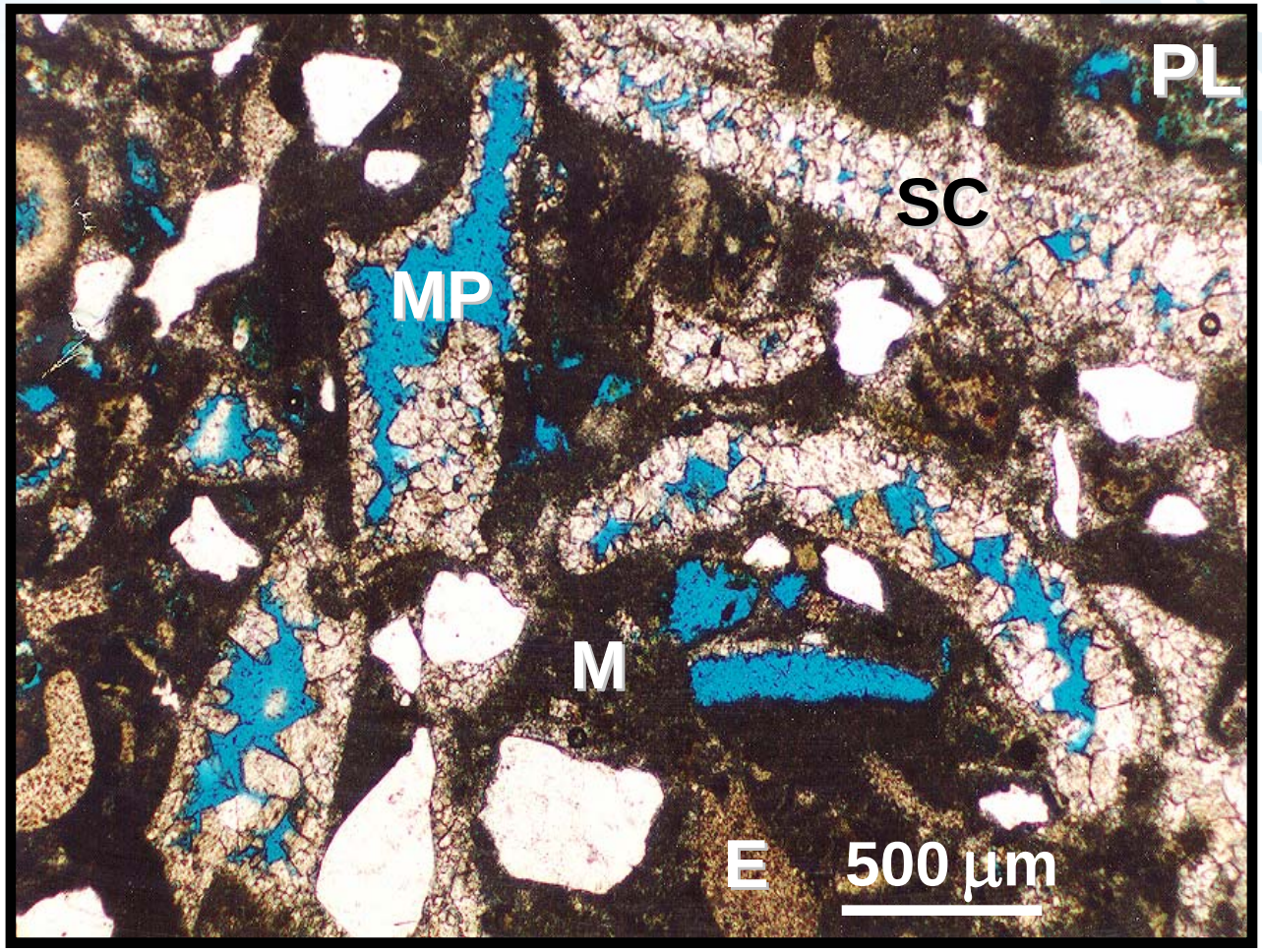
PELECYPOD PACKSTONE



P-22

27 meters

(89 Feet)

ϕ = 17.5%

K = 28 mD

84% Carb

12% Sand

4% Mud

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Summary and Conclusions

- **Mixed carbonate-clastic lithofacies and microfacies vary greatly in the General Separations Area**
- **Depositional environment – marginal marine with a nearby source terrane**
- **Faunal elements indicate clear marine waters of normal salinity**
- **High-energy conditions alternated with quiet water deposition in which muds accumulated**
  - Interpreted to represent a shallowing upwards supersequence with periods of sea-level rise and fall
- **Primary control on areal distribution of facies was depositional environment, controlled by eustacy, and the amount, rate and locus of terrigenous influx**

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Summary and Conclusions

- **Quartz rich facies – high interparticle porosity with excellent permeability**
  - Moderate to high energy deposits nearshore and inner shelf
- **Mud rich facies – dominated by moldic and vug pores, not connected, low to moderate permeability**
  - Low to moderate energy of the inner and middle shelf
- **Both marine phreatic and freshwater phreatic diagenetic pathways observed**