Paleoclimatic and Sequence Stratigraphic Significance of Mineralogy and Ichnology in an Eocene Greensand, Texas*

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Abstract

The overarching purpose of this research project is to examine selected sites throughout the geologic record that represent trace fossils in association with "glaucony" greensands in a sequence stratigraphic context with paleoclimatic implications. An important and informative site for these studies is Stone City Bluff in Burleson County, Texas. There the Main Glauconite Bed (MGB), a trace fossiliferous greensand of the Middle Eocene Stone City Member, Crockett Formation, crops out on the south bank of the Brazos River on the Texas Gulf Coastal Plain. The MGB is a 1.7 m thick greensand, which represents a marine unit within the Stone City Bluff section. It has long been studied by paleontologists and stratigraphers to understand its paleoecology and its place within the regional stratigraphic framework. Our research focuses on the physical and biological processes that occurred during accumulation of the MGB, as evidenced in its ichnologic and mineralogical character in a paleoclimatic context. We examined the trace fossils, ichnofabric and ichnofacies as well as the mineralogy of bulk samples and the pelleted component of the unit.

Results demonstrate a composite ichnofabric for the MGB, which indicates a dynamic history of the deposit from a soft ground substrate in the central bed to a firm ground substrate at the top of bed, as evidenced by the trace fossil assemblage. Initial x-ray diffraction analyses of clay minerals show iron-rich smectite in a clay mixture with kaolinite and illite. Microprobe analyses of selected pellets show that most pellets have negligible K₂O. Both types of analyses indicate a lack of glaucony in the MGB. Further mineralogical analyses are needed, since glaucony typically forms in an offshore setting in modern marine environments, and for that reason, its presence or absence has paleoenvironmental significance. The Stone City Bluff section exhibits parasequence level stratigraphy, demonstrates dynamic sea level fluctuation, and shows evidence of intense biological activity along the Gulf Coast 40 mya. At this time, the paleoclimate was in transition during the Middle Eocene Climatic Optimum. This study of trace fossils and associated greensands provides useful information for discerning the behavior and paleoecology of benthic organisms during dynamic sea level and paleoclimatic conditions.

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References

Odin, G.S., 1988, Green marine clays: oolitic ironstone facies, verdine facies, glaucony facies, and celadonite-bearing facies: a comparative study: Developments in Sedimentology, Elsevier, New York, New York, USA, v. 45, 445 p.

Stenzel, H.B., E.K. Krause, and J.T. Twining (eds.), 1957, Pelecypoda from the type locality of the Stone City beds (middle Eocene) of Texas: Bureau of Economic Geology, University of Texas, Austin, Texas. 237 p.

Yancey, T.E., and A.J. Davidoff (eds.), 1994, Paleogene sequence stratigraphy of the Brazos River Section, Texas: Field trip #1 of the 44th Annual Meeting of the Gulf Coast Association of Geological Societies, Austin, Texas, 4 October 1994, 104 p.

Website

Blakey, R., Middle Eocene ~40Ma: Paleogeography. Web accessed 25 July 2012. http://jan.ucc.nau.edu/rcb7/

Paleoclimatic and

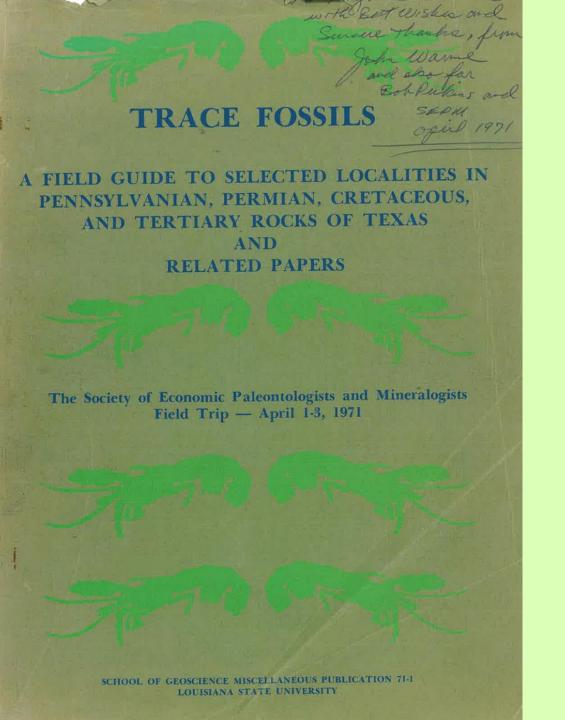
Sequence Stratigraphic Significance

Mineralogy and Ichnology in an

Eocene Greensand, Texas

Sherie C. Harding & Tony Ekdale
University of Utah





The first official trace fossil field trip associated with a **National AAPG-SEPM** Convention (Houston, 1971)

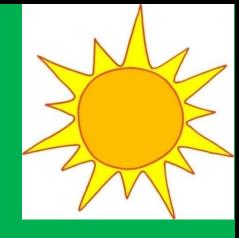
Stop 1
Stone City Bluff



MGB = "Main Glauconite Bed"

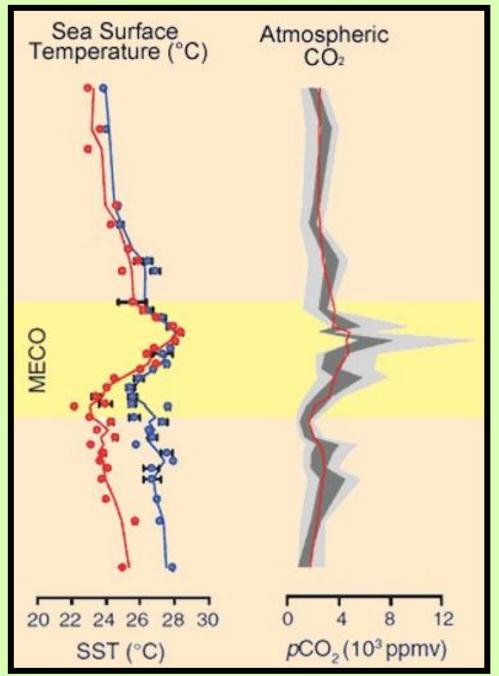


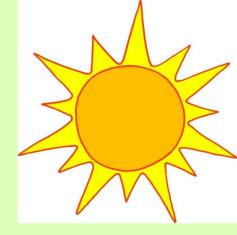
MGB = "Main Glauconite Bed"
MGB = "Main GREEN Bed!"



Paleoclimate

Middle Eocene Climatic Optimum (MECO)





MECO ~40 Ma

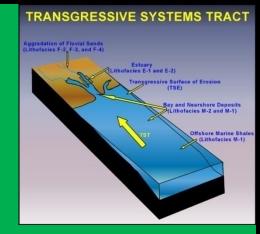
From ODP site 1172-A on east Tasman Plateau, SW Pacific

Is timing of the MECO similar to timing of deposition at Stone City Bluff??

Perhaps

Is the MGB evidence of a biotic response to warming??

Perhaps



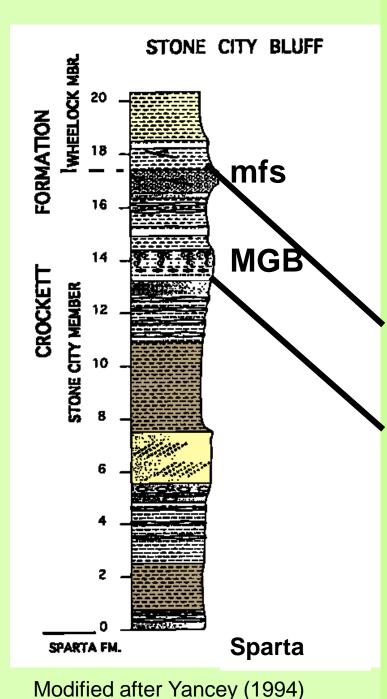
Sequence Stratigraphy

Transgression & Maximum Flooding Surface



Middle Eocene ~40Ma

Blakey http://jan.ucc. nau.edu/rcb7/



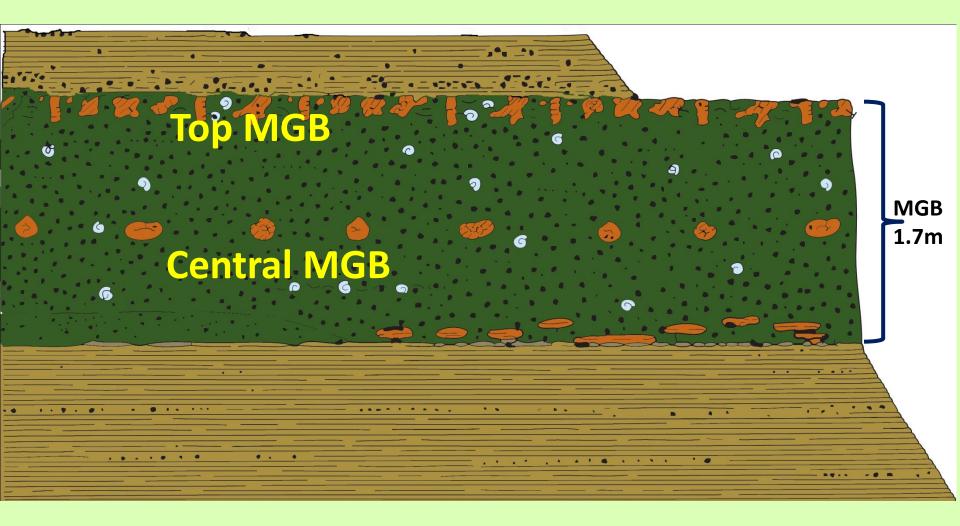
Jackson Group *marine*

Claiborne Group interfingering marine & non marine

Moseley bed - *mfs*Intermediate, IGB
MGB - *condensed bed*

Wilcox Group dominantly nonmarine

Top MGB, T-R Surface, parasequence



Composition and Mineralogy

The non-glauconitic MGB



glaucony (glauconite) (glauconitic minerals)

Defined:

non glaucony
$$K_2O < 2\%$$
 glaucony $K_2O > 2\%$

Analytical Methods

QEMSCAN

Quantitative Evaluation of Materials by SCANning electron microscopy

Electron microprobe

Geochemical characterization of QEMSCAN results

Mossbauer analyses

Determine ferric (Fe3+) / ferrous (Fe2+) ratio

X-ray diffraction

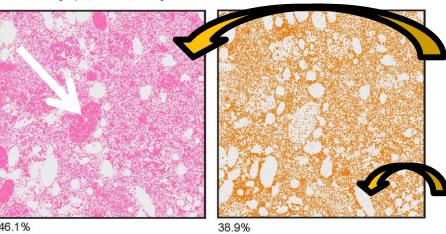
Identify clay minerals



Photomicrograph, transmitted light QEMSCAN Image 100%*

Top MGB

concretionary burrow fill QEMSCAN results (area%)



3.8%

46% apatite-silicate mixture (pellets & matrix)

39% siderite (matrix)

7% Fe, Mg clay 1 (pellets)

4% Fe, Mg clay 2 (pellets)

____ 1 mm

SCB-9

Photomicrograph, transmitted light

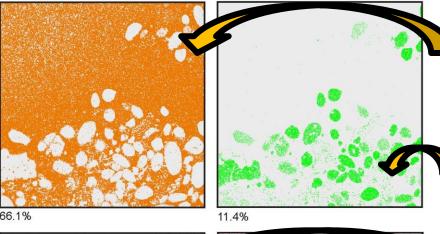
QEMSCAN Image 100%*

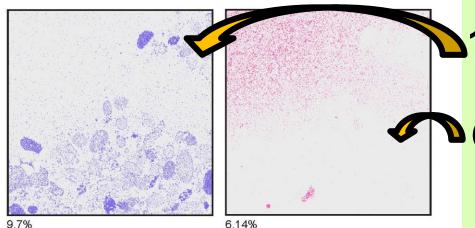
Top MGB

concretionary burrow fill **QEMSCAN** results (area%)



11% Fe, Mg clay 1 (pellets)

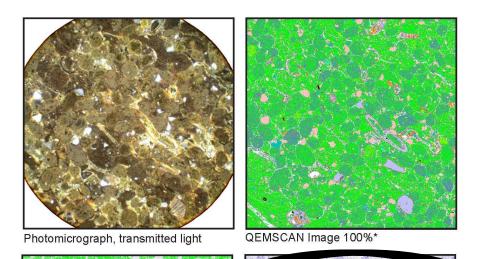




10% Fe, Mg clay 2 (pellets)

6% apatite-silicate mix

SCB-TX-17

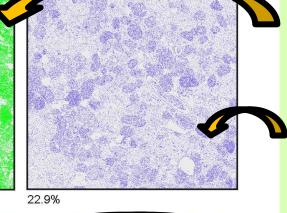


Central MGB

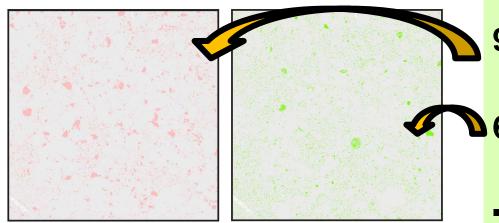
QEMSCAN results area%

54% Fe, Mg clay 1 (matrix)

23% Fe, Mg clay 2 (pellets)



4% 22.9%



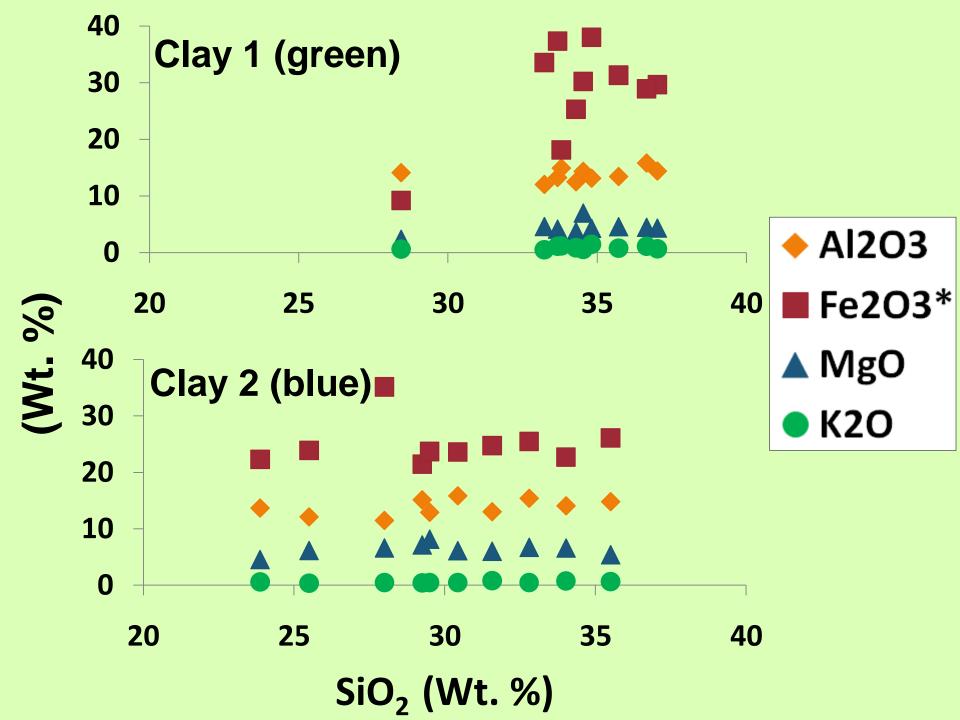
5.6%

9% quartz fragments

6% glaucony

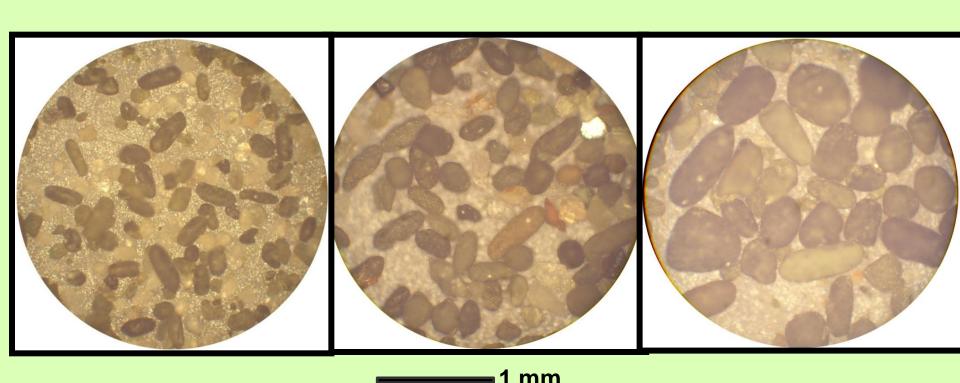
____ 1 mm

SCB-TX-18



Central MGB

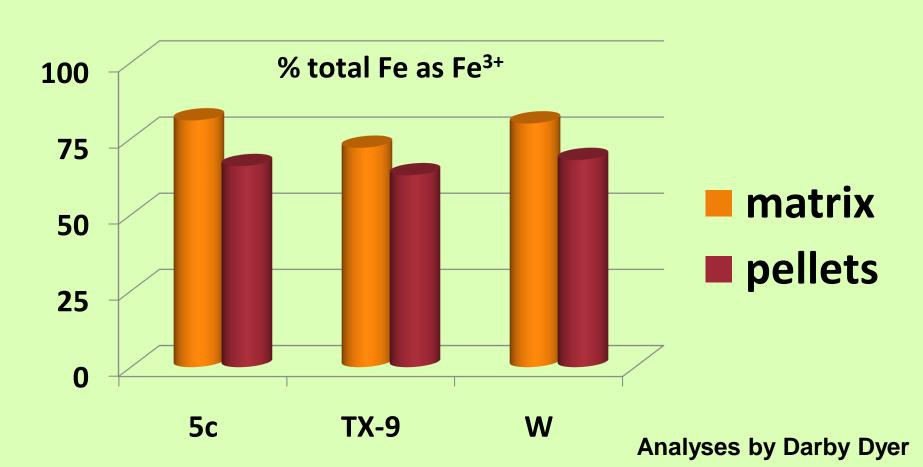
Fecal pellets & matrix separated by Frantz Magnetics



Central MGB

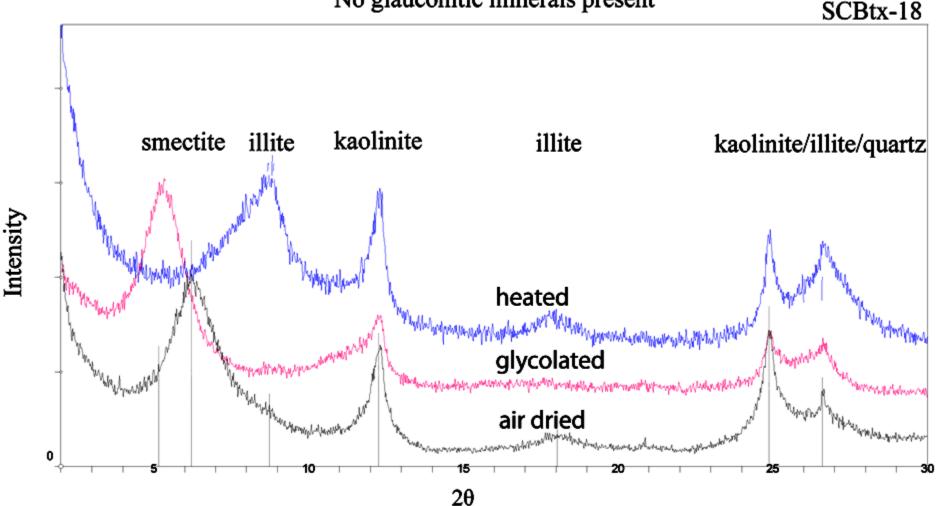
Ferric Iron, % Fe³⁺

Mossbauer analyses



A Clay Mixture

No glauconitic minerals present



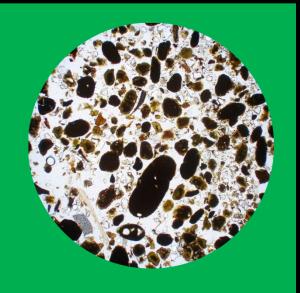
Bulk sample from the Main "Glauconite" bed, Eocene, TX



Mineralogical Contribution to Interpretation

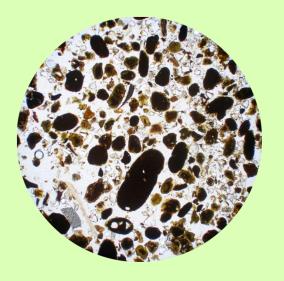
- ➤ Lack of the glauconitization process, why? (insufficient time, depth, salinity, or ocean temperature)
- ➤ Pellets show varied size & composition (indicates a diversity of pellet producers).
- Top MGB has a few detrital glaucony grains (indicates reworked, transported glaucony).





Ichnology

Composite Ichnofabric



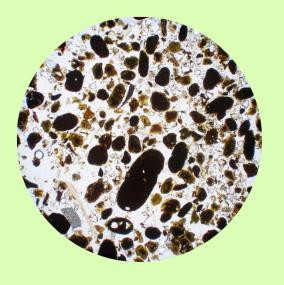
Composite Ichnofabric

Central MGB is one suite of trace fossils

Top MGB is another suite of trace fossils

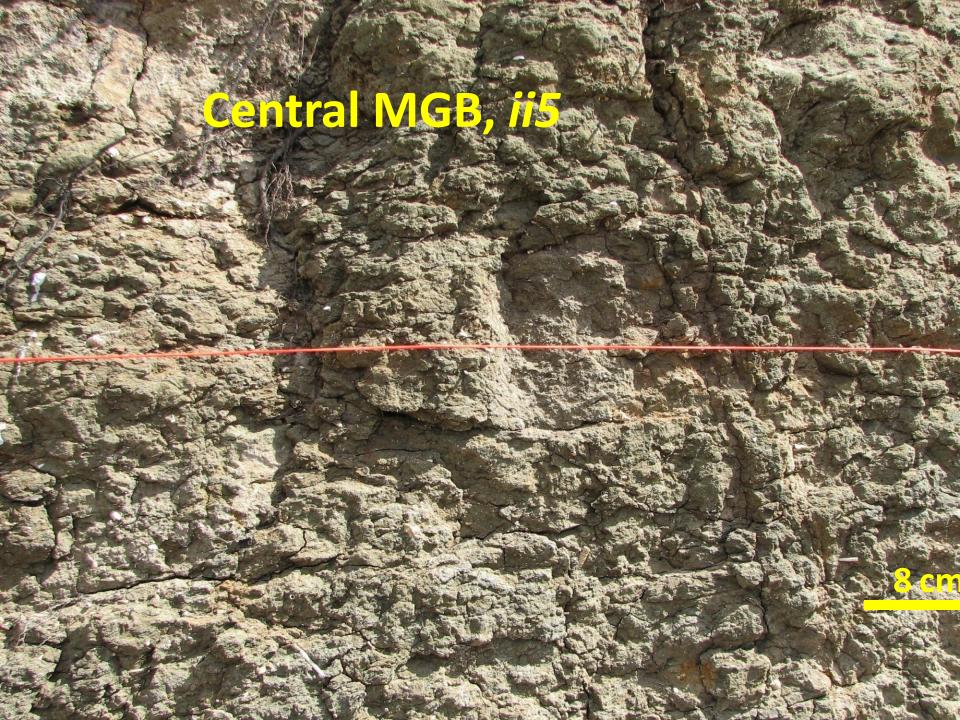
Burrow fill at Top was occupied & re-burrowed

A dynamic ichnofabric (changed through time)



Central MGB Pre Omission Suite

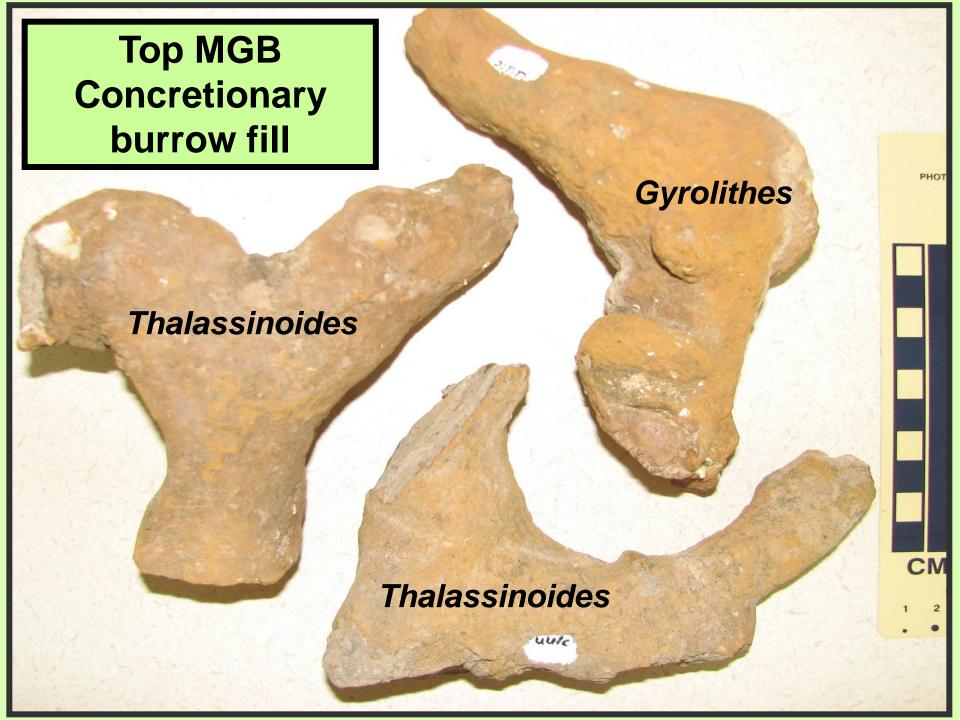
- ➤ Intensely bioturbated (ii5) with indistinguishable individual burrows
- ➤ Ovoid fecal pellets (polychaete worms & deposit feeding pelecypods)
- ➤ Thriving benthic community with high molluscan diversity (>250 spp.)



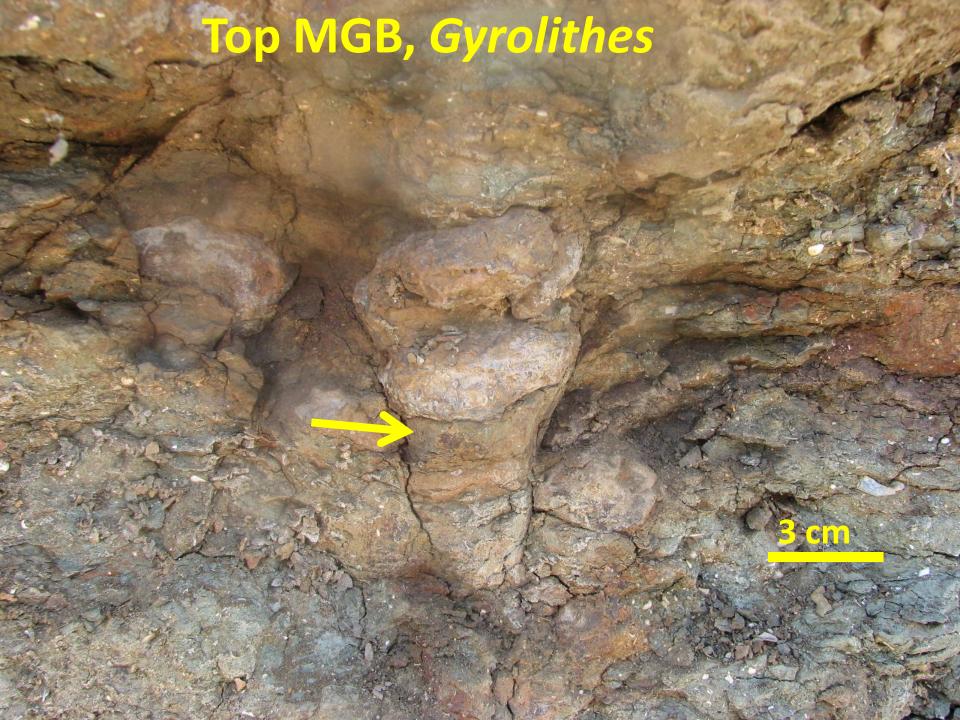


Top MGB Omission Suite

- ➤ Discrete concretionary burrows filled (Gyrolithes &Thalassinoides)
- ➤ Bioglyphs (scratch traces) on casts of burrow walls (Spongeliomorpha)
- ➤ All three burrow types produced by decapod crustaceans







Top MGB concretionary burrow fill scratch traces (bioglyphs) on burrow walls



Top MGB, bioglyphs

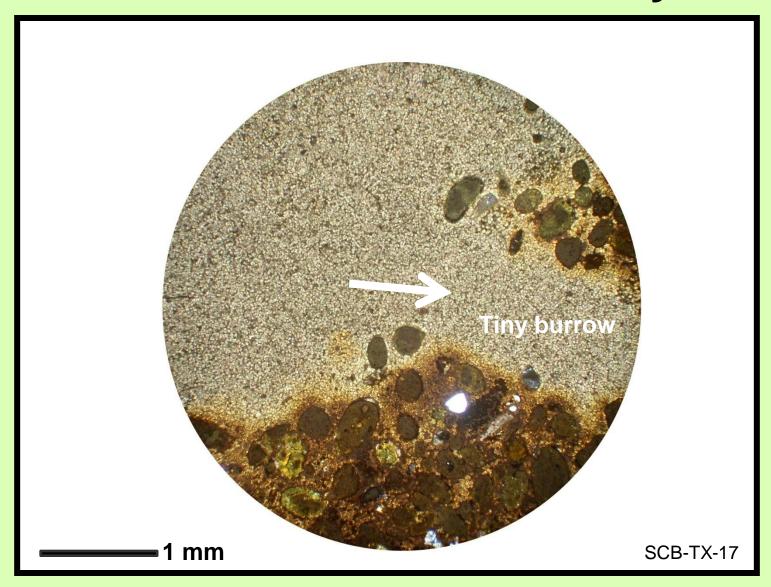


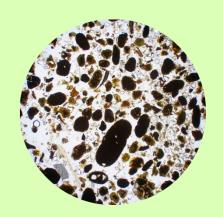


Top MGB Post Omission Suite

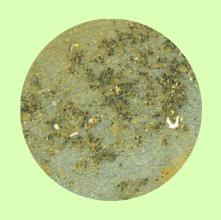
- > Post omission sedimentation in open burrows
- ➤ Burrow fill clastics, pellets, shell fragments, glaucony fragments
- ➤ New burrowing within the burrow fill
- > Subsequent siderite cementation

Top MGB Post burrow fill activity



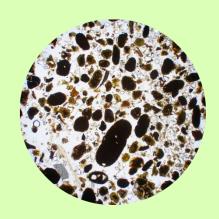


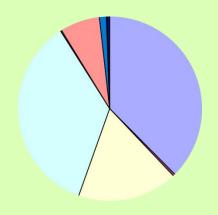
Composite ichnofabric



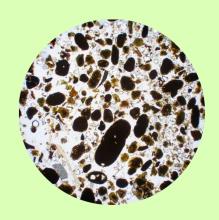
MGB contains three ichnocoenoses and shows sequential occupation of a changing substrate.

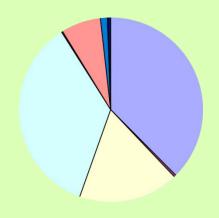
- 1. Softground (pre omission suite)
- 2. Firmground (omission suite)
- 3. Soft burrow fill (post omission suite)



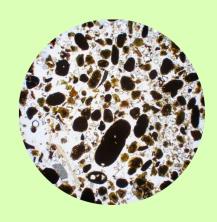


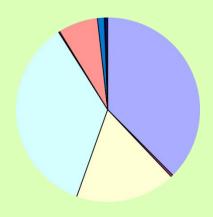
- ➤ The MGB represents a time around ~40 Ma, and may be associated with climate warming.
- ➤ The MGB represents high sea level, is a parasequence topped by a T-R surface.
- > The MGB mineralogy is <u>not</u> glaucony.
- > The MGB trace and body fossils indicate a prolific benthic community.
- > The MGB dynamic ichnology exhibits fossil behavior during a climatic warm interval.



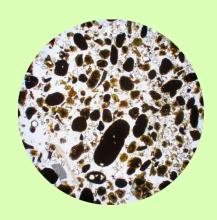


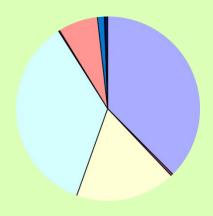
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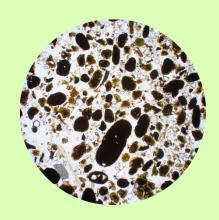


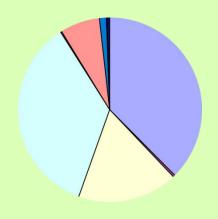
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