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Poster 251-2

Cyclicity within the Paleocene Porters Creek and Naheola formations from archival core drilled in northern Mississippi, USA

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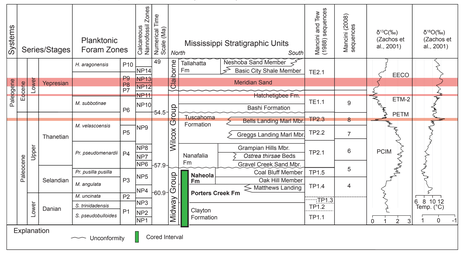
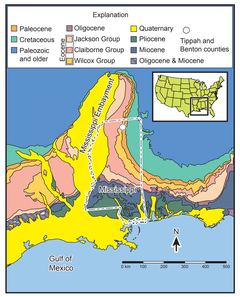
Introduction

- We are studying core from the Paleocene Porters Creek and Naheola formations to characterize background conditions prior to pronounced warming associated with the Paleocene carbon isotope maximum and Paleocene-Eocene hyperthermals.
- Previous work identified possible cyclicity at multiple scales.



Goals

- Examine cyclicity within 3 intervals of core:
  1) 0.57 m of alternating laminae in distal prodelta claystone lithofacies of the Naheola Formation
  2) 8 m of stacked paleosols and lignites within the Naheola Formation
  3) 40 m of magnetic susceptibility data from shelfal mudstone lithofacies of the Porters Creek Formation measured at 0.5 cm intervals



US Gulf Coast Geology

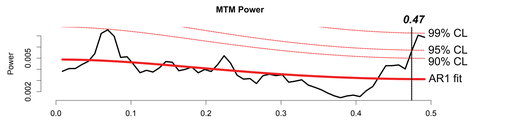
Methods

- Core drilled by the Mississippi Mineral Resources Institute (MMRI) in the 1990s in Benton and Tippah counties, Mississippi; has been in storage since.
- Beginning in 2021, initial core description conducted at the Continental Scientific Drilling Facility at the University of Minnesota, including
  - GeoTek Core Imaging System (CIS)
  - Magnetic susceptibility measured at 0.5 cm intervals on a GeoTek Multisensor Core Logger.
- Goal 1:
  - Imported CIS images into ImageJ and measured thicknesses of cyclical laminae; assigned lithofacies rank of 1 or 2.
  - In package astrochron for R (Meyers, 2014), created lithofacies rank series interpolated at 1-cm intervals, performed multitaper method (MTM) spectral analysis, data demeaned and detrended, 5 DPSS tapers, padded by a factor of 2.
- Goal 2:
  - Assigned lithofacies to transgressive-regressive (T-R) cycles
- Goal 3:
  - Missing data and outliers (determined from boxplot) replaced with local mean.
  - Using R package astrochron (Meyers, 2014), data pre-whitened, demeaned, and detrended, MTM spectral analysis performed with 5 DPSS tapers, padded by a factor of 1.

Results and Discussion

Goal 1: Cyclicity in rhythmically laminated mudstone lithofacies in the Naheola Formation

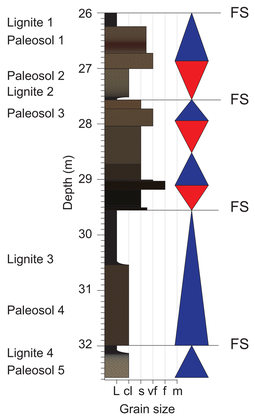
- Laminae assigned to 1 of 2 lithofacies:
  - 1. Light gray, non-water-sensitive clay
  - 2. Dark gray, water-sensitive clay



- 1 significant peak with a frequency of 0.47 cm; period of 2.11 cm.
- Interpreted as rhythmic bedding resulting from cyclical (annual?) changes in salinity shifting the dominant location of clay flocculation relative to the deltaic source of the detrital clays (see Thomas and Murray, 1989).

Goal 2: Stacked paleosols and lignites in the Naheola Formation

- Paleosols developed on prodeltaic mudstones indicate 5 episodes of subaerial exposure.
- Lignites interpreted as interdistributary bays.
- Lithofacies stacking pattern is consistent with delta lobe switching.



T-R Cycles

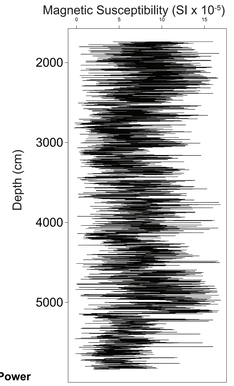
Retrogradation
Progradation
FS = flooding surface

L = lignite
cl = clay
s = silt
vf = very fine sand
f = fine sand
m = medium sand

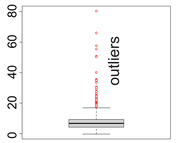
Goal 3: Magnetic susceptibility of shelfal mudstone lithfoacies of the Porters Creek Formation

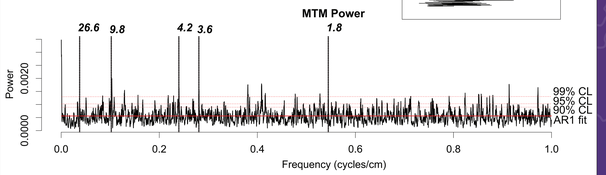
- 40 m of core belong to a single lithofacies: shelfal mudstone
- 8,184 data points, sampling interval of 0.5 cm
- 93 outliers replaced with local mean

Magnetic susceptibility data with outliers replaced; no additional pre-processing applied



Boxplot of all magnetic susceptibility data





- 5 significant peaks (98% confidence level) at periods of 26.6, 9.8, 4.2, 3.6, and 1.8 cm.
- The 26.6 cm period is consistent with a distal expression of the T-R cycles seen in landward lithofacies stacking patterns.
- Magnetic susceptibility maxima and minima represent the influx of terrigenous material during delta lobe building and abandonment, respectively.
- Although the lowest period peaks may be related to the pattern seen in the rhythmically laminated mudstone lithofacies, we refrain from making interpretations until more work is conducted and we have better chronostratigraphic control.

Conclusions

- Spectral analysis of lamina thickness in rhythmically laminated claystone lithofacies of the Paleocene Naheola Formation yields one significant peak at a frequency of 0.47 cm.
  - Interpreted as possibly seasonally driven salinity differences shifting position of flocculation of clay minerals.
  - Implies pronounced seasonality with a rainy season increasing low salinity fluvial input and a dry season with minimal fluvial input.
- Stacking pattern of prodeltaic mudstones, paleosols, and lignites in the Paleocene Naheola Formation is interpreted as the record of 5 of delta-lobe cycles.
- Spectral analysis of magnetic susceptibility data from shelfal mudstones of the Porters Creek Formation yields 5 significant peaks.
  - 26.6 cm cyclicity is inerpreted as the distal expression of T-R cycles, where magnetic susceptibility has a direct relationship to the volume of terrigenous sediment influx.

Future Work

- X-ray diffraction analysis of individual laminae within rhythmic-bedded lithofacies to test differential clay flocculation hypothesis.
- Refinement of sequence-stratigraphic context of cores.
- Additional data collection through the Porters Creek Formation down through the K-Pg boundary into the Clayton Formation.
- Improve chronostratigraphic context of cores to aid interpretations of high frequency cyclicity.
- Refinement of spectral analysis to include X-ray fluorescence and spectrophotometry data.

References

Meyers, S.R. (2014). Astrochron: An R Package for Astrochronology. https://cran.r-project.org/package=astrochron.

Thomas, A.R., and Murray, H.H., 1989, Clay mineral segregation by flocculation in the Porters Creek Formation: Clays and Clay Minerals, v. 37, p. 179-184.

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