HOLOCENE GEOLOGY AND MULTI-PROXY PALEOENVIRONMENTAL RECONSTRUCTION OF THE SUNDA SHELF OFF THE EAST COAST OF PENINSULAR MALAYSIA

Twarog, Michael R
Department of Geological Sciences, East Carolina University, Greenville, NC 27858

Abstract

In May (2016), six 1.25 to 2.2 m long gravity cores were collected at water depths ranging from 68 m to 77 m along a transect crossing the incised Chao-Phraya paleo-river valley between Peninsular Malaysia and southern Vietnam, on the Sunda Shelf (southern South China Sea). The objective of this research is to use multiple proxies to make paleoenvironmental reconstructions of the cored sediments' depositional environments.

The six cores provided 130 samples selected for analysis of bulk sediment magnetic susceptibility (BMS), 66 for elemental analysis by means of x-ray fluorescence spectrometry (XRF), 52 for analysis of foraminiferal assemblages, and 10 for AMS radiocarbon dating. BMS data show that sediments near the base of the cores typically display higher magnetic susceptibility than sediments closer to the surface, although results vary between and within cores. Other studies show that variations in BMS magnitudes are a result of changes in terrestrial sediment flux during deposition. XRF data will help constrain origins of the cored sediment (e.g. terrestrial or marine). For example, aluminum is typically concentrated in aluminosilicates and can be used as a proxy for variations in grain size. Concentrations of calcium, when inversely correlated with aluminum, are commonly interpreted to derive from a different source (e.g., marine). Foraminiferal assemblages will be used as a proxy for environmental change in conjunction with BMS and XRF.

Introduction

The Sunda Shelf, located in the southern South China Sea between peninsular Malaysia, Sumatra, and Borneo, is one of the largest continental shelves in the world. The Sunda Shelf has been the focus of much paleoclimactic and paleoenvironmental research. Several projects, by East Carolina University Master's students (Fig. 1), have attempted to reconstruct the paleoenvironmental conditions on the Sunda shelf. The goal of this research is to extend these reconstructions further offshore. Gravity cores were gathered in the summer of 2016 and radiocarbon ages, processed by the National Ocean Sciences Accelerator Mass Spectrometry facility in Woodshole, MA., are provided in Table 1. Several proxies in this project will be used for the reconstruction of the six cores farthest offshore (Fig. 1). Bulk sediment magnetic susceptibility (BMS) was used as a proxy for terrestrial sediment flux over the Holocene. X-ray fluorescence spectrometry (XRF) will be used to determine possible correlations between magnetic susceptibility and concentrations of major/ trace elements. Foraminiferal assemblages will be identified down core. These assemblages will be used to interpret past environments when compared with modern surficial assemblages identified by Martin (unpublished) and Szarek (2006).

Field Area

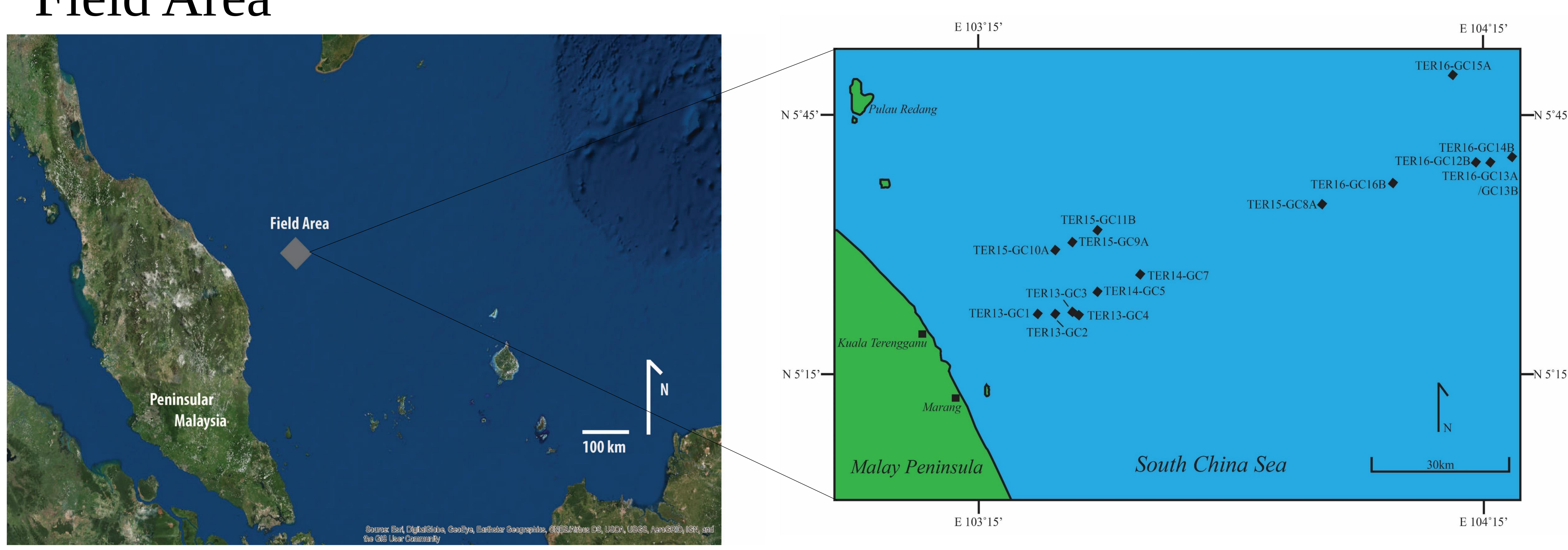

Figure 1. Map showing the Field Area. Cores TER16-GC16B, TER16-GC12B, TER16-GC14B, TER16-GC13A/GC13B, and TER16-GC15A are the focus of this research. The other cores represent work done by other East Carolina Master's students.

Methods

- Gravity cores were collected in the southern South China Sea, May 2016, on a research cruise aboard the *RV Discovery* (operated by Universiti Malaysia Terengganu). Cores were then taken back to the university, divided into one centimeter sections, dried at ~50°C, and packaged for delivery back to East Carolina University.
- Samples for bulk sediment magnetic susceptibility (BMS) were taken every ten centimeters (Fig. 2). A six gram aliquot was weighed out, powdered and analyzed in a Kappabridge MFK-A (Agico) at a field intensity of 200 A/m. Samples were run five times each to ensure reliability. Sample TER15-GC5 (19.2–20.5 cm, Hindes unpublished) was analyzed at the beginning and end of the measurements taken from each core to identify potential oscillations in machine performance. BMS samples were reused for x-ray florescence spectrometry (XRF).
- XRF samples were taken every fifteen centimeters down core (Fig. 2). When this was not the case, an additional sediment sample of six grams was used (this additional sample was also analyzed for BMS).
- Foraminiferal samples were taken every twenty centimeters (Fig. 2) disaggregated and wet-sieved over a nest of 63 micron, 150 micron, and 1000 micron sieves. Approximately three- hundred foraminifera were picked from the 150 to 1000 micron fraction and identified.

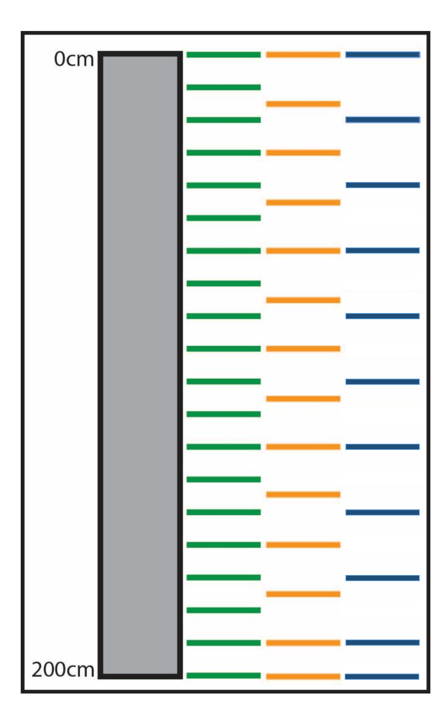

Figure 2. Graphical representation of sampling scheme. Green rectangles are BMS samples (every 10 cm). Orange rectangles are XRF samples (every 15 cm). Blue rectangles are foraminiferal samples (every 20 cm).

Results

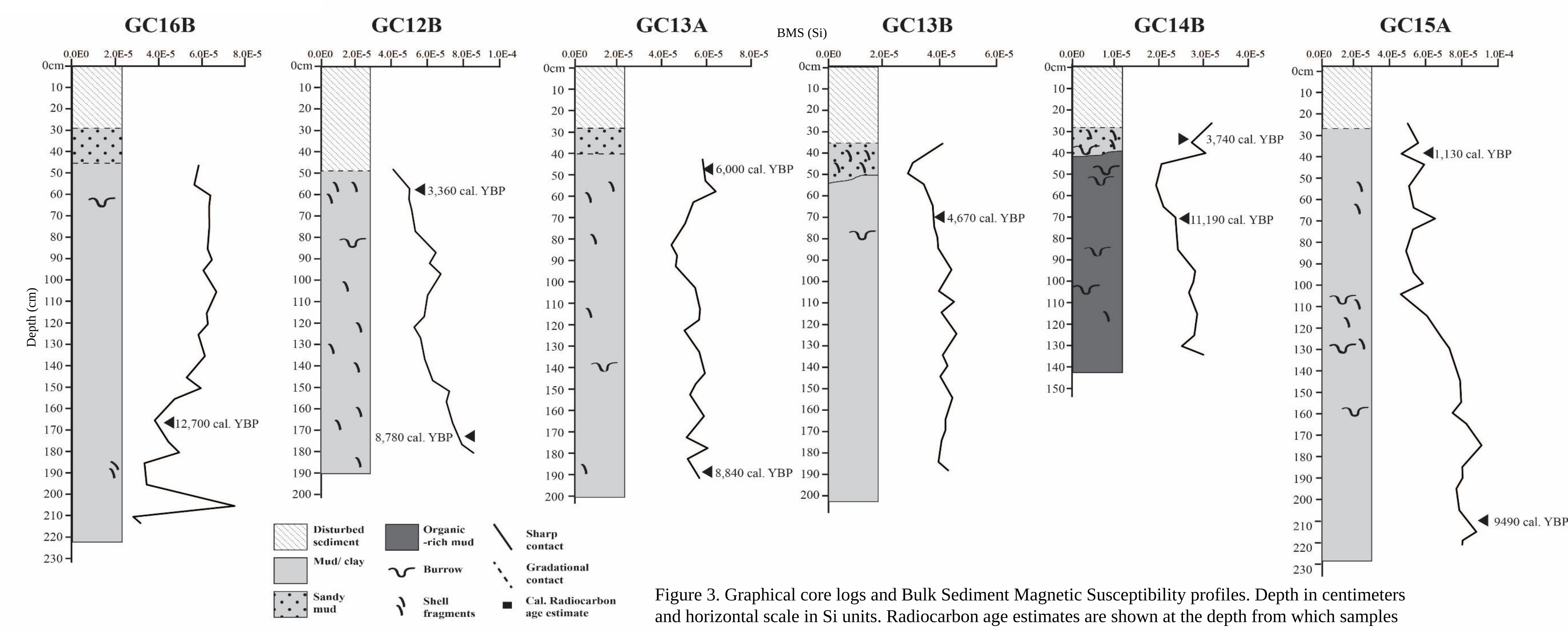

Figure 3. Graphical core logs and Bulk Sediment Magnetic Susceptibility profiles. Depth in centimeters and horizontal scale in Si units. Radiocarbon age estimates are shown at the depth from which samples were collected.

Table 1. AMS C-14 radiocarbon age estimates and supplemental information.

SAMPLE ID	^{14}C AGE (yr)	AGE ERROR (yr)	CALIBRATED YEARS BP	Δ R	Δ R UNCERTAINTY	δ^{13}C	PROCESS	SPECIMEN TYPE
TER16-GC12B, 59-60cm	3440	20	3218-3501	-45	49	-0.38	Hydrolisis	Foraminifera
TER16-GC12B, 174-175cm	8200	30	8597-8960	-45	49	-0.7	Hydrolisis	Foraminifera
TER16-GC13A, 48-49cm	5530	25	5855-6143	-45	49	-0.24	Hydrolisis	Foraminifera
TER16-GC13A, 189-190cm	8270	25	8664-9014	-45	49	-0.71	Hydrolisis	Foraminifera
TER16-GC13B, 70-71cm	4440	20	4522-4812	-45	49	-0.38	Hydrolisis	Foraminifera
TER16-GC14B, 35-36cm	3750	20	3590-3880	-45	49	-0.04	Hydrolisis	Foraminifera
TER16-GC14B, 70-71cm	10150	35	11051-11332	-45	49	-11.39	Hydrolisis	Mollusc
TER16-GC15A, 39-41cm	1530	15	1005-1254	-45	49	-0.32	Hydrolisis	Foraminifera
TER16-GC15A, 219-221cm	8780	25	9380-9600	-45	49	-1.11	Hydrolisis	Foraminifera
TER16-GC16B, 167-168cm	11150	35	12577-12814	-45	49	-7.88	Hydrolisis	Mollusc

Discussion

- Cores GC15A, GC13A, and GC12B are composed of Holocene sediment. Sediments in the other three cores appear to straddle the Pleistocene/ Holocene boundary. Funds for additional radiocarbon age estimates are being sought out in order to help further determine the geochronology of the cores.
- BMS data show several variations in magnitude. Data from nearby studies suggest that higher BMS values result from increased terrestrial sediment flux during deposition, thus variations in magnetic susceptibility could correlate with changes in sediment origin. XRF data will help constrain origins of the cored sediment (e.g. terrestrial or marine) by analyzing changes in key elements (e.g. Al, Fe, Ti, etc.). These changes in concentration could also result from changes in ocean current.
- GC13A and GC13B exhibit slightly serrated profiles without much overall variation in magnitude (Fig. 3). The other four cores exhibit slightly serrated trends that decrease up core. It is possible that the higher magnitudes indicate more terrestrial input. XRF data will help with interpretation.
- Foraminiferal assemblages will be used as a proxy for environmental change in conjunction with BMS and XRF.

References

- Martin, S. Q., Culver, S., Leorri, E., Mallinson, D., Buzas, M., Shazili, N.M. 2015. Taxonomy and distribution of modern benthic foraminifera of the western Sunda Shelf (South China Sea) off peninsular Malaysia. Geological Society of America, National Meeting, Denver, Colorado, USA. Paper No. 40-31.
- Szarek, R., Kuhnt, W., Kawamura, H., Kitazato, H., 2006, Distribution of recent benthic foraminifera on the Sunda Shelf (South China Sea): Marine Micropaleontology, v. 61, p.171-195.

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