IODP Expedition 353: Indian Monsoon Rainfall
Site U1448 Summary

Background and Objectives

Site U1448 is located in the Andaman Sea, ~44 km offshore Little Andaman Island at 1097 mbsl, 17.7 km south of Site U1447. The site lies atop a rise separating north–south oriented basins associated with the Eastern Margin and Diligent faults, both related to the underlying accretionary wedge complex. The ridge-top location should have a lower sedimentation rate and be better protected from turbidite deposition. The objectives at this site are to recover Pliocene to recent sediments in order to reconstruct changes in summer-monsoon rainfall and runoff from the Irrawaddy and Salween rivers at tectonic to sub-orbital timescales.

Operations

At Site U1448, Holes U1448A, U1448B, and U1448C were drilled to total depths of 421.0 m, 358.6 m, and 34.3 m DSF, respectively. In Hole U1448A the APC system (9.5 m long), the half-length (4.7 m long) APC system (HLAPC), and the XCB system were deployed. In Hole U1447B the APC and HLAPC systems were used and only the APC system was deployed for Hole U1448C. Overall, 121 cores were recorded for the site. A total of 427.52 m of core over a 416.2 m cored interval were recovered using the APC system (103% recovery). The cored interval with the HLAPC system was 318.6 m with a recovery of 333.24 m of core (105%). The cored interval with the XCB system was 77.6 m with a recovery of 78.21 m of core (101%).

The overall recovery percentage for Site U1448 was 103%. The total time spent on Site U1448 was 3.9 days.

Principal Results

Lithostratigraphy

The sediments recovered from Site U1448 are principally composed of hemipelagic clays with a significant biogenic component composing four distinct lithological units (I–IV) and are Late Pleistocene to early Miocene age. Unit I is 180 m thick and composed of Late to early Pleistocene greenish gray clay with varying proportions of nannofossils and foraminifers, and clayey nannofossil ooze. Unit II is 160 m thick and composed of early Pleistocene to late Miocene greenish clay with varying proportions of nannofossils and

foraminifers, and characterized by the low proportions (≤1%) of biosilica. Unit III is 40 m thick and composed of late Miocene greenish dark to light gray nannofossil-rich clay and clay with nannofossils, and characterized by the increased abundances of glauconite (up to 7%) and siliceous sponge spicules (up to 4%). A hiatus representing ~7 m.y. occurs at the base of Unit III at 379.11 m CSF-A, where there is an abrupt change to Lithologic Unit IV. Unit IV is comprised of middle–early Miocene greenish gray–light greenish gray biosiliceous ooze with varying proportions of clay and nannofossils. The observed lithological differences between the units are primarily the result of varying abundances of bioclastics (nannofossils, foraminifers, diatoms, and sponge spicules), clay, and glauconite.

Biostratigraphy

Hole U1448A is characterized by a hiatus at 379.11 m CSF-A; below this hiatus, the sediments are of Late Pleistocene to early late Miocene age, while the microfossil assemblages between the hiatus and the bottom of Hole U1448A (420.6 m CSF-A) suggest that the sediments are of middle Miocene age.

Calcareous nannofossils are abundant throughout Hole U1448A, and their preservation is very good in the Pleistocene, Pliocene, and latest Miocene sediments (0–379.1 m CSF-A), with few reworked species. Below the hiatus, nannofossils were abundant as well, but moderately preserved. Nannofossil assemblages are typical of tropical/subtropical paleoenvironments. Foraminifers are well-preserved in all core catcher samples from Hole U1448A; they are dominant in the upper 340 m CSF-A, while their abundance decreases to common just above the hiatus and drops to few to common below the hiatus. Diatoms are rarely present in the uppermost 379.04 m CSF-A of Hole U1448A. Their abundance abruptly increases just below the hiatus and their preservation varies from moderate to good.

The age model for Site U1448 was established by combining nannofossil, planktonic foraminifer, and diatom datums (the latter below the hiatus only). The oldest calcareous nannofossil sample studied above the hiatus suggests an age between 6.91 Ma and 7.42 Ma, while planktonic foramininfer datums suggest that the age of the oldest core-catcher sample above the hiatus is between 5.92 Ma and 8.58 Ma. Slightly different ages are suggested for the sediments below the hiatus by the three different microfossil groups. The interval between the hiatus and the bottom of Hole U1448A was constrained

between 14.91 Ma and 17.71 Ma based on nannofossils. The foraminifer assemblage in the youngest core catcher sample below the hiatus is older than 14.53 Ma, while the oldest planktonic foraminifer datum encountered is the last occurrence of *Praeorbulina glomerosa* (14.78 Ma). The foraminifer *Praeorbulina glomerosa* is found in the deepest sample, U1448A-60X-CC, defining the basal age of U1448A as 14.78–16.27 Ma. Combining the ages of biostratigraphic events of nannofossil and planktonic foraminifers provides the basis for estimating the duration of the Miocene hiatus to approximately 8 m.y. between 6.91–7.47 Ma and 14.91–16.38 Ma. The co-occurrence of the diatom species *Rhaphidodiscus marylandicus* and *Annellus californicus* in the lowermost part of Hole U1448A suggests the bottom of this holer is older than 16.7 Ma (LO of *Rhaphidodiscus marylandicus*) and younger than 17.3 Ma (FO of *Annellus californicus*).

Age-depth relationships for Hole U1448A based on biostratigraphy for the three fossil groups studied show good agreement. Sedimentation rates above the hiatus are between 5–6 cm/k.y. The sedimentation rates below the hiatus are difficult to quantify given the wide range of estimated ages.

Geochemistry

The geochemistry at Site U1448 mainly reflects the anaerobic processes of sulfate reduction and methanogenesis associated with microbial degradation of organic matter. The organic carbon content ranges from 0.2 wt% to 1.4 wt% (average 0.6 wt%). Sulfate declines from 28 mM at the sediment/water interface to nearly zero values at approximately 40 m CSF-A. Alkalinity has a broad peak, significantly lower than Site U1447, starting from 40 m to 150 m CSF-A before gradually decreasing, consistent with the production of bicarbonate during the sulfate reduction. Headspace methane concentrations increase immediately below the sulfate-methane interface, and continue downcore with the highest values between 200–250 m CSF-A. The overall concentrations (20–30 ppmv), however, are quite low compared to Site U1447. High methane/ethane ratios suggest that the methane is mostly of biogenic origin (methanogenesis). A gradual increase in dissolved Ba concentration with depth suggests ongoing barite dissolution. Changes in the concentration of other elements and ions (Fe, Mn, Ca, B, ammonia, and Sr) in interstitial water can be readily explained by microbially mediated chemical reactions and their effects on pH, alkalinity, and mineral dissolution and precipitation. Carbonate content varies significantly between 12 wt% to 37 wt%.

Paleomagnetism

Paleomagnetic measurements were conducted on archive half sections for all three holes at Site U1448. To accommodate the core flow, only APC and HLAPC cores from Hole U1448A were demagnetized by alternating field (AF) demagnetization up to 10 mT. XCB cores from Hole U1448A and APC cores from Holes U1448B and U1448C were measured only for NRM, with a few exceptions. HLAPC cores from Hole U1448B have unfortunately not been measured. Declination values from section measurements suggest the top 200 m CSF-A is largely divided into three magnetozones, corresponding to the Brunhes (C1n), Matuyama (C1r) and Gauss (C2An) chrons. Discrete samples taken from the working half sections of Holes U1448A ($N = 90$) were also analyzed, with stepwise AF-demagnetization typically up to 80 mT, but generally the determination of characteristic remanence (ChRM) was difficult. Stability of NRM appears to be high just below the hiatus, with higher-resolution measurements possibly inferring polarity transitions. Anhysteretic remanent magnetization (ARM) was acquired and measured on a selection of Hole U1448A discrete samples for preliminary insight into depth variations in Site U1448 sediment bulk magnetic properties.

Physical Properties

The physical properties data collected at Site U1448 were generally found to be in good agreement with the lithostratigraphy at this site; however, our unit division boundaries are different for the upper 182.9 m CSF-A. We identified six physical property units in Hole U1448A. The data between Holes U1448A and U1448B correlate well. Many of the changes in physical property characteristics of Hole U1448A were gradual shifts to increasing or decreasing values. NGR data were the only data to show long term cyclicity possibly related to terrigenous input. Unit I shows high variability in most measurements likely from unconsolidation in the upper sediment. Unit II shows little MS variability, increasing density, decreasing porosity, and a relatively steady NGR counts. Unit III is characterized by an increase in MS, density, NGR counts, and a decrease in porosity, and lower b* values indicating more terrigenous material and clay relative to carbonate or siliceous fractions. Unit IV, which corresponds to Lithostratigraphic Unit II, has steady, high MS and density values, a continued decrease in porosity, variable NGR counts and the lowest b* values. Unit V is characterized by decreases in density, MS values, NGR counts, and increases porosity and b*. The physical properties of Unit V likely indicate an increase in abundance of more biosilica-rich clays. All physical property

measurements showed a very dramatic change at 379.1 m CSF-A, which was determined to mark an approximately 7 m.y. hiatus.

Stratigraphic Correlation

A composite scale (CCSF-A) and a splice were constructed for Site U1448 for Holes U1448A, U1448B, and U1448C using magnetic susceptibility, natural gamma ray and RGB data. Splicing among these holes enabled us to construct a continuous stratigraphic sequence down to ~203 m CCSF-D. Following a set gap, a floating composite scale was constructed between ~205 m and ~260 m CCSF-A using Holes U1448A and U1448B. Due to data quality and time availability issues, correlation should be viewed with caution below ~115 m CCSF-A.

Highlights

In contrast to sedimentation at Site U1447, which in the lower Pleistocene and middle–upper Pliocene was partly affected by sediment gravity deposition (turbidites or fine grained grain flows/debris flows), the lower Pleistocene and Pliocene at Site U1448 exhibits a complete hemipleagic succession with all calcareous biostratigraphic markers represented. The intermediate to high sedimentation rates of this succession (5–6 cm/k.y.) will allow high-resolution paleoclimatic reconstructions using calcareous and organic proxy indicators of paleotemperature and salinity in a continuous succession reaching down into the late Miocene (6.91 Ma).

The high-resolution sedimentary succession at Site U1448 also allowed recognition of a suite of volcanic tephra layers, which appear partly correlative to the tephra succession at Site U1443. In particular the tephra of the Late Pleistocene Toba eruption (0.0738 Ma) could be recognized in all three holes at Site U1448 and provides an excellent marker bed for stratigraphic correlation.

The main highlight at Site U1448 was the recovery of pelagic middle Miocene sediment below the distinct seismic reflector at 1.865 s TWT on seismic line AN01-26A. The reflector represents a major unconformity between late Miocene (~ 6.91 Ma) and middle Miocene (~14.53 Ma). The middle Miocene pelagic succession below the unconformity is comprised of a carbonate-rich biosiliceous sedimentary succession, which was fully recovered in very high quality XCB cores and will provide the first insight in monsoonal influenced biogenic sedimentation during the middle Miocene Climate Optimum.