Expedition 320: Pacific Equatorial Age Transect (PEAT I)
Week 4 Report (29 March - 4 April 2009)

5 April 2009

OPERATIONS

Three holes were cored at Site U1333. Hole U1333A provided high quality and recovery APC cored sediments from approximately 3 m below the mudline (~4850 mbsl) to 95 m (Core U1333A-10H). Since we had to drill-over this core barrel to recover it, we switched to XCB coring. XCB coring advanced to 184.1 m, through an approximately 60 m thick sequence of lowermost Oligocene carbonate oozes and nannofossil-bearing Eocene sediments. In the basal section, Core U1333A-20X recovered a 30 cm long interval of lithified limestone, followed by Core U1333A-21X that contained a limestone basalt breccia. Core U1333A-22X recovered a 6 cm piece of basalt. No downhole logging was conducted at Site U1333.

Coring in Hole U1332B was started 5 m shallower than U1333A to recover the mudline and to span the core gaps from the first hole. Core U1333B-1H recovered 7.73 m of carbonate bearing ooze overlain by a few meters of clay. Since the cores recovered from Hole U1333A showed that there was no significant porcellanite or chert layers, we used the APC drill-over strategy in Hole U133B to obtain APC cores across and below the Eocene–Oligocene transition down to 162.7 m. We then XCB cored to basement and a total depth of 180.3 m.

Hole U1333C was designed to provide stratigraphic overlap and confirm stratigraphic correlations made between Holes U1333A and U1333B. APC coring in Hole U1333C started 2.75 m shallower than Hole U1333B and reached to 163.2 m before we had to switch to XCB coring.

SCIENCE RESULTS

Overview

During this week, we cored three holes at Site U1333 (PEAT-3C). Site U1333 is located over seafloor basement that was estimated to be 46 Ma targeting basal sediments

within the equatorial zone. Our objective is to recover middle and late Eocene sediments, as well as Oligocene and younger sediment as part of the PEAT depth transect. These sediments will provide information about changes in the temperature and structure of the near-surface ocean to investigate fluctuating accumulation rates of siliceous ooze and periods of highly fluctuating carbonate compensation depths (CCDs).

Site U1333 recovered a carbonate-bearing interval between the earliest Oligocene at around 112 m up to the earliest Miocene interval below the top few meters of clay, and contributes towards achieving this important depth-transect objective. Site U1333 also documents high sedimentation rates of ~ 1.5 cm/ky during the early Oligocene, and an increasing influx of diatoms within the strikingly white sediments above the Eocene–Oligocene transition. The middle Eocene sediments contain more carbonate sediments/rocks as compared with those in the previous two Sites U1331 and U1332.

Lithostratigraphy

At Site U1333, seafloor basalt is overlain by approximately 183 m of pelagic sediments that are divided into four major lithologic units. Unit I is about 10 m thick and composed of a dark brown radiolarian clay overlying an alternating sequence of dark yellowish brown radiolarian clay and yellowish brown nannofossil ooze. Unit II is approximately 107 m thick and is composed of Oligocene homogenous white to very pale brown nannofossil ooze. Unit III is approximately 60 m thick and is Eocene in age and composed an alternating sequence of dark brown radiolarian ooze, radiolarite, brown nannofossil ooze and chalk. Porcellanite also occurs in is Unit III between approximately 168 and 174 m. Unit IV is an approximately 4-m-thick brown micritic chalk that overlies inter-collated micritic limestone and basalt.

Biostratigraphy

Site 1333 sediments span a near continuous succession from around the lower Miocene boundary to the middle Eocene. Radiolarians are common and well preserved in the Eocene succession but less well-preserved in the Oligocene sediments. There appears to be a complete sequence of radiolarian zones from RN1 down to RP 14 (middle Eocene). Calcareous nannofossils are present and moderately to well preserved through

most of the succession, although there are some short barren intervals around in the middle to late Eocene boundary. The succession appears to span a complete sequence of nannofossil zones from the early Miocene zone NN1 to the middle Eocene zone NP15. Planktic foraminifers are relatively abundant and well preserved from the lowest part of the Miocene to the lower Oligocene; however the upper Eocene sediments contain poorly preserved specimens or are barren. Preservation and abundance slightly increased in some intervals of the middle Eocene, which is recognized by the presence of acarininids and clavigerinellids. Benthic foraminifers were almost continuously present and indicate lower bathyal to abyssal depths.

Paleomagnetism

Paleomagnetic results from Holes U1333 A and U1333B have so far provided an interpretable magnetostratigraphy that extends downhole from the top of Chron C6An.1n (20.040 Ma) to the top of Chron C13r reversal (33.705 > Ma) at ~111.4 m using the APC cores. Cores from Holes U1333B and U1333C are being analyzed at present, and are likely to extend this coverage.

Geochemistry

Geochemical analyses focused on samples from Hole U1333A, as well as continuing work on samples from the first two sites. Samples from the upper part of Hole U1333A have relatively high calcium carbonate contents. The interstitial water geochemistry shows relatively constant chloride values, and initial sulfate results indicate limited sulfate reduction. Alkalinity values are never elevated. However, alkalinity and dissolved strontium values rise slightly near the Eocene–Oligocene transition, which is generally consistent with carbonate dissolution/recrystallization processes. Dissolved silicates increase with depth, with values always <1000 μM.

Physical Properties

A full physical property program was run on all cores from Site U1333 comprising whole-round multi-sensor core logger measurements of magnetic susceptibility, bulk density, P-wave velocity, natural gamma radiation, and measurements

of color reflectance, followed by discrete measurements of moisture and density properties, sound velocities and thermal conductivity. Magnetic susceptibility varies around ~24x10^{-5} SI in radiolarian ooze dominated sections and ~3x10^{-5} SI in more carbonate-rich intervals. Natural gamma measurements are elevated in the uppermost clays and also increase near the lower Oligocene at around 115 m. Velocity gradually increases downhole (from carbonate to more radiolarian-dominated sediments). Velocity varies between 1490 and 1560 m/s with lower velocities in the more carbonate-rich intervals. Bulk density and grain density show a marked decrease around 112 m, which also corresponds to a decrease in carbonate content. Porosity values are generally high in the radiolarian rich sediments (80%) and are lower in the carbonate-rich section (~60%).

Stratigraphic Correlation

Site U1333 magnetic susceptibility and density data proved most useful for correlating between holes. Features in the magnetic susceptibility data are well aligned between the three holes down to a ~160 m core composite depth below seafloor (CCSF-A), although the section below ~140 m CCSF-A is difficult to correlate. A splice representing a complete stratigraphic section extends to below the Eocene/Oligocene boundary to at least 160 m CCSF-A.

Downhole Measurements

Four downhole temperature measurements were conducted in Hole U1333B with the APCT-3 tool. Analyses of the previous sites data indicate that Site U1332 has a heat flow of ~67 mW/m^2 (and a thermal gradient of 74°C/km), similar to heat flow values from nearby ODP Sites 1218 and 1219. In contrast, Site U1331 had a heat flow of about 10 mW/m^2 (and a thermal gradient of 13.4°C/km), but is within the range of the lower values in the global heat flow data set for the eastern Pacific.

TECHNICAL SUPPORT AND HSE ACTIVITES

The shipboard labs continued to be busy processing cores and samples from Holes U1332 and U1333. Efforts continued to be intensely focused on efforts to maintain, troubleshoot, and improve lab instruments, acquisition software, procedures, and

database. Ongoing projects included the organization of the storerooms and inventory updates for the labs. A fire and boat drill was held on March 28 for the entire ship's complement and USIO staff and scientists were shown how to lower the lifeboats.