Expedition 320: Pacific Equatorial Age Transect (PEAT I)
Week 5 Report (5 – 12 April 2009)

12 April 2009

OPERATIONS

After an ~40 hr transit from Site U1333, we started positioning over Site U1334 (PEAT-4C) at 1222 hr (UTC-9h) on 6 April. Three holes were cored at Site U1334 to obtain a complete sedimentary sequence. Hole U1334A recovered Cores 1H to 22H and 23X to 32X from 0 to 285.5 m and recovered 290.4 m (102%). Hole U1334B was offset 25 m west of the first hole and coring started with the bit 5 m deeper. Cores U1334B-1H to 22H and 23X to 31X were taken from 0 to 284 m and recovered 295.3 m (105%). Hole U1334C was offset another 25 m to the west and coring started with the bit 3 m deeper than at Hole U133A. Cores U1334C-1H to 22H and 23X to 32X were taken from 0 to 283.2 m and recovered 290.28 m (102%). Coring was terminated in each hole when basalt was encountered.

This site provide high quality and recovery APC cored sediments from the mudline to ~210 m. XCB cores then advanced to ~285 m with high recovery through lower Oligocene and Eocene chalks. In the basal section, XCB cores recovered an intercalated unit of basalt and hard lithified carbonate, below a 10-20 m thick basal section of nannofossil ooze and chalk.

SCIENCE RESULTS

At Site U1334, three holes were cored targeting the events bracketing the Eocene-Oligocene (EO) transition as part of an investigation of the wider Cenozoic climatic evolution, as well as providing data towards a depth transect across the Oligocene. Site U1334 is in the middle of the Pacific Equatorial Age Transect (PEAT) program, approximately 100 km north of the Clipperton fracture zone, and ~380 km to the southeast of the previously drilled ODP Site 1218.

At Site U1334, late middle Eocene age (38 Ma) seafloor basalt is overlain by ~285 m of pelagic sediment. The uppermost Unit I comprises an 18-m-thick interval of late Miocene brown clay overlying ~19 m of alternating intervals of radiolarian clay and nannofossil ooze. Below this, Unit II is a 187 m thick succession of upper Miocene through Oligocene nannofossil ooze. Unit III is an ~60 m thick unit of late and middle Eocene age that are composed largely of nannofossil chalk with intervals of radiolarite and increasing amounts of clay and micrite. The basal Unit IV (0.5 m thick) consists of intercalated micritic limestone and basalt. The sediment column at Site U1334 has a strong resemblance to that of ODP Site 1218, but with a thinner uppermost clay layer, and higher Oligocene and Eocene sedimentation rates.

Carbonate content exceeds 92% in the upper lower Miocene section and remains high throughout the Oligocene. The Eocene sediments still contain considerable amounts of carbonate, and nannofossil ooze and chalk are dominant lithologies. The middle Oligocene Cores U1334A-16H through U1334-21H exhibited very distinct colors ranging from light grayish green to light blue grading downward to yellow and orange. The top of this interval appears at the same level in all holes, but the base differs by about 10 m. These uniquely colored carbonate oozes exhibit extremely low magnetic susceptibilies; bulk density was required for confident stratigraphic correlation. The Eocene-Oligocene (EO) transition at Site U1334 is much more expanded than at other previous Expedition 320 sites (Sites U1331, U1332, and U1333) and even ODP Site 1218. The EO transition was recovered at ~250 m, and fully recovered in Cores U1334A-27X and U1334B-26X. The Oligocene-Miocene transition was fully recovered in all three holes.

All major microfossil groups have been found in sediments from Site U1334, and provide a consistent, coherent and high resolution biostratigraphic succession spanning near continuous sequence from the middle Miocene to the uppermost middle Eocene. The uppermost 12 m of brown clay are barren of calcareous microfossils, but contain radiolarians of late Miocene age. Nannofossil ooze and radiolarian clays occur in the Miocene and Eocene parts of the section, and nannofossil ooze is dominant in the thick Oligocene section. Radiolarians are present through most of the section, apart from the lowermost cores, and are well preserved in the Eocene. There is a complete sequence of

radiolarian zones from RN5 (middle Miocene) down to RP17 (uppermost middle Eocene). Calcareous nannofossils are present and moderately to well preserved through most of the succession ranging from NN6 (middle Miocene) down to NP17 (uppermost middle Eocene), providing a minimum age estimate for basaltic basement of 37 Ma. Planktic foraminifers are present through most of the succession and are relatively abundant and well preserved from the lower Miocene to the lower Oligocene. Middle Eocene planktic foraminifers are rare and poorly preserved, which limits precision on the identification of foraminiferal zones. Benthic foraminifers are present through most of the section and indicate lower bathyal to abyssal paleodepths.

Preliminary sedimentation rates are about 1 m/m.y. in the topmost sediment cover, vary between ~6 and 17 m/m.y. in the early Miocene through late early Oligocene section, and are about 6 m/m.y. in the lower Oligocene and upper Eocene. Higher rates may occur in the basal 10 m of Eocene nannofossil oozes and chalks.

A full physical property program was run on cores from Site U1334 including whole-round multi-sensor core logger measurements of magnetic susceptibility, bulk density, P-wave velocity, non-contact resistivity, natural gamma radiation, and measurements of color reflectance, followed by discrete measurements of moisture and density properties, sound velocities and thermal conductivity. All track data are variable throughout the section and allow detailed correlation between holes. Magnetic susceptibility (MS) and density vary distinctly with lithology with low values in the carbonate-dominated sections and higher values in the more radiolarian-rich intervals. Natural gamma measurements are elevated in the uppermost clays and show a slight increase at the Eocene/Oligocene boundary. P-wave velocity remains uniform throughout the upper 150 m (~1500 m/s) but increases rapidly to ~1580 m/s toward the base of lithologic Unit III at ~225 m and then decreases sharply back to lower values. Bulk density and grain density increase gradually with increasing carbonate content to a maximum of ~1.8 g/cm^3 at ~204 m.

Multisensor-track data were used to achieve stratigraphic correlation between sediments from Site U1334. So far, magnetic susceptibility from the special purpose fast-track scanner was the main parameter used for real-time correlation; the bulk density sensor on the fast track system was not working. In the very low (negative) susceptibility

interval between ~145 and ~198 m (Cores U1334A-16H through -21H), the magnetic signal could not be used for correlation, and we measured the corresponding cores from Hole U1334B out of sequence on the Multisensor track to obtain bulk density for determining the amount of core overlap. We appear to have a complete stratigraphic section down to just above basement.

A full range of paleomagnetic analyses was conducted on cores and samples from Site U1334 for the APC cored section (upper ~209 m CSF). In Hole U1334A the magnetostratigraphy can be interpreted from Chron 9n (26.51-27.41 Ma), which occurs in the base of Core U1334A-16H (~150 m), up through Chrons C5n.2n (9.987-11.040 Ma) in the upper part of Core U1334A-2H. Susceptibility in the upper 45 m of Hole U1334A averages ~18×10^{-5} and decreases to a mean of 6×10^{-5} from 45 to 135 m. A distinct low in MS occurs from ~142 to 204 m coincides with the interval of very light grayish green, light blue, yellow and orange sediments.

A standard shipboard suite of geochemical analysis of porewater, organic and inorganic properties was conducted on sediments from Hole U1334A. We also conducted a high-resolution (1 per section) porewater investigation across the interval middle Oligocene cores (Cores U1334C-16H through -23X) that exhibited the light grayish green, light blue, yellow and orange colors. The most striking features in the interstitial water geochemistry are a dissolved manganese peak from ~20 to ~240 m, with a maximum of ~6 µM at ~110 m, and a dissolved iron peak up to >15 µM centered at 165 m. The depth range of the dissolved iron peak, indicative of iron oxide reduction, coincides with the colorful interval seen in the lithology and the interval of low magnetic susceptibilities (~140 to 205 m). Sulfate results indicate limited sulfate reduction. Calcium carbonate contents are low in the uppermost ~35 m of Site U1334, and initial results indicate high calcium carbonate contents below the uppermost clay layer.

Five downhole temperature measurements reveal a thermal gradient of 32°C/km and heat flow of ~32 mW/m^2 at this site. This is somewhat lower than values obtained for the nearest ODP Site 1218.

TECHNICAL SUPPORT AND HSE ACTIVITES

The shipboard labs and staff were busy processing remaining cores from Site U1333 and those arriving on deck from Holes U1334A, U1334B, and U1334C. Ongoing projects included the organization of the storerooms and inventory updates for the shipboard laboratories. On April 10, the seismic source for Vertical Seismic Profiles was deployed to test the system prior to the planned experiment during logging in Hole U1334C. The gun and the firing circuits worked well. A problem with the hydrophone was found and corrected.

We received the TAMU Environmental Health and Safety Audit Review of the laboratories. The identified outstanding action items from the report are being addressed. A fire and boat drill was held on April 4 for the entire ship's complement.