Expedition 320: Pacific Equatorial Age Transect (PEAT I)
Week 7 Report (20 – 26 April 2009)

26 April 2009

OPERATIONS: This week we finished coring in Hole U1335B, made the transit to Site U1336 (PEAT-5C) and cored Holes U1336A and U1336B.

Site U1335, Hole U1335B: Coring at Hole U1335B started at 1955 hr on 18 April with the bit 5 m deeper than at Hole U1335A. APC cores U1335B-1H to 41H were taken from 0 to 378.2 m DSF and recovered 392.7 m (104%). This is the second deepest APC penetration in the history of ocean drilling. Twelve core barrels had to be drilled over to release them from the formation and Cores 37H to 41H did not fully stroke and were advanced by recovery. XCB Cores 42X to 46X were taken from 378.2 to 417.5 m and recovered 36.0 m (92%). Coring was terminated when basement was reached.

Originally we had planned three holes at Site U1335. However, after recovering a nice Miocene section with nearly complete recovery and overlap between the two holes, we decided not to core a third hole at Site U1335. In addition, the presence of turbidites and a thick interval with very weak magnetic signal contributed to this decision. We decided to use our remaining time to core at Site U1336 (PEAT-5C) to provide the second PEAT Expedition more information for optimizing their operations plan. We pulled the drill string clear of the seafloor at 1215 hr and departed for Site U1336 at 2145 hr on 21 April.

Site U1336, Hole U1336A: After an 185 nmi transit (17.8 hrs; 10.4 nmi/hr), the ship arrived at Hole U1336A at 1545 hr on 22 April. Coring started in Hole U1336A at 0135 hr on 23 April. APC Cores U1336A-1H to 21H were taken from 0 to 184.8 m and recovered 190.2 m (103%). Several cores only partially stroked and were advanced by recovery; one encountered an inferred ~0.15 m thick chert layer at ~124 m. Cores U1336A-22X to 35X were taken from 184.8 to 302.9 m and recovered 69.0 m (58%). We stopped coring before reaching the basement objective because of the decreasing rates of penetration (as low as ~4 m/hr for Cores 34X and 35X), the relatively low recovery, and the possibility of obtaining a stratigraphically complete Miocene section by coring in a second hole.

Site U1336, Hole U1336B: We started coring in Hole U1336B at 0540 hr on 25 April with the bit 5 m shallower than in Hole U1336A. So far, Cores U1336B-1H to 9H have been taken from 0 to 77.8 m and recovered 70.6 m (91%). We will stop coring no later than 0400 hr and start the transit to Honolulu, Hawaii by 1600 hr on 26 April.

SCIENCE RESULTS

Sites U1335 and U1336 focus on the paleoceanographic events from the early Oligocene into the early and middle Miocene, and both provide a depth transect for the early and middle Miocene together with Site PEAT-7C.

Site U1335 targets the late Oligocene through Miocene. At the end of the Oligocene there is a significant multi-million year long rise in the oxygen isotope record, which is closely followed by a relatively short, sharp increase in oxygen isotope values that has been interpreted as a major glacial episode ("Mi-1") and correlated to a pronounced drop in sea level. This event is very close to the Oligocene/Miocene boundary, and has now been astronomically age calibrated in several ocean basins. Although there are clear periodic isotopic signals indicating major changes in ice volume, ocean temperatures and/or ocean structure, this biostratigraphic boundary has always been somewhat of an enigma. Unlike the major changes in the isotopic stratigraphy, the biostratigraphies of planktonic microfossils show very little change at all across this boundary. In fact it is one of the most difficult epoch boundaries to pick using solely the microfossil biostratigraphies.

Site U1336 (PEAT-5C) targeted the Oligocene and was located on lower Oligocene crust. This interval of time is noted for its markedly heavy benthic oxygen isotopes and its relatively deep CCD. There was probably ice on Antarctica during this interval, but not the large ice sheets to be found there later in the mid-Miocene. There is no compelling evidence for ice sheets in the Northern Hemisphere during the Oligocene and early Miocene. Thus, there was apparently a relatively low global ice volume, relatively cold bottom waters, a relatively cold South Pole, and a relatively warm North Pole. This scenario of a "one cold pole" world has given rise to speculation on the impact of inter-hemispheric temperature imbalance on pole to equator temperature gradients and on the symmetry of the global wind systems. Site U1336 will focus on the paleoceanographic events in the late Oligocene and into the early and middle Miocene, including the climatically significant Oligocene–Miocene transition and its recovery.

Lithostratigraphy

Site U1335: Core description, imaging, and color reflectance logging has been completed for Site U1335. About 420 m of pelagic sediments are divided into two major lithologic units. Unit I, spanning the late Miocene through the Pliocene–Pleistocene, is composed of biogenic oozes with varying amounts of nannofossils, diatoms, radiolarian and foraminifers. Unit II is composed of nannofossil ooze and chalk with many thin beds of nannofossil foraminifer ooze of late Oliogene to late Middle Miocene age. The foraminifer oozes overlie sharp erosional boundaries and tend to fine upwards. Occasionally the foraminifer ooze beds contain a laminated interval. Two distinct intervals of light greenish gray occur in Unit II. The greenish intervals correspond to extremely low magnetic susceptibility and the overall loss of sediment magnetic properties.

Site U1336: Hole U1336A has been described down through Core U1336A-10H. The uppermost cores of late Miocene age contain nannofossil oozes with varying amounts of foraminifers, diatoms, radiolarians and clay. Lower in the section, nearly homogeneous nannofossil oozes dominate. Sediment color shifts from very pale brown in through pale yellow to light greenish gray. The transition from very pale yellow to light greenish gray occurs as a sharp boundary in Core U1336A-10H.

Biostratigraphy

Site U1336: Initial biostratigraphy indicates that 300 m of sediments recovered at Site U1336 span a complete succession from the middle Miocene to the early Oligocene. Calcareous nannofossil preservation is moderate to good in the middle Miocene, moderate in the lower Miocene and moderate to poor, with evidence of recrystallization and overgrowth, in the upper and lower Oligocene. A complete sequence of nannofossil zones are recorded from the lower Oligocene zone NP22 through to the middle Miocene zone NN6. Planktic foraminifera are moderate to well preserved in the middle and lower Miocene but become moderate to poorly preserved in the Oligocene. The succession spans planktic foraminiferal zones O1 through M9b. Radiolaria are moderately preserved in the middle Miocene, becoming moderate to poorly preserved in the lower Miocene and are absent from the Oligocene sediments, except for limited assemblages recovered from the topmost Oligocene zone RP22. Radiolarian biostratigraphy is complete from the top Oligocene zone RP22 through to the middle Miocene zone RN5. Benthic foraminifera are present through most of the section and indicate lower bathyal to abyssal paleo-

depths; as with the other microfossil groups, preservation becomes moderate to poor in the Oligocene sediments.

Paleomagnetism

Site U1335: Paleomagnetism results were obtained from the 77 APC cores recovered at Site U1335. Sediments above ~70 m generally record the paleomagnetic field reliably, providing a magnetostratigraphic record that extends from the Brunhes (Chron C1n; 0–0.78 Ma) down to Chron C5r.1r (~11.0 Ma). Sediments from 110–200 m have also kept relatively good record of Chrons C5AAn down to C6n (~13.2–18.7 Ma). In other intervals, the magnetic remanence is extremely weak and the paleomagnetic directions variably, prohibiting further magnetostratigraphic interpretation. The loss of the primary paleomagnetic signal is attributed to reduction diagenesis.

Physical Properties

Site U1335: We finished processing discrete samples from Hole U1335A and collecting magnetic susceptibility (MS), velocity, natural gamma, and density data from Hole U1335B. All track data are variable throughout the section, allowing a detailed correlation between holes. Magnetic susceptibility varies between 5 to 20 $x10^{-5}$ SI in carbonate-dominated sections and ~29 $x10^{-5}$ SI in more radiolarian-rich intervals; MS values are extremely low between 140 and 205 m. Natural gamma measurements are elevated by an order of magnitude in the uppermost sediments. Velocity shows a constant and gradual downhole increase from 1500 to 1540 m/s to ~350 m and then increase steadily to 1750 m/s at the base of the section. Wet bulk density increases gradually from 1.6 to 1.8 g/cm^3 though this carbonate-dominated succession, and grain density remains fairly constant around 2.7 g/cm^3. Porosity shows a downhole decrease from 80% to 50% at the base of the hole.

Site U1336: Initiated full physical property program on Site U1336 cores.

Stratigraphic Correlation:

Site U1335: Using whole-round magnetic susceptibility and gamma ray density measurements, Holes U1335A and U1335B have been spliced to form a continuous section to the lowermost Miocene at ~398 m core composite depth (CCSF), with only one interruption at 165.15 m CCSF

caused by flow-in at the bottom half of Core U1335A-16H. The section below 398 m CCSF was mostly XCB-cored, lacked clearly identifiable features, and had to be appended for this reason. Sedimentation rates decreased throughout the recovered section from 25 m/m.y. in the late Oligocene to 19 m/m.y in the early to middle Miocene, and remained at 6 m./m.y. throughout the late Miocene to Recent.

Site U1336: Site U1336: Magnetic susceptibility (MS) and gamma ray attenuation (GRA) density data for the first 15 cores of Hole U1336A reveal a pronounced cyclic signal that can are being used to guide coring offsets in the second hole to obtain the most complete stratigraphy possible.

Geochemistry: Sediment geochemistry this week continued work on calcium carbonate analyses from Site U1335 and on organic carbon by acidification from Sites U1334 and U1335. Calcium carbonate contents in U1335 are generally >80% deeper than 65 m, and more variable toward lower values in the upper 65 m. Interstitial water analyses from Site U1335 show alternating peaks of dissolved Mn and Fe associated with distinct sediment color changes that are inferred to be a result of suboxic diagenesis of organic carbon. Interstitial waters also exhibit strong Sr enrichment and Li depletion at intermediate depth.

TECHNICAL SUPPORT AND HSE ACTIVITES

During the week of April 18 the shipboard labs were busy processing cores and samples as coring was completed at Hole U1335C. Ongoing projects included the organization of the storerooms and inventory updates for the shipboard laboratories. Six pallets of cores were moved to the refrigerated container on the bridge deck in preparation for offload in Honolulu.

A program to inspect for safety and tag all plugged in appliances was begun by the Electronics Specialists. A fire and boat drill was held on April 20 for the entire ship's complement. Staff members were shown how to lower the lifeboats.