Figure F1. Regional bathymetry, seismic reflection lines, and boreholes near Site U1509. Stars = Expedition 371 sites, white dots = petroleum borehole sites, gray dots = DSDP sites.

Figure F2. Bathymetry, seismic reflection lines, and dredge locations (Browne et al., 2016) near Site U1509.

Figure F3. Seismic reflection Line 114-04 near Site U1509 (after Etienne et al., 2018). Regional seismic unit and reflector nomenclature (Units 1a, 1b, 2, and 3 and Unconformities RU1 and RU2) following Bache et al. (2014). LHR = Lord Howe Rise, WNR = West Norfolk Ridge. Star = approximate projected dredge location that yielded early Paleocene marine mudstone (Browne et al., 2016). CDP = common depth point, VE = vertical exaggeration.

Figure F4. (A) Seismic reflection Line TAN1409_NCTS_07 at Site U1509 and (B) interpretation of seismic units (circles) (after Etienne et al., 2018). HAR = high-amplitude reflector.

Figure F5. Seismic reflection Line TAN1409_NCTS_02 at Site U1509 and identification of drilled Reflectors A–F.

Figure F6. Lithostratigraphic summary of sedimentary section, Site U1509. cps = counts per second.

Figure F7. Major biogenic and lithologic constituent abundances in sediment based on smear slide analysis, Site U1509. D = dominant (>50%), A = abundant (25%–50%), C = common (10%–25%), R = rare (1%–10%), T = trace (>0%–1%).

Figure F8. Common Subunit Ia lithologies, Site U1509. A. Nannofossil ooze with foraminifers. B. Nannofossil chalk with foraminifers. C. Tuffaceous foraminiferal chalk with sand.

Figure F9. Representative Subunit Ia lithologies, Site U1509. A, B. Nannofossil (nanno) ooze with foraminifers (frm). C, D. Nannofossil chalk with foraminifers. E, F. Tuffaceous foraminiferal chalk with sand. gls = volcanic glass. PPL = plane-polarized light, XPL = cross-polarized light.

Figure F10. Common Subunit Ib lithologies, Site U1509. A. Nannofossil chalk with foraminifers exhibiting disrupted fabric. B. Nannofossil chalk with foraminifers showing slump folds. C. Discrete sharp-based bed of foraminiferal chalk with nannofossils showing an upward succession from disrupted to planar-laminated fabrics, suggesting deposition from waning gravity flow.

Figure F11. Common Subunit Ic lithologies, Site U1509. A. Nannofossil chalk with biosilica and pale green laminae. B. Biosiliceous nannofossil chalk (brown thin beds). C. Dark gray very thin beds of foraminiferal limestone. D. Limestone with wispy laminations. E. Cherty limestone with chert nodules. F. Clayey limestone.

Figure F12. Representative Subunit Ic lithologies, Site U1509. A, B. Nannofossil (nanno) chalk with biosilica. sp = sponge spicule, rad = radiolarian. C, D. Biosiliceous nannofossil chalk. E, F. Foraminiferal (frm) limestone. G, H. Cherty limestone. I, J. Clayey limestone. clay = clay minerals.

Figure F13. Distinct color change across middle Eocene, Site U1509.

Figure F14. Evolution of deformation features in succession recovered, Site U1509. A. Horizontal bedding inferred from pale green laminations in nannofossil chalk. B. Synsedimentary folding in nannofossil chalk. C. Tilted bedding inferred from pale green laminations and faint color banding in nannofossil chalk with biosilica. D. Small-scale reverse faults with a few centimeters offset, displacing biosiliceous beds. E. Small-scale, stepped low-angle normal faults inferred from pale green lamination offset in nannofossil chalk with biosilica. F. Normal faulting and open (extensional?) fractures. Note the offset of a spreiten burrow, likely a *Zoophycos*. G. Asymmetrical fish-like structure and possible S-C fabrics in a sheared zone encountered in limestone of the basal part of Subunit Ic. H. Tilted bedding inferred from faint planar lamination in calcareous claystone.

Figure F15. Transition from Unit I to II, Site U1509.

Figure F16. XRD analyses of sediments over transition from Unit I to II, Site U1509.

Figure F17. Common Subunit IIa lithologies, Site U1509. A. Calcareous claystone. B. Claystone with nannofossils. C. Claystone with silty laminations.

Figure F18. Representative Subunit IIa lithologies, Site U1509. A, B. Calcareous claystone. clay = clay minerals. C, D. Claystone with nannofossils (nanno). E, F. Claystone with silt. slt = silt-sized siliciclastic components, qtz = quartz.

Figure F19. Representative Subunit IIb lithologies, Site U1509. A. Claystone. B, D. Claystone. clay = clay minerals, qtz = quartz. C, E. Bioturbation oriented along general tilt direction, Subunits Ic and IIa. Brightness and contrast were modified to make bioturbation fabrics more distinct.

Figure F20. Microfossil preservation and abundance, Site U1509. Abundance: D = dominant, A = abundant, C = common, F = few, R = rare, P = present, tr = trace, B = barren. Preservation: E = excellent, VG = very good, G = good, M = moderate, P = poor.

Figure F21. Biozonations, Site U1509. CN = calcareous nannofossil, PF = planktic foraminifer.

Figure F22. Preservation state of planktic foraminifers, Site U1509. Scale bars = 100 µm. A. Very good. B. Good. C. Moderate. D. Poor.

Figure F23. Summary of ostracod preservation, abundance, and assemblage composition, Site U1509.

Figure F24. Selected dinocyst taxa. Scale bars = 50 µm. A. *Aiora fenestrata* (371-U1509A-50R-CC). B. *Alterbidinium acutulum* (60R-CC). C. *Alterbidinium pentaradiatum* (67R-1, 5–7 cm). D, E. *Areoligera* sp. (67R-1, 5–7 cm). F. *Cerodinium* sp. A sensu Brinkhuis et al. 2003 (67R-1, 13–16 cm). G. *Cerodinium striatum* (60R-CC). H. *Cordosphaeridium* cpx (67R-1, 5–7 cm). I. *Cordosphaeridium* cpx (67R-1, 5–7 cm).

Figure F25. Selected dinocyst taxa. Scale bars = 50 µm. A. *Corrudinium* sp. (371-U1509A-39R-CC). B. *Dapsilidinium pseudocolligerum* (39R-CC). C. *Dinogymnium* sp. (67R-CC). D. *Eisenackia circumtabulata* type (64R-CC). E. *Eisenackia reticulata* type (66R-CC). F. *Eisenackia reticulata* type (67R-1, 5–7 cm). G. *Glaphyrocysta* sp. (66R-CC). H, I. *Impagidinium* spp. (39R-CC).

Figure F26. Selected dinocyst taxa. Scale bars = 50 µm. A. *Isabelidinium bakeri* (371-U1509A-67R-CC). B. *Manumiella seymourensis* (67R-CC). C. *Manumiella seymourensis* (70R-CC). D, E. *Palaeocystodinium* spp. (70R-CC). F. *Palaeoperidinium pyrophorum* (50R-CC). G. *Palaeoperidinium pyrophorum* (56R-CC). H, I. *Senegalinium* cpx (67R-1, 13–16 cm).

Figure F27. Selected algal and sporomorph taxa. Scale bars = 50 µm. A. *Palambages morulosa* (371-U1509A-70R-CC). B. Bisaccate pollen grain (67R-CC). C. *Nothofagidites* sp. (68R-CC). D, E. Trilete spores (67R-CC). F. Trilete spore (70R-CC).

Figure F28. Pass-through paleomagnetic data, Site U1509. Black dots = NRM intensity and inclination, gray dots = inclination after 20 mT AF cleaning interpolated by 10-point moving average (black line), red dots = inclination of ChRM directions from discrete sample analysis. Magnetic polarity: black = normal, white = reversed, gray = unidentified. Tentative correlation with geomagnetic polarity timescale (GPTS2012) is shown.

Figure F29. Pass-through paleomagnetic inclination after 20 mT AF demagnetization, Site U1509. *N* = number of data points.

Figure F30. Vector endpoint demagnetization diagrams (Zijderveld, 1967) and AF demagnetization behavior for three representative discrete samples, Site U1509. Open squares = projections onto vertical plane, solid squares = projections onto horizontal plane, blue lines = components fitted using selected data points (red squares) by principal component analysis (Kirschvink, 1980).

Figure F31. Stereographic projection of ChRM paleomagnetic directions derived from discrete sample analyses, Site U1509. Dashed line = average inclination (35.6°), associated with 95% confidence angle (±7.3°; gray band). *N* = number of ChRM directions.

Figure F32. AMS data for discrete samples, Site U1509. Top: stereoscopic plot. Blue squares = $\kappa_{max}$ axes, green triangles = $\kappa_{int}$ axes, purple circles = $\kappa_{min}$ axes. Mean directions of $\kappa_{max}$ (open square), $\kappa_{int}$ (open triangle), and $\kappa_{min}$ (open circle) axes, shown along with their 95% confidence ellipses. *N* = number of samples. Bottom: corresponding lineation ($\kappa_{max}/\kappa_{int}$) vs. foliation ($\kappa_{int}/\kappa_{min}$) data.

Figure F33. Bulk density, grain density, porosity, and *P*-wave velocity, Site U1509. Large dots = MAD and PWC values, small dots = whole-round section GRA density and *P*-wave velocity (PWL). Horizontal line = lithostratigraphic unit boundary, dashed horizontal lines = subunit boundaries. For porosity, best-fitting exponential decay curve (line) is shown (see text for details).

Figure F34. Magnetic susceptibility (MSL and MSP), NGR, and L*, a*, b*, Site U1509.

Figure F35. Strength, Site U1509. A. Shear strength measured by automated vane shear. B. Compressive strength measured using pocket and needle penetrometers.

Figure F36. Core data compared with MCS Line TAN1409_NCTS_02, Site U1509. A. Impedance calculated from PWC *P*-wave velocity and MAD density data vs. TWT. Thin horizontal line = lithostratigraphic unit boundary, dashed horizontal lines = subunit boundaries. B. TWT calculated from depths below seafloor and *P*-wave velocity data. Numerical approximation for TWT ($t$) with depth ($z$) is given by $z = 103.33t^2 + 841.76t$. Circles = positions of strong reflectors shown in C and D (red = strongly correlated, open = weakly correlated), dashed lines = fit between seismic data in D and synthetic trace in C. C. Synthetic seismograms (red) and MCS trace data at CDP 1239 (black). Seismic Reflectors D–E and seafloor (SF) are labeled. D. MCS data.

Figure F37. Methane in bulk sediment and sulfate, ammonium, and barium in IW, Site U1509.

Figure F38. IW chemistry, Site U1509. Sulfate concentrations do not become below detection limit at SMT zone, which may result from a calibration issue.

Figure F39. Bulk sediment profiles of $CaCO_3$, total carbon (TC), total inorganic carbon (TIC), total organic carbon (TOC), and total nitrogen (TN), Site U1509.

Figure F40. Methane/ethane ($C_1/C_2$) ratio gradient with sediment temperature, Expedition 371.

Figure F41. Sedimentation accumulation over time, Site U1509. A. Core recovery. B. Shipboard biostratigraphic and magnetostratigraphic datums and interpreted age-depth model. C. LSR and total MAR. Horizontal line = lithostratigraphic unit boundary, dashed horizontal lines = subunit boundaries.