Figure F1. Oceanographic and bathymetric setting, Site U1539. A. Marine geological features and oceanic fronts. FZ = fracture zone, SAF = Subantarctic Front, APF = Antarctic Polar Front (after Orsi et al., 1995). B. Detailed bathymetry with seismic lines and shotpoints.

Figure F2. (A) Multichannel seismic (MCS) and (B) Parasound profiles across Site U1539.

Figure F3. Modern salinity and oxygen distribution in the central South Pacific used to visualize major water masses. SAF = Subantarctic Front, APF = Antarctic Polar Front, NPDW = North Pacific Deep Water, LCDW = Lower Circumpolar Deep Water, AABW = Antarctic Bottom Water.

Figure F4. Hole summaries, Site U1539. GRA = gamma ray attenuation, MSP = point magnetic susceptibility, RGB = red-green-blue, NGR = natural gamma radiation. cps = counts per second. (Continued on next three pages.)

Figure F4 (continued). (Continued on next page.)

Figure F4 (continued). (Continued on next page.)

Figure F4 (continued).

Figure F5. Representative (A) core and (B) X-ray and photomicrograph images in (C) plane-polarized light (PPL) and (D) cross-polarized light (XPL), Holes U1539A and U1539D.

Figure F6. Representative (A) core and (B) X-ray and photomicrograph images of mineral properties of Lithofacies 1b (densely stacked diatom mats) in (C) PPL and (D) XPL, Holes U1539C and U1539D.

Figure F7. Representative (A) core and (B) X-ray and photomicrograph images of mineral properties of Lithofacies 2 (carbonate-bearing to carbonate-rich diatom ooze) in (C) PPL and (D) XPL, Holes U1539C and U1539D.

Figure F8. Representative (A) core and (B) X-ray and photomicrograph images of mineral properties of Lithofacies 3 (diatom-bearing to diatom-rich nannofossil or calcareous ooze) in (C) PPL and (D) XPL, Holes U1539A, U1539C, and U1539D.

Figure F9. Representative images and mineral properties of Lithofacies 5 (foraminiferal ooze and sand associated with turbidites), Hole U1539C. Note the sharp contact of Lithofacies 5 with over- and underlying units in X-radiographs from Sections 18H-6 (blue) and 19H-4 (green).

Figure F10. Primary lithologies used to define sedimentary lithofacies, Site U1539. Pie charts show the lithofacies' relative contributions to Lithostratigraphic Subunits IA and IB. Lithofacies 5 (turbiditic lithofacies) is excluded from this comparison.

Figure F11. Primary lithostratigraphic variations, Site U1539. The unit boundary at ~125 m CCSF-A separates high diatom mat (Lithofacies 1b) abundance in the early part of the record from more frequent and thicker nannofossil ooze facies (Lithofacies 3 and 4) in the latter part of the record. Relative ages of units are based on the preliminary Site U1539 shipboard age model (see Stratigraphic correlation).

Figure F12. A–D. Examples of dropstone occurrence, Hole U1539C.

Figure F13. X-ray diffractograms of discrete samples from Holes (A) U1539A and (B) U1539C corrected for baseline variations resulting from significant proportions of amorphous biogenic silica in the samples (cf. black line in C). Minerals occurring in the samples include quartz (Qtz), feldspar (F; i.e., plagioclase), and calcite (C) and phyllosilicates including illite (Il), chlorite (Chl), kaolinite (K), and their composite ("Clay"). C. Data show characteristic baseline-uncorrected diffractograms of foraminifer-bearing, diatom-rich nannofossil ooze (brown line; Lithofacies 3), diatom-bearing calcareous ooze (green line; Lithofacies 3), and carbonate-rich diatom ooze (orange line; Lithofacies 2).

Figure F14. Characteristic variations in major lithologies and physical properties, Hole U1539A. Lithologies are determined by visual core description, smear slide analyses, and X-ray imaging. Shaded bars show intervals of light-colored nannofossil ooze. GRA = gamma ray attenuation, NGR = natural gamma radiation, MSP = point magnetic susceptibility, RGB = red-blue-green.

Figure F15. Relationships between bulk sedimentary carbonate content and (A) red-green-blue (RGB) blue and (B) color reflectance L* for samples from Subunit IA (gray circles) and Subunit IB (red squares). Symbols in parentheses are data points from the Holocene that were excluded from the regression analysis.

Figure F16. Diatom, radiolarian, calcareous nannofossil, and planktonic foraminifer zonations and biostratigraphic events, Site U1539.

Figure F17. Age-depth plot, Holes U1539A and U1539C. FO = first occurrence, LO = last occurrence.

Figure F18. Distribution of siliceous and calcareous microfossils, Hole U1539A. B = barren, R = rare, F = few, C = common, A = abundant, D = dominant.

Figure F19. Distribution of siliceous and calcareous microfossils, Hole U1539C. B = barren, R = rare, F = few, C = common, A = abundant, D = dominant.

Figure F20. Radiolarians, Holes U1539A and U1539C. Scale bars = 50 µm. 1, 3, 4, 8, 10–12. 383-U1539A-2H-CC. (1) *Actinomma delicatulum* (Dogiel). 2. *Actinomma boreale* Cleve (383-U1539A-1H-CC). (3) *Spongotrochus glacialis* group Popofsky. (4) *Phorticium clevei* (Jørgensen). 5. *Saturnalis circularis* Haeckel (383-U1539C-13H-CC). 6. *Stylatractus universus* Hays (383-U1539A-7H-CC). 7, 9. 383-U1539C-12H-CC. (7) *Antarctissa cylindrica* Petrushevskaya. (8) *Antarctissa denticulata* (Ehrenberg). (9) *Triceraspyris coronata* Weaver. (10) *Botryostrobus auritus* (Ehrenberg). (11) *Peripyramis circumtexta* Haeckel. (12) *Cycladophora davisiana* (Ehrenberg).

Figure F21. Phaeodarian radiolarians, Holes U1539A and U1539C. Scale bars = 50 µm. 1, 2. Triangular shape (383-U1539A-5H-CC), (2) aperture. 3, 4. Kettle shape (383-U1539A-12H-CC), (4) aperture. 5-8. Oval shape (383-U1539C-14H-CC), (6) aperture, (7) internal shell view, (8) close-up of internal shell.

Figure F22. Silicoflagellates, Holes U1539A and U1539C. A–J: Light microscope, K–N: scanning electron microscope. 1. *Dictyocha stapedia* (383-U1539C-7H-CC). 2. *Stephanocha speculum* var. *speculum* (short-spined) (383-U1539C-14H-CC). 3. *S. speculum* var. *bispicata* (383-U1539A-2H-CC). 4. *S. speculum* B (large variety) (383-U1539C-23H-CC). 5, 7. 383-U1539C-10H-CC. (5) *S. speculum* var. *pentagona*. 6. *S. speculum* var. *binocula* (383-U1539A-5H-CC). (7) *S. speculum* var. *octonaria*. 8. *S. speculum* var. *septenaria* (*binocula*; 383-U1539A-11H-CC). 9. Malformed *S. speculum* (383-U1539C-30F-CC). 10. *Octactis pulchra* (383-U1539C-24H-CC). 11. *S. speculum* in nannofossil ooze (383-U1539A-9H-1, 134 cm). 12. *S. speculum* var. *speculum* in abapical view (383-U1539C-18H-CC). 13. *S. speculum* var. *bispicata* (383-U1539A-3H-CC). 14. *Dictyocha stapedia* (383-U1539C-29F-2, 16 cm).

Figure F23. Calcareous nannofossils, Holes U1539A and U1539C. A. *Emiliania huxleyi* (383-U1539A-2H-CC). B. *Gephyrocapsa caribbeanica*. C. *Pseudoemiliania lacunosa*. D. *Gephyrocapsa omega*. E. *Reticulofenestra asanoi*. F, G. *Gephyrocapsa*, (F) medium (4–5.5 µm), (G) large (>5.5 µm). H. *Helicosphaera sellii*. I. Coccosphere of *Coccolithus pelagicus* (383-U1539C-22H-6). J. Nannofossil-rich sediment with *E. huxleyi* and *C. pelagicus* (383-U1539A-3H-CC). K. Ooze of small (<4 µm) *G. caribbeanica* (383-U1539A-9H-CC).

Figure F24. Scanning electron microscope images of calcareous nannofossils, Site U1539. A. *E. huxleyi* (383-U1539A-2H-CC). B. *Gephyrocapsa protohuxleyi* (383-U1539A-5H-4). C. *G. caribbeanica* (383-U1539C-8H-5, 29 cm). D. *P. lacunosa* (383-U1539C-28F-CC). E. *R. asanoi* (383-U1539C-18H-CC). F, G. *Gephyrocapsa*; (F) medium (4–5.5 µm) (383-U1539C-18H-CC), (G) large (>5.5 µm) (383-U1539C-29F-2, 16 cm. H. Nannofossil-rich sediment. *Calcidiscus leptoporus* and small *Gephyrocapsa* (Hole U1539C mudline). I, J. Ooze of *G. caribbeanica* (383-U1539C-8H-5, 29 cm). K. Coccosphere of *C. pelagicus* (383-U1539C-18H-CC). L. Ooze of small (<4 µm) *G. caribbeanica* (383-U1539C-15-CC). M. Ooze of large (>5.5 µm) *Gephyrocapsa* (383-U1539C-29F-2, 16 cm).

Figure F25. Planktonic foraminifers, Site U1539. Scale bars = 100 µm. A–C. Varieties of *Neogloboquadrina pachyderma* with the final chamber (A) larger than, (B) similarly sized, and (C) smaller than the penultimate chamber. D. *Neogloboquadrina incompta*. E. *Turborotalita quinqueloba*. F. *Globigerina bulloides*. G. *Globigerinita glutinata* (note signs of dissolution on all chambers in final whorl). H. *Globigerinita uvula*. I–K. *Globoconella inflata* in (I) umbilical, (J) side, and (K) spiral view. L–O. *Globoconella puncticulata puncticuloides* with typical final chamber in (L) umbilical, (M, N) side, and (O) spiral view. P–R. *G. puncticulata puncticuloides* with kummerform final chamber in (P) umbilical, (Q) side, and (R) spiral view. S–U. *Truncorotalia crassaformis* in (S) umbilical, (T) side, and (U) spiral view. V–X. *Hirsutella scitula* in (V) umbilical, (W) side, and (X) spiral view (note signs of dissolution on earliest chambers).

Figure F26. A. Pyrite framboid (upper left) on planktonic foraminifer *Truncorotalia crassaformis*. B. Close-up of pyrite framboid in A.

Figure F27. Species diversity index (H) and abundance of dominant benthic foraminifer species *Cibicidoides mundulus*, *Epistominella exigua*, *Globocassidulina subglobosa*, *Melonis barleeanum*, *Oridorsalis umbonatus*, and *Pullenia bulloides*, Holes U1539A and U1539C.

Figure F28. Benthic foraminifers, Holes U1539A and U1539C. Scale bars = 100 µm. 1–3, 13–15, 21. 383-U1539A-3H-CC. (1) *Bolivina pacifica*. (2) *Nodosaria* sp. (3) *Fursenkoina complanata*. 4–8, 12, 26, 27, 29–32. 383-U1539A-7H-CC. (4) *Dentalina ariena*. 5. *Dentalina* sp. (6) *Martinottiella communis*. (7) *Uvigerina hispida*. (8) *Uvigerina peregrina*. 9, 23. 383-U1539C-32F-CC. (9) *Procerolagena* sp. 10, 11. 383-U1539A-12H-CC. (10) *Cassidulinoides* sp. (11) *Siphotextularia rolshauseni*. (12) *Pyrulina* sp. (13) *Schlumbergerina* sp. (14) *Quinqueloculina* sp. (15) *Spirosigmoilina* sp. 16. *Lagena hispidula* (383-U1539C-24H-CC). 17, 18. 383-U1539A-1H-CC. (17) *Ehrenbergina carinata*, (18) *Triculina tricarinata*. 19, 20. 383-U1539C-19H-CC. (19) *Fursenkoina bradyi*, (20) *Pyrgo* sp. (21) *Pullenia quinqueloba*. 22, 28. 383-U1539A-5H-CC. (22) *Astrononion* sp. (23) *Ammodiscus tenuis*. 24. *Laticarina pauperata* (383-U1539C-28F-CC). (25) *Pullenia quadriloba*. (26) *Eggerella bradyi*. (27) *Lenticulina convergens*. (28) *Melonis barleeanum*. (29) *Epistominella exigua*. (30) *Globocassidulina subglobosa*. (31) *Gyroidina nitida*. (32) *Cibicidoides mundulus*.

Figure F29. Stained benthic foraminifers in mudline sample, Hole U1539A.

Figure F30. Inclination and natural remanent magnetization (NRM) intensity before and after 15 mT peak alternating field (AF) demagnetization, Site U1539.

Figure F31. Headspace methane concentrations, Holes U1539A and U1539C.

Figure F32. Interstitial water alkalinity and pH, Site U1539.

Figure F33. Interstitial water chloride, sodium, and bromide, Site U1539. Chloride: data points represent the mean of triplicate measurements. Red square = overlying seawater sample.

Figure F34. Interstitial water magnesium and lithium, Site U1539. Red square = overlying seawater sample.

Figure F35. Interstitial water manganese, calcium, and strontium, Site U1539. Manganese was below detection limit in the overlying water. Red square = overlying seawater sample.

Figure F36. Interstitial water phosphate, sulfate, and ammonium, Site U1539. Red square = overlying seawater sample.

Figure F37. Interstitial water potassium, silica, boron, and barium, Site U1539. Barium was below detection limit in the overlying water. Red square = overlying seawater sample.

Figure F38. Solid phase geochemistry of (A) $CaCO_3$, (B) total organic carbon (TOC):total nitrogen (TN), (C) TN, and (D) TOC. Gray bar indicates sample overlap between Holes U1539A and Hole U1539C.

Figure F39. Bulk sediment elemental (Na, K, Si, P, Mg, Ca, Ti, Mn, and Fe) oxides vs. aluminum oxide, Site U1539.

Figure F40. Bulk sediment major and minor element concentrations, Site U1539.

Figure F41. Natural gamma radiation–derived K% (black), K/Th 7-point smoothed (blue), Whole-Round Multisensor Logger magnetic susceptibility (MS; red), and Section Half Multisensor Logger point magnetic susceptibility (MSP; orange), Hole U1539A.

Figure F42. Natural gamma radiation–derived K% (black), K/Th 7-point smoothed (blue), Whole-Round Multisensor Logger magnetic susceptibility (MS; red), and Section Half Multisensor Logger point magnetic susceptibility (MSP; orange), Hole U1539C.

Figure F43. Natural gamma radiation (NGR) total counts, Holes U1539A–U1539D. Scales on NGR counts (*y*-axis) decrease from 50 to 10 from upper to lower panels.

Figure F44. Calculation of K (black), U (blue), and Th (red) semiquantitatively derived from natural gamma radiation, Hole U1539A. Dashed lines = raw data, solid lines = smoothed data.

Figure F45. Bulk density data from WRMSL (green lines) and discrete moisture and density (MAD; dots), Holes U1539A (top) and U1539C (bottom). Top right: correlation between MAD- and gamma ray attenuation (GRA)-derived bulk density data from Holes U1539A (black diamonds) and U1539C (yellow squares). Linear best fit equation and correlation coefficient are shown.

Figure F46. Gamma ray attenuation bulk density (green) and *P*-wave velocity (blue), Hole U1539A. Dashed lines = raw data, solid lines = processed data.

Figure F47. Thermal conductivity data from needle probe measurements, Holes U1539A–U1539D. 0.5 W heating power over 80 s interval. Mean values are taken from three measurements or less in cases with insufficient solution to calculate temperature conductivity.

Figure F48. Advanced piston corer temperature (APCT-3) tool plots of heat flow calculations, Holes U1539A and U1539C. A. In situ sediment temperatures from APCT-3 measurements with average values for Cores 383-U1539A-4H, 7H, and 10H (diamonds) and 383-U1539C-4H, 13H, and 16H (circles). Linear fit is shown. B. In situ thermal conductivity data (squares) with calculated thermal resistance (solid line). C. Bullard plot of heat flow calculated from a linear fit of temperature vs. thermal resistance data.

Figure F49. Red-green-blue (RGB) blue data vs. composite depth, Holes U1539A–U1539D. Data are divided into 100 m intervals. Top: cleaned RGB blue splice constructed by combining data from all holes. (Continued on next page.)

Figure F49 (continued).

Figure F50. Spliced composite records of red-green-blue (RGB) blue, Whole-Round Multisensor Logger gamma ray attenuation (GRA) bulk density, and natural gamma radiation (NGR) vs. composite depth, Site U1539. Data are divided into 50 m intervals. cps = counts per second. (Continued on next two pages.)

Figure F50 (continued.) (Continued on next page.)

Figure F50 (continued).

Figure F51. Complete spliced composite records of cleaned red-green-blue (RGB) blue, Whole-Round Multisensor Logger gamma ray attenuation (GRA) bulk density, and natural gamma radiation (NGR), Site U1539. cps = counts per second.

Figure F52. A. Comparison of coring depth and composite depth scales in the Site U1539 splice. B. Comparison of the growth of cumulative depth offset and core depth.