Figure F1. Site map. Red = Site U1589, yellow = other sites. Inset: location map. Map is based on swath data from several cruises (Nomikou et al., 2012, 2013, 2014; Hooft et al., 2017). KVC = Kolumbo volcanic chain.

Figure F2. Seismic profile across the Anhydros Basin along Seismic Line HH06-15. The basin fill has six seismic stratigraphic units (U1–U6), following Nomikou et al. (2018) and Preine et al. (2022a). Insets: locations of Site U1589 and Holes U1589A–U1589C. Depth in meters. TWT = two-way traveltime.

Figure F3. Lithostratigraphic summary, Site U1589. Tuffaceous muds are included with lapilli and ash (pink) because some of their physical properties, especially MS, align more with volcanic lithologies. Subunits are illustrated in more detail in Figures F4 and F5.

Figure F4. Relative percentages of volcanic, tuffaceous, and nonvolcanic lithologies in Units I–V, Site U1589. Unit I is volcanic rich compared to the nonvolcanic-dominated Units II–V. Subunits correspond to smaller scale variations of volcanic versus nonvolcanic lithologies.

Figure F5. Average grain size distribution, Site U1589. Length of colored bars = relative grain sizes (ash = <2 m; lapilli = 2–64 mm; mud = <63 µm; sand = 0.63–2 mm), with separate scales for volcanic grain size (top) and tuffaceous and nonvolcanic grain size (bottom). Mixed lithologies such as lapilli-ash that have relative grain sizes between two categories are plotted between ticks. Grain size in Unit V (limestone and marble) represents the size of the recovered pieces rather than primary features within the rock.

Figure F6. Representative lithologies from Units I–IV, Site U1589. Unit I is dominated by volcanic deposits: (A) ash layers, (B) tuffaceous muds, and (C) lapilli (-rich) intervals. D. Unit II is dominated by calcareous oozes and muds and has a high occurrence of organic-rich (sapropelic) intervals. E. Sand with shells is most common in Unit III (siliciclastics with shells). F. Unit IV is dominated by highly oxidized, matrix-supported breccias, conglomerates, and sandstone that are brown-orange.

Figure F7. Core disturbances, Site U1589. A, B. Different degrees of biscuiting. C. Brecciated core disturbance. D. Cracks in slightly brecciated lithologies. E. Fall-in. F. Soupy texture observed in water-saturated intervals of unconsolidated ash and the surrounding layers. G. Sediment flowage leaving a smear or thin trail of sediment along the outside rim of the core. H. Mixed sediment. I. Bedding, uniformly bent upward along the core margins (uparching core disturbance). J. Voids that might be the result of basal flow-in, core extension, or low recovery.

Figure F8. Representative volcanic lithologies from Unit I, Hole U1589A. Center: ash layer (top) compared to a tuffaceous mud (bottom).

Figure F9. Nannofossil ooze from Unit II, Site U1589. Left: ash pods. Right: organic-rich layer. Center: nannofossil ooze with rare glass shards (top) and a nonvolcanic calcareous ooze (bottom).

Figure F10. Typical interval from Unit III showing sand with shells or shell fragments, Hole U1589A.

Figure F11. Representative lithologies from Unit IV, Holes U1589A and U1589C. Unit IV is characterized by variably oxidized matrix-supported conglomerate (left) and clast-supported conglomerate grading to gravelly sand (center) and diagenetically altered breccia (right). Clasts are dominantly limestone plus subordinate metamorphic clasts (center).

Figure F12. Unit V, Site U1589. Unit V is characterized by mostly limestone (left and right) with marble clasts (left) and is identified as the basement (Hole U1589C). It is possible that the surrounding sediments were washed out during drilling, leaving behind subrounded clasts of basement rocks.

Figure F13. XRD spectra of selected IW squeeze cake sediment residues, Hole U1589A. A. Tuffaceous mud. B. Ash. C. Organic-rich ooze/ooze. D. Ooze. E. Siliciclastic sediment with shell fragments. F. Breccia. gl = glauconite, qtz = quartz, pl = plagioclase (anorthite [with Na solid solution] in tuffaceous mud and ash; albite [with Ca solid solution] in nonvolcanic sediment), hal = halite, sm = smectite, il = illite, cc = calcium carbonate (calcite and aragonite).

Figure F14. Comparison of MS measured with the STMSL and the WRMSL, Hole U1589A. Top: entire length of Hole U1589A. Bottom: detailed comparison of an area indicated by the black box in the top panel.

Figure F15. Major gaps encountered after retrieval of cores, Holes U1589A and U1589B. Dashed line = zero. Negative values = cores with potential overlap, positive values = gaps.

Figure F16. GRA density and NGR, Core 398-U1589A-10H. Characteristic sawtooth pattern at section boundaries (black vertical lines) as a result of uneven distribution of material within the individual cores is shown.

Figure F17. WRMSL-derived MS data, Holes U1589A–U1589C. Note that MS data are on the CCSF-A depth scale and the spliced section is on the core composite depth below seafloor, Method D (CCSF-D), scale. MS data were clipped at 600 × 10^{-5} SI. Red lines = major gaps in the stratigraphic record.

Figure F18. Splice for Site U1589 showing MS, NGR, and GRA density, as well as the respective spliced core interval from Holes U1589A–U1589C. cps = counts per second.

Figure F19. CCSF-A versus CSF-A core top depths, Holes U1589A and U1589B. Lines fit through the core top depths of all holes give an estimate of the affine growth factor. At Site U1589, this is estimated to be approximately 4%.

Figure F20. Dip data, Site U1589. A. Bedding. B. Structure. U1–U6 = seismic units, h1–h6 = contact surfaces. P, Y = shear fabric.

Figure F21. Box plots of bedding dip, Site U1589. A. Distribution in lithostratigraphic units. B. Distribution in seismic units (U1–U6; h1–h6 = contact surfaces). Gray boxes are delimited by the first (P25) and third (P75) quartiles of the value distributions. The line inside is the median (P50) value, and the lines outside are P5 and P95. The dots are the first outliers smaller than P5 and larger than P95.

Figure F22. Minor faults identified on split core surfaces, Holes U1589A–U1589C. A. Normal fault (398-U1589A-62F-1, 21–35 cm). B. Normal fault (398-U1589B-69F-1, 5–19 cm). C. Normal fault system on the split core surface (398-U1589C-14R-1, 59–72 cm). D. Corresponding X-ray image. No density variations along the fault planes were identified.

Figure F23. Carbonate vein and breccia developed in Unit IV, Hole U1589C. A. Carbonate vein with random orientation (22R-2, 55–65 cm). B. Carbonate veins representing a faint crosscutting relationship (22R-2, 66–76 cm). White arrows = veins cut by postdated veins (black arrows). C. Carbonate veins with preferred orientation on the split core surface (22R-1, 131–143 cm). D. Corresponding X-ray image. Solid red arrows = position of carbonate veins, dashed red arrows = same positions as solid arrows, but no clear structures were identified.

Figure F24. Carbonate breccia developed in Unit V, Hole U1589C. A, B. Limestone breccia (26R-1, 50–53 cm). C. Limestone breccia (26R-1, 34–40 cm). Note that foliations in the brecciated clasts were all oriented to the same direction, indicative of in situ brecciation.

Figure F25. Age-depth plot, Site U1589. Integrated biochronology, sapropels, and MIS boundaries (planktonic foraminifer [PF] zones) in Holes U1589A and U1589B are shown. CN = calcareous nannofossil. Two hiatuses are indicated at the position of onlap surfaces within the seismic stratigraphy. Biohorizons correspond to those given in Tables T6 and T9.

Figure F26. Calcareous nannofossils, Site U1589. 1. *Emiliania huxleyi* (Lohmann) Hay and Mohler (398-U1589A-1H-CC, 54–59 cm). 2. *Pseudoemiliania lacunosa* (Kamptner) Gartner (398-U1589B-67F-CC, 0–5 cm). 3. *Reticulofenestra asanoi* Sato and Takayama (67F-CC, 0–5 cm). 4. *Helicosphaera sellii* (Bukry and Bramlette) Jafa and Martini (398-U1589A-65F-CC, 19–24 cm). 5. *Gephyrocapsa* spp., small form (<4 µm) (40F-CC, 20–25 cm). 6. *Gephyrocapsa* sp. 3 (398-U1589B-57F-

CC, 0–5 cm). 7. *Gephyrocapsa oceanica* Kamptner (398-U1589A-65F-CC, 19–24 cm). 8. *Gephyrocapsa oceanica* Kamptner, large form (>5.5 µm) (66F-CC, 14–19 cm).

Figure F27. Foraminiferal oceanicity and paleowater depth estimates, Site U1589. Blue colors show relationship between oceanicity index and paleowater depth. NA = not applicable.

Figure F28. Biostratigraphic summary, Site U1589. U1–U6 = seismic stratigraphic units, h1–h6 =contact surfaces. CN = calcareous nannofossil, PN = planktonic foraminifer. Interpreted oceanicity: solid line/red points = interpreted oceanicity, dashed line = extrapolation through barren/unreliable sample data. Interpreted paleowater depths: light blue points/shading = shallower paleowater depth interpretation, dark blue points/shading = deeper paleowater depth interpretation.

Figure F29. Planktonic foraminifera, Hole U1589A. A. *Globigerina bulloides*. B. *Globigerina umbilicata*. C. *Globigerina falconensis*. D. *Globigerinoides ruber*. E. *Globigerinoides elongatus*. F. *Globigerinoides pyramidalis*. G. *Trilobatus trilobus*. H. *Orbulina universa*. I. *Turborotalita quinqueloba*, J. *Globoconella inflata*. K. *Truncorotalia truncatulinoides* s.l. (sinistral). L. *Truncorotalia truncatulinoides* s.l. (dextral). M. *Hirsutella scitula*. N. *Globigerinella calida*. O. *Globigerinella siphonifera*. P. *Globigerinita glutinata*. Q. *Neogloboquadrina pachyderma*. R. *Neogloboquadrina incompta* (A, G, H, O: 3H-CC, 17–22 cm; B, D, N, R: 12H-CC, 0–5 cm; C: 60F-CC, 19–24 cm; E: 46F-CC, 17–20 cm; F, P: 59F-CC, 17–22 cm; I, Q: 38F-CC, 20–24 cm; J, K, L: 14H-CC, 10–15 cm; M: 8H-CC, 12–17 cm).

Figure F30. Limestone clast showing *Orbitoides* sp. (398-U1589C-17R-1, 22–26 cm; plane-polarized light [PPL]).

Figure F31. Nummulitic limestone with possible *Nummulites* ex. gr. *perforatus*, *Assilina* sp., *Discocyclina* spp., *Sphaerogypsina* sp., and various undetermined rotaloid forms (398-U1589C-22R-1, 0–3 cm). Scale bar = 2 mm.

Figure F32. Nummilitic limestone with possible *Morozovella* spp. (398-U1589C-22R-1, 0–3 cm; PPL).

Figure F33. Benthic foraminifera, Hole U1589A (unless otherwise noted). A. *Ammonia beccarii*. B. *Amphicoryna scalaris*. C. *Articulina tubulosa*. D. *Bigenerina nodosaria*. E. *Bolivina alata*. F. *Bolivina dilatata*. G. *Bulimina marginata*. H. *Cassidulina laevigata*. I. *Cibicides pachyderma*. J. *Cibicidoides wuellerstorfi*. K. *Favulina hexagona*. L. *Gyroidina soldanii*. M. *Hyalinea balthica*. N. *Melonis affinis*. O. *Oridorsalis umbonatus*. P. *Planulina ariminensis*. Q. *Siphonina reticulata*. R. *Trifarina angulosa*. S. *Trifarina bradyi*. T. *Uvigerina peregrina* (A: 67X-CC, 29–32 cm; B, L, T: 3H-CC, 17–22 cm; C: 398-U1589B-55F-CC, 13–15 cm; D, G, N: 60F-CC, 19–24 cm; E, I, O, P: 47F-CC, 18–21 cm; F: 11H-CC, 17–22 cm; H: 398-U1589B-70F-CC, 8–10 cm; J: 49F-CC, 20–23 cm; K: 12H-CC, 0–5 cm; M: 48F-CC, 16–19 cm; Q: 37F-CC, 22–26 cm; R, S: 9H-CC, 22–27 cm).

Figure F34. Histograms of NRM intensity and low-field MS, Site U1589. Data are based on archive-half section SRM measurements and low-field point MS measurements made at the same intervals downhole.

Figure F35. Bi-plots of low-field MS versus NRM intensity for different lithologies sampled at Site U1589.

Figure F36. Top: lower hemisphere stereographic equal-area projections of NRM directions, Holes U1589A–U1589C. Bottom: same data represented by Kamb contours. Red dashed line = expected inclination. All holes show dominant steep downward directions resulting from a pervasive drilling-induced magnetic overprint. Produced using R. Allmendinger's Stereonet program v.11.2.2 (Cardozo and Allmendinger, 2013).

Figure F37. Examples of AF demagnetization of archive-half sections, Site U1589. Clear linear trends toward the origin are interpretable as characteristic remanences. Solid circles = projection onto horizontal plane, open circles = projection onto vertical plane.

Figure F38. Examples of AF demagnetization of archive-half sections, Site U1589. Complex directional behavior at higher field treatments is indicative of spurious, laboratory-imparted magnetizations suspected to represent gyroremanent magnetizations carried by authigenic greigite. Solid circles = projection onto horizontal plane, open circles = projection onto vertical plane.

Figure F39. Archive-half section magnetic data, Hole U1589A. Red dashed lines = GAD inclinations expected at this site.

Figure F40. Archive-half section magnetic data, Holes U1589B and U1589C. Red dashed lines = GAD inclinations expected at this site.

Figure F41. NRM and 20 mT demagnetization step declinations for APC cores reoriented using data from the Icefield tool with corresponding inclinations, Holes U1589A and U1589B. Red dashed line = GAD inclinations expected at this site.

Figure F42. Conceptual basis for the automated PCA determination process used to analyze demagnetization data from archive-half sections, Expedition 398. PuffinPlot software is used to determine alternative free-fit and anchored PCAs at each measurement point. Agreement within 10° indicates the demagnetization trajectory is broadly directed toward the origin (left). When angular difference is > 10°, samples demagnetization trajectories are not directed to the origin. MAD = maximum angular deviation.

Figure F43. Inclinations of automated PCA free-fit components that pass the selection process illustrated in Figure F45, Site U1589. Red dashed lines = GAD inclinations expected at this site.

Figure F44. Inclinations of acceptable automated PCA free-fit components (left) compared to inclinations after 25 mT demagnetization step color-coded by lithology (right), Hole U1589B. The magnetostratigraphy column (far right) shows the location of reversal boundaries predicted based on the biostratigraphic age model for the site.

Figure F45. Discrete sample anisotropy of low-field magnetic anisotropy, Holes U1589A and U1589B. Left: lower hemisphere stereographic equal-area projections of principal anisotropy axes (min = minimum, int = intermediate, max = maximum). Right: shape parameter plotted against corrected anisotropy degree (Jelínek and Kropáček, 1978).

Figure F46. Physical properties, Site U1589. Dots = whole-round measurements of GRA bulk density, *P*-wave velocity, MS, and NGR. Open symbols = discrete sample MAD bulk density and *x*-direction *P*-wave velocity. cps = counts per second.

Figure F47. Sections showing relationships between lithology and physical property measurements measured on whole rounds and discrete samples, Hole U1589B. Uppermost and lowermost NGR measurements are removed from each section because the values are affected by edges of core liners. cps = counts per second.

Figure F48. AVS shear strength on working-half sections and PP measurements of compressional strength on whole cores, Site U1589. Compressional strength measurements were converted to shear strength. Dashed line = upper AVS detection limit, solid lines = lower and upper PP detection limits.

Figure F49. Discrete measurements of *P*-wave velocity, Site U1589.

Figure F50. Discrete MAD measurements of porosity, bulk density, and grain density, Site U1589.

Figure F51. Thermal conductivity, Site U1589. Black solid line = least-squares best-fit curve.

Figure F52. Downhole temperature, Site U1589. The best-fit linear relationship for the four deepest measurements in Hole U1589B is 4.0 ± 0.2°C/km. A gradient of 100°C/km is shown for reference.

Figure F53. ICP-AES analyses of selected volcaniclastic units used to discriminate between potential volcanic sources, Hole U1589A. A. Total alkali versus SiO_2 plot with the rock nomenclature of Le Maitre et al. (2002) overlain used for sample naming. ol = olivine. B. Ba/Y versus Ba/Zr plot used to correlate samples following Kutterolf et al. (2021).

Figure F54. IW salinity, alkalinity, and pH, Site U1589. Dashed lines = unit boundaries.

Figure F55. IC and ICP-AES concentrations of Br^-, Cl^-, Na, B, Ca, Mg, K, and SO_4^{2-} in IW samples, Site U1589. Dashed lines = unit boundaries.

Figure F56. ICP-AES concentrations of Li, Si, Sr, Mn, Fe, and Ba in IW samples, Site U1589. Dashed lines = unit boundaries.

Figure F57. TOC and carbonate in solid samples, Site U1589. Dashed lines = unit boundaries. TOC sapropel conventions follow Kidd et al. (1978).

Figure F58. Headspace gas analyses of methane, Site U1589. Dashed lines = unit boundaries.

Figure F59. Logging operations, Hole U1589C. Arrows = direction of logging pass.

Figure F60. Logging data with shipboard NGR, Site U1589. For simplicity, only resistivity data acquired by deep channel (0.7 m current penetration) is shown. gAPI = American Petroleum Institute gamma radiation units.