

Figure F1. A. Bathymetry location map, Site U1609 with nearby sites from Expeditions 339 and 397. Box = location of B. B. Zoomed-in bathymetric map, Site U1609.

Figure F2. Present-day water mass circulation patterns on either side of Gibraltar Strait in relation to main topographic features and Expedition 401 sites. AMW = Atlantic Mediterranean Water.

Figure F3. Seismic Profile IL1774 with location and approximate penetration of Hole U1609A and Expedition 339 Hole U1391C. SP = shotpoint, TWT = two-way traveltime.

Figure F4. Lithologic synthesis, Site U1609. See SYNTHLOGS in Supplementary material for editable version of this figure. V.f. = very fine.

Figure F5. Lithologic summary, Site U1609. Curve variation in sedimentary log indicates relative long-term variations of coarser versus finer grained sediments. Black dashed lines = unit boundaries (these are transitional, not abrupt), gray dashed lines with T = interval succession transitions from one unit to another.

Figure F6. Composition of lithologies per core and core and bed thickness by lithology, Site U1609. Black dashed lines = unit boundaries.

Figure F7. Example facies description for each unit, Site U1609. Linescan image and RGB color are from Section Half Imaging Logger (SHIL), X-ray image is from X-Ray Linescan Logger (XSCAN). Reflectance ($L^*a^*b^*$) and MS are from Section Half Multisensor Logger (SHMSL). A. Calcareous mud and calcareous silty mud are dominant, Unit I. Vfs = very fine sand, fs = fine sand, Ms = medium sand, Cs = coarse sand, vcs = very coarse sand. Ch = *Chondrites*, Pl = *Planolites*, Te = *Teichichnus*, Th = *Thalassinoides*, Zo = *Zoophycos*. cps = counts per second. (Continued on next three pages.)

Figure F7 (continued). B. Calcareous mud and clayey calcareous ooze are dominant, Unit II. (Continued on next page.)

Figure F7 (continued). C. Two different calcareous muds (dark and brown) and clayey calcareous ooze are dominant, Unit III. (Continued on next page.)

Figure F7 (continued). D. Two different calcareous muds (dark and brown) and clayey calcareous ooze are dominant, Unit IV.

Figure F8. Powder XRD patterns of 22 squeeze cake residues, Hole U1609A. Samples are arranged from shallowest (top; 1H-1; 1.45 m CSF-A) to deepest (bottom; 73X-2; 603.14 m CSF-A). Patterns are plotted with intensity on logarithmic scale to highlight presence and nature of smaller peaks. Although bulk mineral assemblage is nearly constant downhole, relative intensities of various peaks change with depth.

Figure F9. Representative XRD patterns of <2 μm fractions for samples from each unit, Hole U1609A.

Figure F10. Mineral composition and percentage (excluding mixed-layer I/S) from bulk XRD patterns using Rietveld refinements method, Hole U1609A. Samples are from either squeeze cake residues or spot samples (*). Kao = kaolinite.

Figure F11. Variation in carbonate composition based on coulometry (see Geochemistry) and XRD data, Hole U1609A.

Figure F12. Fine-grained contourites from Unit I, Site U1609. Left: typical expression of subtle lithologic change observed at this site (401-U1609A-24H-1; linescan). Right: rare example showing trace fossil distribution, primary sedimentary structures, and subdivision intervals (C1–C5) according to contourite facies model for bigradational sequences (Stow and Faugères, 2008) (401-U1609B-44X-3I X-ray). Ch = *Chondrites*, Pl = *Planolites*, Pa = *Palaeophycus*, Th = *Thalassinoides*. Yellow circles = occurrence of discrete traces on central interval of bigradational sequence.

Figure F13. Major lithologies for Units I–IV, Site U1609. Dominant siliciclastic and biogenic components are annotated. Bs = biosiliceous fragment, Cl = clay, Cn = calcareous nannofossils, Dol = dolomite, Fd = feldspar, Fm = foraminifer, Gl = glauconite, Hm = heavy mineral, Lith = lithic fragment, Py = pyrite, Qz = quartz, Sp = sponge spicule.

Figure F14. Texture (grain size) and mineralogical composition in main lithologies in Units I–IV based on averaged data from smear slide analysis, Site U1609.

Figure F15. Trace fossil assemblages in Unit I for calcareous silty mud and calcareous mud, Hole U1609B. Note change in BI from 2–3 to 1. Ch = *Chondrites*, Pl = *Planolites*, Zo = *Zoophycos*.

Figure F16. Linkage between lithologic names and mineral compositions from XRD analysis, Hole U1609A. White bars = intervals XRD samples were taken from. Albite = plagioclase.

Figure F17. Turbidite beds (Tu) in clayey calcareous oozes from (left) Units II and (right) III showing some sedimentary characteristics, trace fossil distribution, and infilling material of traces in relation to different parts of turbidite beds, Site U1609. Ch = *Chondrites*, Pl = *Planolites*, Zo = *Zoophycos*.

Figure F18. Turbidite composition of correlated and uncorrelated turbidite layers, Site U1609. Left: linescan images showing full turbidite layer. Smear slide photomicrographs depict major siliciclastic and biogenic components of sediments within turbidite (middle: plane-polarized light; right: cross-polarized light). Bottom centered: pyrite and pyritized biogenic fragments (reflected light). Fd = feldspar, Gl = glauconite, Hm = heavy mineral, Lith = lithic fragment, Mc = microcline, Qz = quartz, Qz ov = quartz overgrowth, Py = pyrite, Sp = sponge spicule, Py sp = pyritized sponge spicule.

Figure F19. Preliminary age model based on depths of calcareous nannofossil and foraminifer bioevents, Site U1609. S/D = sinistral/dextral.

Figure F20. Paleomagnetic results, Hole U1609A. Red vertical line = GAD inclination at site latitude in normal polarity. Smoothed inclination used 1 m moving window. Orange band = standard deviation of smoothing results. ChRM inclination of discrete samples have α_{95} uncertainties. Blue triangles = discrete sample positions. Chron column: black = normal polarity, white = reversed polarity, gray = zones of uncertain normal polarity. Lines and numbers along interpreted chron column = tie points between hole and GPTS. Dashed lines between hole and GPTS = best-fit correlation of well-recognized polarity boundaries.

Figure F21. Paleomagnetic results, Hole U1609B. Red vertical line = GAD inclination at site latitude in normal polarity. Smoothed inclination used 1 m moving window. Orange band = standard deviation of smoothing results. ChRM inclination of discrete samples have α_{95} uncertainties. Chron column: black = normal polarity, white = reversed polarity, gray = zones of uncertain normal polarity. Lines and numbers along interpreted chron column = tie points between hole and GPTS. Dashed lines between hole and GPTS = best-fit correlation of well-recognized polarity boundaries.

Figure F22. AF demagnetization results, Hole U1609A. Left: vector endpoints of paleomagnetic directions measured after each demagnetization treatment on orthogonal projection (Zijderveld) plot. Examples of normal (positive inclinations) and reversed (negative inclinations) polarity are shown in left and right panels, respectively. Squares = horizontal projections, circles = vertical projections. Right: intensity variation with progressive demagnetization.

Figure F23. Detailed paleomagnetic results, upper Tortonian–lowermost Messinian part of Hole U1609B (400–510 mbsf). Complex interval comprises multiple short polarity chrons. Lines = best-fit correlations between inclination record after 20 mT AF demagnetization and GPTS. Age: black = normal polarity, white = reversed polarity, gray = uncertain polarity.

Figure F24. Correlation of magnetostratigraphy, Site U1609. Red vertical line = GAD inclination at site latitude in normal polarity. Smoothed inclination used 1 m moving window. Orange band = standard deviation of smoothing results.

ChRM inclination of discrete samples have α_{95} uncertainties. Chron columns: black = normal polarity, white = reversed polarity, gray = zones of uncertain normal polarity. Lines and numbers along interpreted chron columns = tie points between holes and GPTS. Dashed lines between holes and GPTS = best-fit correlation of well-recognized polarity boundaries.

Figure F25. Sediment accumulation curves from magnetostratigraphic correlations to GPTS 2020 (Raffi et al., 2020), Site U1609. Circles = well-established reversals, triangles = uncertain ages.

Figure F26. Headspace gas methane, ethane, ethene, and propane, Hole U1609A.

Figure F27. IW alkalinity and pH, Hole U1609A. Open symbol = likely contamination when Core 36F was pumped out from the core barrel. Dashed line = mudline (bottom water) values.

Figure F28. IW sodium and chloride concentrations and Na/Cl ratios, Hole U1609A. Dashed line = mudline (bottom water) values.

Figure F29. IW major cation concentrations (calcium, magnesium, and potassium), Hole U1609A. Dashed line = mudline (bottom water) values.

Figure F30. IW major anion concentrations (sulfate and bromide), Site U1609A. Sulfate concentrations are compared with methane concentrations in headspace gas; sulfate concentrations below detection limit are plotted as 0 mM. Dashed line = mudline (bottom water) values.

Figure F31. IW major nutrient concentrations (ammonium and phosphate), Hole U1609A. Phosphate concentrations below detection limit are not plotted.

Figure F32. IW minor element concentrations (Li and Si), Hole U1609A. Dashed line = mudline (bottom water) values.

Figure F33. IW minor and trace element concentrations (Ba, B, and Sr), Hole U1609A. Dashed line = mudline (bottom water) values.

Figure F34. IW trace element concentrations (Fe and Mn), Hole U1609A. Concentrations below detection limit are plotted as 0 μM .

Figure F35. CaCO_3 , organic carbon, nitrogen, and C/N in sediments, Hole U1609A.

Figure F36. Relationship between carbonate weight percent determined by analysis of XRD spectra and coulometry, Hole U1609A. Symbol color indicates lithologies found immediately above and below IW whole-round samples; where they differ, interior color shows lithology above and exterior color shows lithology below.

Figure F37. Relationship between carbonate weight percent and NGR and example of aliasing of NGR cycles by low-resolution sampling for carbonate analysis, Hole U1609A. NGR measurements represent closest analysis to IW whole-round samples (usually within 15 cm). cps = counts per second.

Figure F38. Carbonate Mg/Ca, Mn/Ca, and Sr/Ca, Hole U1609A.

Figure F39. MS, GRA density, and NGR, Site U1609. Gray dots = original three data sets (with anomalous values removed from MS and GRA), overlying black lines = 10 cm locally weighted nonparametric regression (LOWESS) smooth run on all data sets to highlight variations and secular trends. Note that to plot MS

from both holes on same scale, upper 20 m of Hole U1609A is not shown. Complete record is shown in Figure F40. cps = counts per second.

Figure F40. MS and L^* , a^* , and b^* color variation, Site U1609. Gray dots = original three data sets (with anomalous values removed from all data sets), overlying black lines = 10 cm locally weighted nonparametric regression (LOWESS) smooth run on all data sets to highlight variations and secular trends.

Figure F41. A, B. NGR measurements, Site U1609. Corresponding three NGR components (potassium, uranium, and thorium) extracted from total NGR counts using shipboard codes are also shown. Gray box in A = location of B. cps = counts per second.

Figure F42. Thermal conductivity, MAD, GRA bulk density, porosity, and grain density, Hole U1609A. Porosity and grain density were obtained during MAD measurements.

Figure F43. PWL (WRMSL) and PWC results, Site U1609. Comparison of PWC results between holes is also shown.

Figure F44. Comparison between physical properties measured on cores and downhole measurements, Hole U1609A. LCAL = caliper, RHOM = density log, VELP = P -wave log. cps = counts per second.

Figure F45. Downhole logging data summary, Hole U1609A. Density log (RHOM) and MS are from main triple combo run, P -wave logs (VELP) are from Formation MicroScanner-sonic run, true resistivity (RT_HRLT) is from main triple combo run.

Figure F46. Time-depth relationship models that could be used to tie borehole to seismic, Hole U1609A. MD = measured depth, TWT = two-way traveltime, wrt SF = with respect to seafloor.

Figure F47. Seismic profile (Line WPortugal_XL5210) showing estimated penetration and dip, Hole U1609A. SP = shotpoint, TWT = two-way traveltime.

Figure F48. Downhole temperature records from four APCT-3 and two SET2 deployments showing equilibration curves and formation temperatures calculated from them, Site U1609. Calculated formation temperatures are on the right. Lowest temperature during retrieval, gauge of seafloor temperature, is also indicated.

Figure F49. APCT-3 and SET2 formation temperature, Site U1609. Extrapolation to seafloor gives seafloor temperature of 6.9°C. Note unusual cooling with depth opposite to normal warming geothermal gradient trend (see text). 64

Figure F50. NGR and MS record, Holes U1609A (red) and U1609B (blue). Depth offsets for each core from original CSF-A depth scale were generated based on correlation of distinctive features in records between holes, as detailed in affine depth offsets table (Table T21). Splice intervals are detailed in Table T22. MS: gray dots = original two data sets (with anomalous values removed from all data sets), overlying red and blue lines = 20 cm Gaussian smooth run on both data sets to highlight variations and secular trends. CCSF = core composite depth below seafloor. (Continued on next page.)

Figure F50 (continued). 67

Figure F51. A. Age model tie points, Holes U1609A (blue) and U1609B (orange). B. Sedimentation accumulation rates for each data set. C. Cycle thickness. 72