Figure F1. Topographic and bathymetric map of Gibraltar Strait showing locations of Expedition 401 sites and sites from previous expeditions in Atlantic and Alborán Sea. Guadalquivir Basin in Spain and Gharb Basin in Morocco are located at western end of Betic and Rifian Corridors; fossil gateways that closed in Late Miocene and are target of ICDP drilling as part of the IMMAGE Land-2-Sea drilling project. ODP = Ocean Drilling Program, DSDP = Deep Sea Drilling Project.

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

Figure F3. Tectonically controlled reconfiguration of Mediterranean–Atlantic seaways from Middle Miocene to present day. Paleogeography of western Mediterranean after Do Couto et al. (2016). Rifian/Betic seaways (T2), which replaced a wider seaway (T1), are now exposed on land in northern Morocco and southern Spain. T2 scenario (~8 Ma) is the first with potential impact on Atlantic–Mediterranean salinity gradients and overflow formation. (Figure from Capella et al., 2019.)

Figure F4. Map of Mediterranean–Atlantic gateway at Gibraltar and two Miocene connections, Betic and Rifian Corridors, that are now exposed on land in Spain and Morocco, respectively. Red circles = IMMAGE Expedition 401 and ICDP drilling targets, green dots = existing IODP/Ocean Drilling Program (ODP)/Deep Sea Drilling Project (DSDP) sites and Montemayor borehole, which recovered Upper Miocene sediments, and closest sites (U1385, U1588, and U1391) that did not reach Miocene.

Figure F5. Drilling summary, Expedition 401. Original strategy for these deep holes was to wash down through Pliocene, which had been extensively recovered previously, and core from just above 4.5 Ma bioevent to target depth of 8 Ma. Logging at each site was planned but proved difficult or impossible to implement fully. However, recovery was excellent and there was time to drill a second hole at three of the four sites. TD = total depth.

Figure F6. Correlation of lithostratigraphic logs across Expedition 401 sites. Red lines = depth position of key ages horizons at each site, including top and bottom of MSC.

Figure F7. Bathymetric map of Portuguese continental margin showing Sites U1609 and U1385 in relation to previously drilled sites in the area. See Figure F1 for legend.

Figure F8. Seismic Profile IL1774 with location and approximate penetration, Hole U1609A.

Figure F9. Site U1609 synthesis. NGR data shown is derived mainly from Hole U1609B, with upper and lower intervals from Hole U1609A. See Figure F6 for lithology and symbol legend. V.f. = very fine. Labeled vertical lines = transition between hole NGR data sets. cps = counts per second.

Figure F10. Examples of bigradational sequences of contourites. A. Fine-grained contourite with typical expression of subtle lithologic change observed (left: linescan; right: XSCAN), Site U1609. This section is a 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). Ch = *Chondrites*, Pl = *Planolites*, Th = *Thalassinoides*. Yellow circles = discrete traces on central interval of bigradational sequence. B. Fine-grained contourite showing coarsening- and fining-upward sequence, as well as some subtle sedimentary structures, such as parallel lamination and small grain size variations, Site U1610.

Figure F11. Seismic Profile IL3170 with location and approximate penetration, Hole U1610A. CDP = common depth point.

Figure F12. Site U1610 synthesis. See Figure F6 for lithology and symbol legend. V.f. = very fine. cps = counts per second.

Figure F13. Examples of sandy deposits, Site U1610. A. Lithified sandstones with sharp bases and mud clasts. B. Sandstone with mud clasts, fining-upward interval, and coarsening-upward interval. C. Sandstones with parallel lamination and marked color banding. Dark laminations in C are caused by high proportion of glauconite. D, E. *Macaronichnus* trace fossil (red box in D) and typical mineralogical segregation shown between cylinder tube core (lighter minerals; black arrows) and surrounding rim (darker and heavy minerals; green arrows). F, G. Turbidite deposits with evidence of reworking by bottom currents (F: reworking at top of turbidite; G: stacked sets of cross lamination in turbidite).

Figure F14. Seismic Profile JC89-9 with location and approximate penetration, Hole U1385K.

Figure F15. Site U1385 synthesis. See Figure F6 for lithology and symbol legend. cps = counts per second.

Figure F16. Examples of sedimentary structures, Site U1385. A. Alternating lithologies showing regular sedimentary cycles between calcareous clay (darker facies) and clayey calcareous ooze (lighter facies), with detail of trace fossils in contact (dashed white line) between facies. Note differentiation between dark (black arrows) and light (white arrows) trace fossil assemblages and penetration of dark traces into lighter sediments. B–F. Color banding, parallel lamination, cross lamination, and lenticular bedding associated with calcareous clay. Ch = *Chondrites*, Pl = *Planolites*, Th = *Thalassinoides*, Zo = *Zoophycos*.

Figure F17. Bathymetric map of Gulf of Cádiz and Alborán Sea showing Sites U1610 and U1611 in relation to previously drilled sites in the area. See Figure F1 for legend.

Figure F18. Bathymetric map of Alborán Sea with present-day water masses and currents. AW = Atlantic Water, WIW = Western Intermediate Water, LIW = Levantine Intermediate Water, WMDW = Western Mediterranean Deep Water, ShW = shelf water (mix of AW and WMDW). (Figure from Ercilla et al., 2016.)

Figure F19. Water mass structure, Alborán Sea (Ercilla et al., 2016). AW = Atlantic Water, WIW = Western Intermediate Water, LIW = Levantine Intermediate Water, WMDW = Western Mediterranean Deep Water, ShW = shelf water (mix of AW and WMDW).

Figure F20. Schematic maps showing closure and opening of Mediterranean–Atlantic gateways from late Tortonian to Zanclean (updated after Martín et al., 2014).

Figure F21. Seismic Profile CAB01-125 with location and approximate penetration, Holes U1611A and U1611B. SP = shotpoint.

Figure F22. Site U1611 synthesis. NGR data shown are derived mainly from Hole U1611B, with upper and lower intervals from Hole U1611A. Labeled vertical lines = transition between hole NGR data sets. cps = counts per second.

Figure F23. Linescan images of deformational and laminated structures. A. Contorted bedding (slump), microfaulting, and chaotic deposits. B. Conglomerate >1 m long with mud clasts and large bioclasts. C. Examples of lighter colored laminations reflecting variable carbonate content (401-U1611A-36R-1 and 401-U1611B-30R-3), white lamination composed of aragonite that are parallel (401-U1611A-30R-4 and 401-U1611B-31R-4), and deformed (contorted and faulted) parallel and cross lamination (401-U1611A-41R-1).