Figure F1. Walvis Ridge bathymetry, hotspot age models, previous drill sites, and proposed drill sites. Solid line = central plume track of the O'Connor and le Roex (1992) hotspot model (solid circles = 10 Ma). Dashed black line = Torsvik et al. (2008) fixed hotspot model (open circles = 10 Ma). Dashed yellow line = moving hotspot model of Doubrovine et al. (2012) (stars = age in Ma). Squares = DSDP/ODP holes. Red circles = Expedition 391 and 397T drill sites. Inset shows location of Walvis Ridge (WR) in the South Atlantic. MAR = Mid-Atlantic Ridge. Plotted bathymetry is the Global Multiresolution Topography (GMRT) data set (Ryan et al., 2009).

Figure F2. Bathymetry map of the northern Guyot Province, showing Tristan, Gough, and Center track edifices and Expedition 391/397T sites (red circles). Heavy lines = AWI seismic profiles, thin lines = R/V *Thomas G. Thompson* Cruise TN-373 track, blue line = Seismic Line TT-01 from that cruise. Green circles = DSDP Sites 525 and 528 (Leg 74 transect; Moore et al., 1984). Plotted bathymetry is the SRTM15+ predicted bathymetry data set (Tozer et al., 2019). Contour interval = 1 km.

Figure F3. Walvis Ridge age progression from radiometrically dated igneous rocks. Samples with enriched mantle one (EMI)-type composition follow a tight linear trend. High U/Pb (HIMU)-type composition yields ages ~30–40 My younger than the underlying EMI-type basement. Blue shading = Expedition 391/397T site estimated ages (see Homrighausen et al. [2019] for sources of age data). EMORB = enriched mid-ocean-ridge basalt.

Figure F4. Bathymetry map showing Site U1585 and proposed sites on the summit of the Tristan track guyot. Blue line = AWI-20060660 seismic profile, red lines = seismic lines from R/V *Thomas G. Thompson* cruise TN-373 (Sager, 2022). Common midpoints (CMP) are shown every 500 points and annotated every 1000 points on the AWI seismic line. CMP are plotted at the same interval on Seismic Line TN-373, but annotated every 2000 points. Red circle = Site U1585. Open circles = proposed drill sites. Bathymetric contour interval is 200 m, with bold contours at 1000 m levels.

Figure F5. Predicted paleolatitude drift of the TGW hotspot, hotspot models, and true polar wander. Estimated paleolatitudes are calculated from the global average African plate apparent polar wander path (Torsvik et al., 2008), based on a plate motion model with moving hotspots (Doubrovine et al., 2012). This polar wander path was constructed with 20 My window length, averaged every 10 My. Bottom: pink square (525) = paleolatitude determined for 60–75 Ma sediments from Site 525 (Chave, 1984). Its paleolatitude may result from inclination shallowing, common for sediments (Verosub, 1977). Triangle (NPB), square (CPB), and diamond (SPB) = north, central, and south Paraná flood basalts (Ernesto et al., 1990; 1999); star (MC) = Messum gabbros in the Etendeka province (Renne et al., 2002). Blue shading (VK92) = hotspot drift estimated by Van Fossen and Kent (1992). Blue arrows = estimated ages of drill sites from an age progression model (Homrighausen et al., 2019, 2020). Thin vertical lines = 95% confidence limits based on paleomagnetic data scatter only. Top: red = paleolatitudes estimated from paleomagnetic data (same as lower plot). Black = seamount drift if formed at the Tristan hotspot location, assuming a fixed hotspot model (Torsvik et al., 2008). Blue = same for a moving hotspot model (Doubrovine et al., 2012). Green = Tristan hotspot drift from a mantle flow model (Doubrovine et al., 2012), indicating ~7° southward motion over 120 My. Orange = African plate drift in a moving hotspot model (Doubrovine et al., 2012). It is less than the fixed hotspot model because the Tristan hotspot is modeled as moving south. Adding hotspot motion to the moving hotspot model, absolute motion is the total northward motion indicated by the morphology of the TGW chain and the fixed hotspot model. All absolute motion models indicate that the African plate moved nearly monotonically northward, so they do not explain the rapid southward shift in paleolatitudes during the Late Cretaceous or the northward offset of paleolatitudes during the early Cenozoic. The difference between modeled and observed paleolatitudes implies significant true polar wander (purple curve) (Doubrovine et al., 2012).

Figure F6. (Top) Segment of Seismic Line TT-01 over Site U1585 and (Bottom) its interpretation and coring location. Arrow shows the location of Site U1585. Location of seismic line section shown in Figure F4. CMP = common midpoint, TWT = two-way traveltime, VE = vertical exaggeration, SF = seafloor, B = acoustic basement.

Figure F7. Bathymetry map of the area around Site U1585. Red circle = drill site. Red line = Seismic Line TT-01, with dots plotted every 500 CMP, labeled at 2000 common midpoint (CMP) intervals. Bathymetry is the swath bathymetry data from R/V *Thomas G. Thompson* Cruise TN-373 merged with SRTM15+ predicted bathymetry data set (Tozer et al., 2019). Contour interval = 100 m.

Figure F8. Regional seismic profile showing the position of Site U1585 relative to the guyot summit and flank. CMP = common midpoint, TWT = two-way traveltime, VE = vertical exaggeration, arrow = location of site.

Figure F9. Lithostratigraphic summary, Site U1585.

Figure F10. Representative images of Lithofacies 1–6, Site U1585. A. Lithofacies 1: consolidated (semilithified) pale white to pale pinkish gray bioturbated nannofossil ooze with thin bioturbated ash horizon (Section 4R-1, 22–30 cm). B. Lithofacies 2: cyclical reddish brown to gray tuffaceous chalk of increasing degrees with disseminated volcaniclastic-derived clay or fine-grained ash (2R-1, 8–16 cm). C. Lithofacies 2: tuffaceous chalk and chalky silts affected by submarine mass transport processes including soft-sediment deformation and rip-up clasts (lozenge-shaped tuffaceous chalk and tuffaceous siltstone fragments) (22R-2, 100–108 cm). D. Lithofacies 4: coarse pumice and scoria of relatively fresh to oxidized lapilli mixed with similar sized basalt (lithic) fragments with fine reworked laminated graded beds. Pumice and scoria are cemented by a mixture interstitial altered ash and zeolite (5R-2, 69–77 cm). E. Lithofacies 5a: coarse ash to vitric-lithic ash layer; heavily bioturbated tephra deposit within pelagic tuffaceous chalk (15R-3, 6–14 cm). F. Lithofacies 5b: volcaniclastic layers showing evidence for shallower marine biogenic components and reworking including subrounded reworked volcaniclasts with varying quantities of shell debris and incorporation of large fragments of bivalve shell (24R-1, 115–123 cm). G. Lithofacies 6: volcaniclastic-dominated breccias or conglomerate with fine to coarse vitric and lithic lapilli displaying quench textures and (palagonitized) glassy (tachylitic) rinds and inclusions together with zoned (armored and accretionary) pelletal lapilli (30R-2, 115–123 cm).

Figure F11. Images of key elements in Unit II, Hole U1585A. A. Subunit IIA: massive pumice and scoria lapillistone with lithic fragments including vesicular basalt, fine bedded pumice lapillistone, and chalk clast. Cement is altered ash and chalk (4R-4, 86–94 cm). B. Subunit IIA: compacted massive unsorted basaltic lapillistone of dominantly pale green pumice, darker scoria, and basaltic lithics with interstitial cement of altered ash (zeolite) and chalk (6R-3, 52–60 cm). C. Subunit IIB: reworked interval of fine cross-bedded and ripple-bedded pumice and scoria lapilli (9R-2, 5.5–13.5 cm). D. Subunit IIB: cyclic color (oxidative) variation in massive pumice, scoria, and lithic lapillistone (9R-1, 32.5–41.5 cm).

Figure F12. Selected sedimentary features, Hole U1585A. A, B. Pumice/scoria microfossil-bearing lapillistone. Clasts of cuspate and vesicle-rich volcanic glass show alteration and devitrification around the margins; well-preserved chambered microfossil (foraminifera) with overgrowth of secondary minerals (chlorite?). Vesicles and interstitial spaces are entirely filled with carbonate and zeolite (Subunit IIA: 4R-3, 101–102 cm; TS10); (A) plane-polarized light (PPL); (B) cross-polarized light (XPL). C, D. Pumice/scoria microfossil-bearing lapillistone with subrounded microfossil clasts (bryozoan fragments?) with clay-rich carbonate cement. Lithic (basaltic) fragments and altered pyroxene and plagioclase are also present (Subunit IIA: 4R-4, 53–54 cm; TS11); (C) PPL, (D) XPL. E. Lapillistone with volcanic clasts including zoned accretionary lapilli of varying sizes and shape in carbonate-clay matrix. Layered lapilli display concentric (ferric) alteration that follow the original fine ash-layering structure within the lapilli (Unit IV: 30R-2, 133–135 cm; TS26; PPL). F, G. Clay and carbonate layer above contact with igneous basement (Unit V). Contains heavily tuffaceous chalk containing heavily microfossils (foraminifera?) (Unit IV: 31R-5, 70–74 cm; TS29); (F) PPL, (G) XPL.

Figure F13. Images of key elements of Unit III, Hole U1585A. A. Subunit IIIA: basalt-dominated volcanic lapillistone breccia; clasts show variable degrees of alteration. Partially cemented with a mixture of reddish brown tuffaceous chalk and ash (14R-1, 24–32 cm). B. Subunit IIIB: uniform highly bioturbated gray-green tuffaceous silty chalk and with diffuse graded, pumice and ash layer (15R-2, 116–124 cm). C. Subunit IIIC: slump-affected dark gray to greenish gray tuffaceous chalky claystone containing dispersed rounded chalk clasts; brittle fracturing (rip-up clasts) affecting the earlier (underlying) pink-gray chalky substrate (15R-5, 20–28 cm). D. Subunit IIID: densely packed basalt-dominated volcanic lapillistone breccia consisting of scoria and microvesicular aphanitic basalt lapillistone; subrounded tuffaceous chalk pebble blocks (19R-1, 28–36 cm).

Figure F14. Images of key elements of Subunit IIIE, Hole U1585A. A. Chaotic interval in cyclical bioturbated tuffaceous chalk showing soft-sediment deformation and containing lozenge-shaped tuffaceous chalk rip-up clasts (20R-3, 76–84 cm). B. Cyclical bioturbated tuffaceous chalk (greenish gray to reddish brown redox controlled variation) and chaotic interval showing soft-sediment deformation and compaction of lozenge-shaped rip-up clasts (21R-4, 22–30 cm). C. Bioturbated graded ash and lapilli turbidite in greenish gray to reddish brown tuffaceous chalk; first downhole appearance of inoceramid (Late Cretaceous) shell fragments (21R-4, 52–60 cm).

Figure F15. Images of key elements of Subunit IIIF, Hole U1585A. A. Distinct dark horizontal sedimentary and/or redox layer making the Subunit IIIE/IIIF boundary (22R-4, 130–138 cm). B. In situ, paired (upper and lower valves) inoceramid shells preserved in finer sedimentary layers; disrupted by coring (23R-7, 93–101 cm). C. Graded volcaniclastic (ash and lapilli) turbidite containing shallow marine bioclasts and showing erosive scour at base (23R-5, 94–102 cm). D. Coarse ash and lapilli (coarse sand- to gravel-sized) turbidite/slump layer containing subrounded, often altered lithoclasts and comminuted and larger shell debris (including fragmentary and entire oyster shells). Some shell fragments show numerous surface borings; entire shells do not (24R-2, 27.5–35.5 cm).

Figure F16. Image of a key element of Subunit IIIG, Hole U1585A. Lapilli-sized volcanic breccia with angular to subangular, aphanitic nonvesicular basalt fragments displaying chilled margins and partially preserved glassy/palagonitized rims. Ash fraction contains altered rounded accretionary and blocky zoned lapilli (26R-4, 94–102 cm).

Figure F17. Images of key elements of Subunit IIIH, Hole U1585A. A. Prominent redox front in bioturbated cyclical dark greenish gray tuffaceous, carbonate-rich silty sand changing to dark reddish brown (oxidized) lower in the succession (28R-2, 71.5–79.5 cm). B. Sequence of three stacked tuffaceous turbidites; lowermost displaying erosive and sediment loading structures at the interface with underlying tuffaceous chalk (27R-6, 117–125 cm). C. Juvenile pyroclasts: coarse angular and fragmentary lithic lapilli displaying quench textures and (palagonitized) glassy (tachylitic) rinds and inclusions together with zoned (armored and accretionary?) pelletal lapilli often with glassy or lithic nuclei (29R-1, 127–135 cm). D. Shallower marine sediment reworking-cross-bedded layers with shell fragments at the interface between tuffaceous chalk and underlying siltstone (29R-2, 124.5–132.5 cm).

Figure F18. Images of key elements in Unit IV, Hole U1585A. A. Accumulation of juvenile pyroclasts consisting of loosely packed blocky and angular zoned lapilli and fragmentary aphanitic basalt clasts with tachylitic rims. Cement consists of recrystallized calcite and zeolite (30R-3, 20–28 cm). B. Interval of shallow-water sedimentary reworking: moderately well-sorted oxidized volcaniclasts together with shell debris (30R-1, 86–94 cm). C. Irregular and round accretionary lapilli in juvenile volcanic breccia (30R-3, 108–116 cm). D. Vitric lapilli showing internal perlitic alteration; lithic fragments overlying thermally altered chalk that lies immediately above the contact with underlying basaltic basement (31R-5, 54.5–62.5 cm). E. Cored section through a volcanic bomb with tachylitic margins and internal folding and deformation of aphanitic basalt interior (31R-1, 85–100 cm). F. Cored section through a volcanic bomb with tachylitic margins and spalling; internal folding and deformation of aphanitic basalt interior partially infilled with zeolite (31R-1, 128–141 cm).

Figure F19. Stratigraphic column illustrating basement recovery, Hole U1585A.

Figure F20. Select images of core representing different textures observed in Lithostratigraphic Unit V in Hole U1585A. A. Transition from volcaniclastic material to massive basalt flows at the top of Subunit 1a. The upper portion of basalt has a very thin quenched rim. Orange alteration mineral is altered olivine (31R-5, 71–80 cm). B. Change in alteration 25 cm below the top of the flow in Subunit 1a. The olivine alteration transitions from orange to pale blue (31R-5, 101.5–110 cm). C. Lower margin of the upper massive flow in Subunit 1b. Coarse vesicles suggest close proximity to a flow boundary (32R-6, 114–121 cm). D. Massive interior of lower flow in Subunit 1b (32R-9, 6–13 cm). E. Quenched olivine phyric fragment representing Unit 2. This is the only piece recovered from this unit (34R-1, 0–3 cm). F. Fresh massive flow interior in Subunit 3b (36R-7, 1–20 cm).

Figure F21. Composite high-resolution core section images of part of the massive basalt flow in Subunit 3b, Hole U1585A.

Figure F22. Small fine-grained mafic intrusions in Subunit 3b, Hole U1585A. A. Fine-grained magmatic enclave surrounded by the coarser grained massive basalt flow (35R-9, 38–50 cm). B. Subparallel fine-grained vein traversing the coarser massive flow. Dashed lines highlight the location of the vein against the cut surface of the core (37R-5, 25–48 cm).

Figure F23. Photomicrographs of thin sections (TS) from massive lavas, Hole U1585A. A. Subophitic clinopyroxene (cpx) with plagioclase (pl) and altered olivine (ol), Subunit 1a (31R-5, 111–114.5 cm, TS30; PPL). B. Coarser subophitic clinopyroxene phenocryst with groundmass plagioclase and small Fe-Ti oxides, Subunit 1b (32R-2, 62.6–66 cm, TS31; XPL). C. Blocky poikilitic clinopyroxene with olivine and sparse plagioclase inclusions. Large olivine crystals have chlorite rims, whereas smaller olivines are completely replaced, Subunit 3b (37R-5, 123.5–127 cm, TS42; PPL). D. Abundant groundmass olivine surrounded by plagioclase, Fe-Ti oxides, and mesostasis, Subunit 3b (39R-3, 2.5–6 cm, TS46; XPL). E. Skeletal Fe-Ti oxides in coarse plagioclase and clinopyroxene groundmass, Subunit 1b (32R-7, 77–80.5 cm, TS33; XPL). F. Patchy mesostasis with microlites surrounded by groundmass plagioclase and clinopyroxene, Subunit 1b (32R-7, 77–80.5 cm, TS33; PPL).

Figure F24. A. Bluish green dusty powder lining the vesicles and vugs on the surface of grayish blue relatively fresh basalts (33R-1, 122–124 cm). B. Fracture filled with white-green mineral (37R-7, 1–13 cm). C. XRD spectrum of the scraped-off bluish powder from (A). Spectrum peaks match corresponding peaks (shown in gray) for chlorite, kaolinite, and chrysotile (33R-1, 122–124 cm). D. XRD spectrum of the green-white material from (B). Spectrum peaks match corresponding peaks (shown in gray) for talc, chrysotile, and zeolite (37R-1, 10 cm).

Figure F25. Photomicrographs of thin sections (TS) showing fresh clinopyroxene (cpx) and plagioclase (pl) in a chloritized groundmass and mesostasis (37R-5; XPL). Alteration in olivine (ol) is limited to fractures (37R-5, 124–127 cm, TS42).

Figure F26. NRM intensity and paleomagnetic inclination for Hole U1585A sediment cores. Gray dots = NRM, black dots = after 20 mT AF demagnetization. Red = discrete cube samples (Table T4). Open symbols on the zero line show depths of samples that did not produce satisfactory demagnetization results. Magnetic polarity: black and white zones = normal and reversed polarity, respectively. Gray = zone where polarity cannot be determined. See Figure F9 for lithology legend.

Figure F27. NRM intensity and paleomagnetic inclination for Hole U1585A basalt cores. Gray dots = NRM, black dots = after 20 mT AF demagnetization. Red = discrete cube samples (Table T4). Open symbols on the zero line show depths of samples that did not produce satisfactory demagnetization results. No magnetic polarity column is given because the section is entirely reversed polarity. See Figure F33 for lithology legend.

Figure F28. Representative demagnetization plots for Hole U1585A samples. AF demagnetized sediment samples: (A) 3R-1, 72–74 cm, (B) 22R-1, 30–32 cm. Thermally demagnetized sediment samples: (C) 26R-2, 95–97 cm, (D) 10R-1, 104–106 cm. Basalt samples: (E) 32R-1, 13–15 cm, showing high Curie temperature, (F) 237R-7, 36–38 cm, showing low coercivity. From left: equal-area stereonet showing vector endpoints, orthogonal vector (Zijderveld) diagrams showing magnetization endpoint on two orthogonal planes (steps labeled in mT), magnetization intensity, normalized by the NRM value, vs. alternating field. (Continued on next page.)

Figure F29. IRM acquisition curves and backfield curves for discrete sediment samples from Hole U1585A.

Figure F30. IRM acquisition curves and backfield curves for discrete igneous rock samples from Hole U1585A.

Figure F31. Mg# vs. SiO_2, TiO_2, K_2O, Al_2O_3, Ni, V, Zr, and Sr for Site U1585 basalt samples. Major element compositions are normalized to 100 wt% totals. Basalt lava flows from Site U1585 generally lie within or slightly above the compositional array of samples from Sites U1575–U1578; basalt clasts from Site U1585 are more scattered but are generally consistent with Sites U1575–U1578. Some Site U1585 basalt lava flows show strong correlations between Mg# and Ni, recording olivine fractionation and accumulation. Other major and trace element variations are in general accordance with crystal fractionation and accumulation of the phenocryst phases. Data sources: Le Maitre, 1962; Richardson et al., 1984; Weaver et al., 1987; Le Roex et al., 1990; Gibson et al., 2005; Class and le Roex, 2008; Salters and Sachi-Kocher, 2010; Rohde et al., 2013; Homrighausen et al., 2018, 2019.

Figure F32. A. Total alkali vs. silica classification (Le Bas et al., 1986) with alkalic-tholeiitic division (MacDonald and Katsura, 1964). Most basalt clasts and lava flows are alkali basalts, although three clasts are transitional between alkaline and tholeiitic. B. Ti vs. V classification diagram after Shervais (2022) shows that basalt lava flows from Site U1585 lie within the ocean-island basalt (OIB) field, and the basalt clasts fall within the mid-ocean-ridge basalt (MORB) field or straddle the boundary between MORB and OIB. Data sources: Le Maitre, 1962; Richardson et al., 1984; Weaver et al., 1987; Le Roex et al., 1990; Gibson et al., 2005; Class and le Roex, 2008; Salters and Sachi-Kocher, 2010; Rohde et al., 2013; Homrighausen et al., 2018, 2019.

Figure F33. Downhole chemical variations in the igneous basement, Hole U1585A. Select elements measured using ICP-AES. Dashed arrows = similar trends downhole highlighting olivine fractionation and minor accumulation.

Figure F34. Physical properties, Hole U1585A. Yellow line = calculated 50% quantile over each core for a given property. Dashed line = systematic variation of NGR between the subunits of Unit II. cps = counts per second, gantry = discrete sample by caliper. See Figure F9 for lithology legend.

Figure F35. Comparison of averaged measurements using the MSP (SHMSL) vs. MS (WRMSL) susceptibility meters, Hole U1585A. The 50% quartile was calculated based on the data collected from each core and section interval. The measurements that fall on the black line indicate that the measurements are comparable at a given intensity.