Figure F1. Bathymetry map of the northern Guyot Province, showing the Tristan, Gough, and Center track edifices. Heavy lines = 2006 AWI seismic profiles. Thin lines = track of *Thomas G. Thompson* Cruise TN-373. Red line = seismic profile TN373-CT2. Plotted bathymetry is the SRTM15+ predicted bathymetry data set (Tozer et al., 2019). Contour interval = 1 km.

Figure F2. Multibeam bathymetry map of Site U1578 and environs. Detailed bathymetry around Seismic Line TN373-CT2 has been merged with the SRTM15+ bathymetry grid (Tozer et al., 2019). Contours are plotted at 50 m intervals and labeled in kilometers. Heavy blue line = portion of Seismic Line TN373-CT2B shown in Figure F6.

Figure F3. TGW hotspot track bathymetry (Ryan et al., 2009), fixed 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, with dots every 10 Ma. Dashed line = Torsvik et al. (2008) fixed hotspot model, with dots every 10 Ma. Yellow stars and dashed line = moving hotspot model of Doubrovine et al. (2012). Small bold numbers = ages in Ma. MAR = Mid-Atlantic Ridge.

Figure F4. Walvis Ridge age progression from radiometrically dated igneous rocks. Samples with EMI-type composition follow a tight linear trend. All but one exception are samples with HIMU-type composition that yield ages ~30–40 My younger than the underlying basement with an EMI-type geochemical composition (see Homrighausen et al., 2019, for sources of age data).

Figure F5. Predicted paleolatitude drift of the TGW hotspot, hotspot models, and true polar wander. Gray band = current latitudes of the hotspots. Bottom: paleolatitude estimates. Red dots and line = estimated paleolatitudes 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). Thin vertical lines = 95% confidence limits based on paleomagnetic data scatter only. This polar wander path was constructed with 20 My window length, averaged every 10 Ma. Blue circles and line = same paleolatitude curve for a fixed hotspot model (Torsvik et al., 2008). Pink square = paleolatitude determined for 60–75 Ma sediments from Site 525 (Chave, 1984). Its departure from the paleolatitude curve may be a result of inclination shallowing that is common for sediments (Verosub, 1977). Inverted triangle, open square, and purple diamond = paleolatitudes from the north, central, and south Paraná flood basalts (Ernesto et al., 1990, 1999). Orange star = paleolatitude of Messum Gabbros in the Etendeka province (Renne et al., 2002). Blue band (VK92) = hotspot drift estimated by Van Fossen and Kent (1992). Blue arrows = estimated ages of proposed and cored drill sites from an age progression model (Homrighausen et al., 2019, 2020). Top: northward drift and true polar wander. Red circles and line = paleolatitudes estimated from paleomagnetic data (same as lower plot). Black line = northward drift of a seamount over time if formed at the Tristan hotspot location, assuming fixed hotspot model (Torsvik et al., 2008). Blue line = same as black line but for a moving hotspot model (Doubrovine et al., 2012). Green line = paleolatitudes of the Tristan hotspot from a mantle flow model (Doubrovine et al., 2012), indicating ~7° southward motion in 120 Ma. Orange line = northward drift of the African Plate in the moving hotspot model (Doubrovine et al., 2012). This movement is less than predicted by the fixed hotspot model because the Tristan hotspot is modeled as moving south. Adding the hotspot motion to the moving hotspot model absolute motion equals 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; 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. Portion of Seismic Line TN373-CT2B over Site U1578. Top: uninterpreted profile. Bottom: interpretation. TWT = two-way traveltime, CMP = common midpoint, SF = seafloor, R_1 = seismic reflector, B = basement, VE = vertical exaggeration.

Figure F7. Portion of Seismic Line TN373-CT2B showing the northwest flank of the CT guyot. TWT = two-way traveltime, CMP = common midpoint, VE = vertical exaggeration.

Figure F8. Lithostratigraphic synthesis, Site U1578.

Figure F9. Bioturbated clayey nannofossil chalk (Lithofacies 1), Hole U1578A. A. Subunit IIA (12R-3, 1–16 cm). B. Subunit IIB (17R-2, 90–105 cm). C. Top of volcanic basement in Subunit IIB (20R-1, 1–16 cm). Chalk is oxidized with Fe-Mn dentrites. D. Unit III (Sedimentary Interbed S8) (50R-3, 36–51 cm).

Figure F10. Volcaniclastic deposits (Lithofacies 2), Hole U1578A. A. Gray tephra layer on top of poorly consolidated white nannofossil chalk in Subunit IIA (9R-3, 68–83 cm). B. Graded layer of black tephra in Subunit IIB (18R-3, 32–47 cm). Upper part of the layer is bioturbated. C. Massive graded vitric sandstone with rip-up clasts in Unit III (Sedimentary Interbed S5; 30R-4, 24–39 cm). D. Vitric sandstone to siltstone in volcaniclastic turbidites of Unit III (Sediment Interbed S8; 49R-5, 78–93 cm). Includes cross-bedding, cross-laminae (climbing ripples), parallel laminae, and load structures.

Figure F11. Pelagic ooze and chalk, Hole U1578A. A. Ooze in Unit I (1R-3, 105 cm). B. Ooze in Subunit IIA (7R-3, 15 cm). R = radiolarians, S = siliceous sponge spicules, F = small foraminifera, G = fresh volcanic glass. C. Chalk in Subunit IIB (15R-3, 50 cm). G = altered volcanic glass.

Figure F12. Volcanic glass in clastic deposits (Lithofacies 2), Hole U1578A. A. Colorless pumice with nannofossils in a gray tephra layer in the upper part of Subunit IIA (4R-2, 82 cm). B. Brown vesicular glass shards in a black tephra/sandstone layer in Subunit IIB (16R-2, 18 cm). Shards are partly altered and covered by dendrites of unidentified secondary minerals. C. Vesicular brown glass from a black tephra/sandstone layer in the lower part of Subunit IIB (19R-3, 8–10 cm). Arrow = pumiceous clast. D. Highly vesicular volcanic glass from a massive vitric sandstone (possibly a primary volcaniclastic deposit) in Unit III (Sedimentary Interbed S3; 25R-4, 82–85 cm). E. Microbial tubules in fresh volcanic glass from a massive vitric sandstone (possibly a primary volcaniclastic deposit) in Unit III (Sedimentary Interbed S3; 25R-4, 82–85 cm). F. Highly vesicular volcanic glass from a coarse, massive vitric sandstone (possibly a primary volcaniclastic deposit) in Unit III (Sedimentary Interbed S5; 31R-2, 50–54 cm).

Figure F13. Tilted sharp sedimentary contacts and beddings occurring in sedimentary interbeds within the volcanic succession, Hole U1578A.

Figure F14. Examples of sediment-lava interaction, Hole U1578A. A. Peperite in Sedimentary Interbed S1 (23R-3, 31–46 cm). B. Sediment draping of a lava top with infill of a contraction crack in the lava at the base of Sedimentary Interbed S7 (46R-2, 61–76 cm). C. Lava/sediment contact at the top of Sedimentary Interbed S8 (49R-3, 75–90 cm). Arrow = base of the lava, which lacks a glassy chill margin. D. Peperite in a pillow lava stack above Sedimentary Interbed S10 (51R-2, 62–77 cm). Arrows = (nonglassy) contacts between the lava and sediment.

Figure F15. Petrographic evidence in a sedimentary interbed (Unit III; Sediment Interbed S1) for sediment reworking from a shallow-marine environment (22R-5, 103–106 cm; 199.88 mbsf). A. Rounded fragment of red alga. B. Rounded clast of basalt. C. Rounded clast of altered volcanic glass with feldspar. D. Rounded aggregate of crustacean microcoprolites.

Figure F16. Stratigraphic column illustrating igneous basement recovery, Hole U1578A.

Figure F17. Massive basalt flow, Hole U1578A. Sections 28R-1 through 30R-1 represent the majority of the massive basalt flow that comprises Igneous Unit 6 (78% recovery).

Figure F18. Pillow basalt, Hole U1578A. A. Pillow basalt contact (34R-1, 96–125 cm). The lower portion of the upper pillow is vesicle poor and preserves a thick glassy rim that comes in contact with the upper glass rim of the underlying pillow. The upper portion of the lower pillow is moderately vesicular, which is common for pillow basalts at Site U1578. B. Pipe vesicle preserved in the flow interior of a pillow (35R-3, 69–79 cm). C. Chilled, ductile contact between two pillows (39R-3, 33–40 cm). D. Hyaloclastite in the pillow stack (65R-1, 94–109 cm).

Figure F19. Fractionating pillow interior (391-U1578A-60R-1 and 60R-2). Top of flow shows a chilled margin with sparse plagioclase. Plagioclase abundance increases downflow, and near the bottom of Section 60R-1, the highest plagioclase abundance is reached and olivine begins to appear. Continuing down through the flow (top of 60R-2), plagioclase abundance levels off but olivine abundance increases gradually. Nearing the bottom of the flow, olivine is altered to iddingsite.

Figure F20. Massive lavas and sheet flows, Hole U1578A. A, B. Massive lava with large oscillatory zoned plagioclase phenocryst with intergrown clinopyroxene; groundmass consists of subophitic plagioclase, clinopyroxene, and oxides (21R-1, 122.5–125 cm; TS 64; A = cross-polarized light [XPL], B = plane-polarized light [PPL]). C, D. Massive lava with sector-zoned clinopyroxene phenocrysts in subophitic groundmass (24R-4, 123–126 cm; TS 68; C = XPL, D = PPL). E. Rounded olivine (Ol) phenocrysts in a cumulate near the bottom of Igneous Unit 6 massive lava flow (29R-2, 45–48.5 cm; TS 72; XPL). Red dashed box = region shown in F. Cr-spinel (Cr-Sp) inclusion within an olivine phenocryst (29R-2, 45–48.5 cm, TS 72; XPL).

Figure F21. Pillow lava, Hole U1578A. A, B. Plagioclase glomerocrysts with patchy zoning and sieve texture (39R-1, 90–92 cm; TS 78; A = XPL, B = PPL). C. Pillow lava with a groundmass flow fabric (red dashed lines) (45R-2, 45–50 cm; TS 80; PPL). D. Pillow lava with reticulate ilmenite crystal clusters in the groundmass (39R-1, 90–92 cm, TS 78; PPL).

Figure F22. Calcite-filled vein network present in the pillow lava sequence of Igneous Unit 8, Hole U1578A.

Figure F23. Secondary alteration, Hole U1578A. A. Celadonite-, serpentine-, and pyrite (marcasite)-filled vesicles (37R-3, 50–54 cm; Igneous Subunit 8a). Red box = area shown in B. B. Close-up of celadonite (blue) amygdules. C. Edge of pillow basalt (chill margin to top right) with vesicles concentrated along cooling fractures and entirely filled with microcrystalline epidote amygdules (42R-1, 3–16 cm; Subunit 8b). D. Fracture veins (lower left) are filled with a mixture of Fe oxyhydroxide and serpentine (outer) and epidote (inner).

Figure F24. Effect of lava unit emplacement onto sedimentary substrate (391-U1578A-30R-2, 64–75 cm; Sedimentary Interbed S5). Bleached and convolute bedding in turbiditic hyaloclastite sandstones underlie massive flow Igneous Unit 6. The result of mechanical loading followed by longer term hydrothermal interaction and exchange within the substrate of Sedimentary Interbed S5. Dismemberment and mixing of turbiditic units suggests vigorous circulation occurred.

Figure F25. Correlated lithostratigraphy and biostratigraphy, Hole U1578A.

Figure F26. Age-depth model, Hole U1578A.

Figure F27. Magnetic measurements from sediment cores, Hole U1578A. Intensity and Inclination data for the SRM are shown for the middle demagnetization step of 10 mT and the highest demagnetization step of 20 mT, and discrete data show the ChRM inclination from PCA of thermal and AF demagnetization. Red dashed lines = expected normal and reversed GAD inclination for the current location of the site. Black dashed lines = section boundaries; section labels for black dashed lines are between the magnetization and inclination plots. Interpreted polarity: black = normal polarity (inclinations >20°), white = reversed polarity (inclinations <20°), gray = inability to assign polarity (for inclinations between ±20° and regions in which no core was recovered). Polarity chron assignments are based on the timescale of Ogg (2020).

Figure F28. Distributions of inclination values from sediments, Hole U1578A. Top: SRM 20 mT data. Bottom: discrete PCA data. Blue and orange bars = inclinations for discrete AF demagnetized and thermally demagnetized samples, respectively. Black lines = positive and negative average inclinations from the method of McFadden and Reid (1982).

Figure F29. AF demagnetization result for a representative sediment sample, Hole U1578A. A. Equal area stereonet with direction of magnetization vector at different AF steps. B. Orthogonal vector (Zijderveld) plot with magnetization end-points plotted on two orthogonal planes. C. Normalized magnetization strength, M, at a given AF field demagnetization, normalized by the maximum magnetization strength, M_{max}.

Figure F30. Thermal demagnetization result for a representative sediment sample, Hole U1578A. A. Equal area stereonet with direction of magnetization vector at different temperature steps. B. Orthogonal vector (Zijderveld) plot with magnetization end-points plotted on two orthogonal planes. C. Normalized magnetization strength, M, at a given temperature, normalized by the maximum magnetization strength, M_{max}.

Figure F31. IRM acquisition curves and backfield curves for eight discrete sediment samples, Hole U1578A.

Figure F32. Magnetic measurements of basalt cores, Hole U1578A. Intensity and inclination data for the SRM are shown for the middle demagnetization step of 10 mT and the highest demagnetization step of 20 mT, and discrete data show the ChRM inclination from PCA of thermal and AF demagnetization. Red dashed lines = expected normal and reversed GAD inclination for the current location of the site. Black dashed lines = section boundaries; section labels for black dashed lines are between the magnetization and inclination plots. Interpreted polarity: black = normal polarity (inclinations >20°), white = reversed polarity (inclinations <20°), gray = inability to assign polarity (for inclinations between ±20° and regions in which no core was recovered. Polarity chron assignments are based on the timescale of Ogg (2020).

Figure F33. Distributions of inclination values from igneous rocks, Hole U1578A. Top: SRM 20 mT data. Bottom: discrete PCA data. Blue and orange bars = inclinations for discrete AF demagnetized and thermally demagnetized samples, respectively. Solid black lines = averages of positive and negative inclinations using the method of McFadden and Reid (1982), dashed line = zero inclination.

Figure F34. AF demagnetization result for a representative basalt sample, Hole U1578A. A. Equal area stereonet with direction of magnetization vector at different AF steps. B. Orthogonal vector (Zijderveld) plot with magnetization end-points plotted on two orthogonal planes. C. Normalized magnetization strength, M, at a given AF demagnetization, normalized by the maximum magnetization strength, M_{max}.

Figure F35. Thermal demagnetization result for a representative basalt sample from Hole U1578A with a sharp decrease of demagnetization with heating. A. Equal area stereonet with direction of magnetization vector at different temperature steps. B. Orthogonal vector (Zijderveld) plot with magnetization end-points plotted on two orthogonal planes. C. Normalized magnetization strength, M, at a given temperature, normalized by the maximum magnetization strength, M_{max}.

Figure F36. IRM acquisition curves and backfield curves for five discrete igneous rock samples, Hole U1578A.

Figure F37. IW alkalinity, pH, chloride, phosphate, bromide, sulfate, sodium, strontium, magnesium, potassium, calcium, ammonium, barium, boron, iron, lithium, manganese, and silicon versus depth (in mbsf), Hole U1578A. Unit III represents the igneous basement.

Figure F38. TC, $CaCO_3$, and TOC contents versus depth (in mbsf), Hole U1578A. Unit III represents the igneous basement.

Figure F39. pXRF and ICP-AES obtained on the same sample powder, Hole U1578A. ppm = µg/g. Gray dotted line = regression line for the samples. Black line is x = y line. Samples plot on this line if ICP-AES and pXRF contents are identical. Blue dashed line = Sample 39R-2, 33–34 cm, which was measured using a very small amount of powder and is excluded in the regression line calculation.

Figure F40. Mg# vs. SiO_2, TiO_2, Al_2O_3, K_2O, Ni, V, Zr, and Sr, Site U1578. ppm = µg/g. Major element compositions are normalized to 100 wt% totals. Data from Site U1578 generally lie within the compositional array of the previously reported rocks of the Gough and Tristan Islands and Guyot Province or between the Guyot Province and Walvis Ridge samples. The 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; Cliff et al., 1991; Gibson et al., 2005; Willbold and Stracke, 2006; Class and le Roex, 2008; Salters and Sachi-Kocher, 2010; Class and Lehnert, 2012; Rohde et al., 2013; Hoernle et al., 2015; Homrighausen et al., 2018, 2019.

Figure F41. A. Total alkali versus silica classification (Le Bas et al., 1986) with alkalic-tholeiitic division (MacDonald and Katsura, 1964). ppm = µg/g. In contrast to the tholeiitic samples from Sites U1575–U1577, Site U1578 samples are almost exclusively alkali basalts. B. Ti vs. V classification diagram after Shervais (2022) shows that all basaltic lavas from Site U1578 lie within the OIB and straddle the alkaline OIB field, distinct from the previous sites (lower Ti/V values) but similar to Guyot Province samples. Data sources: Le Maitre, 1962; Richardson et al., 1984; Weaver et al., 1987; Le Roex et al., 1990; Cliff et al., 1991; Gibson et al., 2005; Willbold and Stracke, 2006; Class and le Roex, 2008; Salters and Sachi-Kocher, 2010; Class and Lehnert, 2012; Rohde et al., 2013; Hoernle et al., 2015; Homrighausen et al., 2018, 2019.

Figure F42. Downhole chemical variations, Hole U1578A. Select elements measured using ICP-AES in comparison to pXRF data on the same powders and on archive halves. pXRF data point encircled by blue dashed line (39R-2, 33–34 cm) is an outlier due to very high analytical uncertainty (see Figure F39). ppm = µg/g. Green band = high-Ti area in Igneous Unit 1 with highly plagioclase phyric rocks. Yellow bands = MgO and Ni excursions associated with the olivine phenocryst accumulation. Orange band = very high Ti signature in Unit 8. Vertical blue dashed line = boundary between high- and very high–Ti groups.

Figure F43. Lithostratigraphy, core recovery, and physical properties, Hole U1578A. cps = counts per second.

Figure F44. Tephra layers correlated to MS and NGR between seafloor and ~180 mbsf. cps = counts per second.