Figure F1. Bathymetry map of Valdivia Bank, showing the location of Sites U1575–U1577. Bathymetry data are from the satellite-altimetry based SRTM15+ predicted depth grid (Tozer et al., 2019). Contour interval = 500 m.

Figure F2. Walvis Ridge bathymetry (Smith and Sandwell, 1997), fixed hotspot age models, previous DSDP and Ocean Drilling Program (ODP) drill sites (squares), and Expedition 391 proposed sites and drilled sites (red dots). 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 dashed line and yellow stars = moving hotspot model of Doubrovine et al. (2012). Small bold numbers = ages in Ma. MAR = Mid-Atlantic Ridge, WR = Walvis Ridge.

Figure F3. Walvis Ridge age progression from radiometrically dated igneous rocks. Samples with EMI-type composition follow a tight linear trend. Most exceptions are samples with HIMU-type composition that yield ages ~30–40 My younger than the underlying basement with an EMI-type geochemical composition. Expedition 391 sites have estimated ages of 55–65 (Site U1578), 80–85 (Sites U1576 and U1577), and 100–105 Ma (Site U1575) (see Homrighausen et al., 2019, for sources of age data).

Figure F4. Predicted paleolatitude drift of the TGW hotspot, hotspot models, and true polar wander. Expedition 391 sites are shown. Bottom: paleolatitude estimates. Red line with filled red dots = 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 a 20 My window length averaged every 10 Ma. Blue line with open blue circles = 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 black triangle (NPB), open square (CPB), and purple diamond (SPB) = paleolatitudes from the north, central, and south Paraná flood basalts (Ernesto et al., 1990, 1999), respectively. Red star (MC) = paleolatitude of Messum Gabbros (MC) 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 drill sites from an age progression model (Homrighausen et al., 2019, 2020). Top: northward drift and true polar wander. Red line with open circles = 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). It is less than 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, 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 F5. Bathymetry map, Site U1575. Detailed multibeam bathymetry around Seismic Line TN373-13 is merged with the SRTM15+ bathymetry grid (Tozer et al., 2019). Contours are plotted at 10 m intervals and are labeled in kilometers. Black line = Seismic Line GeoB01-25, blue line = Seismic Line TN373-13. Heavy blue line = portion of the line shown in Figure F7.

Figure F6. Portion of Seismic Line GeoB01-25. Top: uninterpreted data. Bottom: interpretation. TWT = two-way traveltime, CMP = common midpoint, VE = vertical exaggeration.

Figure F7. Seismic Line TN373-VB13. Top: uninterpreted section. Bottom: interpretation. Vertical column shows approximate cored section. TWT = two-way traveltime, CMP = common midpoint, VE = vertical exaggeration. R_1, R_2, R_3 = seismic reflectors.

Figure F8. Lithostratigraphic summary, Site U1575.

Figure F9. Nannofossil-foraminifera ooze with radiolarians in the sedimentary cover, Hole U1575A. A. Unit I (9R-4, 41 cm). B. Unit II (21R-1, 45 cm). C. Unit III with a fragment of inoceramid shell in the center (22R-4, 49 cm).

Figure F10. Pyrite framboids and microcrystallites in unconsolidated white nannofossil-foraminifera ooze in Unit I (391-U1575A-8R-4, 5 cm). Foraminifera are absent from the field of view due to preparation of the material.

Figure F11. Main sedimentary structures of Unit II, Hole U1575A. A. Pervasive burrowing in nannofossil-foraminifera chalk with minor radiolarians and clays (Lithofacies 1; 21R-3, 77–85 cm). B. Larger burrow in nannofossil-foraminifera chalk with minor radiolarians and clays (Lithofacies 1; 21R-1, 67–75 cm). C. Planar and cross-lamination in nannofossil-foraminifera clayey siltstone with minor radiolarians and clays (Lithofacies 2; 21R-2, 126.5–134.5 cm). D. Planar and cross-lamination in nannofossil-foraminifera clayey siltstone with minor radiolarians and clays (Lithofacies 2; 21R-2, 46–54 cm).

Figure F12. Volcanic clasts in Units II and III, Hole U1575A. A. Feldspar in nannofossil-foraminifera chalk with minor clays and radiolarians in Unit II (Lithofacies 1; 21R-2, 129 cm). B. Vesicular palagonized glass in nannofossil-foraminifera chalk with minor radiolarians and clays in Unit III (Lithofacies 2; 22R-2, 134 cm). C. Ferromagnesian and Fe oxide minerals in a laminated nannofossil-foraminifera silty claystone in Unit III (Lithofacies 5; 22R-4, 68 cm).

Figure F13. Unit III lithologies, Hole U1575A. A. Brown-pink slightly to heavily burrowed nannofossil-foraminifer chalk (Lithofacies 1; 22R-2, 53–63 cm). B. Brown laminated nannofossil-foraminifera clayey siltstone to sandstone (Lithofacies 2; 22R-3, 12–22 cm). C. Brown-gray nannofossil-foraminifera chalk with convolute/contorted bedding (Lithofacies 3; 22R-4, 25–35 cm). D. Dark brown volcanic siltstone (Lithofacies 5; 22R-4, 74–84 cm).

Figure F14. Bioclastic grainstone at the base of Unit III (Lithofacies 4; 391-U1575A-22R-5, 2–4 cm; thin section 2). This sediment includes abundant subrounded red algae and foraminifera, common subrounded fragments of shells and bryozoans, and rare subrounded fragments of echinoderms.

Figure F15. Sedimentary infills and intervals in the volcanic basement, Hole U1575A. A. Yellow-white burrowed nannofossil limestone (Lithofacies 1; 24R-1, 22–37 cm). B. Yellow-white burrowed nannofossil limestone with foraminifera (Lithofacies 2; 39R-3, 106–123 cm).

Figure F16. Stratigraphic column showing the volcanic succession in Unit IV, Hole U1575A.

Figure F17. Cut core surfaces showing examples of pillow lavas and massive lava flows, Hole U1575A. A. Small pillow fragments with fresh glassy rims (red dashed ovals) and variably altered interiors. B. More complete pillow basalt stack with red dashed lines extrapolating the pillow tops beyond the recovered section. Close-up photos of the pillow lavas reveal reasonably fresh glass rims. C, D. Massive lava flows: (C) fragmented core and (D) continuous core, 100% recovery.

Figure F18. Massive lavas, Hole U1575A. A, B. Massive flow with glomeroporphyritic texture, a clear divide between phenocrysts and groundmass, and zoned plagioclase (30R-2, 6–10 cm; A = cross-polarized light [XPL], B = plane-polarized light [PPL]). C, D. Massive flow with glomeroporphyritic and seriate textures along with plagioclase zoning (26R-2, 22–26 cm; C = XPL, D = PPL). E. Clinopyroxene with patchy zoned core and oscillatory zoning near the rim along with a resorbed contact between the different zoning patterns (25R-4, 7–10 cm; XPL). F. Skeletal groundmass oxides (white crystals) and fresh glass between the phenocrysts (25R-4, 7–10 cm; reflected light).

Figure F19. Pillow lavas, Hole U1575A. A, B. Pillow lava rim with fresh glass in center of photomicrograph, altered glass (palagonite) near fractures on both sides of band of fresh glass; glomerocryst of clinopyroxene and plagioclase cut by a vein, and olivine microlites altered to iddingsite (29R-1, 43–46 cm; A = XPL, B = PPL). C, D. Pillow lava interior with large euhedral plagioclase phenocrysts, small clinopyroxene-plagioclase glomerocrysts, and olivine microphenocrysts altered to iddingsite (29R-1, 43–46 cm; C = XPL, D = PPL).

Figure F20. Sparry calcite crystals in gas blister vug (391-U1575A-34R1, 82–88 cm).

Figure F21. Phenocryst loads, Site U1575. Phenocryst abundances are largely controlled by plagioclase abundance. Total phenocryst content is generally 10%–20% above 245 mbsf and 2%–8% below. This change in phenocryst load occurs within the high-TiO_2 chemical type (Igneous Units 1–5).

Figure F22. Correlated lithostratigraphy and biostratigraphy, Hole U1575A. Preliminary age determinations are indicated.
? = uncertainty that requires more detailed examination and more samples to increase accuracy and resolution.

Figure F23. Age-depth model, Hole U1575A.

Figure F24. AF demagnetization for a representative sediment sample, Hole U1575A. A. Equal area stereographic projection with direction of magnetization vector at different AF steps. B. Orthogonal vector (Zijderveld) plot with magnetization endpoints 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 F25. Magnetization intensity and inclination for sedimentary units, Hole U1575A. Inclinations and intensity data for the SRM are shown for the highest demagnetization step of 20 mT, and discrete sample data points show the ChRM inclinations from PCA. Red dashed lines = expected normal and reversed GAD inclination for the current location of the site. Interpreted polarity: black = normal (inclinations >20°), white = reversed (inclinations <20°), gray = inability to assign polarity (for inclinations between ±20° and regions in which no core was recovered). F = contact between basal sediments and the top of the first lava flow.

Figure F26. Partial ARM acquisition of six representative consolidated sediment samples, Hole U1575A. Samples were measured with a sliding window of 5 mT in a direct current field of 0.2 mT superimposed on an AF maximum field of 70 mT. Field (mT) = highest field in the interval in which ARM was applied (Jackson et al., 1988). For example, the point at 20 mT is the pARM acquired in the 15–20 mT interval.

Figure F27. AF demagnetization for a representative basalt sample, Hole U1575A. A. Equal area stereographic projection with direction of magnetization vector at different AF steps. B. Orthogonal vector (Zijderveld) plot with magnetization endpoints 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 F28. Thermal demagnetization demonstrating partial self-reversal for a representative basalt sample, Hole U1575A. A. Equal area stereonet with direction of magnetization vector at different temperature steps. B. Orthogonal vector (Zijderveld) plot with magnetization endpoints plotted on two orthogonal planes. C. Normalized magnetization strength, M, at a given thermal demagnetization step, normalized by the maximum magnetization strength, M_{max}.

Figure F29. Magnetic intensity and inclination of volcanic units, Hole U1575A. Inclinations and intensity for the SRM data are shown for the highest demagnetization step of 20 mT, and discrete sample data points show ChRM inclinations from PCA. Red dashed lines = expected normal and reversed GAD inclination for the current location of the site. Interpreted polarity: black = normal (inclinations >20°), white = reversed (inclinations <20°), gray = inability to assign polarity (for inclinations between ±20° and regions in which no core was recovered).

Figure F30. Distributions of inclination values for SRM 20 mT data (top) and discrete PCA data (bottom). Blue and orange bars = inclination values from AF and thermal demagnetization data, respectively. Black line = average inclination from the method of McFadden and Reid (1982), gray line = Gaussian average.

Figure F31. IW alkalinity, pH, chloride, phosphate, bromine, sulfate, sodium, strontium, magnesium, potassium, calcium, ammonium, barium, boron, iron, lithium, manganese, and silicon, Hole U1575A. Unit IV represents the igneous basement.

Figure F32. TC, $CaCO_3$, and TOC, Hole U1575A. Unit IV represents the igneous basement.

Figure F33. pXRF and ICP-AES results obtained on the same sample powder, Hole U1575A. Data were divided into four groups based on the amount of powder used for pXRF measurement or the measured totals: Group 1 (1 cm thick powder), Group 2 (0.3–1 cm thick powder), Group 3 (<0.3 cm thick powder), and Group 4 (totals < 96 wt%). Black dotted line = regression line for samples, excluding those with low totals. Gray line is the y = x line. Samples plot on this line if ICP-AES and pXRF contents are identical. Regardless of the sample amount, pXRF and ICP-AES data for both major and trace elements form positive trends with good correlation. ppm = µg/g.

Figure F34. A. Total alkali vs. silica classification (Le Bas et al., 1986) showing that all Hole U1575A samples measured using ICP-AES are basalts straddling the alkalic/tholeiitic boundary (MacDonald and Katsura, 1964). B. Ti vs. V classification after Shervais (2022) showing that all basaltic lavas from Hole U1575A lie within the MORB field and overlapping field of ridge-centered OIB similar to EMI-type samples from Walvis Ridge. In contrast, all island and Guyot Province samples and late-stage HIMU-type samples fall in the OIB and alkaline OIB fields. ppm = µg/g. 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 F35. MgO vs. $Fe_2O_3^T$, K_2O, CaO/Al_2O_3, and Ni for data from basalts from Hole U1575A. Major element compositions are normalized to 100 wt% totals. Brown area = range of North Atlantic MORB compositions with La/Sm < 1.5. Samples overlap with previous samples. Only K_2O correlates well with MgO (R^2 = 0.63), whereas other major oxides (e.g., $Fe_2O_3^T$) and ratios of major oxides (e.g., CaO/Al_2O_3) form weak correlations or clusters. ppm = µg/g. 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 F36. Downhole chemical variations, Hole U1575A. Select elements measured using ICP-AES in comparison to pXRF data on the same powders and on archive-half sections. Superimposed on a broad increase in MgO is an excursion to high TiO_2-Ni-Cu in Igneous Unit 4 (green band), as well as abrupt changes in composition toward the bottom of Unit 5 and, less pronounced, at the top of Unit 9 (dashed lines). ppm = µg/g.

Figure F37. Physical properties, Hole U1575A.