Figure F1. Data reconstructions. A. Left: compilation of atmospheric CO_2 proxies throughout the Cenozoic. Proxy methods are from Masson-Delmotte et al. (2013). Right: "best and worst case" representative concentration pathways (RCPs) for historic and future atmospheric CO_2 emissions (Meinshausen et al., 2011). PD = present day. B. Composite deep-ocean benthic $\delta^{18}O$ record for the last 65 My that represents a combined signal of global ice volume and deep-ocean temperature after ~35 Ma (Zachos et al., 2001). C. Long-term trend in deep-sea temperature through the Cenozoic based on removal of the ice volume component of the benthic $\delta^{18}O$ record using sequence stratigraphic records (black line with gray uncertainty band) and Mg/Ca ratio estimates of deep-sea temperatures (Cramer et al., 2009) and scaled $\delta^{18}O$ for the past 10 My (Miller et al., 2011). D. Reconstruction of sea level lowstands (black lines) with minimum uncertainty ranges (gray shading) and smoothed highstand trend (black dotted line) using sequence stratigraphy for the New Jersey margin. Sea levels >70 m imply a significant tectonic component to this record, particularly prior to the Oligocene (Kominz et al., 2008). Figure reproduced from McKay et al. (2017).

Figure F2. Bathymetric map with Expedition 374 sites and previous DSDP Leg 28, AND, and CRP sites. Ross Sea bathymetry is from the International Bathymetric Chart of the Southern Ocean (Arndt et al., 2013a, 2013b). Existing seismic network is from the Antarctic Seismic Data Library System and includes some single-channel seismic-reflection profiles.

Figure F3. Ross Sea seismic stratigraphy and previous drilling (see Figure F7 for transect line). Expedition 374 sites form a continental shelf-to-rise transect designed to tie into inner shelf sites and trace the Neogene and Quaternary evolution of the WAIS and the forcings and feedbacks influencing past variability.

Figure F4. Expedition 374 sites are located in the most sensitive sector of the Antarctic for assessing ice sheet responses to (A) sea level and (B) ocean heat flux. LGM = Last Glacial Maximum. C–F. A more terrestrial West Antarctica in the Oligocene could support a larger ice sheet than present despite a warmer climate (Wilson et al., 2013). Thus, the timing of Ross Sea overdeepening has important implications for sea level budgets and for understanding mass balance controls. E-O = Eocene–Oligocene, Elev = elevation. G. The integration of sedimentological data with modeling was key to the success of ANDRILL (blue circle). Despite discontinuous sedimentation, targeting time intervals with short-duration magnetic reversals enabled orbital-scale WAIS reconstructions. Models indicate that grounded ice sheets occur at Sites U1521 and U1522 (black circle) during periods of maximum Antarctic ice volume. These ice-proximal sites will enable the assessment of the Antarctic contributions to sea level lowstands, building significantly on the ANDRILL record. Not all modeled glacial maxima are characterized by advance of ice to the continental shelf edge. ATNTS = astronomically tuned Neogene timescale.

Figure F5. Ross Sea bathymetric map (from the International Bathymetric Chart of the Southern Ocean; Arndt et al., 2013a, 2013b). RSBW (blue arrow) derived from the ice shelf water (not shown) flows downslope in the Hillary Canyon and along the central and western Ross Sea shelf slope, contributing to deep waters (e.g., Antarctic Deep Water vs. Antarctic Bottom Water). The ASC carries surface waters westward along the continental shelf break. This along-slope flow also acts to regulate mCDW transport onto the continental shelf.

Figure F6. Chronostratigraphic summary of Ross Sea drilling. Seismic stratigraphy is constrained by drilling in Victoria Land Basin (SR-VLB) but not in the Central and Eastern Basins (EB-RSU). Postcruise research from the Expedition 374 sites will reduce uncertainties associated with RSU2–RSU4 and assess the spatial coherency of these erosional features. Far-field climate ($\delta^{18}O$), CO_2, carbon cycle ($\delta^{13}C$), Equatorial Pacific carbonate compensation depth (CCD), and sea level records discussed in the text are indicated. TD = total depth, NJM = New Jersey margin.

Figure F7. A–D. TWT depth maps for selected regional seismic ANTOSTRAT unconformities with interpretations of ice sheet history (after Brancolini et al., 1995) and location of Expedition 374 sites. Maps of RSU4, RSU3, and RSU2 have now been extended into the continental slope and rise area (E. Olivo, unpubl. data; not shown) and into the western Ross Sea as part of the IPY Rossmap project. Gray shading in A shows the areas lying above sea level at the time of RSU6 on the basis of DSDP Site 270 stratigraphy. Site U1521 is located at the ocean margin of one of these areas, which subsided in the early Miocene and was cut by a large glacial valley by the early to mid-Miocene. Site U1521 will provide environmental information about paleo-ice stream and ocean current interplay during the middle Miocene. Site U1522 is located at the edge of a large embayment of the continental shelf in the eastern Ross Sea, where WAIS streams have carved glacial valleys since RSU3. Sites U1521–U1525 will provide subglacial ice-proximal (Site U1522), glaciomarine ice-proximal (Site U1523) to ice-distal (Sites U1525 and U1524) Miocene to Pleistocene records of past ice sheet/ocean interactions.

Figure F8. Composite seismic cross section of Lines PD90-34, PD90-35, and PD90-36 (after Anderson and Bartek, 1992; De Santis et al., 1995) showing a transect across the central Ross Sea that includes DSDP Sites 272 and 273 and Site U1521. The seismic-reflection profile and age constraint from the sites document that this area was filled with glacial sediments (~250 ms TWT thick) during the early Miocene, suggesting ice advance from the south or southwest. Green reflector = interpreted RSU4 carving a large southeast–northwest-oriented trough across the central Ross Sea (see Figure F7 for transect line). Site U1521 records sediment below and above RSU4, providing information of ice-volume growth and retreat during the early Miocene cooling, the middle Miocene, and the Middle Miocene Climatic Transition. Seismic lines are single-channel seismic-reflection profiles (air gun 2.6 l) collected by Rice University, TX (USA), in 1990 (Anderson and Bartek, 1992). SP = shotpoint.

Figure F9. Bathymetric map with locations of Site U1521, other Expedition 374 sites, DSDP Leg 28 Sites 270–273, and ANDRILL Cores AND-1 and AND-2. Red box = location of inset map with Site U1521 on seismic-profile Line PD90-36 (Figure F10). Bathymetry from Arndt et al., 2013.

Figure F10. Top: single-channel seismic-reflection Profile PD90-36 across Site U1521 (see inset in Figure F9) and DSDP Site 273. Profile (air gun 2.4 l) collected by Rice University, TX (USA), in 1990 (Anderson and Bartek, 1992). Bottom: interpretation of seismic reflectors and RSU4 in top panel. Arrows = reflector termination.

Figure F11. Site U1521 summary. Preliminary environmental interpretation is based on microfossils.

Figure F12. Bathymetric map with locations of Site U1522, other Expedition 374 sites, DSDP Leg 28 Sites 270–273, and ANDRILL Cores AND-1 and AND-2. Red box = location of inset map with Site U1522 on seismic-reflection profile Line I06290-Y2 (Figure F13). Bathymetry from Arndt et al., 2013a, 2013b.

Figure F13. Top: multichannel seismic-reflection Profile I06290-Y2 across Site U1522 (see inset in Figure F12). Profile collected by Istituto Nazionale di Oceanografia e Geofisica Sperimentale (OGS, Italy) under Programma Nazionale delle Ricerche in Antartide (PNRA) in 2005–2006 (Böhm et al., 2009) with a 2 × generator-injector (GI) gun array (11.6 L). Data were acquired with a 600 m streamer (48 channels; first offset = 50 m and last offset = 650 m). Bottom: interpretation of key seismic reflectors in Profile I06290-Y2.

Figure F14. Site U1522 summary. Preliminary environmental interpretation is based on microfossils.

Figure F15. Bathymetric map with locations of Site U1523, other Expedition 374 sites, DSDP Leg 28 Sites 270–273, and ANDRILL Cores AND-1 and AND-2. Red box = location of inset map with Site U1523 at the intersection of seismic-profile Lines IT17RS-301 and IT94AR-127A (Figure F16). Bathymetry from Arndt et al., 2013a, 2013b.

Figure F16. Multichannel seismic-reflection profile Line IT94AR-127A with location of Site U1523 at the cross point with Line IT17RS-301 (see inset in Figure F15). Profile collected by Istituto Nazionale di Oceanografia e Geofisica Sperimentale (OGS; Italy) under Programma Nazionale delle Ricerche in Antartide in 1994 (I. Finetti et al., unpubl. data). Seismic stack profile is available through the Antarctic Seismic Data Library System for scientific purposes. The source used was a 2 × 20 air gun array (74.8 l), and data were acquired with a 1500 m streamer (120 channels; first offset = 164 m and last offset = 1664 m). Reprocessing of Line IT94AR-127A for Expedition 374 was done by Riccardo Geletti (OGS). SP = shotpoint.

Figure F17. Site U1523 summary. Preliminary environmental interpretation is based on microfossils.

Figure F18. Bathymetric map with locations of Site U1524, other Expedition 374 sites, DSDP Leg 28 Sites 270–273, and ANDRILL Cores AND-1 and AND-2. Red box = location of inset map with Site U1524 on seismic-reflection profile Lines TAN0602_08 (Figure F19) and IT17RS-303B. Bathymetry from Arndt et al., 2013a, 2013b.

Figure F19. Top: multichannel seismic-reflection Profile TAN0602_08 with Site U1524 (see inset in Figure F18) at the crosspoint with seismic-reflection Profile IT17RS-303B. Profile collected by National Institute of Water and Atmospheric Research (NIWA) and GNS Science in 2006 using the R/V *Tangaroa* (Lindeque et al., 2016) with a 4 GI gun array (9.8 L). Data were acquired with a 300 m streamer (48 channels; near offset nominally = 129 m and far offset = 422 m) towed at a nominal depth of 10 m below the surface. Bottom: interpretation of key seismic reflectors in Profile TAN0602_08.

Figure F20. Site U1524 summary. Preliminary environmental interpretation is based on microfossils.

Figure F21. Bathymetric map with locations of Site U1525, other Expedition 374 sites, DSDP Leg 28 Sites 270–273, and ANDRILL Cores AND-1 and AND-2. Red box = location of inset map with Site U1525 on seismic-reflection profile Line IT94AR-127 (Figure F22). Bathymetry from Arndt et al., 2013a, 2013b.

Figure F22. Top: multichannel seismic-reflection Profile IT94AR-127 across Site U1525 (see inset in Figure F21). Profile collected by Istituto Nazionale di Oceanografia e Geofisica Sperimentale (OGS, Italy) under Programma Nazionale delle Ricerche in Antartide (PNRA) in 1994 (Finetti et al., unpubl. data) with a 2 × 20 air gun (74.8 L). Data were acquired with a 1500 m streamer (120 channels; first offset = 164 m and last offset = 1664 m). The seismic reflection stack profile is available for scientific purposes through the Antarctic Seismic Data Library System. Reprocessing for Expedition 374 was done by Riccardo Geletti (OGS, unpubl.). Bottom: interpretation of key seismic reflectors in Line IT94AR-127.

Figure F23. Site U1525 summary. Preliminary environmental interpretation is based on microfossils.

Figure F24. Composite seismic section illustrating the transect approach from the continental shelf to the slope and rise. The seismic data have different resolutions and penetration depths because they were collected by several nations with different parameters and targets. Line BGR80-007 (24–air gun array; 23.45 L) was collected by Bundesanstalt für Geowissenschaften und Rohstoffe (Germany) in 1980, Line ATC-208 (bolt-type air gun; 35.58 L) was collected by the Institut Français du Pétrole (France) in 1982, and Lines IT94-127A (2 × 20–air gun array; 74.8 L) and IT17RS-303B (air gun; 3.44 L) were collected by Istituto Nazionale di Oceanografia e Geofisica Sperimentale (Italy) under Programma Nazionale delle Ricerche in Antartide in 1994 and 2017, respectively.

Figure F25. Chronostratigraphy of Expedition 374 sites showing preliminary age constraints and locations of major lithologic boundaries and unconformities. Core numbers are at the right of each column, and ages in millions of years are at the left.

Figure F26. Microfossils from Ross Sea sediments, Expedition 374. Specimen sizes = ~20–200 µm. Diatoms: A. *Thalassiosira vulnifica* (U1523B-10F-CC). B. *Actinocyclus karstenii* (U1523B-10F-CC). C. *Actinocyclus* sp. B of Harwood and Maruyama (1992) (U1523E-16F-CC). D. *Actinocyclus maccollumii* (U1523E-10F-CC). Radiolarians: E. Actinommidid radiolarian (Hole U1523A mudline). F. Spongodiscidid radiolarian fragment (Hole U1523A mudline). G. *Spongoplegma* (?) spp. (Hole U1523A mudline). H. *Spongopyle* spp. (Hole U1523A mudline). Foraminifers: I. *Cibicidoides grossepunctatus* (U1523B-11F-CC). J. *Globocassidulina biora*, pustulose form (U1522A-2R-CC). K. *Globoconella inflata* (U1525A-16H-CC). L. *Nonionella iridea* (U1521A-21R-CC). Dinoflagellates: M. *Selenopemphix* sp. 1 (U1525A-27X-CC). N. *Selenopemphix bothrion* (U1523B-20F-CC). O. *Lejeunecista* sp. cf. *Lejeunecista communis* (U1523B-22F-CC). P. *Operculodinium*? *eirikianum* (U1521A-16R-CC).

Figure F27. Diatom specimens from Ross Sea sediments, Expedition 374. A–F. *Actinocyclus karstenii*. (A, D: U1523E-10F-CC; B–E and F [interior view]: U1523B-10F-CC). G. *Actinocyclus* sp. B of Harwood and Maruyama (1992) (U1523E-16F-CC). H. *Stellarima microtrias* (U1523B-10F-CC). I–K. *Actinocyclus maccollumii* (U1523E-10F-CC; I [interior view]). L. *Thalassiosira striata* (U1523E-16F-CC). M, N. *Thalassiosira vulnifica,* M with corroded valve (U1523E-10F-CC). O. *Thalassiosira webbi* (U1523B-10F-CC). P. *Thalassiosira kolbei* U1523B-10F-CC). Q, R (internal view), S, T. *Thalassiosira torokina* (Q, R: U1523E-10F-CC; S, T: U1523E-16F-CC).