Figure F1. A. Atlantis Massif showing main structural features, location of Lost City hydrothermal field (LCHF), Hole U1309D, and Site U1601 (core recovered in Holes U1601A and U1601C). Bathymetry was collected during Expedition 357 (Früh-Green et al., 2018; Escartín et al., 2022). Box = area of Figure F2. B. Full waveform inversion of Seismic Line Meg 4 and locations of Holes U1309D and U1601C with proposed site numbers. Blue = Expedition 399 core, pink = Expedition 304/305 core. Modified after Harding et al. (2016).

Figure F2. Location of previous drilling during Expeditions 304/305 and 357 (modified after Früh-Green et al., 2016). MeBo = Meeresboden-Bohrgerät 200 drill, RD2 = RockDrill2 drill. Expedition 399 holes are at Site U1309 (Hole U1309D; labeled U1309A–E) and between Sites M0069 and M0072 (Site U1601). LCHF = Lost City hydrothermal field.

Figure F3. Cell counts from interior portions of whole-round cores, Expedition 357. Shaded area = minimum quantification limit (MQL) of 9.8 cells/cm^3. Sediment (Sed) samples from Site M0069 have higher cell counts than other samples from similar depths. Cell counts are generally low; serpentinites at base of Hole M0069A are deepest samples with significant cell counts. From Früh-Green et al. (2018).

Figure F4. Expedition 399 operations summary. X = expedition. KFTS-1 = first KFTS deployment, KFTS-2 = second KFTS deployment.

Figure F5. Lithologic percentages. A. Hole U1601A. B. Hole U1601C. C. Site U1601. For grouping purposes, olivine gabbro includes orthopyroxene-bearing olivine gabbro, gabbro includes disseminated oxide gabbro, oxide gabbro includes oxide-bearing gabbro, gabbronorite includes olivine-bearing gabbronorite and disseminated oxide gabbronorite, and oxide gabbronorite includes oxide-bearing gabbronorite.

Figure F6. Lithostratigraphy, Hole U1601A. White = no recovery. Opx = orthopyroxene.

Figure F7. A. Basalt with filled vesicles, Hole U1601A. B. Thin section of sample from same section under cross polars with two vesicles now containing secondary minerals.

Figure F8. Basalt sample showing potential segregation veins (arrows = two examples), Hole U1601A.

Figure F9. Variation of spinel distribution in dunites, Hole U1601A. A. Trail of Cr-spinel, some of which contain alteration coronas. B, C. Patches of Cr-spinel (arrows) (C: plane-polarized light [PPL]).

Figure F10. Gradational lithologic boundary between orthopyroxene (Opx)-bearing dunite and dunite, Hole U1601A.

Figure F11. Deformed gabbronorite, Hole U1601A.

Figure F12. Harzburgite with granular orthopyroxene, Hole U1601A.

Figure F13. Harzburgite containing two types of orthopyroxene with contrasting grain shape and colors, Hole U1601A. Yellow arrows = granular, white arrows = interstitial.

Figure F14. Lithostratigraphy, Hole U1601C. White = no recovery. Opx = orthopyroxene.

Figure F15. Running average for harzburgites, dunites (including orthopyroxene-bearing dunites), and gabbroic rocks recovered using 20 m bin size and 2 m step size, Hole U1601C.

Figure F16. Modal proportions of ultramafic rocks, Hole U1601C. Data for MAR abyssal peridotite (Warren, 2016) is shown for comparison.

Figure F17. Downhole variation in orthopyroxene (Opx) abundance and grain size, clinopyroxene (Cpx) abundance, and spinel (Spl) abundance in peridotites, Hole U1601C.

Figure F18. Abundance-size relationships for orthopyroxene (Opx) in peridotites, Hole U1601C.

Figure F19. Orthopyroxene (Opx) grain size distribution in peridotites, Hole U1601C. Note progressive decrease in grain size between harzburgite, orthopyroxene-bearing dunite, and dunite.

Figure F20. Coarse-grained Cr-spinel trail in dunite, Hole U1601C.

Figure F21. Textural types of harzburgite, Hole U1601C. A. Relatively fresh harzburgite with granular orthopyroxene (Opx). B, C. Orthopyroxene-rich harzburgite with both granular and interstitial orthopyroxene and relatively high proportions of clinopyroxene (Cpx).

Figure F22. Dunite interval between two orthopyroxene-bearing dunites, Hole U1601C. Note gradational nature of the contact.

Figure F23. Paint splatter dunite, Hole U1601C. Dunite with relatively low proportion of orthopyroxene (Opx) that occurs as small, rounded to amoeboid grains, some of which occur in trails.

Figure F24. Dunite with sharp contact against surrounding harzburgite and coarse-grained granular spinel trail at the center (yellow arrows), Hole U1601C.

Figure F25. Progressive decrease in orthopyroxene (Opx) contents leading to formation of dunites, Hole U1601C. A. Harzburgite grading to orthopyroxene-bearing dunite. B. Small dunite zone with small proportion of orthopyroxene. C. Harzburgite grading to dunite with rare orthopyroxene. Well-developed orthopyroxene-free dunite.

Figure F26. Harzburgite with orthopyroxene that is entirely interstitial type, Hole U1601C.

Figure F27. Downhole variation in mineral abundance and orthopyroxene (Opx) grain size in (olivine [Ol]) websterite, wehrlite, and orthopyroxenite, Hole U1601C. Cpx = clinopyroxene, Spl = spinel.

Figure F28. A, B. Multiple olivine websterite intervals, hosted by dunite (Subunit 3B), Hole U1601C. C, D. Websterite clots in harzburgite (Unit 88).

Figure F29. Orthopyroxenite vein in harzburgite, Hole U1601C.

Figure F30. Wehrlitic vein composed of clinopyroxene trail in peridotite matrix, Hole U1601C.

Figure F31. A. Size distribution of gabbroic intervals recovered, Hole U1601C. B. Volume proportions of different sized gabbroic intervals recovered, Hole U1601C.

Figure F32. Gabbroic interval size as function of lithology for gabbroic rocks, Hole U1601C. Note that histograms count number of gabbroic intervals of each size that include given lithologies, but intervals do not have to be composed entirely of this lithology to be included. For example, troctolite and oxide gabbro occur preferentially in larger gabbroic intervals but typically only form a minor component of them.

Figure F33. Relationship between grain size of plagioclase (plag) and clinopyroxene (cpx) as function of different (A) lithologies and (B) textures, Hole U1601C. Ol = olivine, Ox = orthopyroxene.

Figure F34. Downhole variation in olivine (Ol) abundance, clinopyroxene (Cpx) abundance and grain size, plagioclase (Plag) abundance and grain size, and amphibole and Fe-Ti oxide abundance of mafic intrusions, Hole U1601C.

Figure F35. Textural variation in olivine gabbro, Hole U1601C. A. Relatively uniform medium-grained olivine gabbro with variations in grain size. B. Distinct olivine gabbro texture with equant olivine + plagioclase with small proportions of clinopyroxene. Olivine is partially (gray with mesh texture) to completely (black) serpentinized.

Figure F36. Cut surface showing discrete gabbronorite vein in harzburgite, Hole U1601C.

Figure F37. Troctolite domains within gabbros, Hole U1601C. A. Troctolite forming discrete domains consisting of plagioclase and (serpentinized) olivine. B. Contact between troctolite and gabbro, with troctolite forming propagating veins into gabbro. Top right side is pervasively altered. C. Troctolite vein with white plagioclase and black serpentinized olivine (left of center) in green ophitic gabbro (cut surface). D. Troctolite domains hosted by gabbro similar to one above but from intrusion at shallow levels of hole.

Figure F38. Cut surface illustrating features of oxide gabbro, Hole U1601C. This piece has abundant oxide and moderately abundant sulfides between coarse plagioclase (Plag) and clinopyroxene (Cpx) crystals.

Figure F39. Coarse-grained gabbro in contact with peridotite, Hole U1601C.

Figure F40. Large clinopyroxene (Cpx) growing off contact with peridotite, Hole U1601C.

Figure F41. Troctolite contacts between coarse-grained gabbros and peridotites, Hole U1601C. A. Troctolite contacts on both sides between gabbro intrusion and peridotite, with one side thicker than the other. Note interstitial habit of olivine in troctolite. B. Relatively thin troctolite contact between gabbro and peridotite, with euhedral plagioclase crystal growing across contact. C. Granular olivine in olivine gabbro to troctolite contact between coarse-grained gabbro and peridotite. D. Thick troctolite with olivine-rich parts at gabbro-peridotite contact.

Figure F42. Relative abundance of different textures in gabbroic rocks, Hole U1601C.

Figure F43. Cut surface illustrating pegmatitic clinopyroxene crystals (brown to gold colored crystals) and plagioclase (white to gray), Hole U1601C. Pegmatitic clinopyroxene was observed in several cores, where it typically grows roughly perpendicular to gabbro-peridotite contacts within gabbro.

Figure F44. Relationship between size of gabbroic intervals and average grain size of plagioclase (blue) and clinopyroxene (green), Hole U1601C. Note that grain size peaks in intervals in decimeter–meter range and then decreases in larger interval.

Figure F45. A. Grain size layering (contact outlined by black lines), Hole U1601C. B. Gabbro with patchy grain size variations.

Figure F46. Cut surface illustrating seriate grain size distribution of clinopyroxene, Hole U1601C.

Figure F47. Impregnation vein, Hole U1601C.

Figure F48. Diffuse gabbroic vein in harzburgite, Hole U1601C. Diffuse nature may, in part, relate to alteration overprint.

Figure F49. Contact between gabbro and diorite domains illustrating incipient replacement of clinopyroxene by hornblende at reactive boundary between domains, Hole U1601C.

Figure F50. A. Hornblende-ilmenite diorite with centimeter-scale domains of plagioclase in matrix of hornblende and ilmenite with minor titanite, plagioclase, and sulfides, Hole U1601C. B. Deformed and annealed plagioclase domains in matrix dominated by hornblende and ilmenite (cross-polarized light [XPL]).

Figure F51. Relatively fresh harzburgite showing abundant relict olivine and largely fresh orthopyroxene (Opx) and sparse clinopyroxene (Cpx). A, B. 399-U1601C-149R-3, 94–97 cm (TS134) (A: PPL, B: XPL). C, D. 148R-3, 118–121 cm (TS133) (C: PPL, D: XPL).

Figure F52. Serpentinized dunite (399-U1601A-5R-1, 89–91 cm [TS5]; XPL). Remnant olivine and Cr-spinel are labeled.

Figure F53. Orthopyroxene-bearing dunite illustrating the granular texture of orthopyroxene (399-U1601A-8R-2, 14–16 cm [TS13]; XPL).

Figure F54. Clinopyroxene associated with orthopyroxene in harzburgite (399-U1601A-10R-1, 78–80 cm [TS16]; XPL).

Figure F55. Vermicular Cr-spinel in harzburgite (399-U1601A-10R-1, 78–80 cm [TS16]; PPL).

Figure F56. Plagioclase zoning intensity, Hole U1601C.

Figure F57. Poikilitic gabbronorite with hybrid orthopyroxene-clinopyroxene oikocryst (399-U1601C-35R-2, 120–123 cm [TS75]; XPL).

Figure F58. Cataclastically deformed gabbro with plagioclase- and clinopyroxene-rich domains (399-U1601C-131R-1, 43–46 cm [TS80]; XPL).

Figure F59. Oxide gabbro with inverted pigeonite (399-U1601C-163R-2, 111–113 cm [TS102]; XPL).

Figure F60. Olivine crystal cluster and complex intergrowth of clinopyroxene and olivine gabbro (399-U1601C-151R-2, 15–17 cm [TS95]; XPL).

Figure F61. Oxide gabbro with poikilitic clinopyroxene (399-U1601C-163R-2, 111–113 cm [TS102]; PPL). Chadacrysts are oxide and plagioclase. Late wispy oxide also coats clinopyroxene.

Figure F62. Olivine gabbro with domains of polycrystalline plagioclase and polycrystalline olivine (399-U1601C-172R-1, 136–138 cm [TS107]; XPL). Plagioclase domain internally has annealed texture, whereas reaction relationships are evident between olivine and plagioclase in contact with clinopyroxene.

Figure F63. Troctolite with polycrystalline plagioclase and olivine domains as well as lesser clinopyroxene and orthopyroxene showing orthopyroxene associated with olivine without reaction relationship, which is consistent with origin by mingling of gabbro and mantle peridotite at temperatures near or above gabbro solidus (399-U1601C-139R-1, 89–92 cm [TS89]; XPL).

Figure F64. Downhole variation of background alteration in mafic rocks and serpentinized peridotites based on macroscopic and microscopic observations, Hole U1601A. Estimations from microscopic observations are displayed for comparison (red squares). A. Alteration extent of each mineral and total alteration intensity. B. Primary mineral abundance (open diamonds) and proportion of primary mineral altered to secondary hydrothermal minerals (solid diamonds).

Figure F65. Downhole variation of vein distribution in mafic rocks and serpentinized peridotites, Hole U1601A. Amp = amphibole, Chl = chlorite, Ep = epidote, Carb = carbonate, Pl = plagioclase, Qz = quartz, Srp = serpentine, Br = brucite, Zeo = zeolite, Ox = oxide.

Figure F66. Serpentinized dunite and harzburgite, Hole U1601A. A. Serpentinized dunite containing Cr-spinel (Spl) layer (5R-1, 140–147 cm). B. Serpentinized harzburgite showing two types of bastite after orthopyroxene (Opx), green and gray (10R-1, 18–24 cm). C. Mesh texture after olivine (Ol) in serpentinized dunite (5R-1, 89–91 cm [TS5]). Olivine relicts persist in some mesh cores. Spinel is less altered. D. Serpentine (Srp)-chlorite (Chl)-talc (Tlc) assemblages in bastite after orthopyroxene in serpentinized harzburgite (8R-1, 76–78 cm [TS12]). Former orthopyroxene is surrounded by chlorite or antigorite (Atg) rim. E. Chlorite rim around spinel in serpentinized dunite (5R-1, 89–91 cm [TS5]). F. Olivine relicts close to bastite in serpentinized harzburgite (8R-1, 76–78 cm [TS12]).

Figure F67. Mesh interiors and olivine relicts in serpentinized dunite, Hole U1601A (TS6). A. Serpentine (Srp) and iowaite inferred to be replacing brucite in mesh core after olivine (Ol), and mesh rims are made of magnetite (Mag)-serpentine veins. B. Close-up of olivine relicts containing trails of secondary fluid inclusions.

Figure F68. Alteration minerals and textures of altered gabbronorite, Hole U1601A. A. Foliated gabbronorite. B, C. Minerals and prehnite (Prh)-epidote (Ep) vein (TS7; B: PPL, C: XPL). Box = location of G–I. D. Minerals (TS8; XPL). E. Minerals (TS7; XPL). F. Minerals and prehnite-chlorite (Chl) vein (TS8; XPL). G, H. Spherulitic texture filling porosity and dark vug space and radiating prehnite (TS7; G: PPL, H: XPL). I. Opaque material filling vug as last stage of spherulitic fill (TS7; reflected light [RL]). Amp = amphibole, Cpx = clinopyroxene, fPl = former plagioclase, fPx = former pyroxene, Grt = garnet, Opx = orthopyroxene, Pl = plagioclase, Px = pyroxene.

Figure F69. Alteration minerals and textures of gabbroic veins, Hole U1601A. A. Gabbroic vein in serpentinized harzburgite. B. Mode of occurrence of minerals (TS11; XPL). C. Minerals in gabbroic vein (TS11; PPL). D. Minerals in host serpentinite (TS11; XPL). Amp = amphibole; Arg = arrgillite; Chl = chlorite; Cpx = clinopyroxene; Cpx II = secondary clinopyroxene, possibly diopside; Ctl = chrysotile; fPl = former plagioclase; Grt = garnet; Opx = orthopyroxene; Px = pyroxene.

Figure F70. Alteration minerals, textures, and veins in basalt, Hole U1601A. A. Altered basalt and epidote (Ep) veins. B, D. Mode of occurrence of minerals (TS1; B: XPL, D: PPL). C, E. Mode of occurrence of minerals (TS2; C: XPL, E: PPL). Amp = amphibole, Chl = chlorite, fPl = former plagioclase, fPx = former pyroxene, Pl = plagioclase, Qz = quartz, Tlc = talc, Ttn = titanite.

Figure F71. Downhole variation of background alteration and vein distribution in gabbroic rocks and serpentinized peridotites, Hole U1601C. (Continued on next three pages.)

Figure F72. Main vein types in serpentinized peridotites and at serpentinized peridotite/gabbroic contacts, Hole U1601C. Scale bars = 1 cm. A. Set of white, fibrous to massive, subparallel horizontal transgranular to locally paragranular chrysotile (Ctl) veins cutting serpentinized harzburgite. B. Hydrothermally overprinted magmatic vein of clinopyroxene (Cpx), amphibole(?), prehnite (Prh), and secondary plagioclase (2nd Pl) cut by set of green massive picrolite veins. C. Contact between serpentinized peridotite and altered gabbro. Set of talc (Tlc)-carbonate (Cb) veins branches at contact and further continues in gabbro but not in serpentinite. A few picrolite veins cut through serpentinite and grade to prehnite veins when propagating in gabbro. D. Hydrothermally overprinted magmatic vein cut by set of composite chrysotile-picrolite veins. Picrolite vanishes away from magmatic vein. Amp = amphibole, Pl = plagioclase.

Figure F73. Variably serpentinized peridotite, Hole U1601C. Scale bars = 1 cm. A. Highly serpentinized harzburgite (~70%) with common orthopyroxene (Opx) and olivine (Ol) relicts. Note that chrysotile (Ctl) veins are absent. B. Highly serpentinized harzburgite (~90%) containing green and gray bastite after orthopyroxene. Serpentinite is cut by set of subparallel chrysotile veins. C. Highly serpentinized harzburgite (>90%) containing black and gray bastite after orthopyroxene. Black areas are commonly found around bastite. Serpentinite is cut by a few chrysotile veins. D. Highly serpentinized harzburgite (>90%) containing relicts of orthopyroxene surrounded by black bastite. Serpentinite is cut by set of chrysotile veins. Mag = magnetite.

Figure F74. Variation in serpentinization degree, Hole U1601C. A. Highly serpentinized harzburgite showing typical mesh texture to hourglass texture with abundant magnetite (Mag) forming in mesh rims with no olivine (Ol) preserved (PPL). Mesh texture is cut by late serpentine (Srp) + clay vein containing minor Fe-hydroxides and fine-grained serpentine vein that contains euhedral sulfide minerals (likely pyrite) along edge of vein. B. Serpentinized harzburgite showing patchy alteration with locally abundant olivine preserved, whereas in places olivine grains are entirely replaced by a serpentine + magnetite mesh texture (XPL). Orthopyroxene is partly replaced by serpentine, amphibole and clay minerals forming bastite textures.

Figure F75. Main alteration features of gabbroic rock contacts, Hole U1601C. Scale bars = 1 cm. A. Contact between ductilely deformed and isotropic gabbro. Amphibole (Amp) veins cut through isotropic gabbro. Secondary plagioclase (2nd Pl) and chlorite (Chl) form after plagioclase. B. Highly deformed and altered (prehnite [Prh]) gabbro cut by chlorite-amphibole veins overprinted by late carbonate(?) (Cb) veins. C. Highly altered and bleached gabbro composed of amphibole, secondary plagioclase, and prehnite and cut by late possible zeolite veins. D. Contact between altered gabbro and serpentinized peridotite. Toward the contact, degree of alteration in gabbro increases and igneous minerals are completely replaced by amphibole, secondary plagioclase, and prehnite. It is cut by late talc-carbonate-prehnite veins. E. Talc-carbonate veins cutting through a deformed gabbro. Talc, prehnite, and possibly clay minerals pervasively replace gabbro at vicinity of veins. Zeo = zeolite.

Figure F76. Mode of occurrence of olivine alteration minerals, Hole U1601C. A, B. Amphibole (Amp) + chlorite (Chl) formation after olivine (Ol) (36R-1, 128–131 cm [TS78]; A: PPL, B: XPL). C, D. Amphibole + chlorite + biotite (Bt) formation after olivine (153R-2, 37–39 cm [TS97]; C: PPL, D: XPL). E, F. Serpentine formation after olivine (139R-1, 89–92 [TS89]; E: PPL, F: XPL). G, H. Clay formation after olivine (35R-2, 136–140 cm [TS76]; G: PPL, H: XPL). Cpx = clinopyroxene, Pl = plagioclase, Prh = prehnite, Srp = serpentinite.

Figure F77. Mode of occurrence of pyroxene alteration minerals, Hole U1601C. A, B. Brown amphibole (Amp) (199R-1, 80–82 cm [TS118]; A: PPL, B: XPL). C, D. Brown amphibole (199R-1, 11–14 cm [TS117]; C: PPL, D: XPL). E, F. Replacement of clinopyroxene (Cpx) and orthopyroxene (Opx) by brown and green amphibole (172R-2, 44–47 cm [TS109]; E: PPL, F: XPL). G, H. Replacement of clinopyroxene by brown and green amphibole (131R-3, 66–68 cm [TS83]; G: PPL, H: XPL). I, J. Replacement of clinopyroxene and orthopyroxene by brown, green, and colorless amphibole (22R-2, 3–7 cm [TS71]; I: PPL, J: XPL). K, L. Replacement of clinopyroxene by chlorite (Chl) and/or clay minerals (165R-1, 51–53 cm [TS103]; K: PPL, L: XPL). M, N. Clinopyroxene pseudomorph and vein composed of chlorite and/or clay minerals (134R-2, 109–114 cm [TS87]; M: PPL, N: XPL). Pl = plagioclase. (Continued on next two pages.)

Figure F78. Mode of occurrence of plagioclase alteration minerals, Hole U1601C. A, B. Prehnite formation along microcracks in plagioclase (Pl) (35R-1, 80–83 cm [TS73]; A: PPL, B: XPL). C, D. Plagioclase alteration along zeolite veins (184R-2, 4–7 cm [TS114]; C: PPL, D: PPL). Ol = olivine, Prh = prehnite.

Figure F79. Hydrothermally altered magmatic veins and metasomatic zones between serpentinites and mafic lithologies, Hole U1601C. A, B. Metasomatic zone of amphibole (Amp), chlorite (Chl), clay, and talc (Tlc) intruded into serpentinite (Srp). Chlorite, amphibole, talc, and clay show mylonitic textures. Near contact with serpentinite, amphibole is replaced by clay minerals. Olivine (Ol) is locally preserved near contact with serpentinite. C, D. Statically altered magmatic vein where clinopyroxene (Cpx) is altered to amphibole and chlorite and plagioclase is altered to chlorite, garnet (Grt), and minor prehnite (Prh). E, F. Serpentinite cut by metasomatic veins. Metasomatic veins are composed of large, euhedral, locally kinked amphibole crystals. Locally, primary magmatic texture is still preserved and orthopyroxene and plagioclase (Pl) are replaced by amphibole, chlorite, prehnite, and talc. G, H. Contact between serpentinized harzburgite and troctolite showing increase of alteration from serpentinite contact into troctolite. Olivine in contact with plagioclase contains chlorite coronae, whereas core is comprised of amphibole and serpentine. Mag = magnetite.

Figure F80. Sulfide mineralization in serpentinized peridotites and gabbroic rocks, Hole U1601C. A. Altered gabbro cut by thick vein of sulfides and white mineral (possibly zeolite [Zeo] or chalcedony). B. Altered olivine (Ol) gabbro-serpentinized peridotite contact showing sulfide and clay minerals formation after olivine in olivine gabbro. Massive serpentine veins cut through peridotite and branch onto gabbro. C. Altered and mineralized olivine gabbro/troctolite. Olivine is replaced by clay minerals and sulfide. D. Piece made of carbonate-chalcopyrite-bornite vein. E. Mineralized serpentinized harzburgite cut by network of sulfide (Sulf)-carbonate (Cb) ± serpentinite veins. Brownish aspect of serpentinite (Srp) is likely due to presence of disseminated sulfides grains in mesh. F. Sulfide coating at piece ends of serpentinized peridotite. It forms apparent slickensides, probably after former serpentine. G. Zeolite or chalcedony-chalcopyrite (Ccp)-pyrrhotite (Po) and/or pyrite-sphalerite (Sp) vein cutting through altered gabbro (TS75). H. Pyrrhotite and clay minerals/serpentine assemblages after former olivine in olivine gabbro (TS74).

Figure F81. Secondary fluid inclusions in (A, B) olivine (Ol) (TS73) and (C, D) plagioclase (Pl) (TS85) of gabbroic rocks, Hole U1601C. Cpx = clinopyroxene.

Figure F82. Subophitic diabase showing isotropic igneous texture (399-U1601A-2R-1, 9–12 cm [TS1]; XPL).

Figure F83. Downhole variations in mantle and serpentine fabric intensity and orientation, Hole U1601A.

Figure F84. Planar mantle foliation defined by trains of Cr-spinel (line; measured dip = 27°; 399-U1601A-5R-1, 100–109 cm).

Figure F85. SPO of elongate, pale green orthopyroxene grains (Generation 1) defining subhorizontal, porphyroclastic mantle fabric (399-U1601A-8R-3, 37–44 cm).

Figure F86. Harzburgite hosting two generations of orthopyroxene, identified by color and grain shape (399-U1601A-10R-1, 18–24 cm). Generation 1 (opx1): pale green, rounded, and elongate orthopyroxene typically have SPO that defines mantle fabric (see Figure F85). Generation 2 (opx2): gray, irregular shaped orthopyroxene showing no SPO. In this figure Generation 2 is dominant orthopyroxene.

Figure F87. Serpentine mesh texture with horizontally aligned, needle-shaped oxide grains delineating cleavage planes of former pyroxene (399-U1601A-5R-1, 58–86 cm [TS4]; PPL). Early magnetite-bearing serpentine vein is cut by late magnetite-poor serpentine crack seal vein.

Figure F88. Crystal-plastic (CP) fabric intensity and orientation, degree of brittle fault rock deformation, and brittle fault/fracture dip, Hole U1601A.

Figure F89. Gabbronorite hosting well-defined, subhorizontal, protomylonitic foliation (399-U1601A-6R-1, 23–30 cm). Spherical nodules identified as prehnite and chlorite rosettes are visible at 27 cm on the right, associated with plagioclase.

Figure F90. Rare high-temperature, ductile deformation recorded in rocks, Hole U1601A. A. Gabbronorite-relict and recrystallized plagioclase display core-mantle structure, with surrounding recrystallized plagioclase (6R-1, 25–28 cm [TS7]; XPL). B. Gabbronorite with fish-shaped orthopyroxene porphyroclasts defining protomylonitic fabric (6R-1, 48–51 cm [TS8]; XPL). Orthopyroxene is replaced by amphibole and talc. Felsic microlithons observed are totally replaced by chlorite and prehnite.

Figure F91. Downhole variations in vein and fracture density rank, Hole U1601A.

Figure F92. Alteration vein relationships in serpentinized peridotite, Hole U1601A. A. Serpentine mesh texture defined by magnetite + serpentine veins, cut by younger oxide-rich veins and late serpentine (chrysotile?) veins (5R-1, 58–86 cm [TS4]; unoriented; XPL). B. Three generations of veins in serpentinized harzburgite: 1 = thin, moderately inclined serpentine vein; 2 = horizontal blue-gray fibrous serpentine vein; 3 = carbonate vein with crack-seal relationship with vein Generation 2 (8R-1, 38–40 cm [TS11]; unoriented; XPL).

Figure F93. Serpentine veins radiating from bastite into surrounding mesh texture (399-U1601A-5R-1, 124.5–128 cm [TS6]; XPL).

Figure F94. Gently dipping (25°–30°), faulted composite cross-fiber vein with serpentine and chlorite outer vein and core of fault breccia with clasts of sheet silicate (phlogopite?) (399-U1601A-5R-1, 89–91 cm [TS5]; XPL).

Figure F95. Downhole distribution of structural geology measurements, Hole U1601C. Gray bars = high-strain zones. Mantle fabric index: 0 = protogranular, 1 = porphyroclastic-weakly foliated, 2 = porphyroclastic-strongly foliated, 3 = porphyroclastic/protomylonitic, 4 = mylonitic, 5 = ultramylonitic, 6 = undetermined. Serpentine foliation index: 0 = no mesh, 1 = incipient mesh, 2 = regular mesh, 3 = weakly foliated mesh, 4 = moderately foliated mesh, 5 = strongly foliated mesh, 6 = undetermined. Crystal-plastic (CP) fabric intensity: 0 = undeformed, 1 = weakly foliated/lineated, 2 = strongly foliated/lineated, 3 = protomylonitic, 4 = mylonitic, 5 = ultramylonitic. Brittle deformation rank: 1 = fractured, 2 = microfault, 3 = fault/piece-end fault surface/fault gouge/fault breccia, 4 = cataclasite, 5 = ultracataclasite.

Figure F96. Downhole variation of magmatic vein (<2 cm thick) dip and histograms (15° bins) of vein dip in blocks between each shear zone or zone of distributed deformation, Hole U1601C. Gray bars = crystal-plastic high-strain zones (1–5).

Figure F97. Character of magmatic veins, Hole U1601C. A. Planar contact between gabbroic vein and serpentinized harzburgite (169R-2, 112–129 cm). B. Magmatic infiltration vein (clinopyroxene and plagioclase) cutting serpentinized harzburgite (175R-3, 89–100 cm). C. Gently dipping intrusive contact between coarse-grained gabbro and harzburgite (70R-3, 30–39 cm).

Figure F98. Contact orientations between gabbro and host harzburgite and intragabbro contacts, Hole U1601C.

Figure F99. Nature of intrusive contacts, Hole U1601C. A. Irregular gabbro contact with serpentinized harzburgite (128R-1, 2–40 cm). B. Chilled margin of microgabbro against serpentinized harzburgite (178R-1, 45–60 cm) C. Steeply dipping intrusive contact gabbro into harzburgite (166R-2, 65–73 cm).

Figure F100. Dip in intervals hosting rarely developed magmatic fabrics, including (A) SPO of plagioclase or pyroxene and/or (B) grain size or modal banding, Hole U1601C.

Figure F101. A. Subvertical modal banding in gabbro (399-U1601C-128R-1, 2–40 cm). B. Subvertical modal and grain size banding between troctolite and poikilitic microgabbro (35R-2, 133–147 cm). C. Grain size layering in gabbronorite (199R-1, 50–63 cm). D. Grain size layering in gabbronorite (199R-3, 35–42 cm).

Figure F102. Relationships between diabase intrusion(s) and deformation, Hole U1601C. A. Undeformed diabase intruded into mylonitic, oxide-bearing gabbro; contact at 849 mbsf (172R-2, 16–22 cm) B. Character of deformation in mylonitic gabbro and diabase (134R-2, 126–130 cm [TS88]; XPL).

Figure F103. Downhole variations of mantle and serpentine fabrics, Hole U1601C. Gray bars = high-strain zones as described in crystal-plastic deformation. B. Mantle contact dips (harzburgite-dunite, dunite-websterite, or harzburgite-websterite). C. Mantle fabric dips. D. Serpentine foliation dips.

Figure F104. Distribution of different mantle fabric types in sampled peridotites, Hole U1601C.

Figure F105. Protogranular fabric in harzburgite with amoeboidal grain boundaries of orthopyroxene (greenish gray) (399-U1601C-148R-2, 10–20 cm).

Figure F106. Serpentinized harzburgite with porphyroclastic fabric, Hole U1601C. A. SPO of elongate orthopyroxene with tails (213R-2, 4–16 cm). B. Porphyroclastic weakly foliated fabric showing serpentinized pyroxene clasts and aggregates of pyroxene with parallel aligned long axes (192R-2, 5–8 cm [TS237]; XPL). C. Serpentinized orthopyroxene (Opx) with slightly bent cleavage (175R-1, 85–87 cm [TS141]; XPL).

Figure F107. A. Serpentinized protomylonitic harzburgite showing tails to elongate orthopyroxene suggesting dynamic recrystallization during deformation (399-U1601C-229R-1, 78–86 cm). B. Fish-like amphibole clasts in unstructured serpentine matrix indicate that deformation happened after serpentinization (128R-3, 54–56 cm [TS202]; XPL).

Figure F108. Distribution of serpentine mesh foliation types in serpentinized peridotites, Hole U1601C.

Figure F109. A. Serpentinized harzburgite with incipient mesh (399-U1601C-148R-3, 100–110 cm). Bright spots = unaltered olivine (Ol) and orthopyroxene. B. Serpentine-magnetite veins between relict olivine grains forming incipient mesh (147R-2, 145–147 cm [TS131]; XPL). C. Further developed incipient mesh with zoned mesh cells around relict olivine cores in same sample.

Figure F110. A. Serpentinized harzburgite with patchy normal mesh in areas between pyroxene (399-U1601C-10R-2, 35–44 cm). B. Regular mesh with magnetite aggregates surrounding serpentine mesh cells (136R-4, 110–112 cm [TS209]; XPL, lambda-plate inserted).

Figure F111. A. Foliated mesh in dunite interval between websterite with subparallel anastomosing black magnetite (Mgt) veins (399-U1601C-10R-2, 68–73 cm). B. Weakly foliated mesh with parallel magnetite aggregates (192R-2, 5–8 cm [TS237]; PPL). C. Strongly foliated mesh with closely spaced parallel magnetite aggregates (161R-2, 4–7 cm [TS222]; PPL).

Figure F112. Crystal-plastic (CP) fabric intensity, dip, and shear sense (macro- and microscopic) between 0 and 1300 mbsf, Hole U1601C. Crystal-plastic fabric intensity index: 0 = undeformed, 1 = weakly foliated/lineated, 2 = strongly foliated/lineated, 3 = protomylonitic, 4 = mylonitic, 5 = ultramylonitic. Gray bars = high-strain Zones 1–7.

Figure F113. Crystal-plastic fabric dip for each deformation zone, plotted with 15° bin widths, Hole U1601C. A. Crystal-plastic fabric dips for all low-strain (LS) zones. B–H. Crystal-plastic fabric dips for each individual high-strain (HS) zone (1–7). I. Crystal-plastic fabric dips for all high-strain zones.

Figure F114. Macroscopic crystal-plastic deformation (wet images), Hole U1601C. A. Gabbroic protomylonite (176R-1, 81–90 cm). B. Oxide gabbro protomylonite (159R-3, 8–13 cm). C. Gabbroic mylonite to ultramylonite in contact with peridotite (dark brown, bottom right), reverse shear sense; undeformed talc ± carbonate ± prehnite veins cut mylonite (176R-1, 81–90 cm). D. Oxide gabbro with protomylonitic, mylonitic, and ultramylonitic domains, controlled by variability of protolith grain size and/or lithology (130R-4, 30–45 cm). E. Gabbroic mylonitic to ultramylonite discrete shear zone, normal shear sense (131R-1, 50–72 cm). F. Gabbroic ultramylonite (134R-2, 100–114 cm; unoriented). G. Irregular sheared contacts between mylonitic gabbroic rock (gray) and protomylonitic peridotite (dark brown); alteration veins cut mylonitic fabric (178R-2, 12–27 cm). H. Sheared contact between protomylonitic gabbroic rock (gray) and protomylonitic peridotite (dark brown-gray, top left); green-white talc ± carbonate ± prehnite alteration and veins overprint and cut mylonitic fabric (156R-3, 77–78 cm).

Figure F115. Microscopic crystal-plastic deformation, Hole U1601C. A. Low-strain dynamic recrystallization of plagioclase in seemingly macroscopically undeformed isotropic gabbro (22R-2, 3–7 cm [TS71]; XPL). B. Crystal-plastically foliated gabbro (165R-1, 61–63 cm [TS104]; XPL). Plagioclase (Pl) has undergone GSR dynamic recrystallization, whereas aligned clinopyroxene (Cpx) is relatively undeformed and displays SPO that is probably of magmatic origin but now controls crystal-plastic foliation development. C. Low-strain protomylonite/strongly foliated gabbro (172R-2, 36–39 cm [TS108]; PPL). Aligned olivine (Ol) is weakly deformed and displays SPO that is probably of magmatic origin (given low-strain nature of fabric) but now controls crystal-plastic foliation development. Fine-grained domain at bottom of image is diabase (db) showing minor recrystallization. D. Protomylonitic fabric in gabbro (131R-3, 66–68 cm [TS83]; XPL). Recrystallized plagioclase with has strong subgrain fabric (white arrows). E. Protomylonitic to mylonitic gabbro (131R-2, 62–64 cm [TS82]; XPL with lambda plate). Plagioclase is recrystallized, forming foliation-parallel monomineralic layers with strong CPO indicated by blue color from lambda plate. Recrystallized pyroxene (pyR) in pressure shadows. F. Recrystallized plagioclase with subgrains and serrated grain boundaries (white arrows) (163R-2, 75–79 cm [TS105]; XPL). G. Recrystallized plagioclase with subgrains, amoeboidal grain boundaries, and irregular grain shapes (194R-1, 42–45 cm [TS115]; XPL). H. Oxide gabbro ultramylonite with recrystallized plagioclase showing equant, block to rounded grain shape (206R-1, 22–25 cm [TS120]; XPL). I. Oxide gabbro with recrystallized brown amphibole (Amp) (magmatic or metasomatic) with foliation-parallel SPO (163R-1, 33–36 cm [TS101]; PPL). J. Ultramylonite with ultrafine band of <2 µm unidentified mineral (white arrows, top left) (133R-1, 19–22 cm [TS85]; PPL). K. Oxide gabbro ultramylonite (top right) against protomylonitic gabbro (bottom left) (206R-1, 22–25 cm [TS120]; XPL). L. Mylonite with recrystallized, monomineralic plagioclase- and pyroxene-rich layers (172R-2, 16–19 cm [TS109]; PPL). Undeformed, interstitial brown amphibole with pyroxene, suggests amphibole crystallization from a postkinematic melt infiltration or late metasomatism (white arrows). Undeformed green amphibole (AmpG) veins and alteration overprint and cut plagioclase and pyroxene layers (black arrows).

Figure F116. Macroscopic brittle deformation, Hole U1601C. A. Cataclasis in gabbro (184R-1, 53–63 cm). B. Microfaulting; 6 subparallel reverse faults with >1 cm offset of contact gabbro harzburgite (dip = 40°–55°), each with sheared vein fill (212R-2, 42–50 cm). C. Cataclastic overprint reworking mylonitic gabbro characterized by microfracturing and grain rotation (178R-1, 125–150 cm).

Figure F117. Microscopic brittle deformation, Hole U1601C. A. Whole thin section scan showing microscale cataclastic deformation in talc altered gabbro (176R-2, 95–98 cm [TS111]; XPL). B. Whole thin section scan showing localized fracture and cataclastic altered gabbro (200R-1, 36–39 cm [TS110]; PPL). C. Isotropic gabbro (showing no dynamic recrystallization), cut by microfaults and fractures (151R-1, 22–25 cm [TS91]; PPL). Thin talc veins truncate amphibole veins, with talc veins reactivated as microfault with normal sense offset.

Figure F118. Downhole variation in intensity of recovered brittle structures (Rank 0–5), dip, and shear sense based on macro- or microscopic observations, Hole U1601C. Dip of planes and plunge of slickenfibers on veins at piece end faults are included. Chrysotile slickenfibers in serpentinized harzburgite, and slickenside striae of chalcopyrite in gabbronorite (204R-2, 40–47 cm).

Figure F119. Downhole variation in vein type, Hole U1601C. Vein type, density, and orientation vary by rock type and depth throughout hole. Veins cutting serpentinized harzburgite and dunite include (1) magmatic veins cut by perpendicular pale green picrolite (serpentine) veins; (2) green composite serpentine-magnetite, picrolite (serpentine), and/or rare chlorite veins; (3) white carbonate; and (4) thin white chrysotile veins. Veins cutting gabbroic cores include (1) black to dark green amphibole, (2) green chlorite and/or talc veins, (3) white carbonate-sulfide and prehnite veins, and (4) white zeolite and clay veins.

Figure F120. Macroscopic character of veins, Hole U1601C. A. Magmatic vein cut by picrolite veins in serpentinized harzburgite. B. Oxide gabbro protomylonite to mylonite cut by perpendicular amphibole veins. C. Oxide gabbro cut by green talc and white prehnite and carbonate veins (172R-1, 104–117 cm). D. Mylonitic gabbro with reverse shear sense (dip 45°) cut by gently dipping green talc vein (129R-3, 67–81 cm). E. Gently dipping talc vein cutting protomylonitic gabbro (175R-1, 0–18 cm). F. Subhorizontal little white chrysotile vein cutting serpentinized harzburgite (148R-2, 10–20 cm). G. Subhorizontal carbonate vein cutting serpentinized harzburgite (205R-1, 139–146 cm).

Figure F121. Microscopic character of veins, Hole U1601C. A. Steeply dipping green-brown amphibole vein cuts mylonitic gabbro (131R-2, 57–60 cm [TS81]; XPL). B. Thin chlorite vein cutting fractured plagioclase (153R-1, 96–99 cm [TS96]; XPL). C. Crosscutting chlorite (gray) and clay veins (134R-2, 109–114 cm [TS87], unoriented; XPL). D. Chlorite-clay vein with 40° dip (163R-2, 81–85 cm [TS105]; PPL).

Figure F122. Solute concentration (Cl) and molar ratios (Na/Cl, Mg/Cl, Ca/Cl, nitrate/Cl, K/Cl, Li/Cl, Sr/Cl, B/Cl, and sulfate/Cl) using KFTS (blue circles) and Niskin samplers (red squares; bottom seawater), Hole U1601C. Yellow diamond = contaminated KFTS sample.

Figure F123. (A) Total H_2O versus LOI and (B) total CO_2 versus total H_2O of geochemistry rock samples and (C) total CO_2 versus total H_2O of geochemistry and microbiology rock samples, Site U1601. Opx = orthopyroxene.

Figure F124. LOI and total H_2O, total CO_2, and inorganic CO_2 of geochemistry rock samples, Site U1601. Opx = orthopyroxene.

Figure F125. LOI and total H_2O, total CO_2, and inorganic CO_2 of geochemistry and microbiology rock samples, Site U1601. Opx = orthopyroxene.

Figure F126. Volatile-free SiO_2, CaO, MgO, and FeO concentrations versus Al_2O_3 of serpentinized peridotites (geochemistry samples only), Site U1601. Compositions of Site 1272 and 1274 peridotites (15°20′, Leg 209) are shown for comparison (data: Shipboard Scientific Party, 2004; Paulick et al., 2006; Godard et al., 2008) as well as compilation of orogenic, ophiolitic, and oceanic peridotites compositions (references in Bodinier and Godard, 2013). Also shown are compositions of peridotites and impregnated peridotites previously recovered at Atlantis Massif during Expeditions 357 and 304/305 (Whattam et al., 2022; Expedition 304/305 Scientists, 2006a; Godard et al., 2009). See Figure F123 for Site U1601 symbol legend.

Figure F127. Volatile-free SiO_2, CaO, MgO, and FeO versus Al_2O_3 of serpentinized peridotites (geochemistry and microbiology samples), Site U1601. Compositions of Site 1272 and 1274 peridotites (15°,20′, Leg 209) are shown for comparison (data: Shipboard Scientific Party, 2004; Paulick et al., 2006; Godard et al., 2008) as well as compilation of orogenic, ophiolitic, and oceanic peridotites compositions (references in Bodinier and Godard, 2013). Also shown are compositions of peridotites and impregnated peridotites previously recovered at Atlantis Massif during Expeditions 357 and 304/305 (Whattam et al., 2022; Expedition 304/305 Scientists, 2006a; Godard et al., 2009). See Figures F123 and F126 for legends.

Figure F128. Volatile-free TiO_2, C, and Ni versus Al_2O_3 of serpentinized peridotites (Left: geochemistry samples only, Right: geochemistry and microbiology samples), Site U1601. Compositions of Sites 1272 and 1274 peridotites (15°,20′, Leg 209) are shown for comparison (data: Shipboard Scientific Party, 2004; Paulick et al., 2006; Godard et al., 2008) as well as compilation orogenic, ophiolitic, and oceanic peridotites compositions (references in Bodinier and Godard, 2013). Also shown are the compositions of peridotites and impregnated peridotites previously recovered at Atlantis Massif during Expeditions 357 and 304/305 (Whattam et al., 2022; Expedition 304/305 Scientists, 2006a; Godard et al., 2009). See Figures F123 and F126 for legends.

Figure F129. Volatile-free Sc and V versus Al_2O_3 of serpentinized peridotites (Left: geochemistry samples only, Right: geochemistry and microbiology samples), Site U1601. Compositions of Sites 1272 and 1274 peridotites (15°,20′, Leg 209) are shown for comparison (data: Shipboard Scientific Party, 2004; Paulick et al., 2006; Godard et al., 2008) as well as compilation of orogenic, ophiolitic, and oceanic peridotites compositions (references in Bodinier and Godard, 2013). Also shown are compositions of peridotites and impregnated peridotites previously recovered at Atlantis Massif during Expeditions 357 and 304/305 (Whattam et al., 2022; Expedition 304/305 Scientists, 2006a; Godard et al., 2009). See Figures F123 and F126 for legends.

Figure F130. Volatile-free MgO, Fe_2O_3, CaO, and $Na_2O + K_2O$ versus SiO_2 for diabases, oxide gabbro, gabbros, and olivine gabbros (geochemistry samples only), Site U1601. Compositions of diabases and basalts, gabbros, olivine gabbros, and leucocratic dikes and veins from Expedition 304/305 Hole U1309D (Expedition 304/305 Scientists, 2006a; Godard et al., 2009) are shown for comparison. See Figure F131 for legend.

Figure F131. Volatile-free MgO, Fe_2O_3, CaO, and $Na_2O + K_2O$ versus SiO_2 for diabases, oxide gabbro, gabbros, and olivine gabbros (geochemistry and microbiology samples), Site U1601. Compositions of diabases and basalts, gabbros, olivine gabbros, and leucocratic dikes and veins from Expedition 304/305 Hole U1309D (Expedition 304/305 Scientists, 2006a; Godard et al., 2009) are shown for comparison. Ol = olivine, Leuco = leucocratic.

Figure F132. Volatile-free TiO_2 and V versus Al_2O_3 and Ni and Cr versus Mg# for diabases, oxide gabbro, gabbros, and olivine gabbros (geochemistry samples only), Site U1601. Compositions of diabases and basalts, gabbros, olivine gabbros, and leucocratic dikes and veins from Expedition 304/305 Hole U1309D (Expedition 304/305 Scientists, 2006a; Godard et al., 2009) are shown for comparison. See Figure F131 for legend.

Figure F133. Volatile-free TiO_2 and V versus Al_2O_3 and Ni and Cr versus Mg# for diabases, oxide gabbro, gabbros, and olivine gabbros (geochemistry and microbiology samples), Site U1601. Compositions of diabases and basalts, gabbros, olivine gabbros, and leucocratic dikes and veins from Expedition 304/305 Hole U1309D (Expedition 304/305 Scientists, 2006a; Godard et al., 2009) are shown for comparison. See Figure F131 for legend.

Figure F134. Volatile-free Y, Sr, Ba versus TiO_2 for diabases, oxide gabbro, gabbros, and olivine gabbros (Left: geochemistry samples only, Right: geochemistry and microbiology samples), Site U1601. Compositions of diabases and basalts, gabbros, olivine gabbros, and leucocratic dikes and veins from Expedition 304/305 Hole U1309D (Expedition 304/305 Scientists, 2006a; Godard et al., 2009) are shown for comparison. See Figure F131 for legend.

Figure F135. Mg#, Ca#, Ni, Cr, and TiO_2 of geochemistry rock samples, Site U1601. Opx = orthopyroxene.

Figure F136. Mg#, Ca#, Ni, Cr, and TiO_2 of geochemistry and microbiology rock samples, Site U1601. Opx = orthopyroxene.

Figure F137. Distribution of predominant lithologies of microbiology whole-round samples, Holes U1601A and U1601C. Lithologic descriptions were collected from shipboard igneous petrology descriptions and checked against notes taken during microbiology sample selection process and images of samples taken during microbiology sample processing.

Figure F138. PFT concentrations detected, Hole U1601A. Samples for PFT assay were collected from loose rubble during core shakeout, chiseled microbiology whole-round exteriors, and microbiology whole-round interiors. Trace = detectable peak but not quantifiable, zero = no detectable peak. Jittering of data points along *x*- and *y*-axes for trace and zero is for aesthetic purposes only.

Figure F139. PFT concentrations detected, Hole U1601C. Samples for PFT assay were collected from loose rubble during core shakeout, chiseled microbiology whole-round exteriors, microbiology whole-round interiors, and microbiology samples that could not be chiseled because of their unconsolidated, often crumbly compositions. Trace = detectable peak but not quantifiable, zero = no detectable peak. Jittering of data points along *x*- and *y*-axes for trace and zero is for aesthetic purposes only.

Figure F140. Test enrichment sample (2 cm^3 of 399-U1601C-59R plus 10 mL filter-sterilized seawater) incubated in sealed 15 cm^3 Falcon tube at 20°C for ~4 weeks. A. Fluorescent acridine orange-stained (0.1% wt/vol). B. Transmitted light. Note two cells (black arrow in A) that are undergoing binary fission and appear to be buried within chrysotile aggregate (arrow in B).

Figure F141. Physical properties measured on whole-round sections and discrete samples, Hole U1601A. See text for discussion. Whole-round section data are clipped using MATLAB GUI to account for gaps in pieces and edge effects (see Petrophysics in the Expedition 399 methods chapter [Lang et al., 2025]). MS = magnetic susceptibility. cps = counts/s. Opx = orthopyroxene.

Figure F142. Downhole variation in *P*-wave velocity anisotropy in core samples, Hole U1601A. A. Apparent anisotropy (100% × [max(V_i) − min(V_i)]/V_{Pmean}, where i = x, y, or z). B. Difference of sample V_x relative to V_{Pmean}. C. Difference of sample

V_y relative to V_{Pmean}. D. Difference of sample V_z relative to sample V_{Pmean}. Gb = gabbro.

Figure F143. Physical properties measured on whole-round sections and discrete samples, Hole U1601C. Whole-round section data are plotted as raw data. Red line = average for each core interval. See text for discussion. MS = magnetic susceptibility. cps = counts/s. Opx = orthopyroxene.

Figure F144. Downhole variation in MSL magnetic susceptibility (MS) and GRA bulk density from whole-round section (WR) measurements by lithology, Hole U1601C. Small dots = all section averages, larger symbols = averages for sections, both of which are calculated when either of the two lithologic groups, serpentinized ultramafic rocks or gabbroic rocks, make up 95% of total section. Only data with values greater than 2.1 g/cm^3 were used for GRA bulk density.

Figure F145. Porosity versus grain density in serpentinized peridotite measured on discrete samples, Hole U1601C. Relatively large range in porosity corresponds to relatively small range in grain density. Opx = orthopyroxene.

Figure F146. Downhole variation in *P*-wave velocity anisotropy in core samples, Hole U1601C. A. Apparent anisotropy (100% × [max(V_i) − min(V_i)]/V_{Pmean}, where $i = x$, y, or z). B. Difference of sample V_x relative to V_{Pmean}. C. Difference of sample V_y relative to V_{Pmean}. D. Difference of sample V_z relative to sample V_{Pmean}.

Figure F147. Compressional velocity versus grain density by rock types, Hole U1601C. Opx = orthopyroxene.

Figure F148. Compressional velocity versus bulk density and grain density in Hole U1601C for gabbroic samples compared with previous data from gabbroic sections in Hole 735B at Atlantis Bank, Hole U1473A, and Site U1309 (Atlantis Massif) on MAR at 30°N (Shipboard Scientific Party, 1989, 1999; MacLeod et al., 2017; Expedition 304/305 Scientists, 2006b). Data from Holes U1601C and U1309D are color-coded by lithology. Ol = olivine, Ox = oxide, Gb = gabbro.

Figure F149. Magnetic susceptibility (MS) versus grain density in serpentinized peridotite and gabbro measured on discrete samples (cubes only), Hole U1601C. Two groups of rock types are clearly differentiated. Opx = orthopyroxene.

Figure F150. Calculated concentration of potassium, thorium, and uranium based on spectral signatures of ^{40}K, ^{232}Th, and ^{238}U in NGR measured on whole-round sections, Hole U1601C. Bulk density correction was applied based on GRA data (see Petrophysics in the Expedition 399 methods chapter [Lang et al., 2025]). Very low count rates and lack of volume correction for bulk density limit accuracy of these estimates.

Figure F151. Thermal conductivity measured in Holes U1601A and U1601C compared with other primarily gabbroic or ultramafic ODP/IODP sites. A. All Hole U1601A and U1601C samples colored by lithology. Includes comparison with Sites 1268, 1270, 1271, 1272, and 1274 drilled in MAR from 14° to 16°N during Leg 209 (Shipboard Scientific Party, 2004). B. Serpentinized peridotites in Holes U1601A and U1601C compared to those from Sites 1268, 1270, 1271, 1272, and 1274 at MAR 15°N. C. Gabbroic samples from Holes U1601A and U1601C compared to those from Sites 1268, 1270, 1271, 1272, and 1274 at MAR 15°N, Hole U1309D at Atlantis Massif, and Hole U1473A at Atlantis Bank.

Figure F152. ROP for each core with core lithologies, Hole U1601C. A. Serpentinite and gabbro data are for cores with >95% of either serpentinized ultramafic rocks (including dunite, harzburgite, olivine websterite, websterite, orthopyroxenite, and wehrlite) or gabbros (including gabbro, norite, olivine gabbro, and troctolite), respectively, based on igneous petrology descriptions. Diorite is also included in gabbro for convenience. B. ROP versus serpentinite ratio for each Hole U1601C core and average ROP for two principle lithologic groups.

Figure F153. Temperature (T) results, Hole U1601C. A. All ETBS runs. B. All upgoing runs with ETBS with number of hours since borehole was flushed with cool freshwater.

Figure F154. Temperature and salinity measurements for uppermost ~347 m, Hole U1601C.

Figure F155. Temperature results, Hole U1601C.

Figure F156. Wireline logging data, Hole U1601C. See text for discussion. LCAL = caliper, HSGR = total spectral gamma ray, RHOM = bulk density, RT = true resistivity, RLA = laterolog resistivity.

Figure F157. VSI source and ship geometry, Expedition 399. MSL = mean sea level, SRD = seismic reference depth.

Figure F158. Schlumberger standard calculated concentration of potassium, thorium, and uranium based on spectral signatures of ^{40}K, ^{232}Th, and ^{238}U in wireline logging natural gamma ray data. Overall radiation is very low, limiting accuracy of these elemental estimates. HSGR = total spectral gamma ray, HFK = potassium measurement, HURA = uranium measurement, HTHO = thorium measurement.

Figure F159. FMS image logs with half section images, Hole U1601C. A. Mottled texture of serpentinized peridotite. B. Igneous contact between serpentinized dunite and gabbro. C. Fractured gabbro interval. Fractures are dark because they are more conductive than host gabbro. D. Aligned mineral phases in serpentinized peridotite.

Figure F160. NRM inclination values, Hole U1601A. Measurements were taken on archive half pieces using SRM. Count refers to number of SRM measurements recorded. Bin sizes were determined based on Freedman-Diaconis distribution of data. Probability density was fitted using kernel density estimation.

Figure F161. Predicted chrons and subchrons for Site U1601 for the last 1.5 My. Black = present-day polarity, white = reversed polarity. Brunhes–Matuyama reversal occurred at approximately 781 ka. Age of Atlantis Massif is ~1.5 Ma (Grimes et al., 2008; Escartín et al., 2022). Therefore, expected polarity of rocks is negative, reversed polarity. Additionally, expected inclinations from geocentric axial dipole for this site are ±49°.

Figure F162. NRM and AF 50 mT inclination, declination, and intensity of remanence values compared with lithology (see Igneous petrology for legend), Hole U1601A. Solid circles = NRM data, open circles = AF 50 mT data. Reference lines are calculated from predicted geocentric axial dipole values.

Figure F163. Inclination distributions for each AF demagnetization step, Hole U1601A. Measurements were taken on archive half pieces using SRM. Count refers to number of SRM measurements recorded. Bin sizes were determined based on Freedman-Diaconis distribution of data.

Figure F164. NRM and AF 50 mT inclination, declination, and intensity of remanence values compared with lithology (see Igneous petrology for legend), Hole U1601C. Solid circles = NRM data, open circles = AF 50 mT data. Reference lines are calculated from predicted geocentric axial dipole values. Measurements were taken on archive half pieces using SRM. Count refers to number of SRM measurements recorded. Bin sizes were determined based on Freedman-Diaconis distribution of data.

Figure F165. NRM inclination values, Hole U1601C. Measurements were taken on archive half pieces using SRM. Count refers to number of SRM measurements recorded. Bin sizes were determined based on Freedman-Diaconis distribution of data. Probability density was fitted using kernel density estimation.

Figure F166. Inclination distributions for each AF demagnetization step, Hole U1601C. Measurements were taken on archive half pieces using SRM. Count refers to number of SRM measurements recorded. Bin sizes were determined based on Freedman-Diaconis distribution of data. Probability densities were fitted using kernel density estimations.

Figure F167. Representative example equal-area plots, relative intensity diagrams, and vector endpoint diagrams showing progressive low-temperature dunks, Hole U1601A. Equal-area plots: open circles = upper hemisphere projections, solid circles = lower hemisphere projections. Blue dots = measured points, lines = interpolations between them. Two vectors in Zijderveld diagrams represent orthogonal horizontal (blue) and vertical (red) components of samples' remanence directions. See Table T17 to relate sample's cube number to its source.

Figure F168. Representative example equal-area plots, relative intensity diagrams, and vector endpoint diagrams showing progressive low-temperature dunks, Hole U1601C. See Figure F167 for definitions. See Table T18 to relate sample's cube number to its source.

Figure F169. Representative example equal-area plots, relative intensity diagrams, and vector endpoint diagrams showing progressive AF demagnetization from 5 to 200 mT, Hole U1601A. See Figure F167 for definitions. Dots with green interiors = first and last points in data range used for PCA of first component, dots with purple interiors = first and last points in data range used for PCA of second component, dots with yellow interiors = first and last points in data range used for PCA of third component. These data are origin trending, an indicator that most remanence was removed during demagnetization. See Table T17 to relate sample's cube number to its source.

Figure F170. Representative example equal-area plots, relative intensity diagrams, and vector endpoint diagrams showing progressive AF demagnetization from 5 to 200 mT, Hole U1601C. See Figure F167 for definitions. Dots with green interiors = first and last points in data range used for PCA of first component, dots with purple interiors = first and last points in data range used for PCA of second component, dots with yellow interiors = first and last points in data range used for PCA of third component. Cubes 12372141 and 12277771 data are likely origin trending, an indicator that final vectors of analysis are ChRM directions and that most remanence was removed during demagnetization. Cube 12365241 increases in intensity with increasing AF field, a phenomenon known as gyroremanent magnetization. See Table T18 to relate sample's cube number to its source.

Figure F171. Representative example equal-area plots, relative intensity diagrams, and vector endpoint diagrams showing progressive thermal demagnetization from 0° to 700°C, Hole U1601A. See Figure F167 for definitions. Dots with green interiors = first and last points in data range used for PCA of first component, dots with purple interiors = first and last points in data range used for PCA of second component. These data are origin trending, an indicator that final vectors of analysis are ChRM directions and that most remanence was removed during demagnetization. See Table T17 to relate sample's cube number to its source.

Figure F172. Representative example equal-area plots, relative intensity diagrams, and vector endpoint diagrams showing progressive thermal demagnetization from 0° to 700°C after 200 mT AF treatment, Hole U1601A. Dots with green interiors = first and last points in data range used for PCA of first component, dots with purple interiors = first and last points in data range used for PCA of second component. No significant patterns have been deduced from these data. See Table T17 to relate sample's cube number to its source.

Figure F173. Representative example equal-area plots, relative intensity diagrams, and vector endpoint diagrams showing progressive thermal demagnetization from 50° to 700°C, Hole U1601C. These data are origin trending, an indicator that final vectors of analysis are ChRM directions and that most remanence was removed during demagnetization. See Table T18 to relate sample's cube number to its source.

Figure F174. Log-log plot of NRM versus magnetic susceptibility of archive section halves and discrete samples. Left: Hole U1601A, Right: Hole U1601C. Distribution of values compared to lines of constant *Q* (Königsberger ratio of remanent to induced magnetization; calculated for field of 32.56 A/m) shows that remanence is substantially greater than induced magnetization in most samples.

Figure F175. Representative coercivity spectra. A. Hole U1601A cubes (i: 12248671, ii: 12248681, iii: 12247921). B. Hole U1601C cubes (i: 12293451, ii: 12277781, iii: 12277761). Black = best fit coercivity spectra line, yellow = 95% confidence interval of convolved components, pink = 95% confidence interval of largest component, blue = 95% confidence interval of smallest component.

Figure F176. Lower hemisphere, equal-area projections that show (A) distribution of principal susceptibility axes in specimen coordinates system, stereonets with contour density plots of (B) maximum susceptibility axis and (C) minimum susceptibility axis, and (D) distribution of bulk magnetic susceptibility, Hole U1601A.

Figure F177. (A) K_{max}/K_{int} versus K_{int}/K_{min} in Flinn-type diagram and (B) relationship between P_j and T in Jelinek plot, Hole U1601A.

Figure F178. Downhole AMS parameters, Hole U1601A. A. K_m. B. L. C. F. D. P_j. E. T. See text for AMS parameter definitions.

Figure F179. Downhole AMS parameters, Hole U1601C. A. K_m. B. L. C. F. D. P_j. E. T. See text for AMS parameter definitions.

Figure F180. (A) K_{max}/K_{int} versus K_{int}/K_{min} in Flinn-type diagram and (B) relationship between P_j and T in Jelinek plot, Hole U1601C. Red = more anisotropic samples.

Figure F181. Lower hemisphere, equal-area projections that show (A) distribution of principal susceptibility axes in specimen coordinates system and stereonets with contour density plots of (B) maximum susceptibility axis and (C) minimum susceptibility axis, Hole U1601C.