Figure F1. Location map, Site U1616 (red); Expedition 402 proposed drilling locations (purple = primary sites, pink = alternate sites); and DSDP Leg 42 and ODP Leg 107 and 161 sites (yellow). White line = location of seismic reflection profiles in Figures F2, F3, and F4.

Figure F2. Locations and approximate penetration of Sites U1612, U1615, U1616, and 655B on Seismic Line MEDOC 9 (location in Figure F1). Dashed line = intersection with Seismic Reflection Line MC07. CDP = common depth point, TWT = two-way traveltime.

Figure F3. Seismic Line MC07 connects Vavilov Basin east–west transect (Sites U1612, U1615, and U1616) on Seismic Line MEDOC 9 with Seismic Line MEDOC 8, where Site U1614 is located (Figure F1). A deep sediment trough separates the basement highs drilled during Expedition 402 along Seismic Lines MEDOC 8 and MEDOC 9. Dashed lines = intersection with Seismic Reflection Lines MEDOC 8 and MEDOC 9. TWT = two-way traveltime.

Figure F4. Location and approximate penetration of Site 651A on Seismic Line ST12 (location in Figure F1). Although this line is only about 2 km south of Site U1616, the corresponding basement high is much more subdued and covered by thicker sediment (compare to Figure F2). CDP = common depth point, TWT = two-way traveltime.

Figure F5. Schematic of reentry cone and casing installation, Hole U1616E. Note that depth is not to scale. CSG = casing.

Figure F6. Lithostratigraphic summary, Holes U1616A, U1616B, and U1616E. Sedimentary units are shown. See lithology key in Figure F8 in the Expedition 402 methods chapter (Malinverno et al., 2025).

Figure F7. VCD, Site U1616. Nannofossil and foraminifera ages and main physical properties used for unit identification are shown. See lithology key in Figure F8 in the Expedition 402 methods chapter (Malinverno et al., 2025). cps = counts per second.

Figure F8. Section Half Imaging Logger (SHIL) core images showing representative examples of main lithologies, Site U1616.

Figure F9. Smear slides of main lithologies, Site U1616. PPL = plane-polarized light, XPL = cross-polarized light. There is no smear slide for Subunit IB because no samples were collected.

Figure F10. Typical soft-sediment deformation features found mostly in Unit II, Site U1616.

Figure F11. XRD diffractogram showing dolomite (Dol), quartz (Qtz), and zeolite (Zeol) abundance, Hole U1616B.

Figure F12. Sediments, Holes U1616A and U1616B. A. Volcaniclastic sandy silt. B. Volcaniclastic gravel. C. Volcaniclastic gravel. D. Volcaniclastic silt. E. Volcaniclastic sands. F. Silt. G. Volcaniclastic silt. H. Fine-grained consolidated breccia.

Figure F13. Planktic foraminifera marker species, Site U1616. A, B. *Globigerina bulloides* (402-U1616A-1H-CC). C, D. *Globigerina umbilicata* (402-U1616B-16X-CC). E, F. *Globigerinoides ruber* (402-U1616A-2H-CC). G, H. *Globorotalia excelsa* (402-U1616A-1H-CC).

Figure F14. Planktic foraminifera marker species, Site U1616. A, B. *Neogloboquadrina* spp. (sin) (402-U1616B-5H-CC). C, D. *Neogloboquadrina incompta* (402-U1616B-5H-CC). E, F. *Globorotalia excelsa* (402-U1616A-16X-CC). G, H. *Globorotalia scitula* (402-U1616A-21X-CC).

Figure F15. Planktic foraminifera marker species, Site U1616. A–C. *Globoconella inflata* (402-U1616B-21X-CC). D–F. *Globorotalia bononiensis* (402-U1616B-24X-CC). G–I. *Globorotalia crassaformis* (402-U1616A-26X-CC).

Figure F16. Planktic foraminifera marker species, Site U1616. A–C. *Globigerinella calida* (402-U1616A-2H-CC). D. *Globigerinoides obliquus* (402-U1616B-28X-CC). E. *Orbulina universa* (402-U1616B-5H-CC). F, G. *Trilobatus sacculifer* (402-U1616B-26X-CC).

Figure F17. Calcareous nannofossil biozonal assignment for examined samples according to Di Stefano et al. (2023) scheme for Mediterranean area, Site U1616. See lithology key in Figure F8 in the Expedition 402 methods chapter (Malinverno et al., 2025).

Figure F18. NRM variation, Holes U1616A, U1616B, and U1616E. A. Intensity of NRM and NRM after demagnetization at 20 mT peak AF. B. NRM inclination. C. NRM inclination after demagnetization at 20 mT peak AF. Dashed lines in B and C = GAD values.

Figure F19. NRM and NRM after demagnetization at 20 mT peak AF sediment inclination histograms, Holes U1616A, U1616B, and U1616E. Dashed lines = GAD values.

Figure F20. A, B. AMS ellipsoids, Holes U1616B and U1616E.

Figure F21. Demagnetization of ARM of sediments and basement rocks, Holes U1616B and U1616E.

Figure F22. NRM basement rock variation, Hole U1616E. A. Intensity of NRM and NRM after demagnetization at 20 mT peak AF. B. NRM inclination. C. NRM inclination after demagnetization at 20 mT peak AF. Dashed lines in B and C = GAD values.

Figure F23. NRM and NRM after demagnetization at 20 mT peak AF basement inclination histograms, Hole U1616E. Dashed lines = GAD values.

Figure F24. IRM curves of representative rock samples, Hole U1616E. A. Volume-normalized IRM curves. B. IRM curves normalized by respective maximum values on a logarithmic field scale.

Figure F25. Lithostratigraphic variations in basement rocks, Hole U1616E.

Figure F26. Modal abundance of major minerals in mafic–ultramafic rocks, Hole U1616E. Abundance is calculated as percentage of recovered fraction and out of total depth drilled (drilled fraction) for each core.

Figure F27. Abundance of lithologies in entire basement, Hole U1616E.

Figure F28. Ternary classification diagram for ultramafic lithologies based on modal abundance of olivine (Ol), orthopyroxene (Opx), and clinopyroxene (Cpx), Site U1616.

Figure F29. Main rock types, Hole U1616E. A. Plagioclase-bearing lherzolite with thin magmatic vein. B. Harzburgite with 1.5 cm thick serpentine vein. C. Clinopyroxenite layer in dunite and harzburgite association. D. Plagioclase-bearing lherzolite with discrete plagioclase and clinopyroxene grains. E. Thin patch of plagioclase-bearing websterite in plagioclase-bearing harzburgite.

Figure F30. Mafic intrusive rocks, Hole U1616E. A–C. Olivine gabbro. D. Amphibole-bearing diorite. E, F. Mica-bearing norite.

Figure F31. Alteration log of basement lithologies, Hole U1616E.

Figure F32. Weathering, serpentinization, and microveins, Hole U1616E. A. Lherzolite with weathered and serpentinized olivine and pervasive carbonate microveins. B. Completely serpentinized plagioclase-bearing lherzolite showing white plagioclase veins and patches. Cpx = clinopyroxene.

Figure F33. Bedding dip angles and frequency of faults, fractures, and folds in sediments, Holes U1616A and U1616B.

Figure F34. Deformation structures in sedimentary sequence, Hole U1616B. A. Tilted lamination. B. Reverse fault. C. Normal fault. D. Tectonic breccia; contact between dolomite and basement. E. Tilted lamination. F. Convoluted lamination; MTD.

Figure F35. Structural characteristics, Hole U1616E.

Figure F36. Characteristic rock samples, Hole U1616E. A. Polymictic breccia with clasts of variably serpentinized peridotite, gabbro, mafic intrusions, and basalt. B. Mylonite rock with a sharp contact with an ultramylonitic band. C. Weathered peridotite with magmatic veins partly replaced by serpentine and then carbonate veins. D. Gabbroic breccia. E. Serpentinized peridotite with amphibole and fibrous serpentine veins; striations are visible in serpentine vein on side of sample.

Figure F37. Dip of CPF, Site U1616. Intensity of CPF is measured according to description in Structural geology in the Expedition 402 methods chapter (Malinverno et al., 2025).

Figure F38. Dip of magmatic and metamorphic veins, Hole U1616E.

Figure F39. IW alkalinity, salinity, sodium, and chloride, Holes U1616A (circles) and U1616B (diamonds).

Figure F40. IW magnesium, calcium, and potassium, Holes U1616A (circles) and U1616B (diamonds).

Figure F41. IW lithium, boron, strontium, and silica, Holes U1616A (circles) and U1616B (diamonds).

Figure F42. IW sulfate, ammonium, phosphate, and sulfide, Holes U1616A (circles) and U1616B (diamonds).

Figure F43. Calcium carbonate, carbonate contents, and relative percentages of different carbonate phases, Holes U1616A, U1616B, and U1616E.

Figure F44. Total organic matter, TOC, TN, and atomic TOC/TN ratio, Holes U1616A, U1616B, and U1616E.

Figure F45. Relationship between TOC and TN contents, Holes U1616A and U1616B.

Figure F46. pXRF elemental concentrations, Holes U1616A and U1616B. SHLF = section half, IW SC = IW squeeze cake.

Figure F47. Dissolved methane concentrations in headspace gas samples, Holes U1616A, U1616B, and U1616E.

Figure F48. pXRF samples, Site U1616. Red squares = analytical intervals, numbers = analytical numbers shown in Tables T13 and T14.

Figure F49. ICP-AES samples, Hole U1616E. Red squares = analytical intervals, numbers = analytical numbers shown in Table T15.

Figure F50. A–L. LOI and ICP-AES major and minor element geochemistry variations of igneous rocks, Hole U1616E. Mg# = Mg/(Mg + Fe) atomic ratio. Classifications of units are from Igneous and metamorphic petrology.

Figure F51. A–K. ICP-AES minor/trace element geochemistry variations of igneous rocks, Hole U1616E. Classifications of units are from Igneous and metamorphic petrology.

Figure F52. Bulk chemistry of Site U1616 mantle rock (gray ovals) compared to peridotite compositions at Site U1614 and those from related geologic settings. A. MgO vs. Al_2O_3. B. K_2O vs. Al_2O_3. C. CaO vs. Al_2O_3. D. TiO_2 vs. Al_2O_3. Iberian margin data from Hébert et al. (2001); back-arc data from Akizawa et al. (2021); MORB data from Niu (2004), Regelous et al. (2016), and Godard et al. (2009); PUM data from McDonough and Sun (1995); DMM data from Workman and Hart (2005). Compositional changes during mantle melting were thermodynamically calculated using pMELTS software (Ghiorso et al., 2002) included in alphaMELTS software package (Smith and Asimow, 2005). DMM composition (K, P, and Cr were excluded) after Workman and Hart (2005) was chosen as source material. Isentropic near fractional melting of DMM was conducted at pressures ranging 3 to 1×10^{-4} GPa at 1450°C. Results are pale brown dots with values of melting degree.

Figure F53. Basaltic rock compositions plotted on TAS diagram for extrusive rocks, Sites U1612 and U1616. Classifications are after Le Bas et al. (1986). Tyrrhenian basalt data are from Beccaluva et al. (1990).

Figure F54. Plutonic rock compositions plotted on TAS diagram for plutonic rocks, Sites U1612, U1614, and U1616. Classifications are after Middlemost (1994).

Figure F55. (A) Bulk calcium carbonate content variation and (B) its correlation with bulk CaO content in igneous rocks, Hole U1616E.

Figure F56. XRD spectra showing representative phase characterizations of lherzolite (blue) and harzburgite (orange), Hole U1616E. Arg = aragonite, Cr-spl = chrome spinel, Dol = dolomite, En = enstatite, Lz = lizardite, Mg-cal = Mg-bearing calcite.

Figure F57. Physical properties, Holes U1616A and U1616B. cps = counts per second. See lithology key in Figure F8 in the Expedition 402 methods chapter (Malinverno et al., 2025).

Figure F58. Physical properties for basement rocks, Hole U1616E. Small dots = WRMSL, Section Half Multisensor Logger (SHMSL), and NGR data, large circles = discrete measurements, cps = counts per second. GRA density: small gray dots = raw data, small red dots = 12% correction applied because of incomplete core liners. See lithology key in Figure F8 in the Expedition 402 methods chapter (Malinverno et al., 2025).

Figure F59. Composite of Hole U1616A, U1616B, and U1616E physical properties data (dots) with downhole geophysical profiles (lines) from Run 1 in Hole U1616E. From left: core recovery (black) with associated stratigraphic units and lithologies from core (see Lithostratigraphy); downhole total gamma (SGR, dark green) and computed gamma from K and Th (CGR; light green); total NGR measured on recovered core sections (green); core and downhole data for K (brown), Th (purple), and U (orange); bulk density log (small red dots = WRMSL, large pink circles = MAD); MS (dark purple = MSS log, pink = WRMSL, violet = SHMSL); downhole electrical resistivity for HRLA R2 (cyan) and R5 (blue); and V_P (light blue = discrete Gantry, dark blue = WRMSL). Black horizontal dashed lines = lithostratigraphic unit boundaries defined from cores. cps = counts per second. See lithology key in Figure F8 in the Expedition 402 methods chapter (Malinverno et al., 2025).

Figure F60. Temperatures measured near seafloor and downhole in Vavilov Basin and local temperature gradient from a least-squares line fit, Site U1616.

Figure F61. Composite of Hole U1616A, U1616B, and U1616E physical properties data (dots) with downhole geophysical profiles (lines) from Run 1 in Hole U1616E, zoomed in on sediment–basement transition where very low core recovery was obtained in Hole U1616E. From left: core recovery (black) with associated stratigraphic units and lithologies from core (see Lithostratigraphy); downhole total gamma (SGR, dark green) and computed gamma from K and Th (CGR; light green); total NGR measured on core sections (green); core and downhole data for K (brown), Th (purple), and U (orange); bulk density log (black) (small red dots = WRMSL, large pink circles = MAD); MS (dark purple = MSS log, pink dots = WRMSL, violet dots = SHMSL); downhole electrical resistivity for HRLA R2 (cyan) and R5 (blue); and V_P from core measurements (light blue = discrete Gantry, dark blue = WRMSL). Black horizontal dashed lines = lithostratigraphic unit boundaries defined from cores. cps = counts per second. See lithology key in Figure F8 in the Expedition 402 methods chapter (Malinverno et al., 2025).

Figure F62. Composite of Holes U1616A, U1616B, and U1616E physical properties data (dots) with downhole geophysical profiles (lines) through peridotite basement from Run 3 in Hole U1616E. Spectral gamma ray (SGR) (dark green = SGR, light green = computed gamma from K and Th; total NGR measured on core (green); MS (dark purple = MSS log, pink dots = WRMSL, violet dots = SHMSL); Resistivity (cyan = R2, blue = R5). R2 and R5 measurements from HRLA somewhat correspond to traditional shallow and deep measurements from dual laterolog (Ellis and Singer, 2007). Black horizontal dashed lines = lithostratigraphic unit boundaries. cps = counts per second. See lithology key in Figure F8 in the Expedition 402 methods chapter (Malinverno et al., 2025).

Figure F63. Oxygen concentration profile, Holes U1616A and U1616B. A. 0–200 mbsf. B. Uppermost 2 mbsf. See lithology key in Figure F8 in the Expedition 402 methods chapter (Malinverno et al., 2025).

Figure F64. PFD tracer concentrations measured using gas chromatography, Holes U1616A and U1616B. A. Concentrations in drilling fluids, core exteriors, and core interiors. Box encloses upper and lower quartiles of measured values (median = 11.24 ng/g [dark line]), and whiskers span range of measured values, excluding outliers, compared with concentrations of interior and exterior samples, which are significantly lower. B. Concentrations in core exteriors and core interiors for microbiological analyses, showing less variability of the distribution of PFD concentrations in samples collected from the core interiors (exterior median = 0.020 ng/g; interior median = 0.008 ng/g).