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Delphine Klaessens, Laurie Reisberg, David Jousselin

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1	Highl	y siderophile element and Os isotope results from the structurally
2	atypi	cal Batin dunite in the Wadi Tayin massif of the Oman ophiolite
3	Delphi	ne KLAESSENS ¹ *, Laurie REISBERG ¹ , David JOUSSELIN ¹ , the Oman Drilling Project Science Team
4	¹ Centre	e de Recherches Pétrographiques et Géochimiques, UMR 7358 CNRS -Université de Lorraine,
5	15 rue	Notre Dame des Pauvres, F-54501 Vandoeuvre-lès-Nancy, France
6	Corres	ponding author: Delphine KLAESSENS (delphine.klaessens@univ-lorraine.fr)
7	<u>K</u>	ey Points
8	1.	The Batin dunite is an exceptionally large dunite, interspersed in the mantle section,
9		discordant to asthenospheric flow.
10	2.	Its major and highly siderophile element composition becomes progressively less fertile with
11		increasing height.
12	3.	Magmas were injected in a late melt pulse at unusual depth, and progressively lost their
13		reactive capacity as they migrated upward.

8156 words

15 Plain Language Summary

16 Dunites in ophiolites form by pyroxene dissolution and olivine precipitation during melt-17 peridotite interaction. Highly siderophile elements (HSE) and Os isotopes are excellent tracers of 18 this process. We present structural and geochemical data on dunites and interspersed 19 harzburgites from borehole BA4A ,of the ICDP Oman Drilling Project in the Batin region (Wadi 20 Tayin massif) of the Oman ophiolite. This region features an exceptionally large dunite body, 21 included in the harzburgitic mantle section. This exploratory study of the Batin dunite shows 22 that it contrasts chemically and structurally with dunites from the Moho Transition Zone and 23 basal section of the ophiolite, but presents similarities with dunitic veins of the main mantle 24 section. Nevertheless, its composition changes systematically with height, becoming 25 progressively less fertile, and depleted in the incompatible HSE, platinum and palladium. We 26 suggest that the Batin dunite formed by interaction of the preexisting harzburgite with a large 27 melt pulse that stagnated at ~1200 meters below the Moho. As these melts ascended through 28 the overlying ~300 meters, their composition was modified through interaction with the 29 harzburgite, eliminating their undersaturation in pyroxene and thus their capacity to form 30 dunite. This may explain the upper limit of the dunite at ~900 meters beneath the Moho.

31 **199 words**

32 Abstract

33 Dunites in ophiolites form by pyroxene dissolution and olivine precipitation during melt-peridotite 34 interaction. We present structural and geochemical data on peridotites from the Batin region (Wadi 35 Tayin massif) of the Oman ophiolite, where an exceptionally large (~9.5 kilometer long) dunite body 36 was sampled by the ICDP Oman Drilling Project (BA4A borehole). 900-1200 meters beneath the 37 petrological Moho, this dunite is overlain by harzburgite hosting pyroxene-depleted and pyroxene-38 rich bands. Highly siderophile elements (HSE) and Os isotopes, excellent tracers of melt flow through 39 peridotites, were measured in dunites and interspersed harzburgites from BA4A borehole. The Batin 40 dunite is structurally and chemically distinct from dunites from the Moho Transition Zone and basal 41 section of the ophiolite, resembling instead sparse dunite veins in the main mantle section. Batin 42 dunites have fairly uniform Os, Ir and Ru abundances, but Pd and Pt contents increasing with depth. 43 One deep dunite sample has initial ¹⁸⁷Os/¹⁸⁸Os more radiogenic than MORB. Though the limited 44 number of data demands prudence, we suggest that the Batin dunite formed from a large pulse of 45 radiogenic melts, whose flow was impeded ~1200 meters below the Moho. As these melts ascended, 46 they may have lost their radiogenic character and relative Pt and Pd enrichment through interaction 47 with peridotites, which have much higher HSE contents than melts. Such interaction would also 48 diminish the under-saturation in pyroxene of the melts, eliminating their capacity to sufficiently 49 dissolve the pyroxene of the host harzburgite to form dunite, thus explaining the upper limit of the 50 dunite at ~900 meters.

51 **250 words**

52 Keywords

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Oman ophiolite, Mantle, Melt, Dunite, Highly siderophile elements, Osmium isotopes

54 **1.** Introduction

55 The large and well-exposed Oman ophiolite constitutes an ideal laboratory for studying melt 56 migration in the uppermost mantle. Its ~15 kilometer thick mantle section is mainly composed of 57 harzburgite, which hosts a variety of dunite bodies (e.g. Boudier & Coleman (1981)). Ophiolitic 58 dunites are generally viewed as transport pathways for ascending melts (Büchl et al., 2002, 2004; 59 Kelemen et al., 1995; O'Driscoll et al., 2012) resulting from complete pyroxene dissolution and olivine 60 precipitation in the host peridotite by melt-peridotite interactions (Boudier & Nicolas, 1977; Dick, 1977; Kelemen, 1990; Lambart et al., 2009; Morgan & Liang, 2003). An exceptionally large dunite 61 62 body, which outcrops in the mantle section in the Batin area (Fig. 1), was sampled by the ICDP Oman 63 Drilling Project (Kelemen et al., 2020) (https://www.omandrilling.ac.uk), and constitutes the only 64 dunite body within the harzburgitic section with a size allowing mapping at the 1/25000 to 1/100000 65 scale. The origin of this highly unusual dunite is still unknown.

66 Here, we present structural observations and whole-rock geochemical data on eight samples 67 collected in the ICDP BA4A cored borehole traversing the Batin dunite body. These samples, which 68 comprise four dunites each coupled with a nearby host harzburgite, provide information on melt 69 migration and dunite formation. We focus on the highly siderophile elements (HSE), which include 70 the platinum group elements (PGE: Os, Ir, Ru, Rh, Pt, Pd) as well as Au and Re. A particular emphasis is placed on the Re-Os radiometric system, in which ¹⁸⁷Re decays to form ¹⁸⁷Os ($t_{1/2}$ = 41.6 Ga, λ = 71 72 1.666×10^{-11}) (Smoliar et al., 1996). While all of the HSE are siderophile and moderately to extremely 73 chalcophile, they display different bulk behavior during partial melting of the upper mantle (e.g. 74 Fischer-Gödde et al. (2011)): PPGE (platinum-group PGE: Pt, Pd), Au and Re are slightly to moderately 75 incompatible, while IPGE (iridium-group PGE: Os, Ir, Ru, Rh) are highly compatible. This contrasting 76 behavior creates Earth reservoirs with strikingly different Re/Os ratios, which develop with time 77 distinct Os isotope ratios (Shirey & Walker, 1998). Compared to fertile Iherzolites, mantle 78 harzburgites typically have similar to slightly higher IPGE abundances, lower PPGE, Au and Re 79 concentrations and unradiogenic Os isotope compositions (cf. summary in Becker & Dale (2016)). In 80 contrast, recycled oceanic crust and sediments have very low IPGE contents, and are relatively 81 enriched in PPGE, Au and Re, and as a result, are highly radiogenic (Peucker-Ehrenbrink et al., 2003).

82 Osmium isotopes are particularly useful for studying melt migration through peridotites, and more 83 specifically dunites, because these rocks are very rich in Os compared to typical mantle melts. During 84 melt migration through dunite, the isotopic and elemental compositions of incompatible elements 85 (e.g. light rare earth elements) will be rapidly overprinted in the dunite by equilibration with the 86 magma (Godard et al., 2000; Kelemen et al., 1995), which has much higher concentrations of these 87 elements. For Os (and the other IPGE), however, the mass balance is reversed, allowing gradual 88 changes in Os isotope composition to be recorded in the dunite as melt progressively passes through. 89 We explored this process in an earlier contribution based on a large set of structural observations 90 and geochemical data for peridotites from the Wadi Tayin, Sumail, Nakhl-Rustaq and Haylayn massifs 91 of the southeastern Oman ophiolite (Klaessens et al., 2021). In this previous study, we identified 92 three types of dunite, corresponding to the Moho Transition Zone (MTZ), the main and the basal 93 mantle sections. A strong correlation was observed between the Os isotope compositions of these 94 three types of dunite and their structural contexts. In contrast, the host harzburgites have Os isotope 95 signatures spanning the abyssal peridotite range and not varying systematically with setting. Basal 96 dunites display compositions similar to harzburgite values, while main section dunites have 97 somewhat more radiogenic compositions. MTZ dunites have highly radiogenic compositions similar 98 to those of the overlying lower crust (Peucker-Ehrenbrink et al., 2012), requiring extensive 99 interaction with melts, probably slab-derived, that are more radiogenic than MORB. Such melts 100 cannot have equilibrated with harzburgite or dunite along the path from the source to the Moho, or 101 this radiogenic signature would have been erased. This suggests a very rapid transport mechanism 102 with little melt/rock interaction, possibly hydrofracturing rather than percolation in dunite channels.

103 Our goal in the current contribution is to determine how, or if, the Batin dunite fits into the highly 104 systematic framework provided by our previous study of dunites from throughout the southeastern 105 Oman ophiolite. We do this by examining the variation of ¹⁸⁷Os/¹⁸⁸Os and HSE abundances with height in this atypical and large dunite body. The results are interpreted in light of the structural relationships between the dunite and the overlying and underlying lithologies, with the aim of understanding the conditions that permitted the formation of such a large mass of dunite within the mantle section. Nevertheless, this study is only exploratory and a more extensive investigation will be needed to fully understand the origin of this intriguing feature and whether it relates to crustal accretion of other processes.

- 112 2. <u>Geological context</u>
- 113

2.1. The Oman ophiolite: a fast spreading center above a subducted slab

114 The Oman ophiolite is a 500 kilometer long, 50-100 kilometer wide nappe divided into 13 structurally 115 continuous massifs (Nicolas, et al., 2000a). It originates from an accretion center in the Neothethys 116 active ~95 Myr ago (Rioux et al., 2012). The ophiolite is underlain by a thin (0-100 meters), 117 discontinuous high-temperature metamorphic sole, formed from relics of the oceanic basin over 118 which the ophiolite was thrust before its obduction onto the continent. This overridden unit has a Lu-119 Hf metamorphic age of 104 Myr (Guilmette et al., 2018), which substantially predates the accretion 120 age of the overlying spreading center. This chronological information, coupled with lava chemical 121 compositions indicating hydrous magmatic fractionation trends (MacLeod et al., 2013), suggests that 122 the spreading center parental to the ophiolite was active above a subducting oceanic slab.

Low temperature deformation ascribed to ophiolite emplacement is restricted to the first few hundred meters of the nappe, often at the base of the mantle section. Most of the ophiolite peridotite section preserves coarse-grained porphyroclastic textures, ascribed to "fossilized" asthenospheric mantle flow, while in the crust, gabbros have a grain shape preferred orientation of euhedral crystals, with no superimposed plastic deformation, thus preserving the imprint of magmatic flow (Nicolas, et al. (2000a) and references therein). Plastic flow lineations in the upper mantle and magmatic lineations in the lower crust are parallel, demonstrating that these flow

130 structures formed synchronously at the ridge (Nicolas et al., 1994). The sheeted dike complex is 131 generally near vertical, and the crust-mantle interface (referred to hereafter as the Moho) is nearly 132 horizontal, gently dipping to the east in the northern massifs, and to the south and south-east in the 133 southern massifs. The Oman ophiolite can thus be seen as a paleo-oceanic lithosphere, slightly tilted 134 and dissected by erosion, without any important subsequent deformation (Nicolas, 1989; Nicolas & 135 Boudier, 1995). Given its continuous crustal section and the rarity of faults, the ophiolite is thought 136 to derive from a fast spreading center with a permanent magma chamber; a 5 to 10 cm/yr spreading 137 rate is confirmed by U-Pb dating of zircons from the upper gabbros (Rioux et al., 2012). Systematic 138 structural mapping of the southern massifs has revealed a paleoridge organization resembling 139 microplates at the East Pacific Ridge (Boudier et al., 1997). Notably, a distinct change in dike 140 orientation outlines the limits of a NW-SE spreading center (Fig. 1). Several zones characterized by 141 plunging mantle lineations and capped by a thick Moho Transition Zone (MTZ) (see next section), are 142 interpreted as mantle diapirs, underlying the paleo-ridge axis (Jousselin et al., 1998; Nicolas & 143 Boudier, 1995).

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2.2. Dunite distribution in the mantle section

The mantle section of the Oman ophiolite is mainly composed of harzburgite but dunitic bodies of various geometries and structural contexts are also observed. Klaessens et al. (2021) identified three types of dunite on the basis of field observations in the southeastern part of the ophiolite, each associated with a specific part of the mantle section. These include:

(1) The Moho Transition Zone (MTZ) (Boudier & Nicolas, 1995; Godard et al., 2000; Klaessens et al., 2021; Koga et al., 2001; Rospabé et al., 2018), a 10-500 meter thick horizontal melt storage and reaction zone, composed of pure and plagioclase/clinopyroxene-impregnated dunites and situated just beneath the crust-mantle interface. This zone is thickest above harzburgite diapirs and represents the largest dunite volume in the ophiolite, as shown on various maps (Glennie et al., 1974; Ministry Petroleum and Minerals of Sultanate of Oman, 1986; Nicolas, et al., 2000a).

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155 (2) Dunitic veins and bands scattered in the harzburgitic main mantle section (MMS) (Bartholomew, 156 1983; Boudier & Coleman, 1981; Klaessens et al., 2021; Nicolas, et al., 2000b), corresponding to 0-1 157 meter, rarely up to 5 meters, wide dunitic reaction zones along discordant gabbroic and pyroxenitic 158 dikes. Most crosscut the peridotite foliation (henceforth referred to as "dunite veins"). In some cases, 159 the dike fracture closed completely, with all of its melt extracted to shallower levels, leaving only the 160 dunite reaction zone as an indicator of the magma passage. Rare dunites parallel to the foliation are 161 also observed in the MMS (henceforth "dunite bands"), possibly representing examples of dunite 162 veins transposed by mantle flow.

(3) The Basal banded unit (BBU) (Boudier & Coleman, 1981; Klaessens et al., 2021; Lippard et al., 1986), a highly deformed mantle unit near the basal thrust hosting abundant, 0-20 meter thick, concordant dunitic bands. In some cases, orthopyroxene-depleted harzburgite is found instead of dunite. While these bands present spectacular outcrops such as near the capital Mascate, they are difficult to map at scales larger than 1/10000 and represent a minor volume of dunite in comparison to the MTZ. Their high concentration in the BBU is poorly understood.

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2.3. Study area: the Batin dunite

170 The subject of our study, the Batin dunite located in the eastern Wadi Tayin massif (Fig. 1a), does not 171 fit into any of the three types of dunites defined above. This dunite body is exceptionally large, ≤ 250 172 meter thick, ~9.5 kilometer long and 2 kilometer wide (Fig. 1b), dips slightly towards the south-east, 173 and is elongated perpendicular to the lineation. In this region, the sheeted dike complex is vertical, 174 striking N-S, and mantle flow is horizontal with a lineation direction of ~N70. A mantle diapir has 175 been mapped at the northern end of the dunite body, centered on 22°57'N-58°40'E (Ildefonse et al., 176 1993), prompting the question of whether the dunite body could correspond to the MTZ above the 177 diapir. However, the diapir is not centered on this thick dunite body, and our complementary 178 mapping of the area shows that the Batin dunite is overlain by ~900 meters of harzburgite beneath 179 the Moho (Fig. 1c). A ridge axis (the Khazinah-Batin segment) has been associated with the diapir; its 180 estimated location based on radiogenic dating, with increasing ages on each side (Rioux et al., 2012), coincides with the structural limit between upper gabbro foliations dipping to the east (east flank) or dipping to the west (west flank) (Nicolas & Boudier, 2015). This axis is oriented N-S (parallel to the sheeted dikes), mostly along the 58°37'E longitude; thus placing the Batin dunite 1 (in the north) to 9 (in the south) kilometers east of the axis.

Nearly 5 kilometers southeast of the southern tip of the Batin dunite, the Moho dips slightly to the 185 186 south, overlying a very thin MTZ (~1-3 meters) (Fig. 1b, southernmost orange observation point, and 187 Fig. 2a). Heterogeneous harzburgite, containing pyroxene-rich patches as well as pyroxene-depleted 188 layers (orange dots in Fig. 1b; Fig. 1c), is dominant between this thin MTZ and the Batin dunite. 189 Dunite crops out near the BA4A borehole in the form of lenses. This dunite is crosscut by numerous 190 gabbroic and pyroxenitic dikes (Fig. 1c, 2b), and includes some harzburgite clasts (Fig. 2e). To the 191 north of the BA site, dunite dominates the landscape (Fig. 2c, 2d) and continues to contain coarse-192 grained harzburgite clasts (brown dots in Fig. 1b). Further north, beneath the Batin dunite, dunite is 193 interlayered with harzburgite, in the form of veins, semi-concordant bands, lenses or breccia (purple 194 dots in Fig. 1b; Fig. 1c, 2d, 2f) until the basal banded unit (located further north off the map). The 195 Batin dunite was sampled by the ICDP Oman Drilling Project (Kelemen et al., 2020) 196 (https://www.omandrilling.ac.uk) in the BA borehole series (Fig. 1b), mainly dedicated to studies of 197 serpentinization processes.

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3. Samples and analytical techniques

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3.1. BA hole and sample description

The BA site consists of three cored boreholes, BA1B, BA3A and BA4A (Fig. 1b) (Kelemen et al., 2020) (https://www.omandrilling.ac.uk). As the rocks dip gently towards the southeast, the southernmost hole, BA3A, is closest to the Moho and structurally overlies the middle hole, BA1B, which in turn structurally overlies BA4A, the hole from which our samples are taken. The 300 meter long BA3A hole is mainly composed of harzburgite (Fig. 3) overlying the Batin dunite. The 400 meter long BA1B hole begins in dunite, corresponding to a smaller dunitic body with harzburgite intervals located
above the main Batin dunite (Fig. 3); below a depth of ~160 meters, this hole is dominated by
harzburgite, sometimes crossed by dunite veins or lenses (0.05-2 meter thick). The 300 meter long
BA4A hole was drilled ~700 meters to the NW of the BA1B hole, at the southern tip of the large Batin
dunite; in other words, the first meters of the BA4A hole drill the summit of the buried extension of
this dunite. BA4A hole mainly contains dunite, intersected with decametric to metric harzburgite (Fig.
3), with a maximum continuous dunitic thickness of ~26 meters.

212 In this study, we present major element, highly siderophile element (HSE: Os, Ir, Ru, Pt, Pd, Re) and 213 Os isotopic data for four dunites and four harzburgites (chosen for freshness and very low vein and 214 crack contents) from the BA4A hole; these "harzburgite/dunite pairs" were collected at ~100 meter 215 intervals (Table 1 and Fig. 3). Harzburgites were sampled at distances varying from 3 to 20 meters 216 from their corresponding dunites (Table 1). Batin harzburgites are moderately serpentinized with 217 coarse-grained porphyroclastic textures. Harzburgite BA4A 10 (near 200 meters depth) is visually 218 depleted in orthopyroxene, relative to the 20-25% common orthopyroxene content of Oman 219 harzburgites (Godard et al., 2000), while the shallowest harzbugite BA4A 1 contains aggregates of 220 small orthopyroxene grains with concave and serrated boundaries, suggesting they are partially 221 dissolved by circulating melt, as observed in some harzburgite relics in the MTZ (Boudier & Nicolas, 222 1995). Dunites are moderately to very strongly serpentinized (sample BA4A 2 in particular). They 223 display high-temperature porphyroclastic and granular textures; dunite BA4A 5 shows annealed 224 textures with large overgrown olivine crystals (up to 1 centimeter).

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3.2. Analytical methods

226 Whole-rock major element concentrations were measured by the SARM at the CRPG laboratory 227 (Nancy, France) using an ICP-OES iCap6500 (Carignan et al., 2001). Uncertainties vary from <2% for 228 SiO₂ to <20% for MnO, based on the concentrations presented in Table 1. After chemical separation, 229 HSE and Os isotopic analyses (Table 2 and Supplementary Tables 1-3) were done at CRPG by MC-ICP-

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MS (ThermoScientific Neptune +) (Ir, Ru, Pt, Pd and Re), and N-TIMS using a Finnigan MAT262 mass
 spectrometer (Os). Details of analytical methods are provided in the Supplementary Material.

232 **4.** <u>Results</u>

233 Batin harzburgite major element compositions are coherent with those of other Oman harzburgite 234 samples (Godard et al., 2000; Hanghøj et al., 2010; Klaessens et al., 2021), except for their slightly 235 higher water contents (LOI = 12.41-14.01 wt.%) (Table 1). Their Mg# (0.904-0.911), Al₂O₃ contents 236 (0.45-0.74 wt.%) and Os concentrations (3.63-6.1 ppb) are confined to a limited range (Table 2 and 237 Fig. 4, 5a). A negative correlation exists between Al₂O₃ and MgO contents (recalculated on a volatilefree basis) in Fig. 4a. Batin harzburgites have unradiogenic Os isotopic compositions ($^{187}Os/^{188}Os_{95Ma}$ = 238 239 0.1167-0.1286) in the range of those of abyssal peridotites (Day et al., 2017) (Fig. 5a); all Os isotope 240 ratios have been corrected for radiogenic ingrowth since ophiolite emplacement at 95 Ma. Harzburgite CI chondrite (Horan et al., 2003) normalized HSE abundances display mostly flat patterns 241 242 broadly similar to Primitive Upper Mantle (PUM) estimates (Becker et al., 2006; Day et al., 2017) 243 (Table 2 and Fig. 6a-b). Harzburgite IPGE abundances plot towards the high end of the range 244 observed elsewhere in the Oman ophiolite (Ahmed & Arai, 2002; Hanghøj et al., 2010; Klaessens, 245 2021; Lorand et al., 2009), while their PPGE and Re concentrations are more variable. The shallow 246 harzburgite BA4A 1 shows a moderate enrichment in Pt and Pd and especially in Re. In contrast, 247 other harzburgites, and particularly BA4A 6 (near 100 meters depth), are depleted in PPGE and Re. In 248 addition, harzburgite BA4A 6 displays a V-shaped figure for the IPGE Os-Ir-Ru, suggesting the 249 presence of Platinum Group Minerals (PGM) rich in Ru and Os (e.g. laurite RuS₂ and erlichmanite OsS₂). This harzburgite also has an unradiogenic Os isotopic composition (187 Os/ 188 Os_{95Ma} = 0.1167), 250 251 arguing for extensive melt extraction more than 1 billion years ago, which could explain its low Re 252 content.

Batin dunites have somewhat higher water contents (LOI = 15.38-17.51 wt.%) than dunites and harzburgites from elsewhere in the Oman ophiolite (Godard et al., 2000; Hanghøj et al., 2010;

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255 Klaessens et al., 2021). Nevertheless, their volatile corrected major element contents fall on trends 256 defined by peridotites from throughout the ophiolite. Their Al₂O₃ contents (0.17-0.46 wt.%) and Mg# 257 (0.890-0.902) (Table 1 and Fig. 4) are lower than those of the harzburgites, and are similar to those of 258 the MMS dunites. Their Al₂O₃ and MgO contents correlate negatively along the extension of the 259 harzburgite trend (Fig. 4a). In contrast with the harzburgites, the position of each dunite on the trend 260 is a function of the dunite depth, with the lowest Al_2O_3 and highest MgO contents found in the 261 shallow dunite BA4A 2, while the highest Al₂O₃ and lowest MgO contents occur in the deepest dunite 262 BA4A 14. As they are composed almost exclusively of olivine, Batin dunites, with the exception of 263 sample BA4A 14, are aligned along the olivine composition line, which assumes that FeO + MgO = 264 66.67 mol%, in Fig. 4b. Their Os concentrations (3.40-5.46 ppb; Table 2; Fig. 5b) are fairly constant 265 and in the range of those observed in the Oman MMS and basal dunites (Hanghøj et al., 2010; 266 Klaessens et al., 2021), but clearly higher than those of the MTZ dunites (Klaessens et al., 2021; Xiong et al., 2020a, 2020b). The ¹⁸⁷Os/¹⁸⁸Os_{95Ma} ratios of the Batin dunites range from 0.1220 to 0.1373 and 267 268 are similar to those of the MMS dunites (Klaessens et al., 2021). Sample BA4A 11 (near 200 meters 269 depth) is quite different from the other Batin dunites: its Mg# is lower (0.890 vs. 0.898-0.902) (Fig. 4a) and its Os isotopic composition is more radiogenic $({}^{187}Os/{}^{188}Os_{95Ma} = 0.1354-0.1373 vs. 0.1220-$ 270 271 0.1302) (Fig. 5b). In harzburgite/dunite pairs, dunites are more radiogenic than their corresponding 272 harzburgites with the exception of the BA4A 1/BA4A 2 pair located near the surface (Fig. 5c). Because 273 of sampling constraints, harzburgites and dunites from the same pair were not always collected in 274 close proximity (3-20 meters separation) (Table 1). As shown by tightly spaced sampling of other 275 ophiolites (Haller et al., 2021; O'Driscoll et al., 2018; Snortum & Day, 2020) large Os isotope 276 variations can occur between harzburgites separated by a few meters or even centimeters. The 277 relatively large separation between each dunite and its paired harzburgite thus implies that the 278 compositions of the harzburgites do not necessarily represent those of the harzburgites parental to 279 the associated dunites. Batin dunites display relatively homogenous chondrite normalized HSE 280 abundance patterns (Table 2 and Fig. 6a-b), which contrast with the great variety of HSE spectra 281 determined for dunites from elsewhere in the ophiolite, including those from the Wadi Tayin massif 282 (Hanghøj et al., 2010; Klaessens, 2021). Unlike other Oman dunites, the Batin dunites are enriched in 283 Pd (and Pt); this enrichment increases with depth (Fig. 6c-d). A V-shaped figure for the IPGE Os-Ir-Ru 284 is also observed with lower Ir abundances and generally higher Os concentrations than estimated 285 PUM values (Becker et al., 2006) (Fig. 6a-b). Shallow dunite BA4A 2 has, like its adjacent harzburgite, 286 a higher Re concentration than the other Batin dunites. In contrast, dunite BA4A 5 (near 100 meters 287 depth) shows the lowest Pt and Re abundances of Batin dunites, consistent with the low abundances 288 of these elements in its associated harzburgite BA4A 6 (Fig. 6).

289 **5. Discussion**

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5.1. Seawater contamination versus Magmatic process

291 We first consider whether the radiogenic compositions of some Batin dunites result from hydrothermal circulation of seawater. Seawater had high ¹⁸⁷Os/¹⁸⁸Os (~0.51–0.57 in the mid-292 293 Cretaceous; Ravizza et al. (2001)), so hydrothermal alteration or serpentinization could potentially modify ¹⁸⁷Os/¹⁸⁸Os in these oceanic peridotites. Many authors have considered whether such 294 295 secondary processes could explain radiogenic compositions observed in peridotite samples; 296 arguments are summarized in Becker & Dale (2016). Seawater has a very low Os concentration (~10 297 fg/g) (Levasseur et al., 1998), implying that extremely high water/rock ratios (>1000) are needed to 298 significantly change Os compositions of peridotites. In ophiolitic peridotites, these ratios are almost always <100 (McCulloch et al., 1981), so significant modification of ¹⁸⁷Os/¹⁸⁸Os should be rare. 299

300 Our samples have water contents (LOI < 17.5%, most <15.5%) (Table 1) typical of serpentinized 301 peridotites, but slightly higher than those of other Oman peridotites (Godard et al., 2000; Hanghøj et 302 al., 2010; Klaessens et al., 2021). No correlation is observed between this potential indicator of 303 seawater contamination and Os isotope composition (Supplementary Fig. 1a); moreover, the most 304 radiogenic dunite BA4A 11 (near 200 meters depth) has the lowest LOI value among the Batin 305 dunites. Another indicator of seawater contamination is the Th/U ratio (e.g. Sanfilippo et al. (2016)), because the Th/U ratio of seawater ($\sim 1.5 \times 10^{-6}$) is ~ 6 orders of magnitude lower than that of typical 306 307 peridotite (~3). A simple two-component mixing model (details and parameters in Supplementary Material) was used to determine the variation of 187 Os/ 188 Os with Th/U in peridotite with increasing 308 309 seawater circulation (Supplementary Fig. 1b). For seawater contamination to raise the ¹⁸⁷Os/¹⁸⁸Os 310 ratio of a dunite with 4 ppb Os from a typical peridotitic value of ~0.124 to the most radiogenic 311 composition measured in the Batin dunites (~0.136, sample BA4A 11), a water/rock ratio of >10 000 312 would be required, which would lower the Th/U ratio of this sample to ~0.0003. Though Th and U 313 data are unfortunately not available for this sample, Aupart et al. (in revision) analyzed an 314 immediately adjacent sample (their number BA4A 80-4 (44-49)) and obtained a Th/U ratio of 2.16, 315 implying very low water/rock ratios in this part of the borehole. Other dunites analyzed by these 316 authors from the BA4A hole, as well as harzburgites from BA3A and BA1B holes, have Th/U ratios of 317 0.1-3.8, implying water/rock ratios <50, which are much too low to significantly modify peridotite 318 ¹⁸⁷Os/¹⁸⁸Os ratios. This is coherent with Th/U results from elsewhere in the ophiolite which imply 319 water/rock ratios of <100 even in dunites with highly radiogenic Os compositions (Klaessens et al., 320 2021).

321 These considerations argue strongly that the Os isotope signatures of the Batin samples reflect 322 essentially magmatic processes. While the evidence in favor of stability of PGE abundances during 323 serpentinization is more equivocal than for Os isotopes, similarity in PGE abundances between 324 variably serpentinized samples is often used to argue that the effects of this process are minimal 325 (Becker & Dale, 2016). Furthermore, sulfides, which are the main PGE host phase, are expected to be 326 stable under the reducing conditions typical of serpentinization in ophiolites (e.g. O'Driscoll et al. 327 (2015)). For these reasons, we will assume, as most previous authors have done, that the PGE 328 abundances in our peridotites were primarily controlled by magmatic processes. Rhenium 329 abundances, on the other hand, may be more problematic, as Re is a fluid mobile element. It is thus 330 possible that the elevated Re contents of some of the Batin samples may result from late Re addition rather than magmatic processes. However, in all cases the ¹⁸⁷Re/¹⁸⁸Os ratios are sufficiently low that
 radiogenic ingrowth over the past 95 Ma does not influence interpretation of the Os isotope data.

333

5.2. Record of ancient partial melting event

334 The Batin harzburgites have major element contents (Fig. 4), Os isotope compositions (Fig. 5) and CI 335 chondrite normalized HSE abundance patterns (Fig. 6) similar to those of harzburgites from 336 elsewhere in the Oman ophiolite (Ahmed & Arai, 2002; Godard et al., 2000; Hanghøj et al., 2010; 337 Klaessens, 2021; Klaessens et al., 2021; Lorand et al., 2009) and more generally, those of abyssal peridotites (Becker & Dale, 2016; Day et al., 2017). The ¹⁸⁷Os/¹⁸⁸Os_{95 Ma} ratios of these harzburgites 338 339 are slightly (~0.128; BA4A 1) to greatly (~0.117; BA4A 6) lower than estimates for the PUM (~0.1285 340 at 95 Ma; Day et al. (2017); Meisel et al. (2001)), indicating that (with the possible exception of BA4A 341 1) they experienced one or more ancient partial melting events that predated formation of the 342 ophiolite sequence by hundreds of millions of years. Though the ancient nature of these episodes can 343 be directly inferred only from their Os isotope compositions, such events would also have modified 344 the major element and HSE abundance patterns of these samples. Thus, the compositional variations 345 observed in the harzburgites probably reflect superposition of the effects of melting at the Oman 346 ridge axis on peridotites that were already heterogeneous. Harzburgite BA4A 6 (near 100 meters 347 depth) has the lowest Al₂O₃ content and highest MgO content of all of the harzburgites studied, 348 indicating a high degree of melt extraction. This sample displays a marked V-shaped figure for the 349 IPGE (Os-Ir-Ru) portion of its HSE pattern, coupled with a depletion in PPGE and Re (Fig. 6). These 350 observations suggest that partial melting of this sample was extensive enough to remove nearly all 351 base metal sulphides (BMS) and form Ru and Os-rich PGM (e.g. RuS₂ laurite and OsS₂ erlichmanite) by 352 precipitation and/or exsolution. Furthermore, experimental data indicate that Ru, Os and Ir are 353 moderately compatible in olivine and chromite (Brenan et al., 2016) while Pd, Pt and Re are 354 incompatible. Thus, it can be hypothesized that, after sulfide exhaustion, Ru and Os were retained in 355 laurite/erlichmanite, olivine and chromite, Ir was retained mostly in olivine and chromite, while Pt, Pd and Re were largely removed. Nevertheless, this suggestion should be verified by careful *in situ*studies.

The very unradiogenic Os isotopic composition (¹⁸⁷Os/¹⁸⁸Os_{95Ma} = 0.1167) of harzburgite BA4A 6 358 359 corresponds to a Re-depletion model age (T_{RD}) of ~1.7 Ga (using PUM mantle evolution curve of 360 Meisel et al. (2001)). This represents a minimum age for the melt extraction event evident in the HSE 361 and major element systematics of this sample. In Fig. 6c, a rough correlation is observed between the 362 ¹⁸⁷Os/¹⁸⁸Os_{95Ma} and the Pd/Ir ratios of the Batin harzburgites. It is possible that, at approximately 1.7 363 Ga, one or more melting events caused the Batin harzburgites to become variably depleted in PPGE 364 and Re, leading to a correlation between Re/Os and Pd/Ir, and over time to the development of the observed correlation between Pd/Ir and ¹⁸⁷Os/¹⁸⁸Os by radioactive decay of ¹⁸⁷Re, though we stress 365 366 that this interpretation is speculative and based on very few data. These ancient events would be 367 completely unrelated to the formation of the Batin dunite, which is a late-stage feature, as shown by 368 its elongation perpendicular to the lineation. Though this correlation may have been modified by 369 additional melting during formation of the ophiolite sequence at ~95 Ma, traces of the original 370 relationship remain. In theory, it would be more straightforward to consider the relationship between ¹⁸⁷Os/¹⁸⁸Os_{95Ma} and Re/Os, and a rough correlation between these parameters in the 371 372 harzburgites is indeed observed. However, data are available for only three of the four samples, and 373 the Re content of harzburgite BA4A 1 is surprisingly high, suggesting that the Re in this shallowest 374 sample may have been overprinted. Nevertheless, the Re/Os ratio of harzburgite BA4A 6 is indeed 375 the lowest, as expected.

376

5.3. Systematic chemical variations in the Batin dunite

As the preceding discussion indicates, the Oman harzburgites, including those from the Batin area, display chemical and Os isotopic compositions similar to those of abyssal peridotites, and no obvious relationship exists between composition and position of the harzburgites in the ophiolite section. In contrast, the compositions of dunites from throughout the southeastern part of the ophiolite vary systematically with structural setting (literature data in Fig. 5b). This is particularly obvious in their Os

isotope compositions: BBU dunites, at the base of the ophiolite, have low ¹⁸⁷Os/¹⁸⁸Os_{95Ma} ratios 382 383 indistinguishable from those of nearby harzburgites; MTZ dunites , just below the crust, have highly 384 radiogenic compositions and low Os concentrations; while dunites from the intervening MMS have 385 intermediate Os compositions. These differences in Os composition between the three types of 386 dunites, which are accompanied by more subtle tendencies in major element composition, reflect 387 variations in the extent of melt-rock interaction experienced by dunites in the different parts of the 388 mantle section (Klaessens et al., 2021). This systematic variation provides a framework for 389 interpretation of results from the Batin area.

390 The Batin dunite is exceptionally large with a maximal thickness of 250 meters (Fig. 1). Elsewhere in 391 the ophiolite, such thick dunite bodies are only found in the MTZ above harzburgite diapirs (Nicolas 392 et al., 1996). However, thick MTZ dunites typically include chromitite pods and layered gabbroic 393 lenses, and the underlying harzburgite displays steeply plunging lineations. None of these features 394 have been reported for the Batin dunite. MTZ dunites (Klaessens et al., 2021; Xiong et al., 2020a, 395 2020b) have highly variable Mg# (0.897-0.920) and Al₂O₃ contents (0.09-1.71 wt.%), but most 396 samples plot towards the low Mg# and high Al_2O_3 ends of these ranges (Fig. 4). This relatively fertile 397 character cannot be attributed to plagioclase impregnation, as only one of the MTZ dunites is 398 plagioclase bearing. The MTZ dunites also have low Os concentrations (0.4 to 2.3 ppb) and high initial 399 ¹⁸⁷Os/¹⁸⁸Os ratios (0.132 to 0.149) (Fig. 5b). Dunite Os concentrations are expected to decrease 400 progressively during melt-rock interaction, after near total exhaustion of base metal sulfides lowers the bulk rock Os partition coefficient, while ¹⁸⁷Os/¹⁸⁸Os ratios should increase if the melt is more 401 402 radiogenic than the peridotite (see Klaessens et al. (2021) for modeling). Thus, the very low Os abundances, high ¹⁸⁷Os/¹⁸⁸Os and fertile major element compositions of the MTZ dunites suggest 403 404 that such interaction processes have been extensive in the MTZ. In contrast, Os abundances in the 405 Batin dunites are rather high (3.4-5.5 ppb) (Fig. 5b and Table 2), and similar to those of harzburgites (3.6-6.1 ppb), while their initial ¹⁸⁷Os/¹⁸⁸Os ratios vary from 0.1220 to 0.1373, and so are lower than 406 407 those of MTZ dunites (Fig. 5b).

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408 Batin dunite chemistry also differs from that of BBU dunites (Klaessens, 2021; Klaessens et al., 2021). 409 While the Al_2O_3 contents of the Batin dunites are similar to those of the basal unit, their Mg# (0.890-410 0.902) are distinctly lower than basal dunite values (0.908-0.923) (Fig. 4). The strong PPGE depletion 411 observed in the BBU dunites is absent in the Batin dunites, and the V-shaped figures for the IPGE Os-412 Ir-Ru chondrite normalized abundances are less pronounced (Fig. 6b). Os isotope ratios of Batin dunites (¹⁸⁷Os/¹⁸⁸Os_{95Ma} = 0.1220-0.1373) overlap those of the basal dunites (0.1165-0.1280) (Fig. 5b), 413 414 but tend to be more radiogenic. Unlike at the base of the ophiolite, where dunites and adjacent 415 harzburgites have nearly identical Os isotope compositions (Klaessens et al., 2021), the Batin dunites 416 tend to be more radiogenic than the nearby harzburgites (Fig. 5c).

417 Thus, the Batin dunites display differences with MTZ and BBU dunites of the ophiolite. Instead, they 418 have major element, HSE and Os isotope compositions similar to those of MMS dunites (Fig. 4-5) 419 (Godard et al., 2000; Hanghøj et al., 2010; Klaessens, 2021; Klaessens et al., 2021; Xiong et al., 2020a, 420 2020b). The Os concentrations of the Batin dunites (3.4-5.5 ppb; Table 1) are much less variable than 421 those observed in the MMS (1.1-11.8 ppb), but this may simply reflect the collection of the Batin 422 samples in a much more limited zone. This could also explain the limited variability of the Batin dunite chondrite-normalized HSE abundance patterns (Fig. 6a-b). An affinity with MMS dunites from 423 424 elsewhere in the ophiolite is logical as the Batin dunite is indeed located within the main mantle 425 section. Nevertheless, the Batin body is dramatically larger than the dunite veins and bands seen 426 elsewhere in the MMS.

While the Batin dunites appear to bear some kinship with the MMS dunites from elsewhere in the ophiolite, they show some particular features. In addition to their high IPGE abundances, Batin dunites show enrichment in Pd (from 5.4 to 12.8 ppb) and possibly in Pt (from 7.4 to 9.3 ppb) increasing with depth (Fig. 6). A negative relationship is also observed between Al₂O₃ and MgO contents correlating with depth (Fig. 4a): the deepest dunite BA4A 14 is the richest in Al₂O₃ and PPGE, and the poorest in MgO, while the shallow dunite BA4A 2 contains the lowest Al₂O₃ and PPGE abundances, and the highest MgO contents. The deep dunite BA4A 11 also has a markedly radiogenic Os isotopic composition (Fig. 5b, 6c). The very shallow harzburgite/dunite pair BA4A 1 and 2 (at 10
and 13 meters respectively; Table 1) is enriched in Re relative to other Batin peridotites (Fig. 6a-b).
However, the Re/Os ratio of the dunite is much higher than that of the harzburgite, despite the close
similarity of the ¹⁸⁷Os/¹⁸⁸Os ratios of the two lithologies, strongly suggesting recent enrichment in Re
in these shallow samples.

439

5.4. Batin dunite formation

440 The Batin dunite is unique in the Oman ophiolite because of its exceptionally large size and unusual 441 structural setting, nearly 1 kilometer beneath the Moho. As discussed above, in many respects, the 442 chemical composition of this body resembles those of MMS dunitic veins and bands (Godard et al., 443 2000; Hanghøj et al., 2010; Klaessens, 2021; Klaessens et al., 2021; Xiong et al., 2020a, 2020b). 444 Nevertheless, not all of the chemical characteristics of the Batin dunite correspond to those of the 445 small MMS dunitic veins. A chemical evolution is observed within the Batin dunite, with more fertile 446 compositions (higher Al₂O₃ and lower MgO contents, as well as higher Pt and Pd abundances) found 447 towards the bottom, evolving to less fertile compositions with increasing height (Fig. 4, 6). 448 Furthermore, orthopyroxene-depleted harzburgite bands instead of dunites are often found in the 449 harzburgite overlying the Batin dunite and may result from interaction with melts insufficiently 450 undersaturated in pyroxene to permit complete removal of this phase.

451 We present below a model that may explain many of these observations. This model is unavoidably 452 speculative, as it is based on a small number of samples. As several studies have shown (Haller et al., 453 2021; O'Driscoll et al., 2018; Snortum & Day, 2020), large heterogeneities in Os isotopic composition 454 and HSE abundances can exist on length scales of a meter or less in ophiolites. Therefore, drawing 455 conclusions from a few widely spaced samples may be unwise. Nevertheless, we are struck by the 456 limited variation and surprisingly systematic nature of the dunite HSE patterns, which differ from 457 those seen in dunites from elsewhere in the massif (e.g. Hanghøj et al. (2010); Klaessens (2021)). This 458 relative uniformity may suggest that the magma/rock interaction process that produced the dunites 459 was sufficiently intense to overprint most of the preexisting heterogeneity in the parental 460 harzburgite. We thus suggest that a possible explanation of the existing data is the partial blockage of 461 a large melt volume during its ascent at ~1200 meters below the Moho, forming the base of the Batin 462 dunite by dissolution of the orthopyroxene of the host harzburgite. As these melts slowly continued 463 their migration upwards, their compositions changed through interaction with the harzburgitic 464 precursors and the formation of the thick dunite body, leading to decreasing Al₂O₃ and increasing 465 MgO contents, coupled with a decrease in the degree of melt undersaturation in orthopyroxene. This 466 change in melt composition is evident in the HSE spectra, which suggest that the initial melts were 467 relatively enriched in PPGE, and that this enrichment decreased with continued interaction with the harzburgites as the melts ascended. The elevated ¹⁸⁷Os/¹⁸⁸Os ratio_{95 Ma} of dunite BA4A 11, one of the 468 469 two deepest dunites, indicates that these melts were more radiogenic than MORB, and likely similar 470 to those that interacted with MTZ and MMS dunites elsewhere in the ophiolite (Klaessens et al., 471 2021). As these melts interacted with the peridotite during ascent, they would have become less radiogenic, making them unable to modify the ¹⁸⁷Os/¹⁸⁸Os ratios of the uppermost peridotites, as 472 473 shown by the isotopic similarity between the shallow dunite BA4A 2 and the nearby harzburgite BA4A 1. If this model is correct, the lack of a systematic, monotonic decrease in ¹⁸⁷Os/¹⁸⁸Os with 474 475 height may reflect the fact that the melt-peridotite interaction was superimposed on precursor 476 harzburgites that were already heterogeneous (Fig. 5).

477 In this scenario, the top of the dunite may represent the limit above which the melts were no longer 478 sufficiently undersaturated in pyroxene to fully transform harzburgite into dunite. The pyroxene-479 poor harzburgite bands observed above the dunite could have formed from interaction with such 480 melts. As noted earlier, pyroxene-rich harzburgites are also found above the Batin dunite, which may 481 suggest that some melts became so enriched in the pyroxene component during melt-rock 482 interaction that they reached saturation in this phase. Minor changes in conditions and/or melt 483 composition could then have triggered pyroxene precipitation. Thus, both the pyroxene-depleted 484 harzburgite bands and the pyroxene-rich harzburgite patches in the region above the Batin dunite 485 could potentially be explained by the intensive melt-rock interaction processes that occurred during486 production of the dunite.

487 The reason for melt blockage at depth, sufficient to produce this massive dunite body, is unclear. As 488 mentioned above, the Batin dunite shows discordant contacts at its upper and lower limits, where 489 some magmatic breccia are observed (Fig. 2e-f). The NE-SW elongation of this body also crosscuts at 490 high angle the asthenospheric mantle lineation; it is thus not transposed by mantle flow. These 491 observations suggest that the giant dunite body was formed when and/or where mantle had stopped 492 flowing, in near-lithospheric conditions. A possible explanation of the melt ponding depth may be its 493 correspondence to the lithosphere-asthenosphere boundary. Melt emplacement away from the 494 accretion center, or as a late magmatic event, during the cooling history of the ophiolite could then 495 explain the abundance of melt at this level.

496 **6.** <u>Conclusions</u>

497 This exploratory study of the large Batin dunite body shows that it contrasts chemically and 498 structurally with MTZ and basal dunites of the Oman ophiolite, but presents numerous chemical 499 similarities with dunitic veins and bands of the main mantle section. Nevertheless, the composition 500 changes systematically with height, becoming progressively less fertile, and showing decreasing 501 abundances of the incompatible Platinum Group Elements, Pt and Pd. One interpretation of our field 502 and analytical data may be that the Batin dunite formed by interaction of the preexisting harzburgite 503 with a large pulse of melt that stagnated at ~1200 meters below the Moho. As is true elsewhere in 504 the ophiolite, the dunite-forming melts had more radiogenic Os isotopic compositions than MORB, as shown by the high ¹⁸⁷Os/¹⁸⁸Os ratio of one of the deepest dunites. As the melts migrated upwards, 505 506 interacting with the harzburgite to form dunite, they would have become less radiogenic and their Pt 507 and Pd concentrations would have decreased. They would also have become progressively less 508 undersaturated in pyroxene as they ascended. This suggestion is supported by the bands of 509 pyroxene-poor harzburgites in the zone above the dunite, which likely formed by interaction with 510 melts that lacked the capacity to fully digest all of the pyroxene present in the original rock.

This simple model is based on a very limited number of samples and will surely evolve as more data become available. Structural and geochemical studies of the lithologies overlying and underlying the dunite will be particularly valuable for improving our understanding of this intriguing feature in the Oman ophiolite.

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527 Author Contributions

D. Klaessens, D. Jousselin and L. Reisberg participated in fieldwork and the Oman Drilling Project. D.
Jousselin provided geological context. The Oman Drilling Project Science Team supplies samples. D.
Klaessens completed most of the analyses and wrote the initial manuscript. L. Reisberg supervised
Re-Os analyses. D. Klaessens, L. Reisberg and D. Jousselin discussed the results and their implications,
and assisted in the final revisions to the manuscript.

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533 *CRediT author statement*

- 534 Delphine Klaessens: Conceptualization, Methodology, Formal analysis, Validation, Investigation,
- 535 Visualization, Writing Original Draft, Writing Review & Editing
- 536 Laurie Reisberg: Conceptualization, Methodology, Investigation, Writing Review & Editing,
- 537 Supervision, Funding acquisition
- 538 David Jousselin: Conceptualization, Investigation, Writing Review & Editing, Supervision, Funding 539 acquisition
- 540 The Oman Drilling Project Science Team: Resources, Project Administration

541 Competing Interests statement

542 None of the authors have competing interests.

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737 Figure and Table Legends

738 Figure 1. Oman Drilling Project GT, BT, CM and BA borehole locations in the southeastern massifs 739 (Sumail and Wadi Tayin) of the Oman ophiolite. (a) Simplified geological map of the region (after 740 Nicolas, et al. (2000a)) showing the spatial distribution of the Hawasina sediments, the ophiolite 741 crustal section, the Moho Transition Zone (MTZ) and large dunite outcrops, the mainly harzburgitic 742 mantle section and the metamorphic sole. The inferred ridge axis (bold blue lines), mantle diapirs 743 (stars), main dike orientations (double black lines) and limits of NE-SW dikes (black dashed curves) 744 are indicated. (b) Enlarged view of the Batin region in the northeastern Wadi Tayin massif, where a 745 large dunite (dark brown) outcrops (after Noël (2018)). Mantle and gabbro lineations (Nicolas, et al., 746 2000a), 45° foliation isodip (Ildefonse et al., 1993) and the Khazinah-Batin segment (Rioux et al., 747 2012) are shown. BA cored borehole locations (BA1B, BA3A and BA4A) are indicated (large red dots); 748 studied samples from BA4A hole at the southernmost tip of the exposed part of the dunite body. 749 Smaller dots show field observation sites where harzburgite (orange dots) or dunite (brown dots) is 750 dominant or where both lithologies coexist in roughly equal proportions (purple dots). The Moho and underlying rocks dip gently to the south, so that the stratigraphic level deepens towards the north.
(c) SE-NW schematic vertical section (corresponding to a traverse from point X to Y in Fig. 1b) based
on field observations in the Batin region, showing the distribution of the lithologies above (point X)
and below (point Y) the Batin dunite.

755 Figure 2. Field photographs illustrating the Moho (a), the Batin dunite (b-d), harzburgite clasts 756 trapped in dunitic vein networks close to this giant dunite (e-f) in the study area. (a) Moho dipping 757 slightly to the south and overlying a very thin MTZ (1-3 meters). (b) Altered dunite summit crosscut 758 by numerous gabbroic and pyroxenitic dikes and sills near the BA4A hole. (c) View of dunite irregular 759 summit showing preserved harzburgite clasts (darker) in dunite or indistinguishable depleted 760 harzburgite (lighter) (delimited contacts). G, gravel. (d) Lower part: Batin dunite core with massive 761 and highly altered dunite, allowing development of a wide Wadi (river) bordered with flat terraces. 762 Upper part: Batin dunite summit with zones richer in harzburgite, more resistant to erosion, forming 763 reliefs (purple dots in center of Fig. 1b). (e) Pyroxene-rich harzburgite clasts trapped in dunitic vein 764 network near upper limit of the Batin dunite. (f) Dunitic vein network below the Batin dunite 765 (northernmost observation points of Fig. 1b).

Figure 3. Stratigraphic cross-sections of ICDP BA3A, BA1B and BA4A cored boreholes in the Batin area
of the Oman ophiolite illustrating lithologies. Borehole locations are shown in insert and Fig. 1; BA3A
hole structurally overlies BA1B, covering BA4A. Data from Kelemen et al. (2020)
(https://www.omandrilling.ac.uk). Modified after Aupart et al. (in revision). Samples come from
BA4A hole; their locations and lithologies (light orange for harzburgite and brown for dunite) are
indicated.

Figure 4. Whole-rock major element compositions of Batin harzburgites and dunites, recalculated on
 a volatile-free basis, compared with published peridotite data from the Oman ophiolite. (a) Al₂O₃ vs.
 MgO, (b) FeO vs. MgO and (c) depth vs. Al₂O₃ (for Batin dunites only). In panel (b), dotted grey lines
 represent constant Mg# values and bold dotted black line shows evolution of olivine composition

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constrained by FeO + MgO = 66.67 mol% following Godard et al. (2000). Published Oman peridotite
data (Godard et al., 2000; Hanghøj et al., 2010; Klaessens et al., 2021) include dunites from the Moho
Transition Zone (MTZ), and dunites and harzburgites from the main mantle section (MMS) and the
basal banded unit (BBU). Attribution of samples from the literature to the three domains defined in
Klaessens et al. (2021) was based on their geographic positions in the mantle section.

Figure 5. Os isotope compositions of Batin harzburgites and dunites. (a) ¹⁸⁷Os/¹⁸⁸Os vs. [Os] in 781 harzburgites; (b) ¹⁸⁷Os/¹⁸⁸Os vs. [Os] in dunites; (c) Variations in ¹⁸⁷Os/¹⁸⁸Os of dunite/harzburgite 782 783 pairs (delimited by contours) with depth in BA4A cored borehole. In all panels, pink bands represent estimated ¹⁸⁷Os/¹⁸⁸Os ratio for the Primitive Upper Mantle (PUM) (~0.1289 at 95 Ma (Meisel et al., 784 785 2001); coherent with ~0.1285 at 95 Ma from Day et al. (2017)). Light grey, dark grey and brown curves on the sides of diagrams show the probability distribution of ¹⁸⁷Os/¹⁸⁸Os ratios for abyssal 786 787 peridotites (compilation in Becker & Dale (2016); new data from Day et al. (2017) show a similar 788 distribution), MORB (MORB sulfide data from Gannoun et al. (2016)) and Oman lower crust (Peucker-789 Ehrenbrink et al., 2012) respectively. Published Oman peridotite data are shown for comparison 790 (Hanghøj et al., 2010; Klaessens et al., 2021; Xiong et al., 2020a, 2020b); symbols as in Fig. 4. 791 Attribution of samples from the literature to the three domains defined in Klaessens et al. (2021) was 792 based on their geographic positions in the mantle section. Data for harzburgites and the three types 793 of dunites from Klaessens et al. (2021) are reported in Supplementary Table 4.

794 Figure 6. HSE abundances and Os isotope compositions of Batin harzburgites and dunites. (a-b) CI 795 chondrite (Horan et al., 2003) normalized HSE abundances of harzburgites (a) and dunites (b). (c) ¹⁸⁷Os/¹⁸⁸Os_{95Ma} vs. Pd/Ir. (d) [Pd] vs. [Pt]. (e) Variations in Batin dunites of Pd content with depth in 796 BA4A cored borehole. In all panels, pink fields represent estimated ¹⁸⁷Os/¹⁸⁸Os ratio and HSE 797 798 abundances for Primitive Upper Mantle (PUM) from Meisel et al. (2001) and Becker et al. (2006) 799 respectively, while violet fields represent HSE estimates for PUM from Day et al. (2017). 800 Harzburgite/dunite pairs are shown with same colors (filled symbols for harzburgites; open symbols 801 for dunites). Light and dark grey fields in panels (a-b) show HSE abundances for harzburgites and

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802 dunites from the Oman main (MMS) and basal mantle sections (partially covered by translucent 803 MMS fields) respectively (Klaessens, 2021). In panels (c-d), blue arrows indicate Batin dunite 804 enrichment in Pd and more limited enrichment in Pt increasing with depth. In panel (c), blue dotted 805 line highlights correlation between Pd/Ir and ¹⁸⁷Os/¹⁸⁸Os in harzburgites, consistent with radiogenic 806 ingrowth since ancient partial melting. Published Oman peridotite data are shown for comparison 807 (Hanghøj et al., 2010; Klaessens, 2021; Klaessens et al., 2021) (symbols as in Fig. 4). Attribution of 808 samples reported in the literature to the three domains defined in Klaessens et al. (2021) was based 809 on their geographic positions in the mantle section. Osmium isotope and HSE data of Klaessens 810 (2021) and Klaessens et al. (2021) are reported in Supplementary Tables 4-5.

811 Table 1. Whole-rock major element compositions of the studied Batin peridotites

812 Table 2. HSE concentrations and Os isotope compositions of the studied Batin peridotites and UB-N
813 and MUH-1 standards



after Noël (2018)











Pd/Ir





Pt (ppb)



Pd/Ir

Pt (ppb)

Sample	Lithology	Oman DP reference	Depth	Hzb/Dun pair distance	SiO ₂	AI_2O_3	FeO*	MnO	MgO	CaO	Na_2O	LOI	Total	Mg#
			(m)	(m)	(wt.%)									
BA4A 01	hzb	5-2 (46-51)	10.16	3.175	39.09	0.74	6.76	0.11	38.65	0.73	b.d.l.	12.41	98.49	0.911
BA4A 02	dunite	6-3 (8-13)	13.33		33.12	0.17	7.73	0.12	39.85	0.04	b.d.l.	17.51	98.53	0.902
BA4A 06	hzb	39-2 (74-79)	100.24	4.620	36.71	0.45	7.53	0.12	39.75	0.44	b.d.l.	14.01	98.99	0.904
BA4A 05	dunite	37-4 (35-40)	95.62		33.06	0.23	8.17	0.13	40.29	0.25	b.d.l.	16.23	98.35	0.898
BA4A 10	hzb	73-4 (4-9)	197.20	16.965	37.88	0.63	7.09	0.11	38.58	0.92	b.d.l.	13.87	99.07	0.907
BA4A 11	dunite	80-3 (12-17)	214.17		33.31	0.37	8.84	0.14	40.08	0.32	0.04	15.38	98.47	0.890
BA4A 16	hzb	107-1 (25-30)	293.98	19.770	37.48	0.58	7.02	0.11	39.80	0.71	b.d.l.	13.42	99.11	0.910
BA4A 14	dunite	100-3 (18-23)	274.20		34.08	0.46	7.92	0.13	39.86	0.31	b.d.l.	15.43	98.18	0.900

Table 1. Whole-rock major element compositions of the studied Batin peridotites

Whole-rock major element compositions were analyzed by the SARM (Service d'Analyse des Roches et des Minéraux) at the CRPG laboratory in Nancy (France) using ICP-OES iCap6500. K_2O , TiO₂ and P_2O_5 contents are below detection limit of the instrument. Oman DP references include section unit and sample interval (cm). *Total Fe as FeO.

 $Mg# = Mg/(Mg+Fe)_{at}$: LOI = Loss On Ignition; b.d.l. = below detection limit; Hzb = harzburgite; Dun = dunite.

Table 2. HSE concentrations and Os isotope compositions of the studied Batin peridotites and UB-N

and MUH-1 standards

Sample	Lithology	Depth	[Os]	[Ir]	[Ru]	[Pt]	[Pd]	[Re]	¹⁸⁷ Re/ ¹⁸⁸ Os	(¹⁸⁷ Os/ ¹⁸⁸ Os) _m	$2\sigma\text{error}$	(¹⁸⁷ Os/ ¹⁸⁸ Os) _{95Ma}	$2\sigma\text{error}$
		(m)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)					
BA4A 1	hzb	10.155	4.41	4.30	6.93	9.96	7.19	0.641	0.701	0.12682	0.00057	0.12571	0.00057
BA4A 1-d ₁			6.12	3.83	6.51	9.49	7.57	0.599	0.471	0.12936	0.00145	0.12861	0.00145
BA4A 1-d ₂			4.30					0.564	0.633	0.12710	0.00054	0.12610	0.00054
BA4A 2	dunite	13.330	4.35	3.12	6.69	7.81	5.93	1.203	1.331	0.12669	0.00055	0.12459	0.00055
BA4A 2-d			3.92	2.67	6.20	7.38	5.38	1.277	1.572	0.12450	0.00059	0.12201	0.00060
BA4A 6	hzb	100.245	5.38	3.79	8.28	4.97	3.07	0.096	0.086	0.11684	0.00052	0.11671	0.00052
BA4A 5	dunite	95.625	4.42	3.31	7.67	8.34	6.96	0.239	0.260	0.12696	0.00053	0.12655	0.00054
BA4A 5-d			3.398	2.42	6.35	5.60	6.95			0.12762	0.00062	0.12846	0.00063
BA4A 10	hzb	197.205	3.63	2.80	5.62	6.83	4.31			0.12548	0.00053	0.12552	0.00054
BA4A 11	dunite	214.170	5.46	3.04	7.44	8.59	9.20	0.606	0.535	0.13812	0.00124	0.13728	0.00124
BA4A 11-d ₁			4.55	3.06	6.39	8.59	8.32	0.485	0.514	0.13682	0.00054	0.13601	0.00055
BA4A 11-d ₂			4.69					0.631	0.649	0.13641	0.00053	0.13538	0.00053
BA4A 11-d ₃			4.29					0.496	0.559	0.13675	0.00051	0.13586	0.00051
BA4A 16	hzb	293.975	3.86	3.63	6.14	6.27	4.13	0.295	0.368	0.12354	0.00054	0.12296	0.00054
BA4A 14	dunite	274.205	5.19	3.13	7.17	9.32	10.09	0.539	0.501	0.13097	0.00061	0.13018	0.00061
BA4A 14-d ₁			4.27	3.37	7.06	9.13	12.82	0.542	0.612	0.12644	0.00055	0.12547	0.00055
BA4A 14-d ₂			4.18					0.507	0.584	0.12736	0.00051	0.12644	0.00051
BA4A 14-d ₃			4.20					0.483	0.554	0.12769	0.00053	0.12681	0.00053
Standards													
MUH-1			4.10	2.61	5.65	20.99	8.93	0.276	0.325	0.12658	0.00052		
UB-N 1			3.44	2.76	5.88	6.75	10.44	0.243	0.341	0.12725	0.00055		
UB-N 2			3.30					0.240	0.351	0.12780	0.00052		
UB-N 3			3.43					0.191	0.269	0.12690	0.00051		

HSE concentrations and Os isotopic compositions in whole rock powders were analyzed at the CRPG laboratory in Nancy (France) using MC-ICP-MS (Neptune +) and N-TIMS (Finnigan MAT 262) (Os). All uncertainties are 2SE and include all recognized sources of uncertainty, including in-run analytical precision, reproducibility of standard analyses, uncertainties related to blank variability, uncertainties related to age correction (95 Ma). Duplicate analyses were performed for several samples (noted "-d") and the UB-N standard. Details are presented in the Supplementary Tables 1-3. Hzb = harzburgite.

Supplementary material

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2 1. Analytical methods

3

1.1. Major element compositions

Whole-rock major element concentrations (Table 1) were measured by the SARM at the CRPG laboratory (Nancy, France;http://helium.crpg.cnrs-nancy.fr/SARM/). Loss on Ignition (LOI) was determined by mass loss after calcination at 1000°C. The anhydrous residue was fused with LiBO₂ flux then digested in acid prior to major element analysis using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES iCap6500). Detailed technique description can be found in Carignan et al. (2001). Uncertainties vary from <2% for SiO₂ to <20% for MnO, based on the concentrations.

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1.2. Highly siderophile element abundances and Os isotopic compositions

Highly siderophile element abundances and Os isotopic compositions were analyzed at CRPG. Sample 11 powders (1.5-2g) were spiked with a mixed tracer solution containing ¹⁹⁰Os, ¹⁰¹Ru, ¹⁹¹Ir, ¹⁹⁶Pt, ¹⁰⁵Pd 12 and ¹⁸⁵Re, and digested in a solution of concentrated HCI:HNO₃ (2:5 for samples and 1.5:5 for blanks) 13 in a High Pressure Asher (HPA-S; Anton Paar) for 16 hours at 100 bars and 285°C. This procedure 14 15 brings all of the Os to its most oxidized form (OsO_4) , assuring spike-sample equilibration. Osmium 16 was chemically extracted from the sample solution into liquid bromine, for which OsO_4 has a strong 17 affinity, and purified by microdistillation, using techniques adapted from Birck et al. (1997). Following 18 Os extraction, other HSE were separated from the residual acidic solution by anion-exchange column 19 chromatography using the method of Rehkämper & Halliday (1997). For several of the replicate analyses, only ¹⁸⁷Os/¹⁸⁸Os ratios and Os and Re concentrations were determined. In these cases, Re 20 21 was separated using AG1 X8 resin columns from the residual solution.

22 Rhenium, Pd, Ru, Pt and Ir isotopic compositions used for concentration determinations by isotope 23 dilution were analyzed by MC-ICP-MS (ThermoScientific Neptune +). Given that Rh and Au are 24 monoisotopic elements, it was not possible to analyze them by this method. Instrumental mass fractionation was corrected by standard bracketing, assuming 187 Re/ 185 Re = 1.6738, 108 Pd/ 106 Pd = 0.9236, 102 Ru/ 99 Ru = 2.4726, 194 Pt/ 195 Pt = 0.9744 and 191 Ir/ 193 Ir = 0.5949 for the standard. Osmium isotopic compositions were determined by Negative Thermal Ionization Mass Spectrometry (NTIMS) (Creaser et al., 1991; Völkening et al., 1991) using a Finnigan MAT 262 mass spectrometer. Isotopic ratios of OsO₃⁻ masses were obtained by peak jumping on an ETP electron multiplier. Corrections for heavy oxides, spike contributions and instrumental mass fractionation were made off-line, assuming a natural 192 Os/ 188 Os ratio of 3.08271.

32 Highly siderophile element abundances and Os isotope data are presented in Table 2 and 33 Supplementary Tables 1-2. All uncertainties are 2SE and include all significant recognized sources of uncertainty (in-run analytical precision, standard reproducibility, uncertainties related to variability 34 35 of the amount and isotopic composition of the analytical blank, uncertainties related to the Re/Os 36 ratio and the ensuing age correction). These different uncertainty components are listed for each sample in Supplementary Table 3. The total analytical blanks varied between the two main analytical 37 periods of the study: Os = 0.0007 ± 0.0002 ng, 187 Os/ 188 Os = 0.209 ± 0.122 (n = 3), Re = 0.042 ± 0.078 38 ng, Ir = 0.001 ± 0.002 ng, Pt = 0.015 ± 0.023 ng, Ru = 0.018 ± 0.045 ng, Pd = 0.014 ± 0.022 ng (n = 4) 39 (first period, including all full HSE analyses); Os = 0.0010 ± 0.0000 ng (n = 2), 187 Os/ 188 Os = $0.2204 \pm$ 40 41 0.0058 (n = 1), Re = 0.022 ± 0.003 ng (n = 2) (second period; comprising those replicates analyzed solely for ¹⁸⁷Os/¹⁸⁸Os and Re and Os concentrations); all uncertainties 2σ . The total 2σ uncertainties, 42 including the blank variability, on the initial ¹⁸⁷Os/¹⁸⁸Os ratios of all samples are < 1.2%. UB-N and 43 44 MUH-1 reference materials (Table 2 and Supplementary Tables 1-3), which like our samples are serpentinized peridotites, were analyzed concurrently with the samples, yielding mean ¹⁸⁷Os/¹⁸⁸Os 45 ratios of $0.1273 \pm 0.0005 (2\sigma)$ (n = 3) and $0.1266 \pm 0.0005 (2\sigma)$ (n = 1) respectively, in agreement with 46 the accepted values (MUH-1: Snortum & Day (2020); UB-N : Meisel et al. (2003)). Duplicate analyses 47 were performed for all dunites (n = 2 for BA4A 2,5 and 4 for BA4A 11,14) and harzburgite BA4A 1 (n = 48 49 3).

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2. <u>Seawater alteration of peridotite - mixing model</u>

To exclude a contamination of our samples with seawater, we simulate a simple two component

52 mixture between seawater and a common peridotite in Klaessens et al. (in revision) (Supplementary Fig. 1), similar to the model used by Sanfilippo et al. (2016), using the following equations: 53 $[0s]_{mix} = (f \cdot [0s]_{seawater}) + ((1-f) \cdot [0s]_{per})$ 54 (1) $({}^{187}Os/{}^{188}Os)_{mix} = \frac{1}{[Os]_{mix}} \cdot (f \cdot [Os]_{seawater} \cdot ({}^{187}Os/{}^{188}Os)_{seawater}) + ((1-f) \cdot [Os]_{per} \cdot ({}^{187}Os/{}^{188}Os)_{per})$ 55 (2) Th and U concentrations are calculated in the same manner as Os concentration, using Equation A.1. 56 where: $[Os]_{ner}$: concentration in Os of the peridotite 57 58 [0s]_{seawater}: seawater concentration in Os [*Os*]_{*mix*}: concentration in *Os* of the mixture, including seawater and peridotite 59 $({}^{187}Os/{}^{188}Os)_{per}$: ${}^{187}Os/{}^{188}Os$ ratio of the peridotite 60 $({}^{187}Os/{}^{188}Os)_{melt}$: ${}^{187}Os/{}^{188}Os$ seawater ratio 61 $({}^{187}Os/{}^{188}Os)_{mix}$: ${}^{187}Os/{}^{188}Os$ ratio of the mixture, including seawater and peridotite 62 63 f: seawater fraction 64 We use the following compositions for the peridotite and Cretaceous seawater endmembers: $({}^{187}Os/{}^{188}Os)_{ner} = 0.124$ $({}^{187}Os/{}^{188}Os)_{seawater} = 0.55$ 65 $[0s]_{seawater} = 10^{-5} \text{ ppb}$ 66 $[Os]_{per} = 4 \text{ ppb}$ $[Th]_{seawater} = 5 \times 10^{-6} \text{ ppb}$ 67 [*Th*]_{*per*} = 13 ppb $[U]_{per} = 4.5 \text{ ppb}$ 68 $[U]_{seawater} = 3.3 \text{ ppb}$ For the peridotite, the ¹⁸⁷Os/¹⁸⁸Os ratio chosen is typical of Oman harzburgites, as well as of abyssal 69 70 peridotites, and its Os concentration of 4 ppb is typical of dunites and harzburgites from the Batin area (Table 1, main text). The peridotite Th and U concentrations are those of the depleted peridotite 71 reference material PCC-1 (Govindaraju, 1994). Seawater Os, Th and U contents are the same as those 72 used in the model of Sanfilippo et al. (2016). The seawater ¹⁸⁷Os/¹⁸⁸Os ratio is from Ravizza et al. 73 74 (1999).

75 This mixing model shows that seawater contamination sufficient to produce radiogenic Os compositions similar to that of the most radiogenic Batin sample, dunite BA4A 11 (187 Os/ 188 Os_{95Ma} ~ 76 77 0.136), would require water/rock ratios >10000, and would lower corresponding peridotite Th/U 78 ratios to ~0.0003. In another study of the ICDP Oman Drilling Project BA borehole samples, Th/U 79 ratios of dunites from the same hole used in our study (BA4A; some collected in close proximity with 80 our samples) and of harzburgites from the BA3A and BA1B holes were analyzed (Aupart et al., in 81 revision). These Th/U ratios (0.1-3.8) are all several orders of magnitude higher than 0.0003, implying 82 that seawater contamination was much less important than that required to explain our results by 83 this process. The dunite sample BA4A 80-4 (44-49) of Aupart et al. (in revision) was collected just next to our radiogenic dunite BA4A 11 and has an almost unperturbed Th/U ratio of 2.16. 84 85 Supplementary Fig. 1 shows the Os composition and Th/U ratio range of Batin peridotites in 86 comparison with the mixing model curve and other published Oman peridotite data (Godard et al., 87 2000; Hanghøj et al., 2010; Klaessens et al., 2021; Xiong et al., 2020a, 2020b). These data, in addition 88 to the absence of correlation between LOI values and Os isotope composition in our Batin peridotite 89 samples, argue that they have preserved the Os isotope signatures of essentially magmatic 90 processes.

Figures

section. No correlation is observed between initial Os isotope ratios, LOI, whole-rock Th/U ratios and the Th/U model curve. This curve shows that seawater/rock ratios >10 000 would be required to produce ¹⁸⁷Os/¹⁸⁸Os ratios comparable to those of the MTZ dunites and Batin dunite BA4A 11, and these would be associated with Th/U ratios much lower than the observed values. Thus, seawater contamination cannot explain the radiogenic initial ¹⁸⁷Os/¹⁸⁸Os ratios of these samples.

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Tables

- 110 Supplementary Table 1. Re and Os concentrations and Os isotope compositions of the studied Batin
- 111 peridotites and UB-N and MUH-1 standards

Supplementary Table 2. HSE concentrations of the studied Batin peridotites and UB-N and MUH-1
 standards

- **Supplementary Table 3.** Different components of the uncertainties on HSE concentrations and Os
- 115 isotope compositions entering into the total uncertainties

116 Supplementary Table 4. Re and Os concentrations and Os isotope compositions of Oman

117 harzburgites and the three types of dunites and of the reference materials (Klaessens, 2021;

- 118 Klaessens et al., 2021)
- 119 Supplementary Table 5. HSE concentrations of Oman harzburgites and the three types of dunites
- 120 and of the reference materials (Klaessens, 2021; Klaessens et al., 2021)

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Sample	Lithology	Depth	Mass	[Os]	2σ error	[Re]	2σ error	¹⁸⁸ Os	2σ error	¹⁸⁷ Re/ ¹⁸⁸ Os	2σ error	(¹⁸⁷ Os/ ¹⁸⁸ Os) _m	2σ error	(¹⁸⁷ Os/ ¹⁸⁸ Os) _{95 Ma}	2σ error
		(m)	(g)	(ppb)		(ppb)		(M/g)							
BA4A 1	harzburgite	10.155	2.01412	4.411	0.000	0.641	0.039	3.08E-12	2.22E-14	0.701	0.043	0.12682	0.00057	0.12571	0.00057
BA4A 1-d ₁			2.00379	6.123	0.000	0.599	0.039	4.27E-12	1.90E-13	0.471	0.037	0.12936	0.00145	0.12861	0.00145
BA4A 1-d ₂			1.54518	4.295	0.000	0.564	0.005	3.00E-12	1.91E-14	0.633	0.007	0.12710	0.00054	0.12610	0.00054
BA4A 2	dunite	13.330	2.00336	4.354	0.000	1.203	0.039	3.04E-12	1.75E-14	1.331	0.044	0.12669	0.00055	0.12459	0.00055
BA4A 2-d			1.51420	3.916	0.000	1.277	0.052	2.73E-12	1.54E-14	1.572	0.064	0.12450	0.00059	0.12201	0.00060
BA4A 6	harzburgite	100.245	2.00763	5.375	0.000	0.096	0.039	3.76E-12	1.64E-14	0.086	0.035	0.11684	0.00052	0.11671	0.00052
BA4A 5	dunite	95.625	2.00897	4.416	0.000	0.239	0.039	3.08E-12	1.40E-14	0.260	0.042	0.12696	0.00053	0.12655	0.00054
BA4A 5-d			1.52049	3.398	0.000			2.37E-12	3.05E-14			0.12762	0.00062	0.12846	0.00063
BA4A 10	harzburgite	197.205	2.00718	3.630	0.000			2.53E-12	1.11E-14			0.12548	0.00053	0.12552	0.00054
BA4A 11	dunite	214.170	2.08374	5.463	0.000	0.606	0.038	3.81E-12	9.90E-14	0.535	0.036	0.13812	0.00124	0.13728	0.00124
BA4A 11-d ₁			1.52127	4.552	0.000	0.485	0.051	3.17E-12	1.78E-14	0.514	0.054	0.13682	0.00054	0.13601	0.00055
BA4A 11-d ₂			1.54478	4.686	0.000	0.631	0.002	3.27E-12	3.71E-14	0.649	0.008	0.13641	0.00053	0.13538	0.00053
BA4A 11-d ₃			1.62985	4.286	0.000	0.496	0.002	2.99E-12	3.17E-14	0.559	0.006	0.13675	0.00051	0.13586	0.00051
BA4A 16	harzburgite	293.975	2.00632	3.861	0.000	0.295	0.039	2.70E-12	1.24E-14	0.368	0.049	0.12354	0.00054	0.12296	0.00054
BA4A 14	dunite	274.205	2.03097	5.191	0.000	0.539	0.039	3.62E-12	3.90E-14	0.501	0.036	0.13097	0.00061	0.13018	0.00061
BA4A 14-d ₁			1.55373	4.269	0.000	0.542	0.050	2.98E-12	1.61E-14	0.612	0.057	0.12644	0.00055	0.12547	0.00055
BA4A 14-d ₂			1.56883	4.185	0.000	0.507	0.002	2.92E-12	1.87E-14	0.584	0.004	0.12736	0.00051	0.12644	0.00051
BA4A 14-d ₃			1.52166	4.198	0.000	0.483	0.002	2.93E-12	2.42E-14	0.554	0.005	0.12769	0.00053	0.12681	0.00053
Standards															
MUH-1 4			1.53566	4.096	0.000	0.276	0.051	2.86E-12	9.46E-15	0.325	0.060	0.12658	0.00052		
UB-N 5			2.00186	3.436	0.000	0.243	0.039	2.40E-12	1.26E-14	0.341	0.055	0.12725	0.00055		
UB-N 6			1.61348	3.298	0.000	0.240	0.002	2.30E-12	9.59E-15	0.351	0.003	0.12780	0.00052		
UB-N 7			1.53837	3.426	0.000	0.191	0.010	2.39E-12	9.16E-15	0.269	0.014	0.12690	0.00051		

Supplementary Table 1. Re and Os concentrations and Os isotope compositions of the studied Batin peridotites and UB-N and MUH-1 standards

Re and Os concentrations and Os isotopic compositions in whole rock powders were analyzed at the CRPG laboratory in Nancy (France) using MC-ICPMS (Neptune +) and N-TIMS (Finnigan MAT 262) (Os). All uncertainties are 2 σ and include all recognized sources of uncertainty, including in-run analytical precision, reproducibility of standard analyses, uncertainties related to the variability of the blank and its isotope composition, uncertainties related to the age correction (95 Ma). Duplicate analyses were performed for several samples (noted "-d") and the UB-N standard.

Sample	Lithology	Depth	Mass	[Os]	2σ error	[lr]	2σ error	[Ru]	2σ error	[Pt]	2σ error	[Pd]	2σ error	[Re]	2σ error	Ir/Os	Ir/Ru	Pd/Ir	Re/Os
		(m)	(g)	(ppb)		(ppb)		(ppb)		(ppb)		(ppb)		(ppb)					
BA4A 1	harzburgite	10.155	2.01412	4.411	0.000	4.305	0.002	6.931	0.023	9.960	0.012	7.194	0.011	0.641	0.039	0.98	0.62	1.67	0.15
BA4A 1-d ₁			2.00379	6.123	0.000	3.834	0.002	6.508	0.023	9.488	0.013	7.566	0.011	0.599	0.039	0.63	0.59	1.97	0.10
BA4A 1-d ₂			1.54518	4.295	0.000									0.564	0.005				0.13
BA4A 2	dunite	13.330	2.00336	4.354	0.000	3.115	0.001	6.691	0.023	7.809	0.012	5.931	0.011	1.203	0.039	0.72	0.47	1.90	0.28
BA4A 2-d			1.51420	3.916	0.000	2.672	0.001	6.205	0.030	7.383	0.016	5.379	0.015	1.277	0.052	0.68	0.43	2.01	0.33
BA4A 6	harzburgite	100.245	2.00763	5.375	0.000	3.787	0.001	8.283	0.023	4.972	0.012	3.069	0.011	0.096	0.039	0.70	0.46	0.81	0.02
BA4A 5	dunite	95.625	2.00897	4.416	0.000	3.314	0.001	7.671	0.023	8.344	0.012	6.965	0.011	0.239	0.039	0.75	0.43	2.10	0.05
BA4A 5-d			1.52049	3.398	0.000	2.419	0.001	6.349	0.030	5.599	0.016	6.948	0.015			0.71	0.38	2.87	
BA4A 10	harzburgite	197.205	2.00718	3.630	0.000	2.797	0.001	5.620	0.023	6.830	0.012	4.312	0.011			0.77	0.50	1.54	
BA4A 11	dunite	214.170	2.08374	5.463	0.000	3.035	0.001	7.439	0.022	8.588	0.012	9.205	0.011	0.606	0.038	0.56	0.41	3.03	0.11
BA4A 11-d ₁			1.52127	4.552	0.000	3.055	0.002	6.390	0.030	8.587	0.016	8.320	0.015	0.485	0.051	0.67	0.48	2.72	0.11
BA4A 11-d ₂			1.54478	4.686	0.000									0.631	0.002				0.13
BA4A 11-d ₃			1.62985	4.286	0.000									0.496	0.002				0.12
BA4A 16	harzburgite	293.975	2.00632	3.861	0.000	3.630	0.001	6.139	0.023	6.271	0.012	4.129	0.011	0.295	0.039	0.94	0.59	1.14	0.08
BA4A 14	dunite	274.205	2.03097	5.191	0.000	3.127	0.001	7.174	0.023	9.324	0.012	10.088	0.011	0.539	0.039	0.60	0.44	3.23	0.10
BA4A 14-d ₁			1.55373	4.269	0.000	3.372	0.002	7.058	0.030	9.127	0.016	12.816	0.015	0.542	0.050	0.79	0.48	3.80	0.13
BA4A 14-d ₂			1.56883	4.185	0.000									0.507	0.002				0.12
BA4A 14-d ₃			1.52166	4.198	0.000									0.483	0.002				0.12
Standards																			
MUH-14			1.53566	4.096	0.000	2.613	0.001	5.654	0.030	20.991	0.015	8.931	0.015	0.276	0.051	0.64	0.46	3.42	0.07
UB-N 5			2.00186	3.436	0.000	2.756	0.001	5.882	0.023	6.746	0.012	10.436	0.013	0.243	0.039	0.80	0.47	3.79	0.07
UB-N 6			1.61348	3.298	0.000									0.240	0.002				0.07
UB-N 7			1.53837	3.426	0.000									0.191	0.010				0.06

Supplementary Table 2. HSE concentrations of the studied Batin peridotites and UB-N and MUH-1 standards

HSE concentrations in whole rock powders were analyzed at the CRPG laboratory in Nancy (France) using MC-ICPMS (Neptune +) and N-TIMS (Finnigan MAT 262) (Os). All uncertainties are 2 σ and include all recognized sources of uncertainty, including in-run analytical precision, reproducibility of standard analyses, uncertainties related to the variability of the blank and its isotope composition, uncertainties related to the age correction (95 Ma). Duplicate analyses were performed for several samples (noted "-d") and the UB-N standard.

Sample	Mass	Associate	d blank	[0	Ds] uncertainty		188	os uncertainty				Measured ¹⁸⁷ Os/ ¹⁸⁸ Os u	ncertainty	
		Os	Re	measurement	due to blank variability	Total	measurement	due to blank variability	Total	measurement	due to variability of blank ¹⁸⁸ Os	due to variability of blank ¹⁸⁷ Os/ ¹⁸⁸ Os	due to long term reproducibility of standard	Total
				(2σ-m)	(2 σ)	(2 σ)	(2σ-m)	(2 σ)	(2 σ)	(2σ-m)	(2 σ)	(20)	(2σ)	(2 0)
	(g)			(ppb)			(M/g)							
BA4A 1	2.01412	а	а	0.032	0.000	0.032	2.22E-14	8.95E-17	2.22E-14	0.00026	0.00000	0.00001	0.00050	0.00057
BA4A 1-d ₁	2.00379	а	а	0.273	0.000	0.273	1.90E-13	8.99E-17	1.90E-13	0.00136	0.00000	0.00001	0.00050	0.00145
BA4A 1-d ₂	1.54518	b	b	0.027	0.000	0.027	1.91E-14	1.23E-18	1.91E-14	0.00020	0.00000	0.00000	0.00050	0.00054
BA4A 2	2.00336	а	а	0.025	0.000	0.025	1.75E-14	8.99E-17	1.75E-14	0.00022	0.00000	0.00001	0.00050	0.00055
BA4A 2-d	1.51420	а	а	0.022	0.000	0.022	1.54E-14	1.19E-16	1.54E-14	0.00032	0.00000	0.00001	0.00050	0.00059
BA4A 6	2.00763	а	а	0.023	0.000	0.023	1.64E-14	8.97E-17	1.64E-14	0.00014	0.00000	0.00001	0.00050	0.00052
BA4A 5	2.00897	а	а	0.020	0.000	0.020	1.40E-14	8.97E-17	1.40E-14	0.00019	0.00000	0.00001	0.00050	0.00053
BA4A 5-d	1.52049	а	а	0.044	0.000	0.044	3.05E-14	1.18E-16	3.05E-14	0.00037	0.00000	0.00002	0.00050	0.00062
BA4A 10	2.00718	а	а	0.016	0.000	0.016	1.11E-14	8.98E-17	1.11E-14	0.00018	0.00000	0.00001	0.00050	0.00053
BA4A 11	2.08374	а	а	0.142	0.000	0.142	9.90E-14 8.65E-17		9.90E-14	0.00114	0.00000	0.00001	0.00050	0.00124
BA4A 11-d ₁	1.52127	а	а	0.026	0.000	0.026	1.78E-14	1.18E-16	1.78E-14	0.00021	0.00000	0.00001	0.00050	0.00054
BA4A 11-d ₂	1.54478	b	b	0.053	0.000	0.053	3.71E-14	1.23E-18	3.71E-14	0.00018	0.00000	0.00000	0.00050	0.00053
BA4A 11-d ₃	1.62985	b	b	0.045	0.000	0.045	3.17E-14	1.16E-18	3.17E-14	0.00011	0.00000	0.00000	0.00050	0.00051
BA4A 16	2.00632	а	а	0.018	0.000	0.018	1.24E-14	8.98E-17	1.24E-14	0.00020	0.00000	0.00001	0.00050	0.00054
BA4A 14	2.03097	а	а	0.056	0.000	0.056	3.90E-14	8.87E-17	3.90E-14	0.00035	0.00000	0.00001	0.00050	0.00061
BA4A 14-d ₁	1.55373	а	а	0.023	0.000	0.023	1.61E-14	1.16E-16	1.61E-14	0.00022	0.00000	0.00001	0.00050	0.00055
BA4A 14-d ₂	1.56883	b	b	0.027	0.000	0.027	1.87E-14	1.21E-18	1.87E-14	0.00008	0.00000	0.00000	0.00050	0.00051
BA4A 14-d ₃	1.52166	b	b	0.035	0.000	0.035	2.42E-14	1.25E-18	2.42E-14	0.00018	0.00000	0.00000	0.00050	0.00053
Standards														
MUH-1 4	1.53566	а	а	0.014	0.000	0.014	9.45E-15	1.17E-16	9.46E-15	0.00016	0.00000	0.00001	0.00050	0.00052
UB-N 5	2.00186	а	а	0.018	0.000	0.018	1.26E-14	9.00E-17	1.26E-14	0.00023	0.00000	0.00001	0.00050	0.00055
UB-N 6	1.61348	b	b	0.014	0.000	0.014	9.59E-15	1.18E-18	9.59E-15	0.00015	0.00000	0.00000	0.00050	0.00052
UB-N 7	1.53837	b	b	0.013	0.000	0.013	13 9.16E-15 1.23E-18 9.1		9.16E-15	0.00010	0.00000	0.00000	0.00050	0.00051

Supplementary Table 3. Different components of the uncertainties on HSE concentrations and Os isotope compositions entering into the total uncertainties

Sample	[F	Re] uncertainty		Total ¹⁸⁷ Re	¹⁸⁷ Re/ ¹⁸⁸ Os	Effect of ¹⁸⁷ Re/ ¹⁸⁸ Os	Total uncertainty	Total ¹⁸⁷ Os/ ¹⁸⁸ Os
	measurement	due to blank variability	Total	uncertainty	uncertainty	uncertainty on ¹⁸⁷ Os/ ¹⁸⁸ Os age	initial ¹⁸⁷ Os/ ¹⁸⁸ Os	uncertainty
	(2σ-m) (ppb)	(2σ)	(2σ)	(2σ) (M/g)	(2σ)	(20)	(2σ)	(%)
BA4A 1	0.005	0.039	0.039	1.32E-13	0.043	0.00007	0.00057	0.45
BA4A 1-d ₁	0.004	0.039	0.039	1.32E-13	0.037	0.00006	0.00145	1.13
BA4A 1-d ₂	0.004	0.002	0.005	1.54E-14	0.007	0.00001	0.00054	0.43
BA4A 2	0.003	0.039	0.039	1.31E-13	0.044	0.00007	0.00055	0.44
BA4A 2-d	0.003	0.052	0.052	1.74E-13	0.064	0.00010	0.00060	0.49
BA4A 6	0.000	0.039	0.039	1.31E-13	0.035	0.00006	0.00052	0.45
BA4A 5	0.001	0.039	0.039	1.31E-13	0.042	0.00007	0.00054	0.43
BA4A 5-d	0.000	0.000	0.000				0.00063	0.49
BA4A 10	0.000	0.009	0.009				0.00054	0.43
BA4A 11	0.000	0.038	0.038	1.26E-13	0.036	0.00006	0.00124	0.90
BA4A 11-d ₁	0.000	0.051	0.051	1.73E-13	0.054	0.00009	0.00055	0.40
BA4A 11-d ₂	0.001	0.002	0.002	6.21E-15	0.008	0.00001	0.00053	0.39
BA4A 11-d ₃	0.001	0.002	0.002	5.78E-15	0.006	0.00001	0.00051	0.38
BA4A 16	0.000	0.039	0.039	1.31E-13	0.049	0.00008	0.00054	0.44
BA4A 14	0.000	0.039	0.039	1.29E-13	0.036	0.00006	0.00061	0.47
BA4A 14-d ₁	0.000	0.050	0.050	1.69E-13	0.057	0.00009	0.00055	0.44
BA4A 14-d ₂	0.000	0.002	0.002	5.97E-15	0.004	0.00001	0.00051	0.40
BA4A 14-d ₃	0.001	0.002	0.002	6.15E-15	0.005	0.00001	0.00053	0.42
Standards								
MUH-1 4	0.000	0.051	0.051	1.71E-13	0.060	0.00009	0.00053	0.42
UB-N 5	0.001	0.039	0.039	1.31E-13	0.055	0.00009	0.00056	0.44
UB-N 6	0.000	0.002	0.002	5.79E-15	0.003	0.00000	0.00052	0.41
UB-N 7	0.010	0.002	0.010	3.32E-14	0.014	0.00002	0.00051	0.40

Supplementary Table 3 (suite). Different components of the uncertainties on HSE concentrations and Os isotope compositions entering into the total unce

Sample	[r] uncertainty		[Ru] uncertainty		[1	Pt] uncertainty		[F	d] uncertainty	
	measurement	due to blank variability	Total									
	(2σ-m) (ppb)	(2ơ)	(2σ)	(2σ-m) (ppb)	(2σ)	(2σ)	(2σ-m) (ppb)	(2σ)	(2σ)	(2σ-m) (ppb)	(2σ)	(2σ)
BA4A 1	0.001	0.001	0.002	0.005	0.023	0.023	0.005	0.011	0.012	0.002	0.011	0.011
BA4A 1- d_1	0.001	0.001	0.002	0.005	0.023	0.023	0.005	0.011	0.013	0.003	0.011	0.011
BA4A 1-d ₂												
BA4A 2	0.001	0.001	0.001	0.005	0.023	0.023	0.004	0.011	0.012	0.003	0.011	0.011
BA4A 2-d	0.001	0.001	0.001	0.004	0.030	0.030	0.005	0.015	0.016	0.002	0.015	0.015
BA4A 6	0.001	0.001	0.001	0.006	0.023	0.023	0.004	0.011	0.012	0.002	0.011	0.011
BA4A 5	0.001	0.001	0.001	0.005	0.023	0.023	0.005	0.011	0.012	0.002	0.011	0.011
BA4A 5-d	0.001	0.001	0.001	0.004	0.030	0.030	0.004	0.015	0.016	0.003	0.015	0.015
BA4A 10	0.001	0.001	0.001	0.004	0.023	0.023	0.004	0.011	0.012	0.002	0.011	0.011
BA4A 11	0.001	0.001	0.001	0.005	0.022	0.022	0.005	0.011	0.012	0.002	0.011	0.011
BA4A 11-d ₁	0.001	0.001	0.002	0.005	0.030	0.030	0.005	0.015	0.016	0.002	0.015	0.015
BA4A 11-d ₂												
BA4A 11-d ₃												
BA4A 16	0.001	0.001	0.001	0.004	0.023	0.023	0.005	0.011	0.012	0.002	0.011	0.011
BA4A 14	0.001	0.001	0.001	0.005	0.022	0.023	0.005	0.011	0.012	0.001	0.011	0.011
BA4A 14-d ₁	0.001	0.001	0.002	0.005	0.029	0.030	0.005	0.015	0.016	0.005	0.014	0.015
BA4A 14-d ₂												
BA4A 14-d ₃												
Standards												
MUH-1 4	0.000	0.001	0.001	0.004	0.030	0.030	0.004	0.015	0.015	0.004	0.014	0.015
UB-N 5	0.000	0.001	0.001	0.004	0.023	0.023	0.002	0.011	0.012	0.008	0.011	0.013
UB-N 6	21300											
UB-N 7												

Supplementary Table 3 (suite). Different components of the uncertainties on HSE concentrations and Os isotope compositions entering into the total uncertainties

Supplementary Table 3 (suite). Different components of the uncertainties on HSE concentrations and Os isotope compositions entering into the total uncertainties

Notes:

Column C: Os blanks associated with two different analytical periods: a) 0.0007 ± 0.0002 ng. ¹⁸⁷Os/¹⁸⁸Os = 0.209 ± 0.122 (n = 3): b) 0.0010 ± 0.0000 ng (n = 2). ¹⁸⁷Os/¹⁸⁸Os = 0.220 ± 0.006 (n = 1): uncertainties 2σ Column D: Re blanks associated with two different analytical periods: a) 0.042 ± 0.078 ng (n = 4); b) 0.022 ± 0.003 ng (n = 2); uncertainties 2σ *Column E* : Based on in-run uncertainty on 190 Os/ 188 Os used in isotope dilution calculations Column F From difference between [Os] corrected using Os blank + 2σ and [Os] corrected using Os blank - 2σ Column G: Total uncertainty on [Os] based on combination of uncertainties in columns C and D (square root of individual values squared) Column H : Based on in-run uncertainty on ¹⁹⁰Os/¹⁸⁸Os used in isotope dilution calculations *Column I* : From difference between ¹⁸⁸Os corrected using Os blank + 2σ and ¹⁸⁸Os corrected using Os blank - 2σ Column J: Total uncertainty on ¹⁸⁸Os based on combination of uncertainties in columns F and G Column K : In-run uncertainty on ¹⁸⁷Os/¹⁸⁸Os Column L: From difference between ¹⁸⁷Os/¹⁸⁸Os corrected using ¹⁸⁸Os blank + 2 σ and ¹⁸⁷Os/¹⁸⁸Os corrected using ¹⁸⁸Os blank - 2 σ ; blank ¹⁸⁷Os/¹⁸⁸Os held constant at mean value Column M : From difference between ¹⁸⁷Os/¹⁸⁸Os corrected using ¹³⁷Os/¹⁸⁸Os blank + 2 σ and ¹⁸⁷Os/¹⁸⁸Os corrected using ¹³⁷Os/¹⁸⁸Os blank - 2 σ ; blank ¹⁸⁸Os held constant at mean value Column N : Long-term 2_o reproducibility of in-house liquid standard run by peak jumping on an ETP electron multiplier Column O: Total uncertainty on ¹⁸⁷Os/¹⁸⁸Os based on combination of uncertainties in columns I through L Column P : Based on in-run uncertainty on ¹⁸⁷Re/¹⁸⁵Re used in isotope dilution calculations Column Q : From difference between [Re] corrected using Re blank + 2σ and [Re] corrected using Re blank - 2σ Column R: Total uncertainty on [Re] based on combination of uncertainties in columns N and O (square root of individual values squared) Column S: Total uncertainty on ¹⁸⁷Re - proportional to total uncertainty on [Re] Column T: Total uncertainty on ¹⁸⁷Re/¹⁸⁸Os based on combination of uncertainties in columns H and Q Column U: Uncertainty on age (95 Ma) corrected value of ¹⁸⁷Os/¹⁸⁸Os related to ¹⁸⁷Re/¹⁸⁸Os uncertainty. Uncertainties on age correction related to ¹⁸⁷Re decay constant, ophiolite age and spike calibration are not considered as they should be very small and systematic for all samples (i.e., they cannot produce inter-sample variability) Column V: Total uncertainty on initial ¹⁸⁷Os/¹⁸⁸Os based on combination of uncertainty on measured value (column M) and uncertainty related to age correction (column S) *Column X* Based on in-run uncertainty on ¹⁹¹Ir/¹⁹³Ir used in isotope dilution calculations Column Y: From difference between [Ir] corrected using Ir blank + 2σ and [Ir] corrected using Ir blank - 2σ Column Z: Total uncertainty on [Ir] based on combination of uncertainties in columns I and J (square root of individual values squared) *Column AA* : Based on in-run uncertainty on ¹⁰²Ru/⁹⁹Ru used in isotope dilution calculations Column AB : From difference between [Ru] corrected using Ru blank + 2σ and [Ru] corrected using Ru blank - 2σ Column AC: Total uncertainty on [Ru] based on combination of uncertainties in columns L and M (square root of individual values squared) *Column AD* : Based on in-run uncertainty on ¹⁹⁴Pt/¹⁹⁵Pt used in isotope dilution calculations *Column AE* : From difference between [Pt] corrected using Pt blank + 2σ and [Pt] corrected using Pt blank - 2σ Column AF: Total uncertainty on [Pt] based on combination of uncertainties in columns O and P (square root of individual values squared) Column AG : Based on in-run uncertainty on ¹⁰⁸Pd/¹⁰⁶Pd used in isotope dilution calculations *Column AH* : From difference between [Pd] corrected using Pd blank + 2σ and [Pd] corrected using Pd blank - 2σ Column AI: Total uncertainty on [Pd] based on combination of uncertainties in columns R and S (square root of individual values squared)

Sample	Massif	Vlassif Lithology		Normalized height in the section	Mass	[Os]	2σ error	[Re]	2σ error	¹⁸⁸ Os	2σ error	¹⁸⁷ Re/ ¹⁸⁸ Os	2σ error	(¹⁸⁷ Os/ ¹⁸⁸ Os) _m	2σ error	(¹⁸⁷ Os/ ¹⁸⁸ Os) _{95 Ma}	2σ error	T _{RD} age
					(g)	(ppb)		(ppb)		(M/g)								(Ga)
Moho Transiti	on Zone (MTZ) perid	otites																
10 OM 25	Sumail (Magsad)	pl-impregnated dunite		0.030	1.09260	0.399	0.002	0.114	0.007	2.77E-13	1.40E-15	1.376	0.090	0.1421	0.0005	0.1400	0.0006	-1.8
10 OM 45C	Sumail (Magsad)	pure dunite		0.030	1.08114	0.947	0.002	0.050	0.007	6.60E-13	1.69E-15	0.255	0.038	0.1446	0.0006	0.1442	0.0006	-2.1
18 OK 26	Sumail (Magsad)	cpx-bearing dunite		0.040	1.53157	0.628	0.000	0.409	0.051	4.37E-13	8.76E-16	3.149	0.393	0.1499	0.0006	0.1449	0.0009	-2.9
10 OM 5C*	Sumail (Mansah)	pure dunite		0.025	1.01170	1.063	0.002			7.40E-13	1.72E-15			0.1423	0.0005	0.1411	0.0005	-1.8
10 OM 5C-d	, , , , , , , , , , , , , , , , , , ,				1.00295			0.168	0.008			0.760	0.037					
07 OD 1	Sumail (Mansah)	dunite		0.050	1.07011	0.390	0.002	0.199	0.008	2.71E-13	1.43E-15	2.462	0.100	0.1415	0.0005	0.1376	0.0006	-1.7
16 OL 11B	Wadi Tayin	pure dunite		0.000	2.00833	1.173	0.005	0.033	0.038	8.16E-13	3.88E-15	0.137	0.158	0.1492	0.0008	0.1490	0.0008	-2.8
16 OL 34B	Wadi Tayin	pl/px-impregnated dunite / troctolite		0.028	2.00647	2.305	0.003	0.053	0.043	1.61E-12	5.70E-15	0.111	0.091	0.1321	0.0020	0.1319	0.0020	-0.3
Main mantle s	ection (MMS) perido	ntites																
	Nakhl-Rustan	nl-impregnated depleted barzburgite		0.007	2 03522	2 274	0.003	0 4 4 8	0.009	1 59F-12	5 28F-15	0 9/8	0.019	0 1198	0 0020	0 1183	0 0020	13
16 OD 50	Nakhl-Rustag	harzburgite		0.007	2.03322	2.274 1 211	0.003	0.440	0.009	2 Q/F-12	1 15E-1/	0.548	0.019	0.1136	0.0020	0.1133	0.0020	2.5
16 OD 7	Nakhl-Rustag	harzburgite		0.007	2.04170	4.211 2 921	0.003	0.132	0.009	2.94L-12 2.04F-12	6 29F-15	0.174	0.010	0.1150	0.0012	0.1155	0.0012	0.6
16 OD 4D	Nakhl-Rustag	harzburgite	16 OD 4D ₂	0.033	1 61671	5 5 1 9	0.005	0.025	0.005	3 86F-12	5.01F-14	0.312	0.015	0.1232	0.0010	0.1169	0.0010	17
16 OD 9C	Nakhl-Rustag	harzburgite	16 OD 90	0.089	2 03326	3 691	0.003	0.130	0.009	2 57F-12	2 33F-14	0.170	0.012	0.1287	0.0003	0.1284	0.0003	0.1
16 OD 2	Nakhl-Rustag	harzburgite	10 00 5/(0.241	2.02082	4.314	0.003	0.500	0.009	3.01F-12	8.44F-15	0.559	0.010	0.1299	0.0011	0.1290	0.0011	0.0
16 OD 1A	Nakhl-Rustag	harzburgite	16 OD 1B	0.337	1.72667	4.164	0.006	0.599	0.050	2.91E-12	2.05E-14	0.693	0.058	0.1235	0.0006	0.1224	0.0006	0.8
16 OD 10	Nakhl-Rustag	harzburgite		0.419	2.07269	4.855	0.003	0.381	0.009	3.39E-12	3.19E-14	0.378	0.009	0.1311	0.0011	0.1305	0.0011	-0.2
11 OD 15A	Sumail	harzburgite		0.280	1.00937	3.894	0.002	0.152	0.008	2.72E-12	2.22E-14	0.187	0.010	0.1178	0.0006	0.1175	0.0006	1.6
07 OD 24	Sumail	harzburgite		0.254	1.03742	4.826	0.002	0.460	0.011	3.36E-12	1.35E-14	0.459	0.011	0.1345	0.0005	0.1338	0.0005	-0.7
07 OD 27B	Sumail	harzburgite		0.344	1.02319	4.314	0.002	0.221	0.008	3.01E-12	9.53E-15	0.247	0.009	0.1282	0.0005	0.1278	0.0005	0.2
07 OD 8C	Sumail	harzburgite		0.150	1.04900	5.246	0.002	0.379	0.010	3.66E-12	2.31E-14	0.348	0.009	0.1296	0.0007	0.1291	0.0007	0.0
07 OD 8C-d					1.01024	5.228	0.002	0.321	0.008	3.65E-12	2.41E-14	0.295	0.008	0.1257	0.0006	0.1252	0.0006	0.5
16 OD 4C	Nakhl-Rustaq	pl/cpx-impregnated dunite (vein)	(16 OD 4D _{Hzb})	0.073	1.56818	1.120	0.007	0.305	0.055	7.81E-13	4.92E-15	1.312	0.239	0.1347	0.0010	0.1327	0.0011	-0.7
16 OD 4D _{Dun}	Nakhl-Rustaq	cpx-impregnated dunite (vein)	16 OD 4D _{Hzb}	0.073	1.53878	5.954	0.007	0.414	0.056	4.15E-12	2.08E-14	0.335	0.046	0.1273	0.0005	0.1268	0.0005	0.3
16 OD 9A	Nakhl-Rustaq	pure dunite (band)	16 OD 9C	0.089	2.04511	11.802	0.003	0.431	0.009	8.21E-12	6.48E-14	0.177	0.004	0.1486	0.0006	0.1483	0.0006	-2.7
16 OD 1B	Nakhl-Rustaq	px-bearing dunite (vein)	16 OD 1A	0.337	2.02651	3.145	0.005	0.087	0.043	2.19E-12	9.82E-15	0.134	0.066	0.1332	0.0006	0.1330	0.0006	-0.5
16 OD 1B-d					2.01184	4.353	0.005	0.094	0.043	3.04E-12	1.15E-14	0.104	0.048	0.1314	0.0006	0.1312	0.0006	-0.2
16 OD 31	Wadi Tayin	px-bearing dunite (band)		0.116	2.00913	2.147	0.003	0.910	0.009	1.50E-12	6.50E-15	2.043	0.023	0.1281	0.0021	0.1249	0.0021	0.2
Basal peridotit	tes																	
16 OD 13C	Nakhl-Rustaq	harzburgite	16 OD 13B	0.637	2.01014	4.415	0.005	0.415	0.043	3.08E-12	1.17E-14	0.453	0.047	0.1261	0.0005	0.1254	0.0005	0.5
16 OD 13C-d					2.01725	4.076	0.005	0.379	0.043	2.84E-12	2.00E-14	0.448	0.051	0.1265	0.0006	0.1258	0.0006	0.4
16 OL 25	Wadi Tayin	harzburgite		0.724	2.02610	6.289	0.003	0.081	0.009	4.38E-12	3.93E-14	0.062	0.007	0.1346	0.0009	0.1345	0.0009	-0.7
16 OL 26B	Wadi Tayin	harzburgite	16 OL 26A	0.724	2.01238	3.214	0.003	0.022	0.032	2.24E-12	8.84E-15	0.032	0.048	0.1215	0.0015	0.1215	0.0015	1.1
16 OL 27B	Wadi Tayin	harzburgite	16 OL 27A	0.784	2.01118	4.843	0.003	0.314	0.009	3.38E-12	2.68E-14	0.312	0.009	0.1252	0.0011	0.1247	0.0011	0.6
16 OL 27C	Wadi Tayin	harzburgite		0.784	2.00975	4.097	0.003	0.046	0.009	2.86E-12	1.75E-14	0.053	0.011	0.1131	0.0012	0.1131	0.0012	2.2
16 OL 28B	Wadi Tayin	cpx-bearing harzburgite		0.860	2.02988	4.481	0.003	0.168	0.043	3.13E-12	2.11E-14	0.180	0.046	0.1166	0.0011	0.1163	0.0011	1.8
16 OL 29	Wadi Tayin	cpx-bearing depleted harzburgite		0.872	2.03098	5.187	0.003	0.169	0.009	3.62E-12	2.54E-14	0.157	0.008	0.1226	0.0010	0.1223	0.0010	1.0
16 OL 24	Wadi Tayin	harzburgite		0.878	2.00603	5.475	0.003	0.221	0.009	3.82E-12	2.22E-14	0.194	0.008	0.1234	0.0010	0.1230	0.0010	0.9
16 OD 13B	Nakhl-Rustaq	px-bearing dunite (band)	16 OD 13C	0.637	1.57217	7.169	0.007	0.158	0.055	5.01E-12	3.04E-14	0.106	0.037	0.1216	0.0005	0.1214	0.0005	1.1
16 OD 15E	Nakhl-Rustaq	px-bearing dunite (band)		0.934	1.55944	2.291	0.007	0.106	0.056	1.60E-12	6.96E-15	0.223	0.117	0.1169	0.0007	0.1165	0.0007	1.7
16 OD 18B	Sumail	opx-bearing dunite (band)		0.969	2.01165	6.134	0.005	0.018	0.030	4.28E-12	4.84E-14	0.014	0.024	0.1280	0.0006	0.1280	0.0006	0.2
16 OD 19A	Sumail	pure dunite (band)		0.946	2.00354	0.774	0.005	0.066	0.043	5.41E-13	3.81E-15	0.413	0.269	0.1177	0.0011	0.1171	0.0012	1.6
16 OL 26A	Wadi Tayin	px-bearing dunite (band)	16 OL 26B	0.724	2.01473	4.460	0.003	0.014	0.029	3.11E-12	1.86E-14	0.015	0.031	0.1223	0.0011	0.1222	0.0011	1.0
16 OL 27A	Wadi Tayin	px-bearing dunite (band)	16 OL 27B	0.784	2.01151	4.998	0.003	0.079	0.009	3.49E-12	1.36E-14	0.077	0.009	0.1256	0.0010	0.1255	0.0010	0.6
14 11E	Haylayn	pure dunite (band)		0.990	1.03494	1.474	0.002	0.157	0.008	1.03E-12	2.98E-15	0.512	0.026	0.1257	0.0005	0.1249	0.0005	0.5

Sample	Massif	Lithology	Hzb/Dun pairs	Normalized height in the section	Mass	[Os]	2σ error	[Re]	2σ error	¹⁸⁸ Os	2σ error	¹⁸⁷ Re/ ¹⁸⁸ Os	2σ error	(¹⁸⁷ Os/ ¹⁸⁸ Os) _m	2σ error	(¹⁸⁷ Os/ ¹⁸⁸ Os) _{95 Ma}	2σ error	T _{RD} age
					(g)	(ppb)		(ppb)		(M/g)								(Ga)
Reference mater	rials (UB-N, MUH-1	l, HARZ-01 and OKUM)																
UB-N 1					1.52295	2.805	0.007	0.191	0.057	1.96E-12	1.11E-14	0.328	0.098	0.1279	0.0007	0.1274	0.0007	0.2
UB-N 2					1.71621	3.908	0.006	0.232	0.051	2.73E-12	1.39E-14	0.286	0.062	0.1274	0.0006	0.1270	0.0006	0.3
UB-N 3					2.00842	3.533	0.005	0.208	0.043	2.46E-12	8.70E-15	0.283	0.059	0.1272	0.0006	0.1268	0.0006	0.3
UB-N 4					2.04999	3.995	0.005	0.211	0.042	2.79E-12	1.99E-14	0.254	0.051	0.1272	0.0006	0.1268	0.0006	0.3
UB-N 5					2.00186	3.436	0.000	0.243	0.039			0.341		0.1273	0.0005	0.1267	0.0006	0.3
MUH-1 1					2.01885	4.111	0.005	0.222	0.043	2.87E-12	1.51E-14	0.260	0.050	0.1275	0.0006	0.1271	0.0006	0.3
MUH-1 2					2.00321	5.624	0.005	0.177	0.043	3.92E-12	1.70E-14	0.151	0.037	0.1271	0.0005	0.1269	0.0005	0.3
MUH-1 3					2.01237	5.808	0.005	0.186	0.043	4.05E-12	1.79E-14	0.154	0.036	0.1265	0.0005	0.1263	0.0005	0.4
MUH-1 4					1.53566	4.096	0.000	0.276	0.051			0.325		0.1266	0.0005	0.1261	0.0005	0.4
HARZ-01 1					2.03967	3.540	0.005	0.073	0.043	2.47E-12	1.16E-14	0.099	0.058	0.1261	0.0006	0.1259	0.0006	0.5
HARZ-01 2					2.02701	4.261	0.005	0.561	0.043	2.97E-12	3.14E-14	0.634	0.049	0.1273	0.0007	0.1263	0.0007	0.3
HARZ-01 3					2.01448	5.082	0.005	0.110	0.043	3.55E-12	2.57E-14	0.105	0.041	0.1259	0.0005	0.1257	0.0006	0.5
HARZ-01 4					2.01454	3.776	0.003	0.068	0.009	2.63E-12	8.27E-15	0.087	0.012	0.1278	0.0013	0.1276	0.0013	0.3
OKUM 1					2.00675	0.864	0.005	0.568	0.043	5.92E-13	4.59E-15	3.223	0.247	0.2630	0.0014	0.2579	0.0014	-22.1
OKUM 2					2.01264	1.030	0.005	0.541	0.043	7.08E-13	1.78E-13	2.572	0.680	0.2455	0.0011	0.2414	0.0015	-18.7

Re and Os concentrations and Os isotopic compositions in whole rock powders were analyzed at the CRPG laboratory in Nancy (France) using MC-ICPMS (Neptune +) and N-TIMS (Finnigan MAT 262) (Os). All uncertainties are 2 σ and include all recognized sources of uncertainty, including in-run analytical precision, reproducibility of standard analyses, uncertainties related to the variability of the blank and its isotope composition, uncertainties related to the age correction (95 Ma). Duplicate analyses were performed for several samples (noted "-d") and the reference materials (UB-N, MUH-1, HARZ-O1 and OKUM). Samples belonging to harzburgite/dunite pairs collected in close proximity (<1 meter) are indicated. For each sample, an approximate estimation of its height in the mantle section was obtained by normalizing to the total section height to compare samples from different cross-sections. Re-depletion model ages (T_{RD}) were calculated by comparing measured ¹⁸⁷Os/¹⁸⁸ Os values directly with the mantle evolution curve. They represent minimum ages of melt extraction and should not be equated with true ages.

* For 10 OM 5C sample, (¹⁸⁷Os/¹⁸⁸Os)_{95 Ma} was calculated using Re compositions of its duplicate.

Hzb = harzburgite; Dun = dunite; Px = pyroxene; Opx = orthopyroxene; Cpx = clinopyroxene; Pl = plagioclase.

Supplementary Table 5. HSE concentrations of Oman harzburgites and the three types of dunites and of the reference materials (Klaessens, 2021; Klaessens et al., 2021)
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Sample	Massif	Lithology	Hzb/Dun pairs	Normalized height in the section	Mass	[Os]	2σ error	[ir]	2σ error	[Ru]	2σ error	[Pt]	2σ error	[Pd]	2σ error	[Re]	2σ error	Ir/Os	Ir/Ru	Pd/Ir	Re/Os
					(g)	(ppb)		(ppb)		(ppb)		(ppb)		(ppb)		(ppb)					
Moho Transiti	on Zona (MTZ) parid	lotitac																			
	Sumail (Magsad)	nl imprograted dupite		0.020	1 00260	0 200	0.002									0 114	0.007				0.20
10 OM 45C	Sumail (Magsad)	pi-inpregnated dunite		0.030	1.09200	0.399	0.002									0.114	0.007				0.29
10 ON 45C	Sumail (Magsad)	cox-bearing dupite		0.030	1.00114	0.947	0.002	0.240	0.001	1 057	0.030	0 726	0.015	1 3 2 0	0.015	0.030	0.007	038	0.23	5 50	0.05
10 OK 20	Sumail (Maqsau)	nure dunite		0.040	1.01170	1.063	0.000	0.240	0.001	1.057	0.050	0.720	0.015	1.520	0.015	0.405	0.051	0.58	0.25	5.50	0.05
10 OM 5C-d	Suman (Mansan)	pare dunite		0.025	1.01170	1.005	0.002									0 168	0.008				
07 OD 1	Sumail (Mansah)	dunite		0.050	1.00233	0 390	0.002									0.100	0.008				0.51
16 OL 11B	Wadi Tavin	pure dunite		0.000	2.00833	1.173	0.005	1.265	0.011	1.673	0.006	0.854	0.075	0.100	0.000	0.033	0.038	1.08	0.76	0.08	0.03
16 OL 34B	Wadi Tavin	pl/px-impregnated dunite / troctolite		0.028	2.00647	2.305	0.003	2.220	0.011	4.012	0.009	6.185	0.076	1.873	0.307	0.053	0.043	0.96	0.55	0.84	0.02
								-		-											
Main mantle s	ection (MMS) perido	otites																			
16 OD 5C	Nakhl-Rustaq	pl-impregnated depleted harzburgite		0.007	2.03522	2.274	0.003	1.429	0.011	4.531	0.016	5.221	0.076	5.743	0.303	0.448	0.009	0.63	0.32	4.02	0.20
16 OD 5D	Nakhl-Rustaq	harzburgite		0.007	2.04176	4.211	0.003	2.299	0.011	6.620	0.023	4.692	0.075	1.222	0.302	0.152	0.009	0.55	0.35	0.53	0.04
16 OD /	Nakhl-Rustaq	harzburgite	46.00.40	0.053	2.02020	2.921	0.003	3.886	0.013	5.360	0.019	13.143	0.079	3.415	0.305	0.025	0.009	1.33	0.72	0.88	0.01
16 OD 4D _{Hzb} *	Nakhi-Rustaq	harzburgite	16 OD 4D _{Dun}	0.073	1.616/1	5.519	0.007	3.940	0.026	7.079	0.308	6.531	0.122	3.545	0.021	0.358	0.054	0.71	0.56	0.90	0.06
16 OD 9C	Nakhi-Rustaq	harzburgite	16 OD 9A	0.089	2.03326	3.691	0.003	2.878	0.012	4.778	0.017	5.425	0.076	4.055	0.303	0.130	0.009	0.78	0.60	1.41	0.04
16 OD 2	Nakhi-Rustaq	narzburgite	10.00.10	0.241	2.02082	4.314	0.003	3.755	0.013	6.622 F.8CO	0.023	9.379	0.078	0.866	0.305	0.500	0.009	0.87	0.57	0.23	0.12
16 OD 1A*	Nakhi-Rustaq	narzburgite	16 OD IB	0.337	1./266/	4.164	0.006	3.594	0.025	5.860	0.282	6.914	0.120	3.986	0.022	0.599	0.050	0.86	0.61	1.11	0.14
16 OD 10	Nakni-Rustaq	harzburgite		0.419	2.07269	4.855	0.003	4.109	0.013	7.742	0.028	8.009	0.075	7.198	0.298	0.381	0.009	0.85	0.53	1.75	0.08
11 OD 15A	Sumail	harzburgite		0.280	1.00957	3.094	0.002									0.152	0.008				0.04
07 OD 24	Sumail	harzburgite		0.234	1.03742	4.820	0.002									0.400	0.011				0.10
07 00 278	Sumail	harzburgite		0.344	1.02319	5 246	0.002									0.221	0.008				0.03
07 OD 8C-d	Suman	harzburgite		0.150	1.04500	5 2 2 8	0.002									0.373	0.010				0.07
16 OD 4C*	Nakhl-Rustag	pl/cpx-impregnated dunite (vein)	(16 OD 4Dus)	0.073	1.56818	1.120	0.007	0.738	0.005	1.042	0.309	3,224	0.124	2,113	0.017	0.305	0.055	0.66	0.71	2.86	0.27
16 OD 4Dpm*	Nakhl-Rustag	cpx-impregnated dunite (vein)	16 OD 4D	0.073	1.53878	5.954	0.007	4.692	0.030	8.485	0.334	11.727	0.173	3,756	0.032	0.414	0.056	0.79	0.55	0.80	0.07
16 OD 9A	Nakhl-Rustag	pure dunite (band)	16 OD 9C	0.089	2.04511	11.802	0.003	4.820	0.015	17.233	0.073	20.894	0.082	6.203	0.302	0.431	0.009	0.41	0.28	1.29	0.04
16 OD 1B	Nakhl-Rustag	px-bearing dunite (vein)	16 OD 1A	0.337	2.02651	3.145	0.005	1.828	0.011	5.712	0.012	2.877	0.075	0.514	0.304	0.087	0.043	0.58	0.32	0.28	0.03
16 OD 1B-d		,, 6 , (,			2.01184	4.353	0.005	1.792	0.011	8.332	0.017	3.564	0.075	0.570	0.306	0.094	0.043	0.41	0.22	0.32	0.02
16 OD 31	Wadi Tayin	px-bearing dunite (band)		0.116	2.00913	2.147	0.003	3.023	0.012	2.307	0.010	4.918	0.077	0.220	0.307	0.910	0.009	1.41	1.31	0.07	0.42
Pacal paridatit	200																				
	Nakhi Duataa	house unsite	10 00 130	0.027	2 01014	4 415	0.005	2 664	0.012	C C 07	0.014	0.024	0.077	F COC	0 207	0.415	0.042	0.92	0.55	1 5 2	0.00
16 OD 13C	Nakni-Rustaq	narzburgite	16 OD 13B	0.637	2.01014	4.415	0.005	3.004	0.012	0.097 6.451	0.014	9.624	0.077	5.000	0.307	0.415	0.043	0.83	0.55	1.53	0.09
16 OD 13C-0		baraburgita		0 724	2.01/25	4.076	0.005	2.962	0.012	0.451	0.005	8.700	0.076	5.091 9.E01	0.306	0.379	0.043	0.73	0.46	1.92	0.09
16 OL 25	Wadi Tayin	harzburgite	16 01 264	0.724	2.02010	0.289	0.003	4.390	0.014	9.102	0.033	6 252	0.078	8.501	0.305	0.081	0.009	0.70	0.48	1.93	0.01
16 OL 20B	Wadi Tayin	harzburgite	16 OL 20A	0.724	2.01250	5.214	0.005	2.072	0.011	5.01Z	0.012	0.252	0.070	5.590 9.401	0.300	0.022	0.052	0.56	0.55	2.61	0.01
16 OL 276	Wadi Tayin	harzburgite	10 01 27A	0.784	2.01118	4.645	0.003	3.230	0.012	6 5 5 8	0.024	3 000	0.077	0.491	0.307	0.314	0.009	0.07	0.48	0.15	0.00
16 OL 27C	Wadi Tayin Wadi Tayin	cny-bearing barzburgite		0.784	2.00373	4.057	0.003	3.//4	0.013	6 902	0.023	5 904	0.075	0.5654	0.307	0.040	0.003	0.52	0.50	0.15	0.01
16 01 20	Wadi Tayin Wadi Tayin	cpx bearing depleted barzburgite		0.872	2.02500	5 1 9 7	0.003	3 0/8	0.012	0.502 8 173	0.014	9.504 9.739	0.075	5 101	0.304	0.160	0.045	0.77	0.30	1 20	0.04
16 01 24	Wadi Tayin Wadi Tayin	harzburgite		0.872	2.03038	5.107	0.003	3 5 2 4	0.013	7 285	0.025	7 521	0.077	J.101 A A89	0.304	0.105	0.005	0.70	0.48	1.25	0.03
16 OD 138*	Nakhl-Rustan	px-bearing dunite (band)	16 OD 13C	0.637	1.57217	7,169	0.007	2.815	0.021	7.816	0.311	2.386	0.119	2.686	0.019	0.158	0.055	0.39	0.36	0.95	0.02
16 OD 15E*	Nakhl-Rustag	px-bearing dunite (band)	10 00 100	0.934	1.55944	2.291	0.007	0.873	0.007	3.623	0.310	1.226	0.125	0.389	0.020	0.106	0.056	0.38	0.24	0.45	0.05
16 OD 18B	Sumail	opx-bearing dunite (band)		0.969	2.01165	6.134	0.005	2.032	0.011	10.651	0.022	4.365	0.076	1.362	0.306	0.018	0.030	0.33	0.19	0.67	0.00
16 OD 19A	Sumail	pure dunite (band)		0.946	2.00354	0.774	0.005	0.316	0.011	1.774	0.006	1.296	0.075	0.200	0.308	0.066	0.043	0.41	0.18	0.63	0.09
16 OL 26A	Wadi Tayin	px-bearing dunite (band)	16 OL 26B	0.724	2.01473	4.460	0.003	3.307	0.012	7.149	0.014	6.112	0.076	3.701	0.306	0.014	0.029	0.74	0.46	1.12	0.00
16 OL 27A	Wadi Tayin	px-bearing dunite (band)	16 OL 27B	0.784	2.01151	4.998	0.003	1.257	0.011	3.508	0.013	0.395	0.075	0.150	0.306	0.079	0.009	0.25	0.36	0.12	0.02
14 11E	Haylayn	pure dunite (band)		0.990	1.03494	1.474	0.002									0.157	0.008				0.11

Sample	Massif	Lithology	Hzb/Dun pairs	Normalized height in the section	Mass	[Os]	2σ error	[lr]	2σ error	[Ru]	2σ error	[Pt]	2σ error	[Pd]	2σ error	[Re]	2σ error	Ir/Os	Ir/Ru	Pd/Ir	Re/Os
					(g)	(ppb)		(ppb)		(ppb)		(ppb)		(ppb)		(ppb)					
Reference mate	rials (UB-N, MUH-1,	HARZ-01 and OKUM)																			
UB-N 1*					1.52295	2.805	0.007	1.497	0.011	5.025	0.329	6.808	0.138	6.119	0.081	0.191	0.057	0.53	0.30	4.09	0.07
UB-N 2*					1.71621	3.908	0.006	2.749	0.015	5.730	0.287	7.231	0.123	5.687	0.029	0.232	0.051	0.70	0.48	2.07	0.06
UB-N 3					2.00842	3.533	0.005	3.157	0.024	5.804	0.012	6.549	0.078	5.674	0.309	0.208	0.043	0.89	0.54	1.80	0.06
UB-N 4					2.04999	3.995	0.005	3.650	0.025			7.256	0.077	5.368	0.305	0.211	0.042	0.91		1.47	0.05
UB-N 5					2.00186	3.436	0.000	2.756	0.001	5.882	0.023	6.746	0.012	10.436	0.013	0.243	0.039	0.80	0.47	3.79	0.07
MUH-1 1					2.01885	4.111	0.005	3.951	0.027			8.134	0.080	9.570	0.343	0.222	0.043	0.96		2.42	0.05
MUH-1 2					2.00321	5.624	0.005	2.943	0.022	9.809	0.020	7.350	0.080	8.230	0.314	0.177	0.043	0.52	0.30	2.80	0.03
MUH-1 3					2.01237	5.808	0.005	3.915	0.012	5.846	0.008	25.628	0.084	8.359	0.306	0.186	0.043	0.67	0.67	2.14	0.03
MUH-1 4					1.53566	4.096	0.000	2.613	0.001	5.654	0.030	20.991	0.015	8.931	0.015	0.276	0.051	0.64	0.46	3.42	0.07
HARZ-01 1					2.03967	3.540	0.005	2.319	0.021	6.731	0.010	9.438	0.200	7.372	0.321	0.073	0.043	0.66	0.34	3.18	0.02
HARZ-01 2					2.02701	4.261	0.005	2.317	0.011	5.075	0.007	10.511	0.076	4.998	0.304	0.561	0.043	0.54	0.46	2.16	0.13
HARZ-01 3					2.01448	5.082	0.005	2.717	0.012	5.574	0.008	8.795	0.076	5.680	0.306	0.110	0.043	0.53	0.49	2.09	0.02
HARZ-01 4					2.01454	3.776	0.003	3.409	0.013	5.170	0.019	8.771	0.077	13.127	0.308	0.068	0.009	0.90	0.66	3.85	0.02
OKUM 1					2.00675	0.864	0.005	0.909	0.011	4.387	0.023	14.607	0.078	11.638	0.315	0.568	0.043	1.05	0.21	12.81	0.66
OKUM 2					2.01264	1.030	0.005	1.032	0.013	5.916	0.022	13.135	0.081	11.343	0.313	0.541	0.043	1.00	0.17	10.99	0.53

HSE concentrations in whole rock powders were analyzed at the CRPG laboratory in Nancy (France) using N-TIMS (Finnigan MAT 262) (Os), MC-ICP-MS (Neptune +) and Q-ICP-MS (XSERIES). All uncertainties are 2 σ and include all recognized sources of uncertainty, including in-run analytical precision, reproducibility of standard analyses, uncertainties related to the variability of the blank and its isotope composition. Duplicate analyses were performed for several samples (noted "-d") and the reference materials (UB-N, MUH-1, HARZ-01 and OKUM). Samples belonging to harzburgite/dunite pairs collected in close proximity (<1 meter) are indicated. For each sample, an approximate estimation of its height in the mantle section was obtained by normalizing to the total section height to compare samples from different cross-sections.

* Analyses using Q-ICP-MS XSERIES.

Hzb = harzburgite; Dun = dunite; Px = pyroxene; Opx = orthopyroxene; Cpx = clinopyroxene; Pl = plagioclase