

Petrophysical contrasts across a faulted dunite–harzburgite boundary in Hole BA1B, Samail Ophiolite, Oman

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Supplementary Tables

Supplementary Table S1. Datasets, observation scales, analytical roles, and interpretive limits.

Dataset	Data type	Measurement / observation scale	Role in this study	Interpretive limit
VCD and structural logs	Visual core and structural descriptions	Core and interval scale	Define lithology, alteration style, veins, fractures, shear fabrics, cataclastic intervals, and fault-related features where documented.	Do not quantify porosity, permeability, resistivity, fracture connectivity, or hydraulic state.
T12	Laboratory physical properties	Discrete plug/cube-scale specimens	Provide porosity and wet electrical resistivity for selected specimens in Zones A–G.	Do not represent continuous downhole profiles or whole-zone populations.
ST1	Core-scanner physical properties	Core-scanner scale	Provide GRA density and magnetic susceptibility observations selected at, or nearest to, T12 specimen depths.	Do not substitute for T12 porosity/resistivity or identify magnetic mineral phases.
T07	Whole-rock geochemistry	Discrete whole-rock samples	Provide LOI and H ₂ O as broad bulk volatile and hydration-related indicators.	Do not directly measure serpentinization extent, porosity, permeability, resistivity, or fracture connectivity.
Boundary coverage screen	Dunite–harzburgite contact and T12 coverage check	Contact-to-sample scale	Report whether the listed contacts have selected T12 observations sufficiently close for a local comparison.	Not an exhaustive inventory of all contacts and not an independent causal test of boundary effects.
T06	X-ray diffraction of secondary vein material	Discrete vein-material analyses	Provide vein-scale mineralogical context where available.	Do not represent whole-rock mineralogy, bulk hydration, mineral abundance, or petrophysical properties.

Source. Hole BA1B VCD and structural records and Site BA1 T06, T07, T12, and ST1 tables in Kelemen et al. (2020). Dataset names and reported depths are retained as record locators.

Supplementary Table S2. Petrophysical observations used in the selected intervals. (A) Individual T12 porosity and wet-resistivity records. (B) Focused matched-ST1 summary for Zones C–E.

Panel A. Individual T12 observations identified by Hole BA1B and reported sample depth.

Zone	Sample depth (m)	Porosity (vol%)	Wet electrical resistivity ($\Omega \cdot m$)	Record and interpretation note
A	80.028	1.26	12127.09	T12, Hole BA1B, 80.028 m; selected observation within Zone A.
A	82.653	1.78	3192.59	T12, Hole BA1B, 82.653 m; selected observation within Zone A.
B	88.997	1.22	9306.63	T12, Hole BA1B, 88.997 m; high-resistivity observation within Zone B.
B	89.890	4.17	158.30	T12, Hole BA1B, 89.890 m; locally conductive observation within Zone B.

Zone	Sample depth (m)	Porosity (vol%)	Wet electrical resistivity ($\Omega\cdot\text{m}$)	Record and interpretation note
C	155.307	3.81	148.54	T12, Hole BA1B, 155.307 m; single point observation for Zone C.
D	159.685	5.43	111.60	T12, Hole BA1B, 159.685 m; 2.185 m above the 161.87 m boundary.
D	160.860	12.83	Not measured	T12, Hole BA1B, 160.860 m; 1.010 m above the boundary. No paired resistivity; high porosity may partly reflect chip loss during MAD measurement.
D	162.254	8.60	77.55	T12, Hole BA1B, 162.254 m; 0.384 m below the boundary.
E	164.018	1.78	3873.03	T12, Hole BA1B, 164.018 m; selected observation immediately below Zone D.
E	165.540	0.94	5899.88	T12, Hole BA1B, 165.540 m; low-porosity, high-resistivity observation in Zone E.
F	217.227	0.98	1575.80	T12, Hole BA1B, 217.227 m; selected observation in Zone F.
F	218.910	1.26	2608.34	T12, Hole BA1B, 218.910 m; selected observation in Zone F.
G	223.611	0.83	4368.90	T12, Hole BA1B, 223.611 m; single point observation for Zone G.

Panel B. Focused matched-ST1 descriptive summary for Zones C–E.

ST1 parameter	Unit	Zone C	Zone D	Zone E
Matched observations (N)	count	1	3	2
GRA density, mean $\pm$ SD	g/cm ³	2.639	2.624 $\pm$ 0.014	2.671 $\pm$ 0.037
GRA density, observed range	g/cm ³	2.639	2.613–2.640	2.645–2.697
Magnetic susceptibility, matched observations (N)	count	1	3	2
Magnetic susceptibility, mean $\pm$ SD	$\times 10^{-5}$ SI	1124	1617 $\pm$ 344	444 $\pm$ 341
Magnetic susceptibility, observed range	$\times 10^{-5}$ SI	1124	1221–1839	203–685

Note. Panel B reports descriptive summaries of ST1 observations selected at, or nearest to, the corresponding T12 depths. N counts selected matched observations, not all scanner readings within a zone. SD describes variability among those observations and is not instrumental uncertainty or a confidence interval. Record-level matching can be reconstructed from the cited Site BA1 ST1 depth table.

Supplementary Table S3. Selected T07 whole-rock LOI and H₂O values associated with Zones A, B, D, E, and F in Hole BA1B; no direct in-zone T07 samples were available for Zones C or G.

Sample depth (m)	Related zone	Lithology	LOI (wt%)	H ₂ O (wt%)	Position relative to zone	Selection status	Use in interpretation
80.075	A	Harzburgite	13.8	14.8	Inside Zone A	Selected peridotite sample	Elevated bulk volatile/H ₂ O values outside Zone D.
82.270	A	Harzburgite	13.8	15.0	Inside Zone A	Selected peridotite sample	Elevated bulk volatile/H ₂ O values outside Zone D.
89.710	B	Dunite	14.7	15.2	Inside Zone B	Selected peridotite sample	Bulk volatile/H ₂ O values similar to Zone D, but not the complete Zone D petrophysical pattern.
160.085	D	Dunite	14.8	15.62	Inside Zone D	Selected peridotite sample	Highest H ₂ O among the listed peridotites; not a direct measure of serpentinization or pore connectivity.

Sample depth (m)	Related zone	Lithology	LOI (wt%)	H ₂ O (wt%)	Position relative to zone	Selection status	Use in interpretation
163.440	E (adjacent)	Harzburgite	13.5	13.34	0.440 m below Zone D and 0.560 m above Zone E	Adjacent peridotite sample	Shows elevated bulk volatile/H ₂ O values adjacent to the main interval.
163.940	E (adjacent)	Harzburgite	14.1	14.71	0.940 m below Zone D and 0.060 m above Zone E	Adjacent peridotite sample	Shows elevated bulk volatile/H ₂ O values immediately above Zone E.
217.305	F	Harzburgite	12.3	12.58	Inside Zone F	Selected peridotite sample	Provides a lower-sequence peridotite comparison.
219.340	F	Clinopyroxene	4.78	5.20	Inside Zone F	Lithology-specific comparison only	Excluded from the peridotite hydration-proxy comparison.

Note. LOI and H₂O are treated as broad bulk volatile and hydration-related indicators. LOI is not mineral-specific and may include contributions from volatile species other than structurally bound water. The listed samples are selected observations, not statistically representative samples of entire zones. T07 records are identified by Hole BA1B and reported depth in the Site BA1 source table.

Supplementary Table S4. Coverage-based screening of listed dunite–harzburgite contacts against the selected T12 observations.

Contact depth (m)	Contact context	Coverage status	Selected T12 observation(s)	Absolute distance (m)	Porosity (%)	Wet resistivity ($\Omega\cdot\text{m}$)	Defensible use
~2.95	Unambiguous D–H contact in compiled log	No selected local T12 constraint	None available in the analytical subset	—	—	—	Inconclusive; cannot test a local boundary-related response.
~7.15	Unambiguous D–H contact in compiled log	No selected local T12 constraint	None available in the analytical subset	—	—	—	Inconclusive; cannot test a local boundary-related response.
~99.81	Unambiguous D–H contact in compiled log	Only a non-local selected observation	89.890 m	~9.92	4.17	158.30	The observation is too distant for a local contact test; classify as inconclusive.
161.87	Principal D–H sequence boundary within the fault-related interval	Selected observations within 2.19 m	159.685; 160.860; 162.254 m	0.384–2.185	5.43–12.83 (N=3)	77.55–111.60 (N=2)	Documents the selected Zone D association; does not isolate faulting from lithology or prove causation.
~341.70	Unambiguous D–H contact in compiled log	No selected local T12 constraint	None available in the analytical subset	—	—	—	Inconclusive; cannot test a local boundary-related response.

Note. This table is a coverage screen of the listed unambiguous contacts, not an exhaustive inventory of every centimetre-scale, gradational, interlayered, or uncertain contact in Hole BA1B. No post hoc distance threshold is used to convert non-local measurements into boundary observations. Within the selected analytical subset, only the principal 161.87 m boundary has T12 observations within 2.2 m. The other listed contacts remain inconclusive, so the dataset cannot independently determine whether an unfaulted lithological contact would reproduce the Zone D pattern.

Supplementary Table S5. Qualitative evidence matrix for alternative contextual interpretations of the Zone D observations.

Contextual factor	Evidence considered	Pattern relevant to a simple one-factor account	Observed pattern in the selected data	Defensible interpretation
Bulk hydration / alteration	T07 LOI and H ₂ O; VCD alteration descriptions	Intervals with comparable bulk hydration indicators would be expected to show a comparable complete petrophysical pattern.	Selected peridotites in Zones A, B, and D and adjacent to E have broadly elevated LOI/H ₂ O, whereas the complete four-property combination occurs only in Zone D.	A simple bulk-hydration account does not consistently reproduce the selected observations. LOI/H ₂ O are non-unique proxies.
Veins and brittle fractures	VCD descriptions; qualitative core-image inspection; T12 data	Vein/fracture-rich intervals would be expected to show comparable high porosity and low wet resistivity.	Zone B includes veins/fractures and one low-resistivity observation, but its second observation is highly resistive and its mean porosity is lower than Zone D.	Veins or fractures may contribute locally; qualitative occurrence alone does not establish openness or connectivity.
Logged structural overprint	VCD and structural logs; T12 observations	Other structurally overprinted intervals would be expected to reproduce the complete Zone D response.	Zones E and G contain logged structural overprint but remain comparatively low in porosity and high in resistivity.	Logged deformation is not a sufficient descriptive indicator of the complete pattern within the selected cases.
Magnetic susceptibility	ST1 magnetic susceptibility and alteration context	If susceptibility were an independent control, similarly elevated values would coincide consistently with the other petrophysical properties.	Zone D has the highest selected-zone mean, but Zones C, F, and G also have elevated values without the complete Zone D pattern.	Susceptibility records bulk magnetic variability; it neither identifies the carrier nor explains pore/resistivity behavior independently.
Lithological contact	Listed D–H contacts and selected T12 coverage	A locally sampled unfaulted D–H contact would be required for a direct comparison with Zone D.	The listed clean contacts lack local selected T12 constraints; the ~99.81 m observation is ~9.92 m away.	Lithological contrast alone remains untested rather than rejected by the current selected dataset.
Combined fault–boundary setting	VCD/structural context; T12 and ST1 observations; contact coverage screen	A spatial association would place the strongest combined contrast where the major fault-related interval overlaps the principal boundary.	Zone D contains the selected four-property contrast and encompasses both features.	This is the contextual association most consistent with the selected observations, but purposive selection, sparse data, scale mismatch, and covariation preclude a causal test.

Note. This matrix is a structured qualitative comparison, not a formal hypothesis test. The factors are not experimentally independent, the intervals were selected purposively, and sample coverage is small and unequal. Accordingly, the matrix assesses consistency within the selected observations; it does not eliminate alternative mechanisms or demonstrate causal fault–boundary interaction.

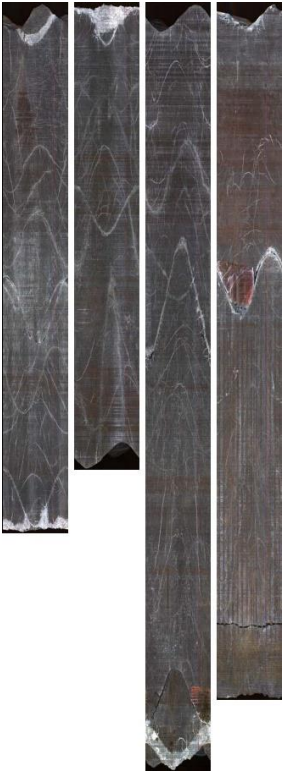
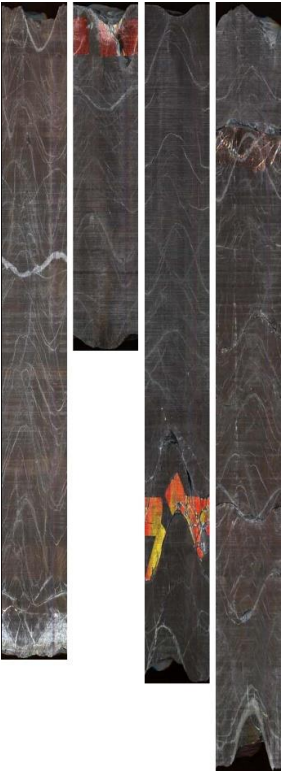
Supplementary Table S6. Qualitative core-image checks for image intervals overlapping selected Zones A–E.

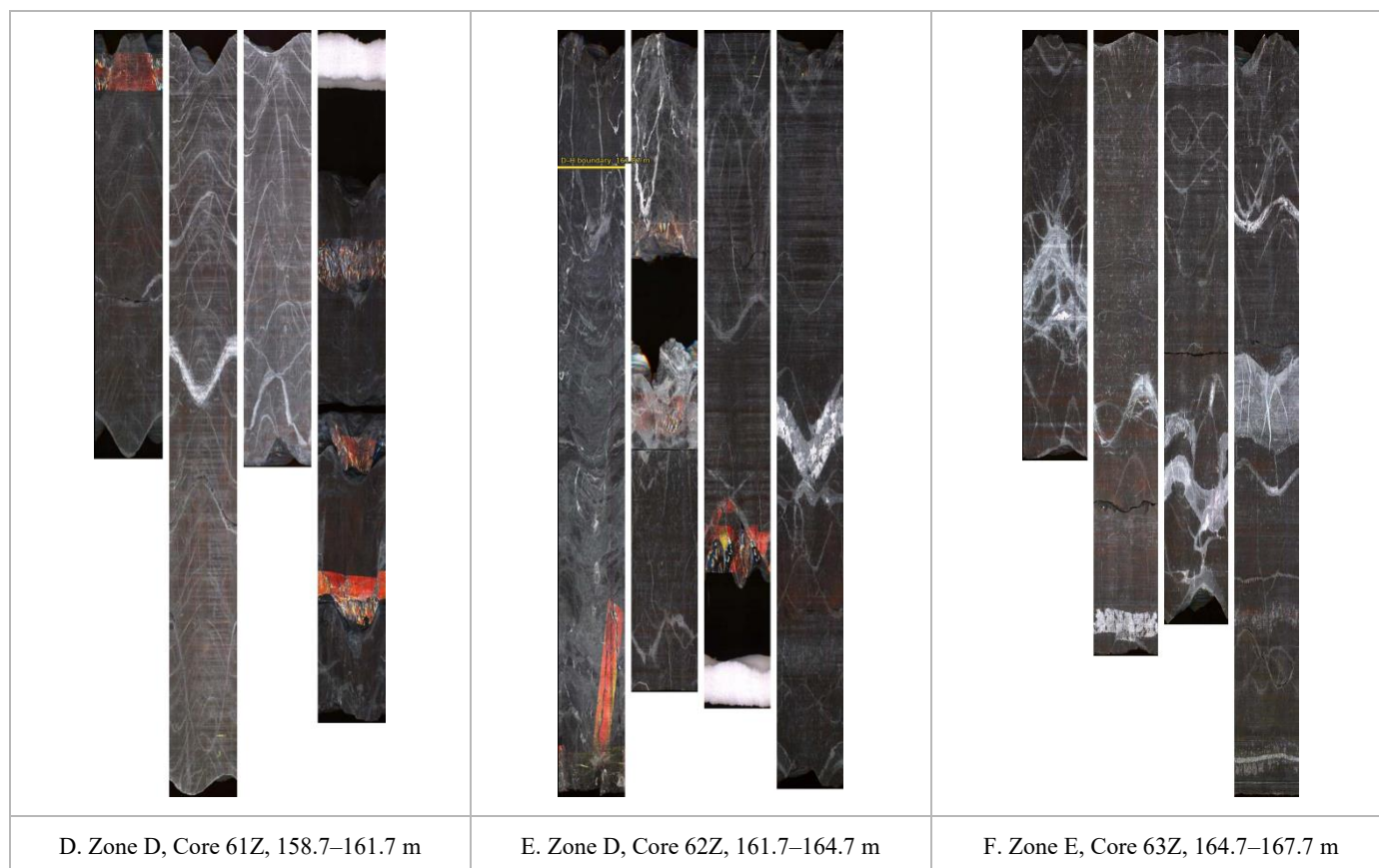
Zone	Core image	Image depth coverage (m)	Qualitative observation	Relation to analytical zone and VCD
A	36Z	83.7–86.7	Veins and fractures are visible.	Overlaps Zone A from 83.7 to 85.0 m and extends below it; used only as qualitative VCD corroboration.
B	37Z–38Z	86.7–92.7	Veins and fractures are visible; no fault core is identified from image inspection alone.	Images bracket and extend beyond Zone B (88–90 m); VCD remains the primary structural evidence.

Zone	Core image	Image depth coverage (m)	Qualitative observation	Relation to analytical zone and VCD
C	60Z	155.7–158.7	Vein- and fracture-rich core is visible.	Overlaps Zone C from 155.7 to 157.0 m and extends toward the Zone D interval.
D	61Z–62Z	158.7–164.7	Dense veining/fracturing and broken or incomplete core intervals are visible.	Covers Zone D and adjacent margins; visual appearance alone does not distinguish natural damage from recovery/handling effects.
E	63Z	164.7–167.7	A veined interval is visible below Zone D.	Overlaps Zone E from 164.7 to 166.0 m and extends below it.

Note. Core 36Z was inspected for Zone A but is not reproduced in Supplementary Figure S1. The displayed panels cover broader depth intervals than the analytical zones and are not at a common scale. Red/orange markings, gaps, broken pieces, and missing material may include curation, drilling, recovery, or handling artifacts and were not quantified as geological structures.

Supplementary Figures

		
A. Zone B, Core 37Z, 86.7–89.7 m	B. Zone B, Core 38Z, 89.7–92.7 m	C. Zone C, Core 60Z, 155.7–158.7 m



Supplementary Figure S1. Representative Oman Drilling Project core images from intervals overlapping selected Zones B–E in Hole BA1B, used only to corroborate VCD-based structural descriptions qualitatively. (A) Core 37Z, 86.7–89.7 m; (B) Core 38Z, 89.7–92.7 m; (C) Core 60Z, 155.7–158.7 m; (D) Core 61Z, 158.7–161.7 m; (E) Core 62Z, 161.7–164.7 m, containing the principal sequence boundary at 161.87 m; and (F) Core 63Z, 164.7–167.7 m. Image coverage extends beyond several analytical-zone boundaries. Panels preserve the source strip arrangement, are cropped, and are not shown at a common scale. Colored markings, gaps, broken pieces, and missing material may include drilling, recovery, curation, or handling effects and were not counted as fractures or damage. The images were not used to measure fracture or vein density, aperture, connectivity, permeability, or hydraulic state. Source images: Oman Drilling Project Site BA1 core-image archive (Kelemen et al., 2020; <https://doi.org/10.14379/OmanDP.proc.2020>).

Supplementary Reference

Kelemen, P. B., Matter, J. M., Teagle, D. A. H., Coggon, J. A., and the Oman Drilling Project Science Team: Proceedings of the Oman Drilling Project: Scientific Drilling in the Samail Ophiolite, Sultanate of Oman, International Ocean Discovery Program, College Station, TX, <https://doi.org/10.14379/OmanDP.proc.2020>