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Supplemental Material

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Ultra-high pressure mantle metasomatism in continental collision zones recorded by post-collisional mafic rocks

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EPMA analytical condition

Major compositions of the minerals were analyzed using a JEOL JXA-8230 electron probe microanalyzer in wavelength-dispersive mode. The accelerating voltage was 15 kV. Olivine and clinopyroxene were analyzed with 1 μm beam size at 20 nA. Amphibole, biotite, sanidine and plagioclase were analyzed with 3–5 μm beam size at 20 nA. Sodium was analyzed first to minimize errors due to volatilization. Dwell times were 10s on element peaks and half that on background locations adjacent to peaks. Raw x-ray intensities were corrected using a ZAF (atomic number, absorption, fluorescence) correction procedure. A series of natural and synthetic SPI standards including sanidine (K), pyrope garnet (Fe, Al), diopside (Ca, Mg), jadeite (Na), rhodonite (Mn), olivine (Si), rutile (Ti) and apatite (P, F), tugtupite (Cl) were used for calibration.

Melting trajectories in Fig. 7B

The melting trajectory of the Phl-peridotite (also contains minor calcic amphibole) is based on the experimental results of [Condamine and Médard \(2014\)](#). Melt $\text{K}_2\text{O}/\text{Na}_2\text{O}$ ratios were reported in their study. Melt Rb/Sr ratios were calculated based on the batch melting model:

$$c_i^L = \frac{c_i^0}{\bar{D}_i * (1 - F) + F}$$

where c_i^0 denotes the concentration of element i in the protolith; c_i^L is its concentration in the melt; \bar{D}_i is the bulk partition coefficients, which is calculated based on the phase proportion and the partition coefficient for each phase (D_i). F is the melting degree. Here, the phase proportion and F are available from [Condamine and Médard \(2014\)](#). Mineral/melt D_{Rb} and D_{Sr} used for the calculation are listed in the following [Supplemental Table S4](#). Rb/Sr ratio in the protolith is set at 0.5, which value is comparable to many natural phlogopite peridotite samples ([Zanetti et al., 1999](#); [Zhang et al., 2011](#)).

The melting trajectory of the MARID assemblage is from [Foley et al. \(2022\)](#). The run products, melting degree and measured melt $\text{K}_2\text{O}/\text{Na}_2\text{O}$ and Rb/Sr ratios are listed in the following [Supplemental Table S5](#).

Table S1. EPMA determined mineral compositions in the Shidao mafic dykes

Mineral	SiO ₂	TiO ₂	Al ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O	Cr ₂ O ₃	NiO	P ₂ O ₅	F	Cl	Total	Mg#
12-DS-03																
12-DS-03-p-ol-1	41.75	0.00	0.03	9.01	0.13	49.95	0.29	0.02	0.00	0.08	0.27	0.04			101.55	90.89
12-DS-03-p-ol-2	41.44	0.00	0.00	10.59	0.18	48.31	0.25	0.00	0.00	0.09	0.22	0.02			101.10	89.14
12-DS-03-p-ol-3	42.20	0.00	0.07	9.02	0.14	48.44	0.90	0.03	0.00	0.05	0.29	0.01			101.15	90.63
12-DS-03-p-ol-4	41.32	0.00	0.05	9.40	0.14	48.73	0.44	0.02	0.00	0.03	0.15	0.07			100.35	90.32
12-DS-03-p-ol-5	41.39	0.01	0.09	9.36	0.16	48.88	0.43	0.04	0.00	0.23	0.26	0.01			100.87	90.39
12-DS-03-p-ol-6	41.63	0.00	0.08	9.76	0.15	49.57	0.20	0.01	0.00	0.08	0.21	0.01			101.69	90.14
12-DS-03-p-ol-7	41.06	0.01	0.03	12.65	0.19	46.94	0.04	0.00	0.00	0.03	0.11	0.00			101.05	86.98
12-DS-03-p-ol-8	40.89	0.00	0.00	14.75	0.23	46.04	0.04	0.00	0.01	0.00	0.02	0.00			101.98	84.89
olivine average	41.46	0.00	0.04	10.57	0.16	48.36	0.32	0.02	0.00	0.05	0.19	0.02			101.19	89.17
1σ	0.41	0.00	0.04	2.07	0.03	1.30	0.28	0.01	0.00	0.03	0.09	0.02			0.54	2.14
12-DS-03-p-cpx-1	52.66	0.65	2.72	4.54	0.07	15.59	22.91	0.22	0.01	0.06	0.07	0.02			99.51	86.08
12-DS-03-p-cpx-2	51.87	0.71	3.29	5.16	0.08	15.74	22.95	0.22	0.00	0.10	0.02	0.01			100.13	84.58
12-DS-03-p-cpx-3	52.26	0.77	3.11	5.08	0.10	15.64	22.72	0.26	0.00	0.14	0.00	0.02			100.11	84.72
12-DS-03-p-cpx-4	51.42	0.54	3.06	8.52	0.42	12.62	21.98	0.83	0.01	0.02	0.01	0.02			99.45	72.72
12-DS-03-p-cpx-5	52.38	0.57	2.73	3.97	0.07	15.89	22.88	0.22	0.01	0.52	0.04	0.01			99.30	87.80
12-DS-03-p-cpx-6	53.70	0.43	1.49	3.73	0.10	16.68	23.08	0.17	0.00	0.21	0.02	0.00			99.60	88.96
12-DS-03-p-cpx-7	51.37	0.84	3.64	6.10	0.11	15.11	22.23	0.29	0.00	0.03	0.00	0.02			99.74	81.67
clinopyroxene average	52.23	0.64	2.86	5.30	0.14	15.32	22.68	0.32	0.00	0.16	0.02	0.01			99.69	83.79
1σ	0.81	0.14	0.68	1.63	0.13	1.28	0.41	0.23	0.00	0.17	0.02	0.01			0.32	5.42
12-DS-03-m-bt-1	36.27	2.50	14.87	16.29	0.21	14.43	0.00	0.14	9.62	0.05	0.02	0.02	0.48	0.15	94.81	61.46
12-DS-03-m-bt-2	36.37	2.89	14.78	16.18	0.22	14.54	0.03	0.16	9.25	0.02	0.04	0.00	0.56	0.17	94.93	61.80
12-DS-03-m-bt-3	35.69	2.51	14.80	15.52	0.21	14.30	0.07	0.26	9.23	0.03	0.00	0.02	0.55	0.16	93.06	62.39
12-DS-03-m-bt-4	36.31	2.85	14.76	16.22	0.24	13.82	0.02	0.12	9.22	0.01	0.00	0.02	0.52	0.14	94.00	60.53
12-DS-03-m-bt-5	34.64	2.60	15.52	15.86	0.20	14.03	0.05	0.14	8.93	0.00	0.01	0.03	0.37	0.14	92.34	61.41
biotite average	35.86	2.67	14.95	16.01	0.22	14.22	0.03	0.16	9.25	0.02	0.02	0.02	0.50	0.15	93.83	61.52
1σ	0.73	0.19	0.32	0.32	0.02	0.30	0.03	0.05	0.24	0.02	0.02	0.01	0.08	0.01	1.12	0.68
12-DS-03-m-amp-1	38.62	1.16	13.11	18.83	0.30	9.43	11.45	1.86	2.20	0.02	0.00	0.02			96.99	47.41
12-DS-03-m-amp-2	38.88	1.37	13.41	19.06	0.28	9.33	11.51	1.95	2.26	0.02	0.03	0.04			98.13	46.84

12-DS-03-m-amp-3	38.63	1.33	13.06	19.10	0.32	9.24	11.38	1.98	2.28	0.02	0.00	0.01			97.36	46.54
12-DS-03-m-amp-4	39.08	1.34	12.95	18.89	0.31	9.26	11.53	2.17	2.13	0.02	0.01	0.00			97.69	46.87
12-DS-03-m-amp-5	39.17	1.33	13.83	18.96	0.33	9.36	11.39	1.98	2.22	0.00	0.00	0.01			98.58	47.05
amphibole average	38.87	1.31	13.27	18.97	0.31	9.32	11.45	1.99	2.22	0.02	0.01	0.02			97.75	46.94
1σ	0.25	0.09	0.35	0.11	0.02	0.08	0.07	0.11	0.05	0.01	0.01	0.01			0.62	0.32
12-DS-03-m-pl-1	57.85	0.02	26.45	0.29	0.04	0.01	8.15	6.49	0.14	0.00	0.00	0.02			99.46	
12-DS-03-m-pl-2	59.42	0.00	25.92	0.39	0.02	0.01	7.03	7.10	0.15	0.01	0.00	0.03			100.06	
12-DS-03-m-pl-3	58.04	0.02	27.22	0.13	0.00	0.00	8.41	6.20	0.12	0.00	0.01	0.01			100.15	
12-DS-03-m-pl-4	60.25	0.00	25.55	0.38	0.01	0.00	7.31	7.00	0.19	0.01	0.00	0.01			100.71	
12-DS-03-m-pl-5	61.59	0.01	25.49	0.30	0.00	0.00	6.88	6.73	0.17	0.00	0.02	0.00			101.18	
plagioclase average	59.43	0.01	26.13	0.30	0.01	0.00	7.56	6.71	0.15	0.00	0.01	0.01			100.31	
1σ	1.56	0.01	0.72	0.10	0.02	0.00	0.69	0.37	0.03	0.01	0.01	0.01			0.66	
12-DS-03-m-san-1	66.73	0.04	18.81	0.34	0.04	0.00	0.12	0.98	13.99	0.00	0.00	0.00			101.04	
12-DS-03-m-san-2	65.96	0.04	18.44	0.48	0.00	0.00	0.12	1.52	14.21	0.00	0.02	0.00			100.80	
12-DS-03-m-san-3	66.95	0.09	19.23	0.16	0.02	0.00	0.34	2.70	11.27	0.00	0.00	0.00			100.76	
12-DS-03-m-san-4	66.41	0.04	18.95	0.18	0.03	0.00	0.04	1.64	13.55	0.01	0.00	0.00			100.84	
12-DS-03-m-san-5	67.17	0.03	18.99	0.34	0.02	0.00	0.11	2.22	12.61	0.01	0.00	0.02			101.52	
Sanidine average	66.64	0.05	18.88	0.30	0.02	0.00	0.15	1.81	13.13	0.01	0.00	0.00			100.99	
1σ	0.47	0.02	0.29	0.13	0.01	0.00	0.11	0.66	1.21	0.01	0.01	0.01			0.31	
12-DS-04																
12-DS-04-p-cpx-1	52.76	0.69	2.95	4.62	0.12	16.08	22.70	0.26	0.02	0.10	0.04	0.02			100.34	86.23
12-DS-04-p-cpx-2	52.57	0.59	2.57	4.64	0.08	16.23	22.82	0.24	0.00	0.09	0.03	0.01			99.88	86.29
12-DS-04-p-cpx-3	52.68	0.59	2.57	4.46	0.06	16.10	23.16	0.22	0.00	0.07	0.03	0.03			99.97	86.68
12-DS-04-p-cpx-4	50.99	1.10	4.15	5.74	0.10	15.60	22.23	0.24	0.01	0.03	0.04	0.03			100.23	83.02
clinopyroxene average	52.25	0.74	3.06	4.87	0.09	16.00	22.73	0.24	0.01	0.07	0.03	0.02			100.11	85.55
1σ	0.85	0.24	0.75	0.59	0.02	0.28	0.39	0.01	0.01	0.03	0.00	0.01			0.22	1.70
12-DS-04-m-bt-1	35.00	1.83	15.62	16.96	0.21	14.44	0.11	0.11	8.29	0.00	0.02	0.01	0.58	0.03	92.95	60.51
12-DS-04-m-bt-2	36.34	1.65	15.03	15.76	0.23	15.10	0.03	0.16	9.10	0.00	0.02	0.00	0.71	0.03	93.85	63.30
12-DS-04-m-bt-3	34.68	1.65	15.61	16.35	0.22	14.41	0.06	0.11	8.18	0.00	0.01	0.01	0.59	0.03	91.65	61.33
12-DS-04-m-bt-4	36.79	1.86	15.10	16.02	0.23	14.94	0.08	0.12	9.38	0.00	0.01	0.03	0.63	0.03	94.94	62.67

12-DS-04-m-bt-5	35.07	1.92	15.47	16.26	0.23	15.09	0.05	0.08	8.60	0.00	0.00	0.00	0.71	0.04	93.21	62.55
biotite average	35.58	1.78	15.36	16.27	0.22	14.79	0.07	0.12	8.71	0.00	0.01	0.01	0.64	0.03	93.32	62.07
1σ	0.93	0.12	0.28	0.45	0.01	0.35	0.03	0.03	0.52	0.00	0.01	0.01	0.06	0.00	1.21	1.13
12-DS-04-m-amp-1	39.24	0.92	12.86	17.32	0.30	9.94	11.56	2.13	2.16	0.01	0.02	0.01			96.46	50.81
12-DS-04-m-amp-2	40.03	0.85	13.17	17.76	0.29	10.22	11.26	2.40	2.13	0.02	0.04	0.00			98.17	50.88
12-DS-04-m-amp-3	40.24	0.87	13.10	17.75	0.28	10.21	11.26	2.22	2.05	0.01	0.03	0.00			98.02	50.87
12-DS-04-m-amp-4	40.80	0.94	12.88	17.22	0.34	10.49	11.40	2.41	2.09	0.00	0.01	0.01			98.59	52.31
12-DS-04-m-amp-5	39.46	0.81	13.39	18.04	0.27	10.35	11.49	2.24	2.15	0.01	0.00	0.03			98.24	50.81
amphibole average	39.95	0.88	13.08	17.62	0.30	10.24	11.39	2.28	2.12	0.01	0.02	0.01			97.90	51.13
1σ	0.62	0.05	0.22	0.34	0.03	0.21	0.13	0.12	0.05	0.01	0.01	0.01			0.83	0.66
12-DS-04-m-pl-1	66.81	0.00	21.46	0.09	0.01	0.01	1.18	9.99	0.40	0.00	0.00	0.01			99.95	
12-DS-04-m-pl-2	66.98	0.02	20.83	0.26	0.01	0.00	1.11	10.21	0.18	0.01	0.01	0.01			99.62	
plagioclase average	66.90	0.01	21.14	0.18	0.01	0.00	1.15	10.10	0.29	0.00	0.01	0.01			99.78	
1σ	0.12	0.01	0.45	0.12	0.00	0.00	0.05	0.15	0.15	0.01	0.01	0.00			0.23	
12-DS-04-m-san-1	64.60	0.06	18.93	0.18	0.01	0.00	0.05	1.45	14.19	0.00	0.00	0.00			99.47	
12-DS-04-m-san-2	64.90	0.07	19.04	0.23	0.01	0.00	0.04	1.41	14.12	0.00	0.01	0.00			99.83	
sanidine average	64.75	0.07	18.98	0.21	0.01	0.00	0.04	1.43	14.15	0.00	0.01	0.00			99.65	
1σ	0.21	0.01	0.08	0.03	0.00	0.00	0.01	0.03	0.05	0.00	0.01	0.00			0.25	

Tables S2–S3 are listed in separate excel files.

Table S4. Partition coefficients for Rb and Sr between minerals and potassium-rich melts. Numbers in bold are selected to conduct the calculation in Figure 7.

Data Source	Mineral	Liquid	D _{Rb}	D _{Sr}
Adam & Green (2006)	Phlogopite	Basanite	6.23	0.16
Foley et al. (1996)		Lamprophyre	5.18	0.18
LaTourrette et al. (1995)		Basanite	2.48	0.16
Adam et al. (1993)	Ca-amphibole	Basanite	0.34	0.33
Adam & Green (2006)		Basanite	0.18	0.33
LaTourrette et al. (1995)		Basanite	0.20	0.30
Tiepolo et al. (2003)	K-richterite	Lamproite	0.07	1.53
Adam & Green. (2006)	Clinopyroxene	Basanite	<0.001	0.1
Foley et al. (1996)		Lamprophyre	0.0047	0.0963

Table S5. Run conditions, products and K₂O, Na₂O, Rb, Sr contents of the melt in the experiments of [Foley et al. \(1999, 2022\)](#).

Starting Assemblage	Cpx+Phl+Kr+5% Rt	Cpx+Phl+Kr	Cpx+Phl+Kr	Cpx+Phl+Kr
Pressure (kbar)	15	15	15	15
Temperature (°C)	1025	1050	1100	1200
Run products	Cpx+ Kr +Ol+Phl+Rt +Melt	Cpx+Phl+Ol +Melt	Cpx+Phl+Ol+Melt	Cpx+Ol+Melt
melt compositions				
K ₂ O (wt%)	10.06	13.42	12.58	12.87
Na ₂ O (wt%)	5.65	4.7	4.36	3.01
Rb (ppm)	128	4.44	84	413
Sr (ppm)	419	43.65	286	1603
Melting degree (%)	14	17	24	44
K ₂ O/Na ₂ O	1.78	2.86	2.89	4.28
Rb/Sr	0.305	0.102	0.294	0.258

The starting assemblage is composed of a third each of Cpx, Phl and Kr, whereas the 1025 °C run also contains 5% rutile. As K₂O, Na₂O, Rb and Sr are absent in rutile, its influence on melt K₂O/Na₂O and Rb/Sr can be neglected.

Table S6. Phase proportions and melting modes used in the non-modal fractional melting modelling.

	Ol	Opx	Cpx	Grt	Sp	Phl	Kr	Sum
Source mineral weight fractions								
Grt-phl-lherz (PU624)	0.50	0.09	0.20	0.16	0.00	0.06		1
Grt-kr-lherz (PU620)	0.52	0.08	0.16	0.17			0.07	1
Sp-phl-lherz (BRIAN-PHL)	0.44	0.30	0.16		0.03	0.07		1
Sp-kr-lherz (BRIAN-KR)	0.42	0.28	0.15		0.03		0.13	1
weight fractions of mineral in the partial melts (before Phl / Kr disappear)								
Grt-phl-lherz (C16)	-0.06	-0.23	0.52	0.18		0.59		1
Grt-kr-lherz (S93)		-1.45	-0.77				3.23	1
Sp-phl-lherz (C14)	-0.58	0.56	0.47		0.05	0.50		1
Sp-kr-lherz (S93)	-0.69		-0.53				2.22	1
weight fractions of mineral in the partial melts (after Phl / Kr disappear)								
Grt-lherz (P03)	0.08	-0.19	0.81	0.30				1
Sp-lherz (P03)	-0.25	0.33	0.83		0.08			1

Table S7. Partition coefficients used in the non-modal fractional melting modelling.

	Ol	Opx	Cpx	Grt	Sp	Phl	Kr
D _{La}	0	0.0003	0.029	0.0014	0.0100	0.0001	0.0821
D _{Dy}	0.00068	0.0033	0.33	2.4	0.01	0.017	0.0665
D _{Yb}	0.0011	0.0044	0.28	6.5	0.01	0.01	0.1105

Partition coefficients in olivine (Ol), orthopyroxene (Opx), clinopyroxene (Cpx), garnet (Grt), phlogopite (Phl) are from [Prelević et al. \(2012\)](#). D values in spinel (Sp) and K-richterite (Kr) are from [McKenzie & O'Nions \(1991\)](#) and [Tiepolo et al. \(2003\)](#), respectively. These D values are comparable to numerous other studies (<https://kdd.earthref.org/KdD/>).

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