Supplementary

Table S1a. Structur refinement details for OEn at ambient conditions.

	Mg#100 OEn				
	R626	**R638**	**R545**	**R598**	**R623**
Chemical formula	$Mg_{0.958}(Si_{1.019}Al_{0.007})O_3$	$Mg_{0.966}(Si_{1.016}Al_{0.005})O_3$	$Mg_{0.990}(Si_{1.005}Al_{0.005})O_3$	$Mg_{0.940}(Si_{0.956}Al_{0.005})O_3$	$Mg_{0.935}(Si_{0.974}Al_{0.001})O_3$
crystal size (mm^3)	0.30 × 0.12 × 0.12	0.12 × 0.06 × 0.07	0.10 × 0.04 × 0.03	0.20 × 0.09 × 0.08	0.60 × 0.30 × 0.25
Space group	Orthorhombic, *Pbca*	Orthorhombic, *Pbca*	Orthorhombic, *Pbca*	Orthorhombic, *Pbca*	Orthorhombic, *Pbca*
a (Å)	18.2218(4)	18.2181(4)	18.2201(3)	18.2235(3)	18.2182(10)
b (Å)	8.8107(2)	8.8100(2)	8.8111(2)	8.81060(10)	8.8140(4)
c (Å)	5.17640(10)	5.17660(10)	5.17500(10)	5.17730(10)	5.1753(2)
V ($Å^3$)	831.05(3)	830.85(3)	830.79(3)	831.27(2)	831.02(7)
ϱ_{calcd} ($g\ cm^{-3}$)	3.210	3.211	3.211	3.209	3.210
Z	8	8	8	8	8
T (K)	293	293	293	293	293
absorption coe.	0.568	0.568	0.568	0.567	0.568
Range of hkl	$-19 \leqq h \leqq 30$	$-30 \leqq h \leqq 30$	$-24 \leqq h \leqq 26$	$-30 \leqq h \leqq 30$	$-18 \leqq h \leqq 30$
	$-14 \leqq k \leqq 14$	$-14 \leqq k \leqq 14$	$-12 \leqq k \leqq 12$	$-14 \leqq k \leqq 14$	$-14 \leqq k \leqq 14$
	$-8 \leqq l \leqq 8$	$-8 \leqq l \leqq 8$	$-7 \leqq l \leqq 7$	$-8 \leqq l \leqq 8$	$-8 \leqq l \leqq 8$
Total refls.	7602	22791	15583	15508	7360
Unique refls.	2010	2014	1270	2006	2007
Observed refl. $F_O > 2(F_O)$	1459	1636	1075	1864	1871
R_{int}	0.0573	0.0398	0.0294	0.0204	0.0247
R_1 [a]	0.0331	0.0264	0.0214	0.0186	0.0229
wR_2 [b]	0.0911	0.0743	0.0583	0.0512	0.0613
Goodness-of-fit	1.079	1.152	1.052	1.065	1.106
Refined parameters	93	93	95	95	95
restraints	0	0	0	0	0

[a] $R_1 = (\sum ||F_O| - |F_C||)/\sum |F_O|$. [b] $wR_2 = \{\sum[w(F_O{}^2 - F_C{}^2)^2]/\sum[w(F_O{}^2)^2]\}^{1/2}$.

Table S1b. Structur refinement details for OEn at ambient conditions.

Al-bearing OEn	
R624	R608
$Mg_{0.925}(Si_{0.967}Al_{0.037})O_3$	$Mg_{0.933}(Si_{0.962}Al_{0.031})O_3$
0.18 × 0.10 × 0.09	0.22× 0.12 × 0.10
Orthorhombic, *Pbca*	Orthorhombic, *Pbca*
18.2128(4)	18.2139(4)
8.7902(2)	8.7995(2)
5.17460(10)	5.17410(10)
828.43(3)	829.27(3)
3.274	3.271
8	8
293	293
0.583	0.583
$-33 \leqq h \leqq 35$	$-20 \leqq h \leqq 30$
$-11 \leqq k \leqq 17$	$-14 \leqq k \leqq 14$
$-10 \leqq l \leqq 10$	$-8 \leqq l \leqq 8$
10,308	7643
2824	2004
2049	1711
0.0573	0.0300
0.0341	0.0235
0.0833	0.0603
1.043	1.095
96	96
3	3

Table S2. Atomic coordinates, occupancy, and displacement parameters for OEn at ambient conditions.

		Mg#100 OEn					Al-bearing OEn	
		R626	**R638**	**R545**	**R598**	**R623**	**R624**	**R608**
Mg1	*x*	0.37687(4)	0.37686(3)	0.37685(3)	0.37694(2)	0.37682(2)	0.37755(2)	0.37726(2)
	y	0.51339(7)	0.51328(6)	0.48684(6)	0.51362(3)	0.51310(3)	0.51416(5)	0.51376(4)
	z	0.35884(12)	0.35897(10)	0.35860(10)	0.35880(5)	0.35868(5)	0.35626(8)	0.35701(7)
	U_{iso}	0.00742(17)	0.00740(13)	0.00683(17)	0.00691(8)	0.00603(8)	0.00704(10)	0.00694(10)
	occupancy	0.964(3)	0.969(3)	0.953(3)	0.978(2)	0.959(2)	0.947(2)	0.956(2)
Mg2	*x*	0.37584(3)	0.37584(3)	0.37584(3)	0.37581(2)	0.37584(2)	0.37594(2)	0.37593(2)
	y	0.65405(7)	0.65398(5)	0.65396(5)	0.65390(3)	0.65389(3)	0.65392(5)	0.65388(4)
	z	0.86593(12)	0.86519(9)	0.86574(10)	0.86579(5)	0.86582(5)	0.86404(8)	0.86445(7)
	U_{iso}	0.00571(16)	0.00557(12)	0.00547(16)	0.00496(8)	0.00462(8)	0.00526(10)	0.00517(10)
	occupancy	0.975(3)	0.978(3)	0.960(3)	0.973(2)	0.966(2)	0.964(2)	0.964(2)
SiA	*x*	0.27166(2)	0.27168(2)	0.27168(2)	0.27160(2)	0.27169(2)	0.27154(2)	0.27159(2)
(TA)	*y*	0.34145(5)	0.34142(4)	0.34155(4)	0.34161(2)	0.34156(2)	0.34170(3)	0.34171(3)
	z	0.05020(9)	0.94989(7)	0.04999(7)	0.04978(4)	0.05026(4)	0.04854(6)	0.04903(5)
	U_{iso}	0.00525(10)	0.00500(8)	0.00395(14)	0.00373(6)	0.00323(7)	0.00431(8)	0.00394(8)
	occupancy	0.975(3)	0.979(3)	0.954(3)	0.973(2)	0.965(2)	0.963(2)	0.963(2)
SiB	*x*	0.47366(2)	0.47366(2)	0.47355(2)	0.47363(2)	0.47357(2)	0.47345(2)	0.47343(2)
(TB)	*y*	0.33739(5)	0.33740(4)	0.33734(4)	0.66263(2)	0.33734(2)	0.66279(3)	0.66275(3)
	z	0.20161(9)	0.20159(7)	0.79841(8)	0.79855(4)	0.79834(4)	0.80078(6)	0.80011(5)
	U_{iso}	0.00491(10)	0.00493(8)	0.00373(13)	0.00372(6)	0.00319(7)	0.00450(8)	0.00390(8)
	occupancy	0.971(3)	0.977(3)	0.951(3)	0.971(2)	0.965(2)	0.930(7)	0.894(9)
AlB	*x*						0.47345(2)	0.47343(2)
	y						0.66279(3)	0.66275(3)
	z						0.80078(6)	0.80011(5)
	U_{iso}						0.00450(8)	0.00390(8)
	occupancy						0.033(7)	0.067(10)
O1A	*x*	0.18336(7)	0.18338(5)	0.18346(5)	0.18336(3)	0.18341(3)	0.18312(4)	0.18327(4)
	y	0.33992(14)	0.34001(11)	0.34023(11)	0.34011(6)	0.34014(6)	0.34005(9)	0.34011(8)
	z	0.0356(2)	0.03524(18)	0.03459(19)	0.03455(10)	0.03463(10)	0.03372(15)	0.03377(14)
	U_{iso}	0.0061(2)	0.00612(15)	0.0072(2)	0.00613(10)	0.00574(10)	0.00708(14)	0.00694(14)
O2A	*x*	0.31094(7)	0.31101(5)	0.31099(5)	0.31091(3)	0.31096(3)	0.31090(4)	0.31099(4)
	y	0.50241(14)	0.50238(11)	0.50230(11)	0.49756(6)	0.50242(6)	0.49692(9)	0.49715(8)
	z	0.04310(2)	0.04344(19)	0.04352(19)	0.04312(10)	0.04343(10)	0.04178(16)	0.04216(14)
	U_{iso}	0.00800(2)	0.00776(16)	0.0087(2)	0.00717(10)	0.00687(10)	0.00844(14)	0.00790(13)

O3A	x	0.30311(7)	0.30311(5)	0.30311(5)	0.30312(3)	0.30319(3)	0.30298(4)	0.30304(4)
	y	0.22273(14)	0.22267(11)	0.22250(11)	0.22290(6)	0.22264(6)	0.77714(10)	0.77718(8)
	z	0.8315(2)	0.83143(19)	0.83176(19)	0.83081(10)	0.83158(10)	0.82963(16)	0.83013(13)
	U_{iso}	0.0078(2)	0.00789(16)	0.0087(2)	0.00730(10)	0.00685(10)	0.00825(15)	0.00787(14)
O1B	x	0.56252(7)	0.56253(5)	0.56240(6)	0.56247(3)	0.56242(3)	0.56270(4)	0.56257(4)
	y	0.34022(14)	0.34017(10)	0.34039(10)	0.34020(6)	0.34033(6)	0.66039(9)	0.66010(8)
	z	0.80000(20)	0.80018(18)	0.80021(19)	0.80061(10)	0.80022(10)	0.80272(15)	0.80201(14)
	U_{iso}	0.00620(20)	0.00622(15)	0.0070(2)	0.00630(10)	0.00593(10)	0.00728(14)	0.00706(14)
O2B	x	0.43281(7)	0.43289(5)	0.43275(6)	0.43283(3)	0.43278(3)	0.43275(5)	0.43275(4)
	y	0.48321(14)	0.51650(11)	0.48308(11)	0.51673(6)	0.48311(6)	0.51615(9)	0.51654(8)
	z	0.6898(2)	0.68953(19)	0.68887(19)	0.68928(10)	0.68895(10)	0.68850(16)	0.68852(13)
	U_{iso}	0.00770(20)	0.00754(16)	0.0083(2)	0.00757(10)	0.00699(10)	0.00849(14)	0.00816(14)
O3B	x	0.44747(7)	0.44757(5)	0.44753(6)	0.44753(3)	0.44757(3)	0.44722(5)	0.44736(4)
	y	0.30449(14)	0.30460(11)	0.19500(12)	0.30475(6)	0.30492(6)	0.30634(9)	0.30584(8)
	z	1.10360(20)	1.10336(18)	0.60388(19)	1.10380(10)	1.10371(10)	1.10720(15)	1.10597(13)
	U_{iso}	0.00780(20)	0.00781(16)	0.0086(2)	0.00705(10)	0.00649(10)	0.00839(15)	0.00818(14)

Table S3a. The Si-O bond distances (Å) and tetrahedral volume (Å^3) of OEn.

	Mg#100 OEn Hydrous					**Al-bearing OEn (low-Al) Hydrous**		**Mg#100 OEn Anhydrous**	**Al-bearing OEn (high-Al) Hydrous**
	R626	R638	R545	R598	R623	R624	R608	[37]	[23]
Si1-O2A	1.5890(13)	1.5892(10)	1.5875(11)	1.5881(6)	1.5886(6)	1.5897(9)	1.5896(8)	1.5860	1.5906(19)
Si1-O1A	1.6109(13)	1.6106(10)	1.6095(11)	1.6101(6)	1.6099(6)	1.6123(8)	1.6107(8)	1.6090	1.6145(19)
Si1-O3A	1.6445(13)	1.6443(10)	1.6443(11)	1.6459(5)	1.6456(5)	1.6438(8)	1.6449(7)	1.652	1.6400(18)
Si1-O3A	1.6638(13)	1.6636(10)	1.6651(11)	1.6643(5)	1.6640(6)	1.6630(8)	1.6631(7)	1.658	1.6642(18)
$V_{SiA(TA)}$	2.180	2.179	2.177	2.179	2.179	2.180(8)	2.179	2.176	2.1815
Si2-O2B	1.5877(13)	1.5894(10)	1.5884(11)	1.5892(5)	1.5884(6)	1.5964(9)	1.5930(8)	1.5880	1.6076(19)
Si2-O1B	1.6195(13)	1.6192(10)	1.6192(11)	1.6191(6)	1.6185(6)	1.6257(9)	1.6238(8)	1.619	1.6459(20)
Si2-O3B	1.6754(13)	1.6737(10)	1.6748(11)	1.6752(5)	1.6743(6)	1.6781(9)	1.6752(8)	1.671	1.6885(19)
Si2-O3B	1.6756(13)	1.6764(10)	1.6766(11)	1.6765(5)	1.6766(6)	1.6804(9)	1.6793(8)	1.674	1.6851(19)
$V_{SiB(TB)}$	2.246	2.247	2.247	2.248	2.246	2.269	2.259	2.238	2.3162

Table S3b. The M-O bond distances (Å) and octahedral volume (Å^3) of OEn.

	Mg#100 OEn Hydrous					Al-Bearing OEn (low-Al) Hydrous		Mg#100 OEn Anhydrous	Al-Bearing OEn (high-Al) Hydrous
	R626	R638	R545	R598	R623	R624	R608	[37]	[23]
M1-O2A	2.0061(14)	2.0057(11)	2.0071(11)	2.0056(6)	2.0060(6)	2.0019(9)	2.0027(8)	2.0070	1.9867(20)
M1-O1A	2.0225(13)	2.0240(11)	2.0265(11)	2.0264(6)	2.0260(6)	2.0203(9)	2.0230(8)	2.02	2.0090(20)
M1-O2B	2.0432(13)	2.0420(11)	2.0444(11)	2.0433(6)	2.0445(6)	2.0324(9)	2.0367(8)	2.049	2.0045(19)
M1-O1B	2.0627(14)	2.0619(11)	2.0632(11)	2.0618(6)	2.0625(6)	2.0556(9)	2.0582(8)	2.063	2.0346(20)
M1-O1A	2.1487(13)	2.1490(10)	2.1505(11)	2.1488(6)	2.1500(6)	2.1459(9)	2.1484(8)	2.146	2.1333(20)
M1-O1B	2.1655(13)	2.1659(10)	2.1685(11)	2.1683(6)	2.1686(6)	2.1582(9)	2.1624(8)	2.162	2.1334(19)
V_{M1}	11.769	11.768	11.801	11.784	11.792	11.669	11.719	11.756	11.352
M2-O2B	1.9936(14)	1.9927(11)	1.9899(11)	1.9914(6)	1.9901(6)	1.9917(9)	1.9910(8)	1.9860	1.9981(20)
M2-O2A	2.0333(14)	2.0312(11)	2.0290(11)	2.0345(6)	2.0296(6)	2.0359(9)	2.0328(8)	2.032	2.0566(19)
M2-O1B	2.0552(13)	2.0553(11)	2.0537(11)	2.0579(6)	2.0542(6)	2.0530(9)	2.0539(8)	2.057	2.0563(19)
M2-O1A	2.0923(14)	2.0897(11)	2.0877(11)	2.0910(6)	2.0875(6)	2.0992(9)	2.0944(8)	2.096	2.1279(20)
M2-O3A	2.2865(14)	2.2866(11)	2.2861(11)	2.2870(6)	2.2868(6)	2.2867(9)	2.2871(8)	2.297	2.2846(20)
M2-O3B	2.4445(14)	2.4464(11)	2.4420(11)	2.4411(6)	2.4441(6)	2.4002(9)	2.4160(8)	2.45	2.3139(20)
V_{M2}	12.450	12.437	12.408	12.439	12.416	12.345	12.371	12.472	12.254

Table S4a. Unit cell parameters of Mg#100 OEn (R598) under high pressure.

P(GPa)	*a* (Å)	*b* (Å)	*c* (Å)	*V* (Å^3)
0	18.2235(3)	8.8106(1)	5.1773(1)	831.26(2)
1.34	18.166(1)	8.7657(10)	5.159(3)	821.50(12)
4.12	18.071(2)	8.6891(14)	5.1243(3)	804.61(10)
6.32	17.996(2)	8.6323(15)	5.0994(3)	792.19(9)
8.45	17.931(2)	8.5837(14)	5.0785(3)	781.66(9)
10.37	17.877(2)	8.5412(14)	5.0600(4)	772.63(10)
11.66	17.855(3)	8.5187(25)	5.0556(6)	768.95(17)
13.22	17.871(6)	8.502(5)	5.0355(13)	765.08(34)

Table S4b. Structure refinement details for the Al-bearing enstatite (R608) under high pressure.

P(GPa)	**0.00010**	**1.72**	**4.56**	**7.07**	**8.45**	**10.00**
a (Å)	18.2139(4)	18.114(5)	18.014(4)	17.930(4)	17.915(10)	17.859(6)
b (Å)	8.7995(2)	8.7530(36)	8.6694(25)	8.6106(28)	8.5733(33)	8.5484(19)
c (Å)	5.1741(10)	5.1562(8)	5.1180(6)	5.0905(7)	5.0771(11)	5.0632(7)
V (Å^3)	829.28(3)	817.50(26)	799.29(18)	785.90(20)	779.80(36)	772.98(40)
Range of hkl	$-20 \le h \le 30$	$-19 \le h \le 19$	$-19 \le h \le 19$	$-19 \le h \le 19$	$-19 \le h \le 19$	$-19 \le h \le 19$
	$-14 \le k \le 14$	$-8 \le k \le 8$	$-8 \le k \le 8$	$-8 \le k \le 8$	$-8 \le k \le 8$	$-8 \le k \le 8$
	$-8 \le l \le 8$	$-4 \le l \le 4$	$-4 \le l \le 4$	$-4 \le l \le 4$	$-4 \le l \le 4$	$-4 \le l \le 4$
Unique refl.	2004	318	306	515	597	643
Observed refl. $F_o > 2\sigma(F_o)$	1711	198	206	342	404	301
$2\theta_{max}$ (°)	55.68	42.52	42.62	47.04	53.90	42.60
R_{int}	0.030	0.089	0.064	0.092	0.089	0.103
R_1	0.024	0.061	0.056	0.068	0.073	0.106
wR_2	0.060	0.123	0.118	0.131	0.180	0.264
GooF	1.093	1.078	1.055	1.127	1.083	1.131
Refined parameters	96	46	46	46	46	46
	3	3	3	3	3	3

Table S5. Structural refinement details of Al-bearing OEn (R608) at high pressure.

Radiation type	AgKα
Pressure (GPa)	1.72
Temperature (K)	298
Composition	$Mg_{1.865}Al_{0.061}Si_{1.924}O_6$
Space group	orthorhombic, *Pbca*
Lattice parameters	a = 18.114(5), b = 8.753(4), c = 5.1562(8) $\alpha = \beta = \gamma = 90°$
Volume (Å^3)	817.5(5)
Z	8
ϱ_{calcd} (g cm^{-3})	3.318
Range of hkl	$-19 \le h \le 19$, $-8 \le k \le 8$, $-4 \le l \le 4$
μ(mm^{-1})	0.591
Total reflections	1646
Unique reflections	318
R_{int}	0.1192
R_1	0.0637
wR_2	0.1426
Goodness-of-fit	1.032
Refined parameters	46
restraints	3

Atom	*x*	*y*	*z*	*Uiso*	*occupancy*
SiA	0.2710(2)	0.3417(6)	0.0462(9)	0.0074(15)	0.968(17)
SiB	0.4727(2)	0.3372(6)	0.8015(10)	0.0099(15)	0.944(17)
AlB	0.4727(2)	0.3372(6)	0.8015(10)	0.0099(15)	0.058(10)
Mg(M1)	0.3761(3)	0.6563(7)	0.8615(11)	0.0060(17)	0.933(15)
Mg(M2)	0.3778(3)	0.4851(7)	0.3548(12)	0.0084(17)	0.939(15)
O1A	0.1835(5)	0.3404(13)	0.0310(20)	0.008(2)	1
O2A	0.3105(6)	0.5028(13)	0.0410(20)	0.011(3)	1
O3A	0.3034(5)	0.2233(12)	0.8250(20)	0.008(2)	1
O1B	0.5631(5)	0.3389(12)	0.8040(20)	0.009(2)	1
O2B	0.4326(5)	0.4844(13)	0.6910(20)	0.011(3)	1
O3B	0.4477(6)	0.1944(14)	0.6140(20)	0.017(3)	1

Radiation type	AgKα
Pressure (GPa)	4.56
Temperature (K)	298
Composition	$Mg_{1.865}Al_{0.061}Si_{1.924}O_6$
Space group	orthorhombic, *Pbca*
Lattice parameters	a =18.018(3), b = 8.6654(18), c = 5.1169(5) $\alpha = \beta = \gamma = 90°$
Volume (Å^3)	798.9(2)
Z	8
ϱ_{calcd} (g cm^{-3})	3.395
Range of hkl	$-19 \le h \le 19$, $-8 \le k \le 8$, $-4 \le l \le 4$
μ(mm^{-1})	0.605
Total reflections	1628
Unique reflections	307
R_{int}	0.1020
R_1	0.0576
wR_2	0.1224
Goodness-of-fit	1.077
Refined parameters	46
restraints	3

Atom	*x*	*y*	*z*	*Uiso*	*occupancy*
SiA	0.2711(2)	0.3416(5)	0.0414(7)	0.0087(13)	0.989(15)
SiB	0.4726(2)	0.3370(5)	0.8038(8)	0.0076(13)	0.921(16)
AlB	0.4726(2)	0.3370(5)	0.8038(8)	0.0076(13)	0.056(10)
Mg(M1)	0.3763(2)	0.6574(6)	0.8586(10)	0.0047(15)	0.930(13)
Mg(M2)	0.3779(2)	0.4833(6)	0.3508(9)	0.0063(15)	0.940(13)
O1A	0.1831(5)	0.3390(12)	0.0242(18)	0.010(2)	1
O2A	0.3103(5)	0.5062(12)	0.0368(17)	0.009(2)	1
O3A	0.3040(5)	0.2227(11)	0.8241(17)	0.007(2)	1
O1B	0.5623(5)	0.3379(11)	0.8081(18)	0.006(2)	1
O2B	0.4331(5)	0.4843(11)	0.6874(19)	0.010(2)	1
O3B	0.4459(5)	0.1911(11)	0.6136(19)	0.008(2)	1

Radiation type	AgKα
Pressure (GPa)	7.07
Temperature (K)	298
Composition	$Mg_{1.865}Al_{0.061}Si_{1.924}O_6$
Space group	orthorhombic, *Pbca*
Lattice parameters	a =17.9353(8), b = 8.610(3), c = 5.094(5) $\alpha = \beta = \gamma = 90°$
Volume (Å^3)	786.6(7)
Z	8
ϱ_{calcd} (g cm^{-3})	3.448
Range of hkl	$-19 \le h \le 19$, $-8 \le k \le 8$, $-4 \le l \le 4$
μ(mm^{-1})	0.614
Total reflections	1721
Unique reflections	342
R_{int}	0.1320
R_1	0.0698
wR_2	0.1437
Goodness-of-fit	1.117
Refined parameters	46
restraints	3

Atom	*x*	*y*	*z*	*Uiso*	*occupancy*
SiA	0.2711(2)	0.3428(6)	0.0411(9)	0.0029(14)	1
SiB	0.4729(2)	0.3378(7)	0.8038(9)	0.0102(14)	0.90(2)
AlB	0.4729(2)	0.3378(7)	0.8038(9)	0.0102(14)	0.061(11)
Mg(M1)	0.3763(3)	0.6579(8)	0.8574(11)	0.0036(16)	1
Mg(M2)	0.3782(3)	0.4822(8)	0.3508(11)	0.0063(18)	1
O1A	0.1820(6)	0.3411(15)	0.021(2)	0.009(3)	1
O2A	0.3105(6)	0.5094(15)	0.034(2)	0.009(3)	1
O3A	0.3031(6)	0.2204(13)	0.824(2)	0.007(2)	1
O1B	0.5618(5)	0.3401(15)	0.808(2)	0.005(2)	1
O2B	0.4342(6)	0.4870(15)	0.681(2)	0.012(3)	1
O3B	0.4462(6)	0.1911(14)	0.617(2)	0.007(3)	1

Radiation type	AgKα
Pressure (GPa)	8.45
Temperature (K)	298
Composition	$Mg_{1.865}Al_{0.061}Si_{1.924}O_6$
Space group	orthorhombic, *Pbca*
Lattice parameters	a =17.941(11), b = 8.561(4), c = 5.0771(14) $\alpha = \beta = \gamma = 90°$
Volume (Å^3)	779.8(6)
Z	8
ϱ_{calcd} (g cm^{-3})	3.478
Range of hkl	$-19 \le h \le 19$, $-8 \le k \le 8$, $-4 \le l \le 4$
μ(mm^{-1})	0.620
Total reflections	1843
Unique reflections	404
R_{int}	0.1547
R_1	0.0758
wR_2	0.1850
Goodness-of-fit	1.077
Refined parameters	46
restraints	3

Atom	*x*	*y*	*z*	*Uiso*	*occupancy*
SiA	0.2710(3)	0.3432(5)	0.0381(9)	0.0098(14)	0.991(16)
SiB	0.4729(3)	0.3389(5)	0.8071(9)	0.0076(14)	0.923(17)
AlB	0.4729(3)	0.3389(5)	0.8071(9)	0.0076(14)	0.061(10)
Mg(M1)	0.3764(3)	0.6573(6)	0.8539(11)	0.0032(15)	0.904(16)
Mg(M2)	0.3778(4)	0.4820(6)	0.3472(11)	0.0107(17)	0.965(17)
O1A	0.1818(7)	0.3391(12)	0.024(2)	0.011(2)	1
O2A	0.3077(7)	0.5114(11)	0.031(2)	0.007(2)	1
O3A	0.3041(7)	0.2233(12)	0.820(2)	0.013(3)	1
O1B	0.5624(7)	0.3376(11)	0.811(2)	0.008(2)	1
O2B	0.4340(8)	0.4850(12)	0.685(2)	0.017(3)	1
O3B	0.4446(7)	0.1878(11)	0.611(2)	0.009(2)	1

Radiation type	AgKα
Pressure (GPa)	10
Temperature (K)	298
Composition	$Mg_{1.865}Al_{0.061}Si_{1.924}O_6$
Space group	orthorhombic, *Pbca*
Lattice parameters	a =17.859(6), b = 8.5484(19), c = 5.0632(7) $\alpha = \beta = \gamma = 90°$
Volume (Å^3)	773.0(3)
Z	8
ϱ_{calcd} (g cm^{-3})	3.509
Range of hkl	$-19 \le h \le 19$, $-8 \le k \le 8$, $-4 \le l \le 4$
μ(mm^{-1})	0.625
Total reflections	1450
Unique reflections	301
R_{int}	0.1558
R_1	0.1063
wR_2	0.2642
Goodness-of-fit	1.131
Refined parameters	46
restraints	3

Atom	*x*	*y*	*z*	*Uiso*	*occupancy*
SiA	0.2701(5)	0.3432(8)	0.0399(14)	0.016(3)	0.96(3)
SiB	0.4725(5)	0.3377(8)	0.8088(15)	0.018(3)	0.96(3)
AlB	0.4725(5)	0.3377(8)	0.8088(15)	0.018(3)	0.059(11)
Mg(M1)	0.3764(5)	0.6587(9)	0.8542(17)	0.009(3)	0.89(2)
Mg(M2)	0.3783(6)	0.4830(9)	0.3461(18)	0.019(3)	0.98(2)
O1A	0.1822(12)	0.3396(17)	0.024(3)	0.015(4)	1
O2A	0.3074(12)	0.5139(18)	0.029(3)	0.017(4)	1
O3A	0.3048(11)	0.2209(17)	0.816(3)	0.017(4)	1
O1B	0.5621(10)	0.3368(15)	0.822(3)	0.009(4)	1
O2B	0.4339(12)	0.4861(18)	0.682(3)	0.023(4)	1
O3B	0.4462(12)	0.1881(16)	0.626(4)	0.018(4)	1

Table S6. Estimation for water in olivine according to partitioning coefficient.

	P (GPa)	**T (°C)**	**D_{water} ***	**Mg-end OEn (ppm) #**	**Al-bearing OEn (ppm) #**	**Olivine calculated (ppm)**	**Total (60ol40en)**	**Total (80ol20en)**
MFSH	5	1175	0.58	515		888	739	813
		1250	0.28	515		1839	1310	1574
MFASH	7.5	1175	0.78		978	1254	1033	1199
		1250	1.01		978	968	976	970

MFSH: MgO–FeO–SiO_2–H_2O. MFASH: MgO–FeO–Al_2O_3–SiO_2–H_2O. * D_{water} is from *Ferot and Balfan-Casanova* [24]. # Water content was measured by SIMS from this study.