Table S1: Locations and selected major, minor and volatile element concentrations for Southern Mid-Atlantic Ridge basalts.

Sample (EW9309)	2D-1g	3D-1g	4D-3g	5D-5g	7D-1g	8D-1g	9D-1g
Location	Discov.	Discov.	Discov.	Discov.	Discov.	Discov.	Discov.
Latitude (°S)	47.548	47.795	47.967	48.240	48.760	48.963	49.147
Longitude (°W)	349.82	349.85	349.92	350.01	349.93	350.03	350.09
Depth (m)	2493.5	2549.0	2895.0	3452.5	3217.5	3893.5	3892.0
SiO_2 **a**	51.66	50.95	51.24	51.09	51.23	52.13	52.14
MgO **a**	6.24	7.21	7.60	7.08	6.79	7.38	7.16
K_2O **a**	0.76	0.57	0.40	0.67	1.22	0.37	0.53
H_2O (wt%) **b**	0.483(7)	0.378(6)	0.296(4)	0.436(9)	0.503(14)	0.295(13)	0.392(5)
CO_2 (ppm) **c**	160(15)	181(11)	173(16)	219(30)	190(13)	192(13)	281(12)
La **d**	15.49	12.57	9.31	14.26	17.73	8.70	9.15
Ce **d**	34.52	28.27	21.71	32.34	36.42	21.44	22.12
$^{87}Sr/^{86}Sr$ **e**	.704127		.703762	.703976	.705093	.704286	.704604
$^{206}Pb/^{204}Pb$ **e**	18.064	18.114	18.069	18.084	17.773	17.798	17.811
H_2O/Ce	140	134	136	135	138	138	177

Vesicles (vol%) [f]	0.1	4.0	5.5	0.8	1.5	1.0	0.2
$X^{m}_{H_2O,mol}$ X 10^4 [g]	6.7	4.0	2.4	5.4	7.3	2.4	4.3
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	114.7	125.8	119.2	150.9	134.5	131.4	188.0
$X^{v}_{H_2O}$ [i]	0.058	0.032	0.020	0.036	0.054	0.018	0.023
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	1.32	1.50	1.43	1.81	1.57	1.59	2.33
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	1.40	1.55	1.46	1.88	1.66	1.62	2.38
$X^{v}_{CO_2}$ [l]	0.943	0.968	0.981	0.965	0.946	0.982	0.977
P_{equil} [m]	365	402	380	486	431	420	614
$M^{v}_{H_2O}$ (wt%) [n]	0.000	0.002	0.002	0.001	0.002	0.000	0.000
Bulk H_2O (wt%) [o]	0.483	0.380	0.298	0.437	0.505	0.295	0.392
%H_2Odegassed [p]	0.0	0.5	0.7	0.1	0.3	0.1	0.0

Table S1: Southern MAR basalts (cont.).

Sample (EW9309)	25D-1g	26D-1g	28D-3g	33D-1g	34D-1g	37D-1g	41D-1g
Location	Discov.	Discov.	Discov.	Discov.	Discov.	Discov.	Discov.
Latitude (°S)	47.348	47.353	46.900	45.990	45.847	45.233	44.020
Longitude (°W)	349.68	346.6	346.55	345.92	345.81	344.93	343.92
Depth (m)	2032.0	3857.0	3416.5	3381.0	3442.5	3534.0	3522.0
SiO_2 **a**	53.98	50.08	49.67	49.92	49.86	49.39	50.44
MgO **a**	7.51	7.06	8.47	7.83	8.35	8.11	8.36
K_2O **a**	0.28	0.12	0.14	0.74	0.06	0.41	0.10
H_2O (wt%) **b**	0.148(4)	0.226(4)	0.177(2)	0.301(15)	0.125(5)	0.277(4)	0.165(4)
CO_2 (ppm) **c**	90(24)	242(29)	151(11)	237(38)	299(24)	233(27)	248(35)
La **d**	5.48	4.42	4.39	12.16	2.76	8.35	3.49
Ce **d**	12.97	13.78	13.26	26.43	9.03	20.5	11.16
$^{87}Sr/^{86}Sr$ **e**	.705728	.703072	.703196	.704475	.703544	.704121	.703273
$^{206}Pb/^{204}Pb$ **e**	18.098	18.034	18.066	17.992	17.983	17.974	17.894
H_2O/Ce	114	164	134	114	138	135	148

Vesicles (vol%) f	4.5	5.0	0.8	0.9	0.5	5.0	3.5
$X^{m}_{H_2O,mol}$ X 10^4 g	0.6	1.4	0.8	2.5	0.4	2.1	0.7
$X^{0,m}_{H_2O,mol}$ X 10^4 h	63.0	161.8	103.6	159.6	195.8	156.8	165.0
$X^{v}_{H_2O}$ i	0.009	0.008	0.008	0.016	0.002	0.13	0.43
$X^{m}_{CO_3^{2-}}$ X 10^4 j	0.75	2.00	1.25	1.96	2.48	1.93	2.06
$X^{0,m}_{CO_3^{2-}}$ X 10^4 k	0.75	2.02	1.26	1.99	2.49	1.96	2.07
$X^{v}_{CO_2}$ l	0.996	0.992	0.993	0.985	0.998	0.987	0.996
P_{equil} m	197	523	328	516	641	506	534
$M^{v}_{H_2O}$ (wt%) n	0.000	0.001	0.000	0.000	0.000	0.001	0.003
Bulk H_2O (wt%) o	0.148	0.227	0.177	0.301	0.125	0.278	0.168
%H_2O degassed p	0.4	0.4	0.1	0.1	0.0	0.5	2.0

Table S1: Southern MAR basalts (cont.).

Sample (EW93-09	11D-1g	14D-1g	15D-1g	17D-1g	19D-1g	18D-1g	20D-1g
Location	Shona1	Shona1	Shona1	Shona1	Shona1	Shona2	Shona2
Latitude (°S)	49.443	50.267	50.578	50.757	51.062	51.053	51.428
Longitude (°W)	352.03	352.94	353.57	353.66	353.84	353.80	354.22
Depth (m)	3868.0	3347.0	2980.0	2942.5	1743.0	1991.0	1719.0
SiO_2 **a**	50.91	51.04	50.10	49.45	49.58	50.86	50.46
MgO **a**	8.02	7.41	7.81	7.82	7.19	8.31	6.77
K_2O **a**	0.05	0.08	0.14	0.18	0.12	0.19	0.33
H_2O (wt%) **b**	0.159(4)	0.180(5)	0.205(4)	0.281(8)	0.347(16)	0.200(5)	0.333(19)
CO_2 (ppm) **c**	192(18)	189(23)	162(20)	138(11)	77(8)	143(9)	81(13)
La **d**	3.07	3.68	4.79	5.61	3.75	5.83	8.45
Ce **d**	10.62	11.91	13.65	15.46	10.76	14.68	20.80
$^{87}Sr/^{86}Sr$ **e**	.702562	.702644	.702741	.702680	.702740	.703231	.703440
$^{206}Pb/^{204}Pb$ **e**	18.133	18.355	18.489	18.71	18.923	18.415	18.593
H_2O/Ce	149	151	150	182	323	136	160

Vesicles (vol%) [f]	0.5	0.5	1.0	1.5	2.0	10.0	0.3
$X^{m}_{H_2O,mol}$ X 10^4 [g]	0.7	0.9	1.1	2.2	3.3	1.1	3.1
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	129.9	128.1	111.0	96.3	56.7	98.6	59.2
$X^{v}_{H_2O}$ [i]	0.005	0.007	0.010	0.022	0.059	0.011	0.052
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	1.59	1.57	1.44	1.14	0.638	1.190	0.671
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	1.60	1.58	1.36	1.17	0.677	1.20	0.707
$X^{v}_{CO_2}$ [l]	0.996	0.994	0.990	0.979	0.943	0.990	0.949
P_{equil} [m]	415	409	352	304	177	311	185
$M^{v}_{H_2O}$ (wt%) [n]	0.000	0.000	0.000	0.001	0.001	0.001	0.000
Bulk H_2O (wt%) [o]	0.159	0.180	0.205	0.282	0.348	0.201	0.333
%H_2Odegassed[p]	0.0	0.0	0.1	0.2	0.3	0.7	0.0

Table S1: Southern MAR basalts (cont.).

Sample (EW9309)	21D-1g	22D-3g	23D-1g
Location	Shona2	Shona2	Shona2
Latitude (°S)	51.822	52.458	52.157
Longitude (°W)	354.5	355.43	354.66
Depth (m)	2025.0	3059.0	2609.0
SiO_2 **a**	50.77	51.37	50.84
MgO **a**	7.10	4.83	6.09
K_2O **a**	0.38	0.52	0.30
H_2O (wt%) **b**	0.364(21)	0.649(19)	0.369(39)
CO_2 (ppm) **c**	119(10)	125(16)	n.a.
La **d**	8.91	14.58	9.07
Ce **d**	21.71	36.13	24.50
$^{87}Sr/^{86}Sr$ **e**	.703115	.703576	.703058
$^{206}Pb/^{204}Pb$ **e**	18.721	18.182	18.480
H_2O/Ce	168	180	151

Vesicles (vol%) [f]	0.8	
$X^{m}_{H_2O,mol}$ X 10^4 [g]	3.69	12.5
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	85.2	97.3
$X^{v}_{H_2O}$ [i]	0.043	0.128
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	0.986	1.033
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	1.030	1.183
$X^{v}_{CO_2}$ [l]	0.957	0.873
P_{equil} [m]	268	308
$M^{v}_{H_2O}$ (wt%) [n]		
Bulk H_2O (wt%)[o]		
%H_2Odegassed[p]		

Table S1 caption:

Values in parentheses are 1σ standard deviations of multiple analyses in the last or last two decimal places.

a Locations, depths, and major elements for south Atlantic basalts are from Douglass et al.[9]. Discov. is Discovery segment. Shona1 is Shona group 1. Shona2 is Shona group 2.

b Total dissolved water analyzed using transmission infrared spectroscopy on doubly polished glass wafers according to method given in Dixon and Clague[27] using a linear background correction and a molar absorptivity of 63 ± 3 l/mol-cm (P. Dobson, S. Newman, S. Epstein, and E. Stolper, 1988, unpublished results) for the fundamental OH stretching band at 3535 cm^{-1}. Reported concentrations are the mean of 4 to 6 individual analyses. Precision is ~± 2% and accuracy is ~ ± 10%.

c Total dissolved CO_2 (all dissolved as carbonate groups) determined using a molar absorptivity of 375 ± 20 l/mole-cm for carbonate bands at 1430 and 1515 cm^{-1} in MORB glass. Background corrections for the carbonate bands were performed on reference-subtracted spectra using interactive baseline and curve-fitting routines available in the OPUS software on the Brüker IFS-66 infrared spectrometer. Carbonate bands are modeled as the sum of two gaussians of equal band height, 1515 and 1430 cm^{-1}, each with full-width at half height (FWHH) of 75 ± 5 cm^{-1}. The lowest point of the region of overlap between the 1515 and 1430 cm^{-1} bands is two-thirds of the maximum band height. Precision is ~7 to 10% and accuracy is ~±20%. Detection limit is ~30 ppm. For samples with no detectable CO_2, a concentration of <30 ppm is reported and a value of 15 ± 15 is used in the degassing modeling calculation.

d La and Ce data from Douglass et al.[33].

e Radiogenic isotopic compositions from Douglass et al.[9].

f Vesicularity for south Atlantic basalts were estimated visually on the doubly polished glass wafers.

g - m Equilibration pressure (P_{equil}) and vapor composition (mole fraction of H_2O and CO_2 in the vapor - $X^v_{H_2O}$ and $X^v_{CO_2}$) are calculated iteratively according to Dixon[52]. An excel spreadsheet for these calculations is available from JED.

g Mole fraction of molecular water dissolved in the melt are calculated from measured total water contents using the regular solution model of Dixon et al.[53] and equations to calculate mole fractions on a single oxygen basis:
$wt\%H_2O^{sum}_{tot} = wt\%OH + wt\%H_2O_{mol}$; $X^m_{OH} = 2\left(X_B - X^m_{H_2O,mol}\right)$;

$$\mathrm{X^m_B(total)} = \left\{\left(\mathrm{wt\%H_2O^{sum}_{tot}}/18\right)\Big/\left(\left(100 - \mathrm{wt\%H_2O^{sum}_{tot}}\right)\Big/36.6 + \mathrm{wt\%H_2O^{sum}_{tot}}/18 + \mathrm{wt\%CO_2}/44\right)\right\}$$

,

$$\mathrm{X^m_{H_2O,mol}} = \left\{\left(\mathrm{wt\%H_2O_{mol}}/18\right)\Big/\left(\left(100 - \mathrm{wt\%H_2O_{tot}}\right)\Big/36.6 + \mathrm{wt\%H_2O_{tot}}/18 + \mathrm{wt\%CO_2}/44\right)\right\}$$

; where 36.6 is the molecular weight of anhydrous basalt on a single-oxygen basis.

h Theoretical mole fraction of molecular water dissolved in the melt if the melt were saturated with a pure H_2O fluid at the pressure of vapor saturation (see “m” below) are calculated using the equation[50] for H_2O solubility in tholeiite at 1200°C

$$X^{m}_{H_2O,mol}(P\ ,T_o)=X^{m}_{H_2O,mol}(P_o,T_o)\frac{f_{H_2O}(P,T_o)}{f_{H_2O}(P_o,T_o)}\exp\left\{\frac{(-V^{o,m}_{H_2O})(P-P_o)}{RT_o}\right\}$$, where

$X^{m}_{H_2O,mol}(P,T_o)$ is the mole fraction of molecular water in melt saturated with fluid with a fugacity of water of $f_{H_2O}(P,T_o)$ at pressure, *P*, and temperature, T_o (1473.15 K); $X^{m}_{H_2O}(P_o,T_o)$ is the mole fraction of molecular water in melt in equilibrium with vapor with a fugacity of water of $f_{H_2O}(P_o,T_o)$ at pressure P_o (1 bar) and temperature T_o; $f_{H_2O}(P_o,T_o)$ =1 bar; $V^{o,m}_{H2O}$, assumed constant over the range of compositions studied here, is the molar volume of water in the melt in its standard state (12 cm^3/mol); and R is the gas constant (83.15 cm^3 bar/mol-K). A 30% decrease in the H_2O solubility as SiO_2 decreases from 49 to 40 wt% is achieved by allowing the mole fraction of molecular water dissolved in the melt at standard state to vary as a function of SiO_2 according to the model of Dixon[52] $X^{m}_{H_2O,mol}(P_o,T_o)=-3.0356\times10^{-5}+1.2889\times10^{-6}SiO_2$.

i $X^{v}_{H_2O}$ is the mole fraction water in a H_2O-CO_2 fluid and equals $X^{m}_{H_2O,mol}\big/X^{o,m}_{H_2O,mol}$ assuming ideal mixing in the fluid. $X^{m}_{H_2O,mol}\big/X^{o,m}_{H_2O,mol}$ =1 for melt in equilibrium with pure H_2O fluid, $X^{m}_{H_2O,mol}\big/X^{o,m}_{H_2O,mol}$ = 0 for melt in equilibrium with pure CO_2 fluid[53].

j Mole fraction of carbon dissolved as carbonate in the melt is calculated using:

$$\mathrm{X}^{\mathrm{m}}_{\mathrm{CO_2}}=\left\{\left(\mathrm{wt\%CO_2}/44\right)\big/\left(\left(100-\mathrm{wt\%H_2O}-\mathrm{wt\%CO_2}/36.6\right)+\mathrm{wt\%H_2O}/18+\mathrm{wt\%CO_2}/44\right)\right\}$$

.

k Theoretical mole fraction of carbonate in a melt in equilibrium with pure CO_2 fluid at the vapor saturation pressure is calculated using:

$$X^{m}_{CO_3^{2-}}(P,T_o)=X^{m}_{CO_3^{2-}}(P_o,T_o)\frac{f_{CO_2}(P,T_o)}{f_{CO_2}(P_o,T_o)}\exp\left\{\frac{-\Delta V^{o,m}_{r}(P-P_o)}{RT_o}\right\}$$, where variables are

defined as in (b) with carbon dioxide replacing water and carbonate replacing molecular water. $\Delta V_r^{o,m} = (V_{CO_3^{2-}}^{o,m}) - (V_{O^{2-}}^{o,m})$ and $V_{O^{2-}}^{o,m}$ and $V_{CO_3^{2-}}^{o,m}$ are the molar volumes of the melt species in their standard states and have been taken to be independent of P, T, and melt composition (23 cm^3/mole). A 5X increase in CO_2 solubility as SiO_2 decreases from 49 to 40 wt% SiO_2 is achieved by allowing the mole fraction of carbonate dissolved in the melt to vary as a function of SiO_2 [52]; $X_{CO_3^{2-}}^{m}(P_o, T_o) = 8.697\times10^{-6} - 1.697\times10^{-7} SiO_2$.

l $X_{CO_2}^{v}$ is the mole fraction of CO_2 in the fluid assuming ideal mixing, and is equal to $X_{CO_3^{2-}}^{m} \big/ X_{CO_3^{2-}}^{0,m}$.

m P_{equil} is pressure at which the following condition of vapor saturation is satisfied:

$(X_{H_2O,mol}^{m} \big/ X_{H_2O,mol}^{o,m}) + (X_{CO_3^{2-}}^{m} \big/ X_{CO_3^{2-}}^{0,m}) = 1$ [54].

n Mass of water vapor in the vesicles (wt%) is calculated assuming ideal gas behavior for the vesicle gases and using the equation: $M_{H_2O}^{v} = 100\times\frac{18.015\times Perupt\times V_{H_2O}^{v}}{RT}$, where R is the gas constant (83.15 cm^3 bar/mol-K), T is the"rigid temperature" of 1273 K, and $V_{H_2O}^{v}$ is the volume of water vapor in the vesicle gases defined by $V_{H_2O}^{v} = X_{H_2O}^{v}\times\frac{[(\%ves/100)\times V_{glass}]}{[1-(\%ves/100)]}$, where V_{glass} is the volume of glass (assuming a glass density of 2.8 g/cm^3).

o Bulk water concentration is the sum of dissolved and exsolved (vapor) species.

p Percent water degassed is 100* $M_{H_2O}^{v} \big/ Bulkwater$.

Table S2: Locations and selected major, minor and volatile element concentrations for FAZAR/Northern Mid-Atlantic Ridge basalts.

Sample (AII127)	D1-2	D3-1a	D3-2a	D3-3a	D55-1b	D55-3	D4-4
Location	HA-1	OH-5	OH-5	OH-5	OH-3	OH-3	OH-3
Latitude (°S)	33.176	33.657	33.657	33.657	33.727	33.727	33.847
Longitude (°W)	39.246	38.204	38.204	38.204	37.784	37.784	37.730
Depth (m)	2712	3889	3889	3889	3736	3736	3319
SiO_2 **a**	50.12	48.28	48.15	48.24	50.29		49.78
MgO **a**	7.89	9.87	9.93	9.76	9.13		9.44
K_2O **a**	0.05	0.04	0.03	0.02	0.07		0.04
H_2O (wt%) **b**	0.169(7)	0.122(4)	0.126(1)	0.116(13)	0.145(3)	0.139(2)	0.129(12)
CO_2 (ppm) **c**	130(30)	262(18)	246(17)	232(15)	265(6)	216(9)	204(13)
La **d**	1.83			1.34	1.88	1.92	2.80
Ce **d**	6.26			3.64	5.12	5.18	6.56
$^{87}Sr/^{86}Sr$ **e**	.702745				.702973		
$^{206}Pb/^{204}Pb$ **e**	18.090				18.577		
H_2O/Ce	270			318	283	268	197

Vesicles (vol%) [f]	1.0	1.0	1.0	1.0	1.0	1.0	1.0
$X^{m}_{H_2O,mol}$ X 10^4 [g]	0.75	0.38	0.41	0.35	0.55		0.43
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	89.80	130.0	117.0	114.2	175.2		137.3
$X^{v}_{H_2O}$ [i]	0.008	0.003	0.004	0.003	0.003		0.003
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	1.08	2.18	2.04	1.93	2.20		1.69
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	1.09	2.19	2.05	1.94	2.21		1.70
$X^{v}_{CO_2}$ [l]	0.992	0.998	0.998	0.998	0.998		0.997
P_{equil} [m]	283	428	386	375	569	466	440
$M^{v}_{H_2O}$ (wt%) [n]	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bulk H_2O (wt%) [o]	0.169	0.122	0.126	0.116	0.145	0.139	0.129
%H_2Odegassed [p]	0.1	0.0	0.0	0.0	0.0	0.0	0.0

Table S2: FAZAR basalts (cont.).

Sample (AII127)	D4-9	D5-5	D5-9	D54-3	D7-6	D7-10	D53-1
Location	OH-3	OH-3	OH-3	OH-3	OH-2	OH-2	OH-2
Latitude (°S)	33.847	33.912	33.912	34.058	34.356	34.356	34.525
Longitude (°W)	37.730	37.706	37.706	37.648	37.100	37.100	36.996
Depth (m)	3319	3018	3018	3335	2941	2941	3062
SiO_2 **a**	49.92	49.16	49.72	51.25	5.75		51.04
MgO **a**	9.15	9.86	8.94	7.27	9.35		8.25
K_2O **a**	0.08	0.05	0.09	0.17	0.05		0.08
H_2O (wt%) **b**	0.157(3)	0.131(4)	0.174(3)	0.242(1)	0.097(4)		0.155(7)
CO_2 (ppm) **c**	188(4)	180(13)	146(5)	104(7)	125(8)		200(7)
La **d**		2.05		3.71	1.38	1.32	2.27
Ce **d**		5.79		9.37	3.84	3.85	6.40
$^{87}Sr/^{86}Sr$ **e**				.702937	.702760		
$^{206}Pb/^{204}Pb$ **e**				18.455	18.768		
H_2O/Ce		226		258	253		242

Vesicles (vol%) [f]	1.0	1.0	1.0	1.5	1.5	1.5	1.5
$X^{m}_{H_2O,mol}$ X 10^4 [g]	0.64	0.44	0.80	1.6	0.24		0.63
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	127.3	122.1	100.3	73.30	86.0		134.9
$X^{v}_{H_2O}$ [i]	0.005	0.004	0.008	0.021	0.003		0.004
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	1.56	1.49	1.21	0.863	1.04		1.66
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	1.57	1.50	1.22	0.881	1.04		1.67
$X^{v}_{CO_2}$ [l]	0.995	0.997	0.994	0.979	0.997		0.996
P_{equil} [m]	407	389	317	230	271		432
$M^{v}_{H_2O}$ (wt%) [n]	0.000	0.000	0.000	0.001	0.000		0.000
Bulk H_2O (wt%) [o]	0.157	0.131	0.174	0.243	0.097		0.155
%H_2Odegassed [p]	0.1	0.0	0.1	0.3	0.0		0.1

Table S2: FAZAR basalts (cont.).

Sample (AII127)	D52-3	D8-5	D8-6	D50-1	D50-2	D48-1	D9-10
Location	OH-1	OH-1	OH-1	OH-1	OH-1	PO-8	PO-8
Latitude (°S)	34.578	34.709	34.709	34.842	34.842	35.104	35.220
Longitude (°W)	36.515	36.494	36.494	36.433	36.433	34.960	34.765
Depth (m)	2971	2734	2734	2235	2235	3900	1657
SiO_2 **[a]**	51.27	49.85	49.80		50.13	51.53	48.30
MgO **[a]**	7.43	9.61	9.47		8.88	7.02	5.71
K_2O **[a]**	0.16	0.04	0.04		0.13	0.59	1.80
H_2O (wt%) **[b]**	0.234(1)	0.119(12)	0.138(0)	0.220(15)	0.241(2)	0.547(3)	0.792(59)
CO_2 (ppm) **[c]**	148(3)	161(16)	153(2)	104(6)	121(2)	198(14)	82(12)
La **[d]**	4.21	1.86		3.74	3.87		47.33
Ce **[d]**	10.42	5.18		9.37	9.53		95.59
$^{87}Sr/^{86}Sr$ **[e]**	.702907	.702824	.702824		.702936		.703677
$^{206}Pb/^{204}Pb$ **[e]**	18.704	18.481	18.481		18.614		19.060
H_2O/Ce	225	230		235	253		83

Vesicles (vol%) f	1.5	2.0	2.0	2.0	2.0	15.0	60.0
$X^{m}_{H_2O,mol}$ X 10^4 g	1.5	0.36	0.49		1.6	8.7	19.09
$X^{0,m}_{H_2O,mol}$ X 10^4 h	102.2	109.7	104.7		84.60	140.7	61.0
$X^{v}_{H_2O}$ i	0.014	0.003	0.005		0.018	0.062	0.313
$X^{m}_{CO_3^{2-}}$ X 10^4 j	1.22	1.34	1.27		1.00	1.64	0.676
$X^{0,m}_{CO_3^{2-}}$ X 10^4 k	1.24	1.34	1.28		1.02	1.74	0.983
$X^{v}_{CO_2}$ l	0.986	0.997	0.996		0.982	0.938	0.688
P_{equil} m	324	348	332	229	266	452	196
$M^{v}_{H_2O}$ (wt%) n	0.000	0.000	0.000	0.000	0.001	0.026	0.383
Bulk H_2O (wt%) o	0.234	0.119	0.138	0.220	0.242	0.573	1.175
%H_2Odegassed p	0.2	0.1	0.1	0.2	0.2	4.5	32.6

Table S2: FAZAR basalts (cont.).

Sample (AII127)	D46a	D49-3	D45a	D44-1	D44-5	RC136	D43-1
Location	PO-8	PO-8	PO-8	PO-8	PO-8	PO-8	PO-8
Latitude (°S)	35.243	35.257	35.302	35.318	35.318	35.359	35.520
Longitude (°W)	34.820	36.263	34.865	34.862	34.862	34.851	34.784
Depth (m)	1930	3684	2487	2383	2383	2367	3146
SiO_2 **a**	50.57	50.67	50.15	48.20	50.86	50.65	51.09
MgO **a**	7.49	7.78	8.36	7.72	7.75	7.62	7.65
K_2O **a**	0.702	0.175	0.55	1.972	0.610	0.57	0.46
H_2O (wt%) **b**	0.645(20)	0.274(3)	0.395(20)	1.290(28)	0.599(18)	0.667(32)	0.419(6)
CO_2 (ppm) **c**	136(6)	234(5)	140(11)	73(7)	145(6)	101(11)	175(5)
La **d**	20.48	4.96	12.46	45.27			10.18
Ce **d**	41.08	11.71	25.25	86.97			20.60
$^{87}Sr/^{86}Sr$ **e**	.703438	.702936	.703664	.704040		.703479	
$^{206}Pb/^{204}Pb$ **e**	19.17	18.720	18.465	17.820		19.029	
H_2O/Ce	157	234	156	148			203

Vesicles (vol%) [f]	30.0	5.0	25	25		25	
$X^{m}_{H_2O,mol}$ X 10^4 [g]	12	2.0	4.4	52.81	11	13.26	5.0
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	104.5	157.4	99.60	88.1	108.6	82.29	122.8
$X^{v}_{H_2O}$ [i]	0.118	0.013	0.044	0.600	0.097	0.161	0.040
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	1.12	1.94	1.16	0.599	1.20	0.834	1.45
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	1.27	1.97	1.21	1.49	1.33	0.993	1.51
$X^{v}_{CO_2}$ [l]	0.882	0.987	0.957	0.401	0.903	0.840	0.960
P_{equil} [m]	331	508	315	287	345	259	392
$M^{v}_{H_2O}$ (wt%) [n]	0.060	0.002	0.022	0.251		0.077	
Bulk H_2O (wt%) [o]	0.705	0.276	0.417	1.541		0.744	
%H_2Odegassed [p]	8.5	0.6	5.2	16.3		10.4	

Table S2: FAZAR basalts (cont.).

Sample (AII127)	D43-3A	D41-1	D41-2	D40-6	D40-4	D10-2A	D10-4A
Location	PO-8	PO-6	PO-6	PO-6	PO-6	PO-6	PO-6
Latitude (°S)	35.520	35.671	35.671	35.772	35.772	35.954	35.954
Longitude (°W)	34.784	34.281	34.281	34.226	34.226	34.159	34.159
Depth (m)	3146	2697	2697	2445	2445	2321	2321
SiO_2 **a**	51.23	51.63	51.63	51.29	51.29	50.87	51.36
MgO **a**	7.28	6.49	6.49	8.01	8.01	8.74	8.24
K_2O **a**	0.56	0.24	0.24	0.14	0.14	0.16	0.12
H_2O (wt%) **b**	0.499(33)	0.523(13)	0.395(31)	0.195(13)	0.216(4)	0.204(22)	0.213(8)
CO_2 (ppm) **c**	148(26)	123(5)	91(7)	184(12)	228(12)	179(17)	215(8)
La **d**				3.88			4.08
Ce **d**				9.75			9.74
$^{87}Sr/^{86}Sr$ **e**				.703940		.703035	.703035
$^{206}Pb/^{204}Pb$ **e**				18.126		18.522	18.243
H_2O/Ce				200			219

Vesicles (vol%) [f]				10	15	2.0	2.0
$X^{m}_{H_2O,mol}$ X 10^4 [g]	7.2	7.9	4.4	1.0	1.2	1.1	1.2
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	104.4	91.80	67.20	125.1	153.0	121.9	14.9
$X^{v}_{H_2O}$ [i]	0.067	0.086	0.065	0.008	0.008	0.009	0.008
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	1.22	1.02	0.754	1.53	1.89	1.48	1.78
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	1.31	1.11	0.806	1.54	1.91	1.50	1.80
$X^{v}_{CO_2}$ [l]	0.934	0.914	0.935	0.992	0.992	0.991	0.992
P_{equil} [m]	340	290	210	399	493	389	467
$M^{v}_{H_2O}$ (wt%) [n]				0.001	0.002	0.000	0.000
Bulk H_2O (wt%) [o]				0.196	0.218	0.204	0.213
%H_2Odegassed [p]				0.7	1.0	0.1	0.1

Table S2: FAZAR basalts (cont.).

Sample (AII127)	D10-6	D11-4	D11-6	D12-5	D13-6	D14-2	D38-3
Location	PO-6	PO-5	PO-5	PO-4	PO-2	PO-2	PO-1
Latitude (°S)	35.954	36.161	36.161	36.296	36.996	37.053	37.122
Longitude (°W)	34.159	33.975	33.975	33.757	32.942	32.906	32.349
Depth (m)	2321	3048	3048	2278	2678	2963	2870
SiO_2 **a**	51.29	50.65	50.55	50.23	51.12	51.01	51.56
MgO **a**	8.14	8.73	8.75	9.35	7.85	6.99	7.48
K_2O **a**	0.13	0.17	0.15	0.09	0.17	0.16	0.20
H_2O (wt%) **b**	0.213(7)	0.285(9)	0.266(16)	0.186(13)	0.241(14)	0.345(23)	0.326(8)
CO_2 (ppm) **c**	210(19)	151(11)	168(12)	168(15)	165(23)	145(14)	141(2)
La **d**	3.98		4.74	2.94	3.54	3.72	
Ce **d**	9.64		10.86	7.59	8.80	9.80	
$^{87}Sr/^{86}Sr$ **e**	.703035		.703090	.703196	.703019	.703302	.702953
$^{206}Pb/^{204}Pb$ **e**	18.243		18.606	18.842	18.498	18.818	18.921
H_2O/Ce	221		245	245	274	352	

Vesicles (vol%) [f]	2.0			2.0	5.0	3.0	3.0
$X^{m}_{H_2O,mol}$ X 10^4 [g]	1.2	2.2	1.9	0.91	1.6	3.3	2.9
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	141.6	104.8	115.6	114.7	113.3	101.8	99.00
$X^{v}_{H_2O}$ [i]	0.009	0.021	0.017	0.008	0.014	0.032	0.030
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	1.74	1.25	1.39	1.39	1.37	1.20	1.17
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	1.76	1.28	1.42	1.40	1.39	1.24	1.20
$X^{v}_{CO_2}$ [l]	0.991	0.979	0.984	0.993	0.986	0.968	0.970
P_{equil} [m]	455	332	368	365	360	322	313
$M^{v}_{H_2O}$ (wt%) [n]	0.000			0.000	0.001	0.002	0.002
Bulk H_2O (wt%) [o]	0.213			0.186	0.242	0.347	0.328
%H_2Odegassed [p]	0.1			0.1	0.5	0.5	0.5

Table S2: FAZAR basalts (cont.).

Sample (AII127)	D37-1	D37-3	D36-12	D36-24	D15-1	D15-2	D35-1
Location	PO-1	PO-1	PO-1	PO-1	PO-1	PO-1	PO-1
Latitude (°S)	37.250	37.250	37.264	37.264	37.297	37.297	37.421
Longitude (°W)	32.297	32.297	32.269	32.269	32.271	32.271	32.270
Depth (m)	1963	1963	1867	1867	1600	1600	2730
SiO_2 **a**	51.40	51.40	51.85	51.89	51.21	51.20	51.37
MgO **a**	8.28	8.28	7.48	7.74	8.12	8.04	7.88
K_2O **a**	0.17	0.17	0.21	0.17	0.20	0.19	0.23
H_2O (wt%) **b**	0.257(22)	0.252(9)	0.348(4)	0.288(7)	0.287(4)	0.282(8)	0.382(8)
CO_2 (ppm) **c**	109(14)	106(4)	88(6)	121(10)	152(11)	128(5)	159(5)
La **d**		4.50	5.37	4.90	5.24	5.05	6.33
Ce **d**		10.60	12.48	11.43	11.41	11.51	14.34
$^{87}Sr/^{86}Sr$ **e**			.702961		.702945	.702945	
$^{206}Pb/^{204}Pb$ **e**			18.870		18.860	18.860	
H_2O/Ce		238	279	252	252	245	266

Vesicles (vol%) **f**			20		20	20	
$X^{m}_{H_2O,mol}$ X 10^4 **g**	1.8	1.7	3.4	2.3	2.2	2.2	4.1
$X^{0,m}_{H_2O,mol}$ X 10^4 **h**	76.90	74.70	64.20	85.20	105.4	89.70	111.7
$X^{v}_{H_2O}$ **i**	0.023	0.023	0.052	0.027	0.021	0.024	0.037
$X^{m}_{CO_3^{2-}}$ X 10^4 **j**	0.904	0.879	0.729	1.00	1.26	1.06	1.32
$X^{0,m}_{CO_3^{2-}}$ X 10^4 **k**	0.925	0.898	0.769	1.03	1.29	1.09	1.37
$X^{v}_{CO_2}$ **l**	0.977	0.979	0.948	0.973	0.979	0.976	0.963
P_{equil} **m**	241	234	201	268	335	283	355
$M^{v}_{H_2O}$ (wt%) **n**			0.015		0.005	0.006	
Bulk H_2O (wt%)**o**			0.363		0.292	0.288	
%H_2Odegassed**p**			4.1		1.8	2.0	

Table S2: FAZAR basalts (cont.).

Sample (AII127)	D16-1	D17-1	D17-5	D19-1A	D21-5	RC59	RC63
Location	PO-1	KP-5	KP-5	KP-4	KP-3	KP-3	KP-3
Latitude (°S)	37.449	37.841	37.841	38.126	38.495	38.608	38.828
Longitude (°W)	32.231	31.521	31.521	30.726	30.262	30.224	30.087
Depth (m)	2916	926	926	1917	1950	1485	1240
SiO_2 **a**	52.27	49.51	50.20	50.48	51.11	50.50	49.74
MgO **a**	6.82	8.30	8.20	7.62	5.85	9.37	8.16
K_2O **a**	0.24	0.67	0.59	0.69	1.07	0.31	0.71
H_2O (wt%) **b**	0.240(11)	0.503(2)	0.441(62)	0.519(20)	1.220(73)	0.413(1)	0.764(10)
CO_2 (ppm) **c**	130(7)	39(4)	39(7)	72(7)	20(5)	85(12)	32(10)
La **d**			14.21	18.56	23.40	7.25	
Ce **d**			28.42	36.47	48.95	15.45	
$^{87}Sr/^{86}Sr$ **e**			.703280		.703372		.703504
$^{206}Pb/^{204}Pb$ **e**			19.151		19.651		19.479
H_2O/Ce			155	142	249	267	

Vesicles (vol%) [f]	5.0	40	40	60	25	15	20
$X^{m}_{H_2O,mol}$ X 10^4 [g]	2.0	7.3	5.5	7.8	47	4.8	18
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	90.90	34.50	32.70	57.70	60.80	63.60	39.90
$X^{v}_{H_2O}$ [i]	0.022	0.211	0.169	0.135	0.774	0.076	0.443
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	1.08	0.323	0.323	0.596	0.164	0.704	0.264
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	1.10	0.407	0.386	0.688	0.727	0.761	0.473
$X^{v}_{CO_2}$ [l]	0.978	0.789	0.832	0.865	0.226	0.924	0.558
P_{equil} [m]	287	107	101	180	190	199	124
$M^{v}_{H_2O}$ (wt%) [n]	0.002	0.079	0.062	0.237	0.308	0.012	0.084
Bulk H_2O (wt%) [o]	0.276	0.582	0.503	0.756	1.528	0.425	0.848
%H_2Odegassed [p]	0.7	13.6	12.4	31.4	20.1	2.9	9.9

Table S2: FAZAR basalts (cont.).

Sample (AII127)	D22-5	D22-6	D29-1	D27-4	RC84	D26-1	D26-5
Location	KP-2	KP-2	KP-2	KP-1	KP-1	KP-1	KP-1
Latitude (°S)	39.044	39.044	39.437	39.504	39.659	39.907	39.907
Longitude (°W)	30.028	30.028	29.849	29.739	29.737	29.674	29.674
Depth (m)	1386	1386	1905	2287	1820	2093	2093
SiO_2 **a**	52.15	51.70	49.39	51.56	51.09	51.32	51.25
MgO **a**	6.05	6.42	7.66	7.98	8.80	7.63	7.67
K_2O **a**	0.85	0.81	0.70	0.31	0.31	0.18	0.20
H_2O (wt%) **b**	0.882(69)	0.922(69)	0.801(2)	0.455(11)	0.374(3)	0.364(20)	0.343(10)
CO_2 (ppm) **c**	22(3)	29(4)	89(3)	107(19)	104(14)	191(42)	173(4)
La **d**	19.92	19.39	17.85	8.00		5.01	
Ce **d**	41.13	40.49	37.28	17.92		11.75	
$^{87}Sr/^{86}Sr$ **e**	.703369	.703434	.703335	.703144		.703039	.703035
$^{206}Pb/^{204}Pb$ **e**	19.435	19.447	19.416	18.999		18.629	18.625
H_2O/Ce	214	228	215	254		310	

Vesicles (vol%) [f]	28	28		21	10	15	15
$X^{m}_{H_2O,mol}$ X 10^4 [g]	24	26	20	5.9	3.9	3.7	3.3
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	39.10	46.30	80.30	79.30	75.50	131.8	120.0
$X^{v}_{H_2O}$ [i]	0.611	0.567	0.243	0.074	0.052	0.028	0.027
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	0.181	0.239	0.734	0.886	0.861	1.58	1.43
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	0.463	0.550	0.968	0.956	0.908	1.63	1.47
$X^{v}_{CO_2}$ [l]	0.391	0.435	0.758	0.926	0.949	0.973	0.973
P_{equil} [m]	121	144	252	249	237	422	382
$M^{v}_{H_2O}$ (wt%) [n]	0.201	0.183		0.027	0.006	0.006	0.006
Bulk H_2O (wt%) [o]	1.083	1.105		0.482	0.380	0.370	0.349
%H_2Odegassed [p]	18.5	16.5		5.7	1.7	1.6	1.7

Table S2: FAZAR basalts (cont.).

Sample (AII127)	RC78	D25-2	D24-2
Location	KP-1	KP-0	KP-0
Latitude (°S)	40.079	40.261	40.522
Longitude (°W)	29.662	29.595	29.537
Depth (m)	2560	2442	3030
SiO_2 **a**	51.27		50.64
MgO **a**	8.45		8.40
K_2O **a**	0.42		0.26
H_2O (wt%) **b**	0.522(34)	0.205(15)	0.325(52)
CO_2 (ppm) **c**	153(5)	118(11)	107(8)
La **d**		3.57	6.97
Ce **d**		8.72	15.38
$^{87}Sr/^{86}Sr$ **e**			
$^{206}Pb/^{204}Pb$ **e**			
H_2O/Ce		235	211

Vesicles (vol%) [f]	2		
$X^{m}_{H_2O,mol}$ X 10^4 [g]	7.9		2.9
$X^{0,m}_{H_2O,mol}$ X 10^4 [h]	111.4		76.60
$X^{v}_{H_2O}$ [i]	0.071		0.038
$X^{m}_{CO_3^{2-}}$ X 10^4 [j]	1.27		0.887
$X^{0,m}_{CO_3^{2-}}$ X 10^4 [k]	1.36		0.921
$X^{v}_{CO_2}$ [l]	0.929		0.962
P_{equil} [m]	354	258	240
$M^{v}_{H_2O}$ (wt%) [n]	0.002		
Bulk H_2O (wt%) [o]	0.524		
%H_2O degassed [p]	0.4		

Table S2 caption:

a Locations, depths, and major elements from Langmuir et al.[40].

d Trace element data from Asimow et al., in preparation.

e Radiogenic isotopic compositions from Dosso et al.[43].

All other explanations are the same as in Table 1.

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