DATA REPOSITORY (WATTS ET AL., 2010; GSA item #2010147)

Figure 1 Notes:

Oxygen isotope values of crustal basement rocks that predate the SRP were compiled for Precambrian, Jurassic, Cretaceous and Tertiary intrusive granites. Magmatic values were estimated with measured zircon $\delta^{18}O$ values by adding 1.8 per mil, applicable at magmatic temperatures of ~800°C. See below for locations, ages, magmatic $\delta^{18}O$ ranges and references.

Longitude	Location	Age	$\delta^{18}O$ range	Reference
118.78	Nevada	Cretaceous	7.5–7.6	1
118.38	Nevada	Cretaceous	7.3–9.5	1
118.38	Nevada	Jurassic	7.2–8.2	1
118.33	Nevada	Tertiary	7.3–8.3	1
118.17	Nevada	Tertiary	6.7–7.6	1
117.25	Nevada	Cretaceous	9.5–9.7	1
117.22	Nevada	Cretaceous	9.2–9.3	1
117.02	Nevada	Jurassic	10.2–10.4	1
117.03	Nevada	Cretaceous	11.2–11.4	1
116.08	Idaho	Cretaceous	7.4–8.4	2
116.02	Idaho	Cretaceous	8.3–10.2	2
115.55	Nevada	Cretaceous	9.6–10.1	1
115.55	Nevada	Tertiary	7.7–9.5	1
115.50	Nevada	Tertiary	9.6–9.9	1
115.48	Nevada	Tertiary	10.3	1
115.37	Nevada	Cretaceous	11.7	1
115.10	Nevada	Tertiary	6–8	3
115.07	Nevada	Tertiary	7.1–8.1	1
114.57	Nevada	Jurassic	8.0–9.6	1
114.48	Nevada	Precambrian	6.7–7.9	1
114.38	Nevada	Tertiary	8.6	1
114.30	Nevada	Precambrian	7.8–8.8	1
114.27	Nevada	Jurassic	9.6	1
114.07	Utah	Tertiary	7.7–8.7	1
114.01	Utah	Tertiary	7.0–8.0	1
113.43	Utah	Jurassic	8.9–9.3	1
113.98	Utah	Tertiary	8.0	1
113.89	Utah	Precambrian	7.8–11.6	1
113.90	Utah	Precambrian	8.1–9.7	1
113.86	Utah	Precambrian	7.7	1
113.87	Utah	Precambrian	7.4	1
111.75	Utah	Tertiary	7.3–7.9	1
110.57	Utah	Tertiary	7.8	1
110.67	Utah	Tertiary	8.3	1
109.80	Montana	Precambrian	7.3–9.1	4

[1] King, E.M, Valley, J.W., Stockli, D.F., and Wright, J.E., 2004, Oxygen isotope trends of granitic magmatism in the Great Basin: Location of the Precambrian craton boundary as reflected in zircons: Geological Society of America Bulletin, v. 116, p. 451-462, doi: 10.1130/B25324.1

[2] King, E.M, Beard, B.L., and Valley, J.W., 2007, Strontium and oxygen isotopic evidence for strike/slip movement of accreted terranes in the Idaho Batholith: Lithos, v. 96, p. 387-401, doi:10.1016/j.lithos.2006.11.001

[3] Wickham, S.M, and Peters, M.T., 1990, An oxygen isotope discontinuity in high-grade rocks of the East Humboldt Range, Nevada: Nature, v. 345, p.150-153, doi:10.1038/345150a0.

[4] Valley, J. W., Lackey, J. S., Cavosie, A. J., Clechenko, C. C., Spicuzza, M. J, Basei, M. A. S., Bindeman, I. N., Ferreira, V. P., Sial, A.N., K ng, E. M., Peck, W. H., Sinha, A. K. and Wei, C. S., 2004, 4.4 billion years of crustal maturation: oxygen isotope ratios of magmatic zircon: Contrib Mineral and Petrol, v. 150, p. 561-580.

Figure 1 Notes (Cont.):

Eruptive volumes and references of low-$\delta^{18}O$ rhyolite units for the SRP volcanic fields in Fig. 1B are as follows:

SRP volcanic field	Low-$\delta^{18}O$ rhyolite units	Eruptive volumes (km^3)	Total eruptive volume (km^3)	Reference
Bruneau-Jarbidge and Twin Falls	Cougar Point Tuffs	5,900		
	post-Cougar Point Tuff rhyolites	1,100	7,000-10,000	1
Heise	Kilgore Tuff and post-Kilgore rhyolites	1,800	1,800	2
Yellowstone Plateau	post-Huckleberry Ridge Tuff rhyolites	>10-20		
	Mesa Falls Tuff	280		
	post-Lava Creek Tuff rhyolites	900	1,200	3

[1] Leeman et al., 2008 (full ref. in text)

[2] Morgan, L.A., and McIntosh, W.C., 2005, Timing and development of the Heise volcanic field, Snake River Plain, Idaho, western USA: Geological Society of America Bulletin, v. 117, p. 288–306, doi: 10.1130/B25519.1.

[3] Hildreth et al., 1984 (full ref. in text)

Oxygen isotope data and references for Bruneau-Jarbidge, Heise and Yellowstone Plateau rhyolites are on page 3 of the Data Repository. Oxygen isotope data for Twin Falls rhyolites ($\delta^{18}O$=2.1-3.2 per mil) are from Ellis et al., in prep.

Table 1 supplementary data: Oxygen isotope analysis by laser fluorination

		SiO_2 (wt%)	$\delta^{18}O$ (‰)	average	1 s.d.	1 s.e.
SK locality						
B1	whole rock	56.07	6.42	6.42	0.00	0.00
B1	whole rock		6.42			
B2	whole rock	63.18	7.09	7.26	0.23	0.16
B2	whole rock		7.42			
B3	whole rock	69.79	7.11	7.26	0.21	0.15
B3	whole rock		7.41			
B10	whole rock	52.23	6.84	6.77	0.09	0.07
B10	whole rock		6.70			
R4	whole rock	54.40	6.78	6.75	0.05	0.04
R4	whole rock		6.71			
73-68X	whole rock	56.77	6.79	6.95	0.22	0.15
73-68X	whole rock		7.10			
SK-3	whole rock	54.90	6.35	6.26	0.12	0.09
SK-3	whole rock		6.17			
COM locality						
CKI-1	whole rock	69.12	9.42	9.35	0.09	0.07
CKI-1	whole rock		9.28			
CKI-1	quartz		9.38	9.47	0.12	0.09
CKI-1	quartz		9.56			
70-40	whole rock	71.36	7.91	7.76	0.21	0.15
70-40	whole rock		7.61			
70-40	quartz		8.40			
70-40	pyroxene		5.97	6.15	0.25	0.18
70-40	pyroxene		6.33			
SI-1	whole rock	67.70	6.82	6.98	0.22	0.16
SI-1	whole rock		7.14			
SI-1	quartz		7.42	7.43	0.02	0.02
SI-1	quartz		7.45			
SI-1	pyroxene		4.56	4.51	0.07	0.05
SI-1	pyroxene		4.46			
COM-1	whole rock	74.56	7.49	7.43	0.08	0.06
COM-1	whole rock		7.37			
COM-1	fused whole rock		8.10	7.91	0.27	0.19
COM-1	fused whole rock		7.72			
COM-9A	whole rock	73.08	9.18	9.20	0.02	0.02
COM-9A	whole rock		9.22			
COM-9B	whole rock	54.31	8.05	7.91	0.19	0.14
COM-9B	whole rock		7.78			
COM-14	whole rock	72.07	6.55	6.43	0.17	0.12
COM-14	whole rock		6.31			
COM-22	whole rock	68.53	6.83	6.85	0.02	0.02
COM-22	whole rock		6.87			
COM-25	whole rock	72.52	6.70	6.67	0.05	0.03
COM-25	whole rock		6.63			
SM locality						
SM-2A	whole rock	65.37	7.86	7.78	0.10	0.07
SM-2A	whole rock		7.71			
SM-2F	whole rock	69.67	7.56	7.50	0.07	0.05
SM-2F	whole rock		7.45			
SM-2G	whole rock	68.95	8.27	8.09	0.25	0.18
SM-2G	whole rock		7.91			
DM-103	whole rock	73.76	7.90	7.93	0.04	0.03
DM-103	whole rock		7.96			
DM-103	fused whole rock		7.97	7.87	0.15	0.11
DM-103	fused whole rock		7.76			

Methods:

Oxygen isotope analyses were performed at the University of Oregon stable isotope lab using an integrated CO_2-laser fluorination MAT 253 mass spectrometer system. Xenolith whole rock powders were analyzed in duplicates of 1.5-2mg aliquots, and two samples were analyzed as both dry and fused whole rock powders to ensure that the results were consistent for each technique. Gore Mountain Garnet standards ($\delta^{18}O$=5.75‰) were analyzed with the unknowns during each analytical session and these were used to correct $\delta^{18}O$ results on a SMOW scale. Variability on the standards ranged from -0.03 to 0.35‰. For three of the xenolith samples analyzed, we had access to coarse whole rock fractions that enabled mineral separation of quartz, and in two cases pyroxene, which we analyzed for $\delta^{18}O$ to establish metamorphic fractionation temperatures (700-800 deg C) between whole rock powders and quartz, and pyroxene and quartz.

Figure 2 Notes:

SK, COM and SM xenolith values are shown in Table 1. Idaho Batholith values are taken from Criss and Fleck (1987). Yellowstone, Heise and Bruneau Jarbidge rhyolites and Snake River Plain and Yellowstone basalts are shown in the table below with a reference key. SRP basalts were used in Figs. 2A and 2B, Yellowstone basalts were used in the plots of Pb isotopes vs. $\delta^{18}O$ (Data Repository).

	Sample	$\delta^{18}O$ melt (‰)	$^{87}Sr/^{86}Sr_i$	$^{143}Nd/^{144}Nd$	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{208}Pb/^{204}Pb$
Yellowstone rhyolites							
HRT-A	HRT-3A	*7.3*	0.71171	0.51214	17.050	15.504	38.061
HRT-B	HRT-1B	7.0	0.70980	0.51220	16.998	15.497	38.083
HRT-C	HRT-C	7.5	0.72685	0.51169	18.051	15.751	37.941
Blue Creek Flow	BC-1	2.9	0.71719	0.51198	—	—	—
Mesa Falls Tuff	MFT-2	5.4	0.70868	0.51218	17.260	15.560	38.350
Lewis Canyon rhyolite	YL96-11	*5.9*	0.71401	0.51217	17.291	15.573	38.447
LCT-A	LCT3a	5.9	0.71093	0.51215	17.289	15.552	38.413
LCT-B	LCT-2,B	*6.3*	0.71000	0.51224	17.285	15.555	38.541
Middle Biscuit Basin flow	YL96-20	1.1	0.71930	0.51214	17.886	15.664	38.425
Canyon Flow	YL96-18	0.7	0.71607	0.51217	17.806	15.633	38.348
Scaup Lake Flow	YL96-9	4.0	0.70993	0.51224	17.593	15.590	38.278
Solfatara Plateau flow	YL96-16	3.2	0.71116	0.51225	17.356	15.546	38.106
West Yellowstone flow	YL96-1	*4.5*	0.71039	0.51227	17.548	15.579	38.261
Pitchstone Plateau flow		*4.5*	0.71101	0.51226	17.525	15.575	38.243
Refs:	4	4	6,7	6,7	8,9	8,9	8,9
Heise rhyolites							
Blacktail Creek	95-2001a	6.6	0.71238	0.51215	18.211	15.641	38.371
Walcott	06-HS-18	6.3	0.70991	0.51216	18.246	15.646	38.438
Wolverine Creek	06-HS-16	6.5	0.70947	0.51233	18.014	15.607	38.320
Lidy Hotsprings	08-HS-10	4.4	0.71138	0.51214	—	—	—
Conant Creek	06-HS-5	6.3	0.70895	0.51229	—	—	—
Kilgore	TNP 96-43	3.4	0.71029	0.51222	—	—	—
Kilgore	06-HS-14	3.5	0.71071	0.51215	—	—	—
Kilgore	95-2017b	3.3	0.71038	0.51225	—	—	—
Kilgore	06-HS-11	3.6	0.71066	0.51223	—	—	—
Kilgore	06-HS-10	3.2	0.71048	0.51222	18.345	15.690	38.632
Juniper Buttes	06-HS-4A	4.6	0.70986	0.51220	17.203	15.497	38.242
Long Hollow	626-1	3.7	0.70917	0.51219	—	—	—
Indian Creek	06-HS-1	3.0	0.71074	0.51224	—	—	—
Sheridan Reservoir	06-HS-19	4.0	0.71815	0.51199	—	—	—
Refs:	1,2	1,2	2	2	3	3	3
Bruneau-Jarbidge rhyolites							
CP III	I-569	3.8	0.70865	0.51219	—	—	—
CP VII	I-841	0.2	0.71031	0.51219	—	—	—
CP XIII	X-37	3.2	0.70935	0.51225	18.113	15.632	38.497
CP XV	I-459	1.1	0.70938	0.51222	18.843	15.727	39.744
Ind. Batt	I-445	2.1	0.71044	0.51224	18.716	15.712	39.734
Brun. Jasp.	I-411	3.4	0.71062	0.51229	—	—	—
Sheep Ck	I-1208	2.2	0.71150	0.51226	—	—	—
Dorsey Ck	I-529	1.5	0.71220	0.51230	—	—	—
Dorsey Ck	I-1001	1.5	0.71194	0.51230	—	—	—
Ticr	L80-78	3.8	0.71215	0.51227	—	—	—
Refs:	10	10,11	10	10	3	3	3
Snake River Plain basalts							
Spencer-Kilgore	SRP-02	5.6	0.70617	0.51238	—	—	—
Gem Valley	SRP-07	5.6	0.70650	0.51238	—	—	—
near Idaho Falls	SRP-10	5.4	0.70560	0.51246	—	—	—
Quaking Aspen Butte	SRP-13	5.4	0.70630	0.51239	—	—	—
N Robbers Lava Field	SRP-16	5.6	0.70555	0.51252	—	—	—
Antelope Butte	SRP-17	5.6	0.70803	0.51234	—	—	—
Spencer-Kilgore	SRP-19	5.8	0.70570	0.51244	—	—	—
Refs:	12	1	12	12			
Yellowstone basalts							
Osprey basalt	P-104WR	—	0.70657	0.51241	16.772	15.424	37.185
younger basalt of Gerrit	6YC-140B-WR	—	—	—	17.240	15.490	38.230

older basalt of Gerrit	6YC-142WR	5.2	0.70601	0.51246	17.310	15.520	38.240
Madison River basalt	6YC-139WR	5.7	0.70659	0.51234	16.840	15.470	38.280
Madison River basalt	6YC-139WR	5.7	0.70659	0.51234	16.789	15.400	38.115
Falls River basalt	6YC-145WR	—	—	—	16.990	15.560	38.140
Falls River basalt	6YC-145WR	—	—	—	16.963	15.497	37.924
Swan Lake Flat basalt	6YC-133WR	5.9			16.680	15.390	37.480
Swan Lake Flat basalt	6YC-133WR	5.9			16.696	15.386	37.502
Swan Lake Flat basalt	6YC-136WR	—	0.70578	0.512483	16.790	15.390	37.590
basalt of Warm River	6YC-144WR	5.4	0.70565	0.512461	17.200	15.460	38.060
basalt of Warm River	6YC-144WR	5.4	0.70565	0.512461	17.232	15.505	38.132
Junction Butte Basalt	70-0-59WR	—	—	—	16.098	15.300	36.921
Junction Butte Basalt	70-0-65WR	—	—	—	16.595	15.401	37.108
basalt of the Narrows	70-0-64WR	—	—	—	16.662	15.294	36.461
Refs:	9	13	6	6	9	9	9

PB ISOTOPES VS. δ^{18}O

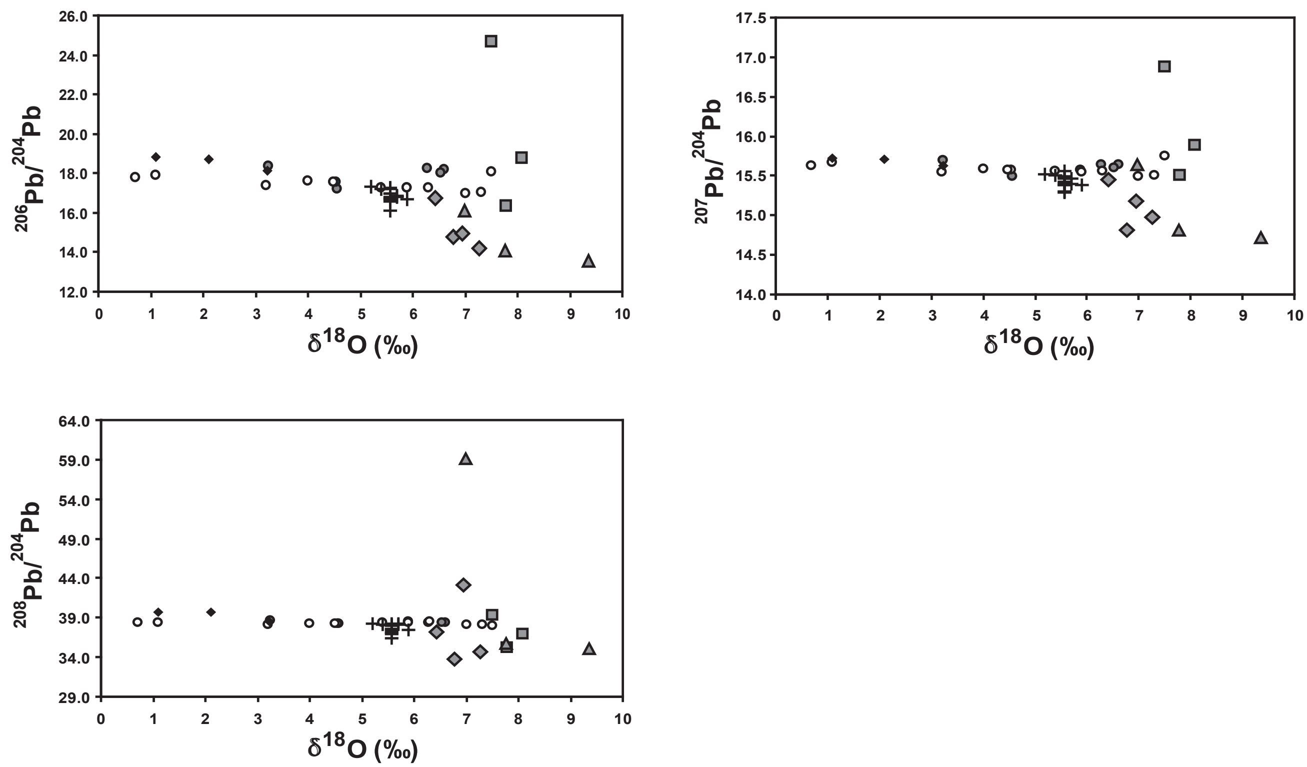


Figure 3 Notes:

Binary mixing models were constructed with the mixing equation and data shown below. Crust and mantle mixing hyperbolas were calculated with R_{crust}/R_{mantle} concentration ratios of 0.1, 1 and 10, where R=C_O/C_{Sr} (Fig. 3A) and R=C_O/C_{Nd} (Fig. 3B). All normal-δ^{18}O Heise and Yellowstone magmas plot within the crust-mantle mixing field. Mixing lines from normal to low-δ^{18}O endmembers were constructed for HRT-A-Canyon Flow, HRT-C-Middle Biscuit Basin Flow, and HRT-B-Solfatara Plateau Flow. Canyon Flow and Middle Biscuit Basin Flow contain HRT aged zircons, and thus are genetically related to HRT (Bindeman et al., 2008). Trace element and isotope data for phenocrysts and groundmass glasses suggest an HRT lineage for Solfatara Plateau (Vazquez et al., 2009). We selected HRT endmembers with the most similar Sr isotope ratios to the low-δ^{18}O endmembers to construct the mixing curves. Second order polynomials were fit to the hyperbolic mixing curves (R^2≥0.96) and projected along the Sr-O and Nd-O axes, where they converged at δ^{18}O =-1.5 to -0.4‰ (Sr-O) and δ^{18}O =-1.0 to 0.7‰ (Nd-O) (Figs. 3A and 3B). Mixing lines were constructed between normal-δ^{18}O HRT endmembers (A,B, and C) and a hypothetical low-δ^{18}O source of -1.5‰ (Sr-O) and -1.0‰ (Nd-O), with a range of concentrations of Sr (0-100ppm) and Nd (40-100pm) to illustrate the variance in curvature of the mixing lines (Data Repository). In addition to the three normal-δ^{18}O HRT endmembers, a "model HRT melt" composition (average of HRT-A and HRT-C isotope ratios and concentrations) was also used as a normal-δ^{18}O mixing endmember in the Sr-O Data Repository plots.

Mixing equation:

$$R_{mix}=[R_AC_AF_A+R_BC_B(1-F_A)]/[C_AF_A+C_B(1-F_A)]$$

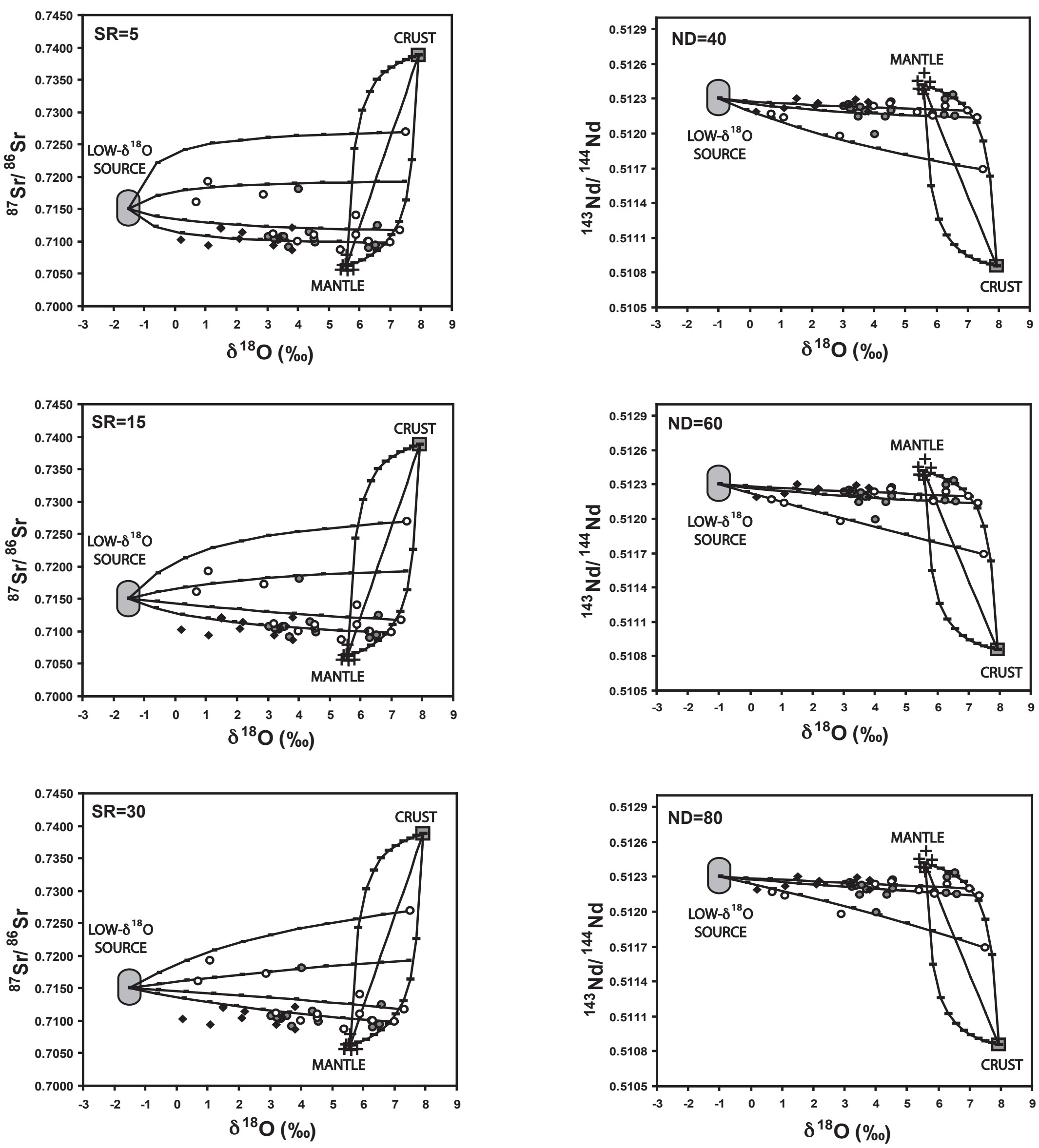
R= isotope ratio of element

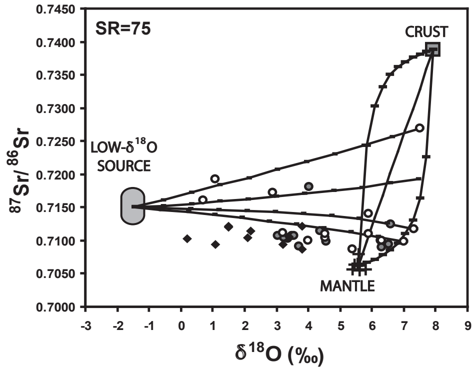
F= mass fraction

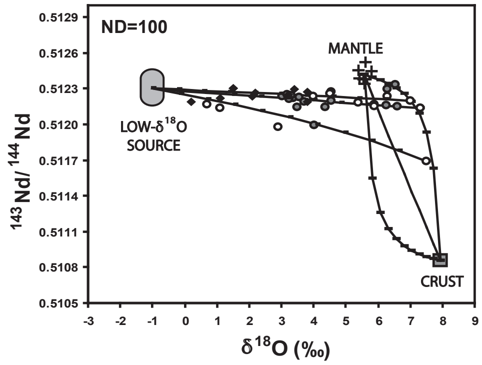
C= concentration of element

	Sample	$\delta^{18}O$ melt (‰)	$^{87}Sr/^{86}Sr_i$	$^{143}Nd/^{144}Nd$	O (wt%)	Sr (ppm)	Nd (ppm)
Crust							
crustal xenolith	DM-103	7.9	0.73878	0.510853	48.83	360	25.7
Refs:	14	this study	14	14	3	3	3
Mantle (SRP basalt average)							
R=0.1	SRP basalts	5.6	0.70626	0.51242	43.53	32	2
R=1	SRP basalts	5.6	0.70626	0.51242	43.53	321	23
R=10	SRP basalts	5.6	0.70626	0.51242	43.53	3209	229
Refs:	12	1	12	12	12	calculated	calculated
Normal-$\delta^{18}O$ rhyolite endmembers							
HRT-A	HRT-3A	*7.3*	0.71171	0.51214	49.35	21.42	97
HRT-B	HRT-1B	7.0	0.70980	0.51220	48.38	49.2	77
HRT-C	HRT-C	7.5	0.72685	0.51169	48.84	67.74	64
Model HRT melt	—	7.4	0.71928	0.51191	49.10	44.58	80.5
Refs:	4	4	6	6	5	6	3
Low-$\delta^{18}O$ rhyolite endmembers							
Middle Biscuit Basin flow	YL96-20	1.1	0.71930	0.51214	49.37	49.2	56.6
Canyon Flow	YL96-18	0.7	0.71607	0.51217	49.22	82.5	60.7
Solfatara Plateau flow	YL96-16	3.2	0.71116	0.51225	48.78	9.0	80.23
Refs:	4	4	6,7	6,7	5	8,15	8,15
Low-$\delta^{18}O$ source	—	-1.5	0.7150	0.5122	48.99	15	60
	—	-1.0	0.7160	0.5123	48.99	15	60
Refs:		estimated	estimated	estimated	estimated	estimated	estimated

VARYING CONCENTRATIONS (PPM) OF SR AND ND FOR HYPOTHETICAL LOW-$\delta^{18}O$ SOURCE







Reference Key:

[1] Bindeman et al., 2007 (full ref. in text)

[2] Watts et al. (in prep.)

[3] Leeman (unpublished)

[4] Bindeman et al., 2008; values in italics were calculated from data in Bindeman and Valley, 2001

[5] Bindeman and Valley, 2001, Low-δ^{18}O rhyolites from Yellowstone: Magmatic evolution based on analyses of zircons and individual phenocrysts: Journal of Petrology, v. 42, p. 1491-1517.

[6] Hildreth, W., Halliday, A.N., and Christiansen, R.L., 1991, Isotopic and chemical evidence concerning the genesis and contamination of basaltic and rhyollitic magma beneath the Yellowstone Plateua volcanic field: Journal of Petrology, v. 32, p. 63-138.

[7] Vazquez, J.A., Reid, M.R., 2002. Time scales of magma storage and differentiation of voluminous high-silica rhyolites and Yellowstone caldera, Wyoming. Contributions to Mineralogy and Petrology, v. 144, p. 274–285.

[8] Vazquez, J.A., Kyriazis, S.F., Reid, M.R., Sehler, R.C., and Ramos, F.C., 2009, Thermochemical evolution of young rhyolites at Yellowstone: Evidence for a cooling but periodically replenished postcaldera magma reservoir: Journal of Volcanology and Geothermal Research, v. 188, p. 186-196.

[9] Doe, B.R., Leeman, W.P, Christansen, R.L., and Hedge, C.E., 1982, Lead and strontium isotopes and related trace elements as genetic tracers in the upper Cenozoic rhyolite-basalt association of the Yellowstone Plateau volcanic field: Journal of Geophysical Research, v. 87, p. 4785-4806.

[10] Bonnichsen et al., 2008 (full ref. in text); δ^{18}O values are for feldpsar

[11] Ellis et al. (in prep.)

[12] Graham et al., 2009 (full ref. in text)

[13] Hildreth et al., 1984 (full ref. in text)

[14] Leeman et al., 1985 (full ref. in text)

[15] Guillaume, G., 2009, The dynamics of post-collapse magmatism at rhyolitic calderas: analogue experiments and geochemistry of Yellowstone lavas [Ph.D. thesis]: Montreal, McGill University, 237 p.