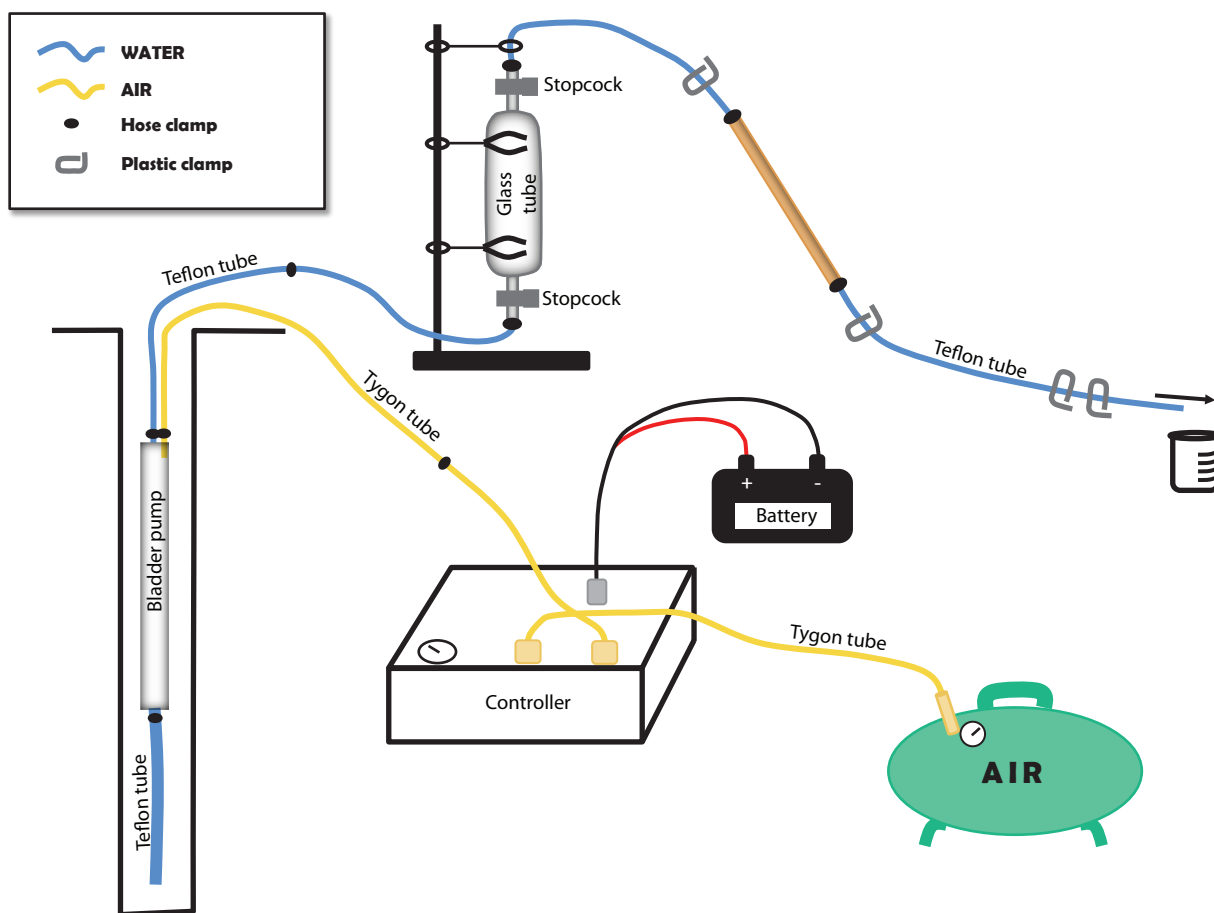


Dissolved gases in hydrothermal (phreatic) and geyser eruptions at Yellowstone National Park, USA

Shaul Hurwitz et al.

Figure DR1: water and dissolved gas sampling setup



Thermal water and dissolved gases were sampled with a Geotech portable bladder pump© that has pre-determined controlled timed cycles of compressed air alternately squeezing a flexible Teflon bladder to displace water out of the pump to the surface and then an exhaust period allowing the pump to refill. Water enters and fills the pump through an inlet check valve at the bottom of the pump housing by hydrostatic pressure. Once full, compressed air enters the space between the bladder and the pump housing, squeezes the bladder, and pushes the water to the surface. The pump was connected to the controller unit with Teflon (in the water) and Tygon® tubing at the surface. Approximately ten liters of thermal water were flushed through the tubes prior to sampling.

Figure DR2: Molar composition of thermal pools and Well Y-7 waters

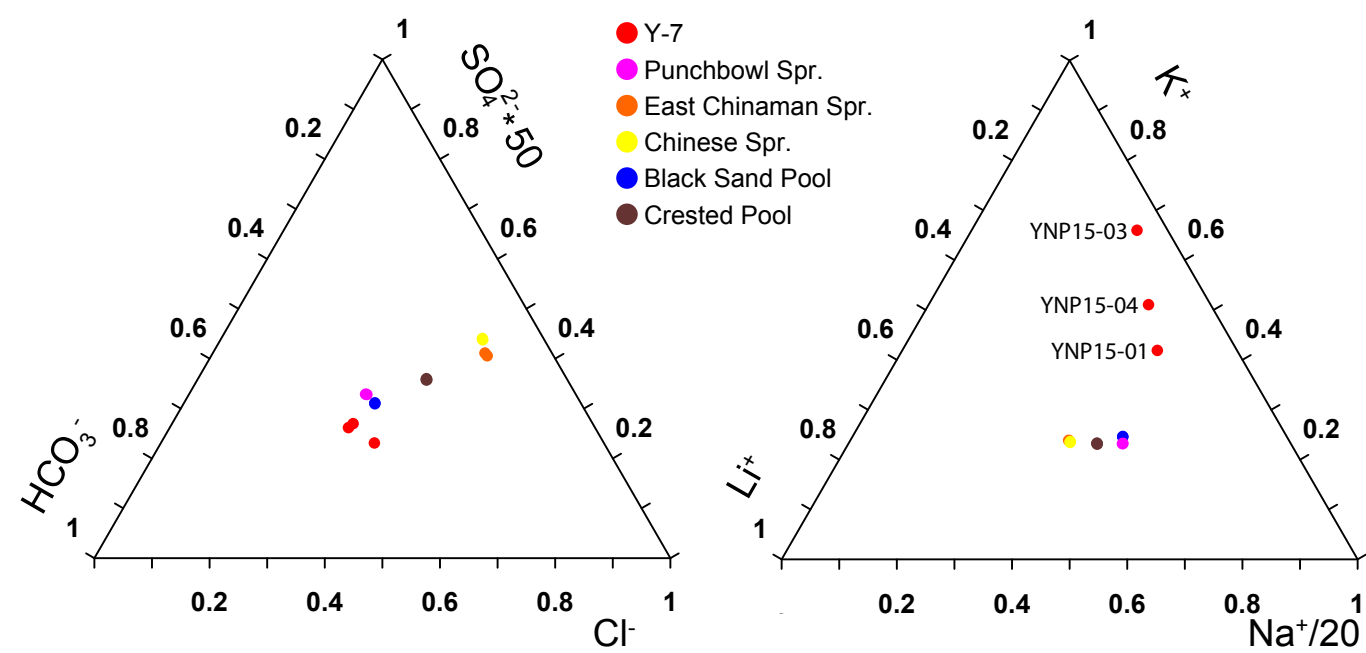


Figure DR3: temperature-dependent Henry's Law constants calculated from equation 6 and Table 1 of Harvey (1996)

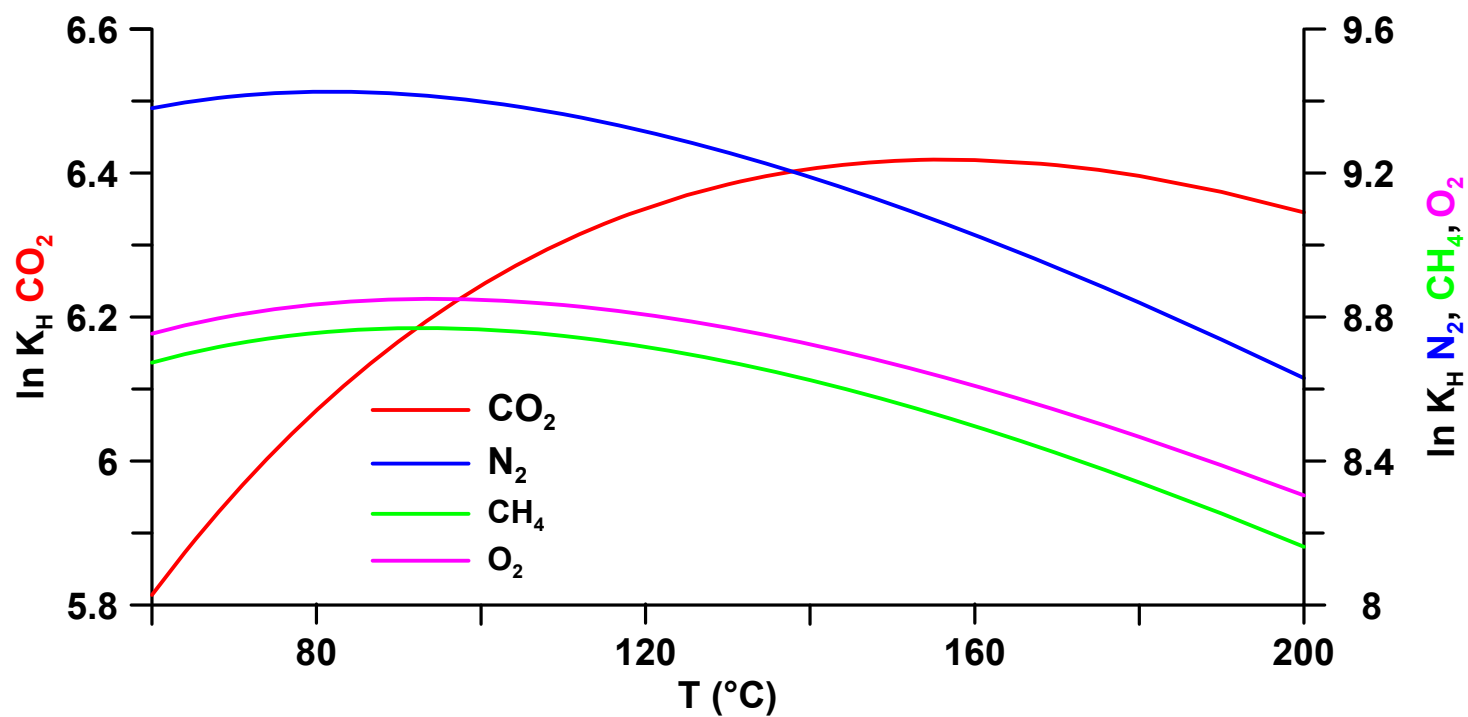


Table DR1: location of well and pools

Name	Latitude	Longitude
Well Y-7	44° 29' 8.6"	110° 51' 7.5"
Black Sand Pool	44° 28' 1.4"	110° 51' 6.6"
Punch Bowl Spring	44° 28' 10.0"	110° 50' 55.1"
Crested Pool	44° 25' 50.6"	110° 50' 11.1"
East Chinamen Pool	44° 27' 43.6"	110° 49' 44.2"
Chinese Spring	44° 27' 43.1"	110° 49' 44.6"

Table DR2: depth, temperature and chemistry of water samples*

		Depth	T	pH	pH	Ca	Mg	Na	K	Li	Al	As	Cl	SO ₄	H ₂ S	Alk.	F	Br	NO ₃	SiO ₂	B	HCO ₃ /Cl	RE
		m	(°C)	field	(lab)	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
YNP15-01	Y-7	13.7	85	6.77	8.07	0.28	0.031	280	23	1.32	0.03	0.81	177	8.1	0.28	420	19.1	0.37	<0.02	217	1.89	2.4	-1%
YNP15-03	Y-7	70.1	136	6.88	7.88	0.52	0.004	394	77	1.10	0.36	1.09	308	10.4	0.00	570	30.9	0.94	<0.02	320	3.35	1.9	-3%
YNP15-04	Y-7	50.9	124	6.74	7.88	0.26	0.013	294	33	1.25	0.08	0.93	195	9.1	0.03	444	21.8	0.57	<0.02	253	2.16	2.3	-2%
YNP15-05	Black Sand Pool	6.1	94	8.66	9.04	0.32	0.001	427	19	3.91	0.39	1.35	314	16.0	0.70	583	27.7	0.9	0.06	313	3.21	1.9	-3%
YNP15-06	Black Sand Pool	1.5	93	8.67	9.05	0.34	0.002	428	19	3.92	0.41	1.39	315	15.9	1.02	585	28.2	0.9	0.06	314	3.18	1.9	-4%
YNP15-07	Punchbowl Spr.	4.4	93	7.57	8.07	0.35	<0.001	413	17	3.83	0.20	1.26	289	16.8	0.05	592	27.7	0.85	<0.02	325	2.89	2.0	-4%
YNP15-08	Punchbowl Spr.	1.4	93	7.63	8.17	0.34	<0.001	414	17	3.82	0.20	1.25	292	16.8	0.07	590	27.7	0.85	<0.02	327	2.91	2.0	-4%
YNP15-09	Crested Pool	11.3	111	9.17	9.63	0.41	0.002	383	17	4.50	0.40	1.48	364	17.7	2.66	384	27.6	1.06	0.12	323	3.73	1.1	-5%
YNP15-10	Crested Pool	6.7	95	8.95	9.49	0.41	<0.001	393	18	4.62	0.42	1.52	372	18.3	2.33	393	28.7	1.08	0.11	329	3.87	1.1	-4%
YNP15-11	Crested Pool	3.0	91	9.09	9.54	0.42	<0.001	394	18	4.64	0.43	1.50	374	18.2	2.09	397	29.0	1.09	0.06	334	3.91	1.1	-5%
YNP15-12	East Chinaman	5.0	95	7.59	8.22	0.69	<0.001	312	17	4.75	0.18	1.27	384	18.1	3.02	162	24.4	1.14	0.04	328	4.15	0.4	-4%
YNP15-13	East Chinaman	1.5	94	7.65	8.34	0.69	<0.001	313	17	4.74	0.18	1.30	390	17.9	3.09	161	24.0	1.14	0.04	330	4.13	0.4	-4%
15WA113	Chinese Spr.	1.5	95	7.59	8.17	0.62	0.001	307	16	4.61	0.17	1.28	382	19.9	4.77	155	23.4	1.12	0.05	322	4.02	0.4	-4%
YNP15-14	Chinese Spr.	4.6	97	7.78	8.19	0.61	<0.001	306	16	4.60	0.17	1.28	378	19.9	4.36	153	22.7	1.11	0.04	319	3.95	0.4	-4%

* Water chemistry was analyzed at the U.S. Geological Survey Laboratory in Boulder, Colorado using methods described in McCleskey et al. (2010).

** Alkalinity as HCO₃

*** Charge balance

Table DR3: Concentrations of dissolved noble gases (in $\mu\text{m/kg}$) and isotope ratios*

	^4He	Ne	Ar	Kr	Xe	R/Ra	$^{20}\text{Ne}/^{22}\text{Ne}$	$^{40}\text{Ar}/^{36}\text{Ar}$	$^{86}\text{Kr}/^{84}\text{Kr}$	$^{130}\text{Xe}/^{132}\text{Xe}$
YNP-15-01	0.050	0.006	7.034	1.56E-03	2.20E-04	7.07	9.90	296.29	0.30	0.15
YNP-15-03	0.034	0.003	4.362	1.13E-03	1.82E-04	7.20	9.84	304.35	0.30	0.15
YNP-15-04	0.027	0.002	3.625	9.66E-04	1.59E-04	7.12	9.84	297.58	0.30	0.15
YNP-15-07	0.002	0.002	0.270	6.69E-05	1.29E-05	6.00	10.00	291.09	0.31	0.16
YNP-15-09	0.001	0.001	0.157	4.90E-05	9.16E-06	1.76	***	***	0.30	0.15
YNP-15-12	0.002	0.002	0.605	1.23E-04	1.97E-05	4.36	9.97	283.25	0.31	0.16

* Noble-gas concentrations and isotopic ratios were measured at the USGS Noble Gas Laboratory in Denver, Colorado using methods described in Hunt (2015),

** The ratio of $^3\text{He}/^4\text{He}$ in the sample to the ratio in the atmosphere

*** concentration too low for determining a ratio

Hunt, A.G., 2015, U.S. Geological Survey Noble Gas Laboratory's standard operating procedures for the measurement of dissolved gas in water samples. U.S. Geological Survey Techniques and Methods, book 5, chap. A-11, 22 p., <http://dx.doi.org/10.3133/tm5A11>