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Noble Gas Isotopes in Mineral Springs within the Cascadia Forearc, Washington and Oregon

By Patricia A. McCrory, James E. Constantz, and Andrew G. Hunt

Open-File Report 2014–1064

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2014

Suggested citation:
McCrory, P.A., Constantz, J.E., and Hunt, A.G., 2014, Noble gas isotopes in mineral springs within the Cascadia Forearc, Wasihington and Oregon: U.S. Geological Survey Open-File Report 2014-1064, 20 p., *http://dx.doi.org/10.3133/ofr20141064.*

ISSN 2331-1258 (online)

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
	Mass	
pound, avoirdupois (lb)	0.4536	kilogram (kg)

SI to Inch/Pound

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Volume	
liter (L)	0.2642	gallon (gal)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
°F=(1.8×°C)+32.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Datums

Horizontal coordinate information is referenced to the World Geodetic System of 1984 (WGS84).

Vertical coordinate information is referenced to the World Geodetic System Earth Gravitational Model Geoid of 1996 (WGS84 EGM96 Geoid).

Elevation, as used in this report, refers to distance above mean sea level.

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Introduction

This U.S. Geological Survey report presents laboratory analyses along with field notes for a pilot study to document the relative abundance of noble gases in mineral springs within the Cascadia forearc of Washington and Oregon (fig. 1). Estimates of the depth to the underlying Juan de Fuca oceanic plate beneath the sample sites are derived from the McCrory and others (2012) slab model. Some of these springs have been previously sampled for chemical analyses (Mariner and others, 2006), but none currently have publicly available noble gas data. Helium isotope values as well as the noble gas values and ratios presented below will be used to determine the sources and mixing history of these mineral waters.

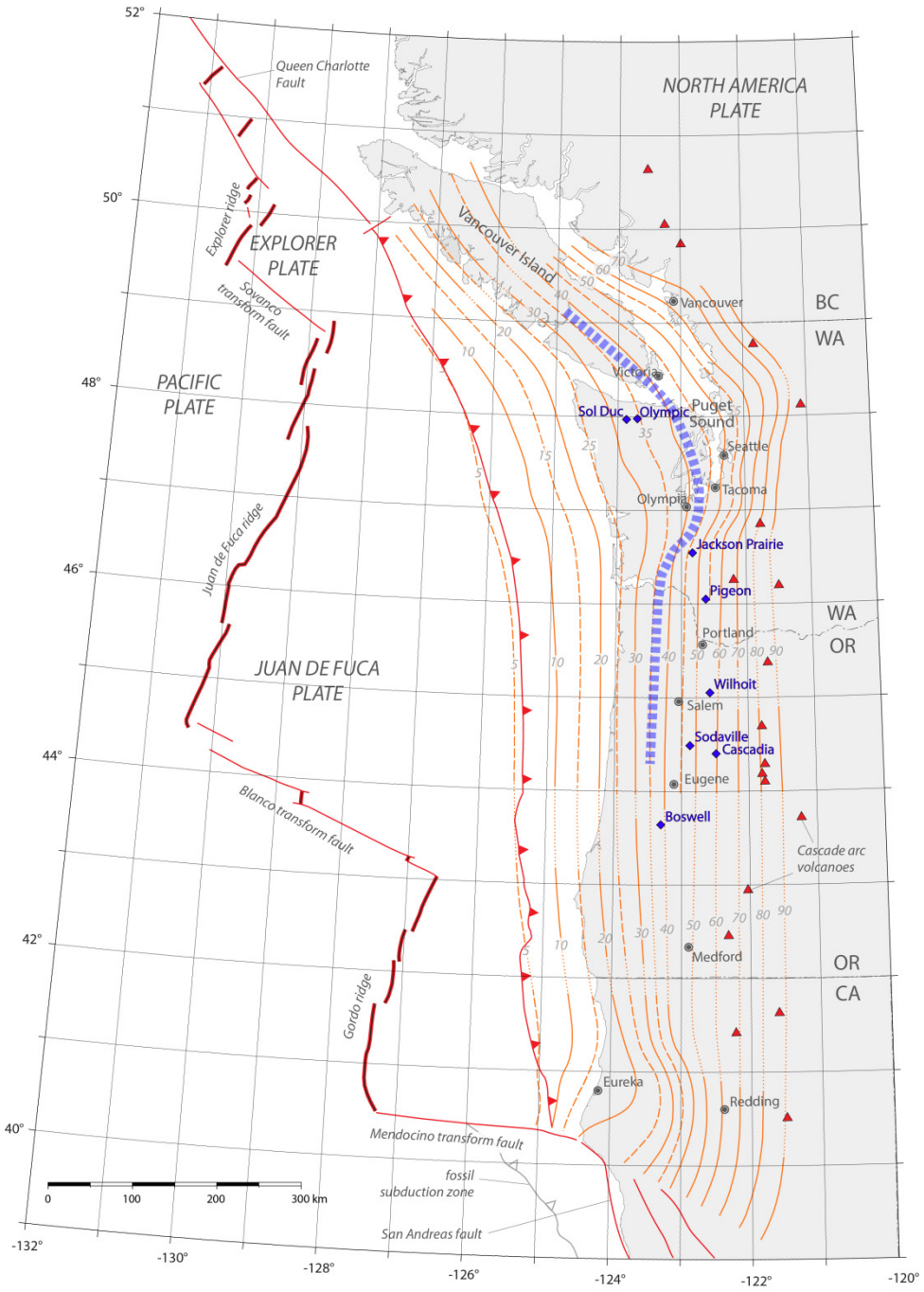

Figure 1. Map showing location of mineral spring sites with respect to Juan de Fuca plate model of McCrory and others (2012) and the location of the forearc mantle corner (McCrory and others, 2014). Iso-depth contours of the Juan de Fuca slab are in kilometers below surface. Thick dashed line denotes forearc mantle corner; labeled blue diamonds denote mineral spring sites; red triangles denote Cascade arc volcanoes. Transverse Mercator projection, WGS84 datum, standard parallel -128°, centered at 46.8°N, -128°W, with standard parallel rotated 3° clockwise of vertical (plate boundaries modified from Wilson, 2002).

Methods

Field

Water samples were collected from the mineral and soda springs in copper tubes that are pinched shut at each end with metal clamps. We first established siphon flow through Tygon® tubing attached to both ends of an 18-in. length of copper tubing. The copper tube was tilted so that water flowed vertically upward during collection. We then gently tapped the outside of the copper tube just before tightening the downstream clamp to release any bubbles that might be stuck to the inside wall of the tube. The nuts on the downstream clamp were slowly tightened using a torque wrench set to 10 ft-lbs. After the downstream clamp was closed, we closed the upstream clamp. Finally, we removed the Tygon® tubes, filled both ends of the copper tube with spring water, and sealed the ends with rubber caps.

Sample site locations and elevations were determined with a handheld GPS device that utilizes horizontal and vertical WGS84 datums.

Analytical

Gas analyses were performed in the U.S Geological Survey Noble Gas Laboratory in Denver, Colorado. Gas samples were released into an ultra-low vacuum extraction line ($<5\times10^{-9}$ torr) and passed through a set of ethanol/dry ice slush (approximately -72 ^{o}C) traps to remove water vapor. The volume of dry gas was measured with a calibrated capacitance manometer and an aliquot was introduced to a quadrupole mass spectrometer for analysis of bulk gas (hydrogen, methane, nitrogen, and carbon dioxide). The remaining gas was exposed to a STS-101 getter heated to 350 ^{o}C to remove reactive-gas components, leaving a mixed sample of the noble gases. An aliquot of the purified gas was admitted to a MAP-215-50 magnetic-sector mass spectrometer for analysis of argon, krypton, and xenon (^{36}Ar, ^{38}Ar, ^{40}Ar, ^{84}Kr, ^{86}Kr, ^{130}Xe, and ^{132}Xe), while the remaining gas was cryogenically separated and analyzed for both helium (^{3}He and ^{4}He) and neon isotopes (^{20}Ne, ^{21}Ne, and ^{22}Ne). Gas from dissolved gas samples was separated using a gas extraction bulb connected to the ultra-low vacuum line. Each sample was introduced to the extraction bulb under vacuum and exposed to 15 minutes of agitation in an ultrasonic bath at 30 ^{o}C to promote complete extraction of dissolved gas. The extracted gas was then analyzed using the same method described above and presented as total elemental composition rather than isotopic composition. The resulting gas concentrations are based on the calibrated responses of the mass spectrometers and total volume of extracted gas. Noble gas solubilities were derived from Weiss (1970, 1971), Weiss and Kyser (1970), and Benson and Krause (1976).

Mineral Spring Sites Sampled for Noble Gas Isotopes

Sol Duc Mineral Springs, Olympic National Park, Washington

Bogachiel Peak 7.5-minute topographic quadrangle map. Sampled August 2012. Juan de Fuca slab depth approximately 33 km.

[Microsoft® Excel file of this table is available for download at http://pubs.usgs.gov/of/2014/1064/]

Water sample	CH_4 (ccSTP/g × 10^{-2})	1σ err	N_2 (ccSTP/g × 10^{-2})	1σ err	Ne (ccSTP/g × 10^{-7})	1σ err	Ar (ccSTP/g × 10^{-4})	1σ err	Kr ccSTP/g × 10^{-8})	1σ err
Sol Duc	1.295	0.06	0.55	0.02	0.88	0.01	1.51	0.02	3.58	0.07
ASW at 5°C			1.53		2.00		4.11		9.96	
ASW at 46°C			0.76		1.46		1.90		3.78	
ASW at 80°C			0.50		1.11		1.16		2.18	
ASW										

Water sample	Xe (ccSTP/g × 10^{-8})	1σ err	$^{20}Ne/^{22}Ne$	1σ err	$^{40}Ar/^{36}Ar$	1σ err	$^{86}Kr/^{84}Kr$	1σ err	$^{130}Xe/^{132}Xe$	1σ err
Sol Duc	0.32	0.01	9.83	0.023	294.4	1.4	0.306	0.002	0.147	0.003
ASW at 5°C	1.49									
ASW at 46°C	0.46									
ASW at 80°C	0.17									
ASW			9.8		295.5		0.300		0.150	

Run notes:

1. ASW (Air Saturated Water) computed for listed temperatures at an elevation of 1,600 ft; no salinity correction was applied to the gas solubility data.

2. Samples do not calculate back to a single solubility temperature, represent a mix of colder and warmer water that has been heated, and is degassing at the pool interface.

20120823-01 PMc (water)
N 47° 58.125' W 123° 51.793'
Elevation: 1,629 ft
Water temperature: approximately 49.8 °C
Specific conductance: **334 µS/cm**

The main mineral spring at this site feeds commercially run soaking pools within the Olympic National Park.

The operations manager of Sol Duc Hot Springs Resort opened the wooden cover to the mineral spring source. The water level was about 10 ft below deck level, however, too deep for siphon sampling. Instead, the water sample was drawn from a hose connected to the spring (after letting water run from hose for about 5 minutes). Sample collected using siphon feed.

This mineral spring has been previously sampled for chemical analyses by Roland Tabor (June 1970), and by Robert Mariner and William Evans (July 1977) as reported in Mariner and others (2006).

Olympic Mineral Springs, Olympic National Park, Washington

Mount Carrie 7.5-minute topographic quadrangle map. Sampled August 2012. Juan de Fuca slab depth approximately 35 km.

[Microsoft® Excel file of this table is available for download at http://pubs.usgs.gov/of/2014/1064]

Water sample	CH_4 (ccSTP/g × 10^{-2})	1σ err	N_2 (ccSTP/g × 10^{-2})	1σ err	Ne (ccSTP/g × 10^{-7})	1σ err	Ar (ccSTP/g × 10^{-4})	1σ err	Kr (ccSTP/g × 10^{-8})	1σ err
Olympic #4	0.860	0.04	0.66	0.02	0.91	0.01	2.16	0.03	5.17	0.1
ASW at 5°C			1.53		2.00		4.11		9.96	
ASW at 46°C			0.76		1.46		1.90		3.78	
ASW at 80°C			0.50		1.11		1.16		2.18	
ASW										

Water sample	Xe (ccSTP/g × 10^{-8})	1σ err	$^{20}Ne/^{22}Ne$	1σ err	$^{40}Ar/^{36}Ar$	1σ err	$^{86}Kr/^{84}Kr$	1σ err	$^{130}Xe/^{132}Xe$	1σ err
Olympic #4	0.33	0.01	9.86	0.023	295.9	1.4	0.306	0.002	0.154	0.003
ASW at 5°C	1.49									
ASW at 46°C	0.46									
ASW at 80°C	0.17									
ASW			9.8		295.5		0.300		0.150	

Run notes:

1. ASW (Air Saturated Water) computed for listed temperatures at an elevation of 1,600 ft; no salinity correction was applied to the gas solubility data.
2. Samples do not calculate back to a single solubility temperature, represent a mix of colder and warmer water that has been heated, and is degassing at the pool interface.

20120824-01 PMc (water)
N 47° 58.582’ W 123° 41.3039’ ±19 ft
Elevation: 2,177±4 ft
Water temperature: approximately 45.8 °C
Specific conductance: **290 µS/cm**

A series of at least six mineral springs seep from the hillside along a trail within Olympic National Park. Public road access to the trailhead was closed in 2012 because of ongoing dam removal on the upper Elwah River (otherwise hikers would likely have been soaking in the hot springs). A park ranger unlocked the gate above the ranger station and arranged for road access past the dam removal site to the trailhead. The springs are located about a 45-minute hike from the trailhead.

Water temperature and specific conductance were measured for each of six springs, and the hottest spring was sampled. This spring also had the most gas bubbles venting from bottom of its pool. Our initial attempt to sample gas bubbles proved to be unsuccessful as too few bubbles discharged from the bottom of the pool, and from variable spots at irregular intervals. Sample collected using siphon feed.

This mineral spring has been previously sampled for chemical analyses by Roland Tabor (June 1969), and by Robert Mariner and William Evans (July 1977) as reported in Mariner and others (2006).

Well #67, Jackson Prairie Natural Gas Storage Facility, Washington

Jackson Prairie 7.5-minute topographic quadrangle map. Sampled August 2012. Juan de Fuca slab depth approximately 47 km.

[Microsoft® Excel file of this table is available for download at http://pubs.usgs.gov/of/2014/1064/]

Water sample	CH_4 1σ err (ccSTP/g × 10^{-2})	N_2 1σ err (ccSTP/g × 10^{-2})	Ne 1σ err (ccSTP/g × 10^{-7})	Ar 1σ err (ccSTP/g × 10^{-4})
Mary's Corner	1.917	0.6	0.518	0.89
ASW at 20°C		1.17	18.17	3.06

Water sample	Kr 1σ err ccSTP/g × 10^{-8})	Xe 1σ err ccSTP/g × 10^{-8})	$^{20}Ne/^{22}Ne$ 1σ err	$^{21}Ne/^{22}Ne$ 1σ err
Mary's Corner	2.0	0.28	9.841	0.028
ASW at 20°C	6.84	0.93		

Water sample	$^{38}Ar/^{36}Ar$ 1σ err	$^{40}Ar/^{36}Ar$ 1σ err	$^{86}Kr/^{84}Kr$ 1σ err	$^{130}Xe/^{132}Xe$ 1σ err
Mary's Corner	0.216	299.4	0.304	0.154
ASW at 20°C				

Gas sample	H_2 1σ err (ccSTP/cc)	CH_4 1σ err (ccSTP/cc)	N_2 1σ err (ccSTP/cc)	C_2H_6 1σ err (ccSTP/c)
Mary's Corner	<0.002	0.583	0.414	<0.002

Gas sample	O_2 1σ err (ccSTP/cc)	CO_2 1σ err ccSTP/cc)	^{20}Ne 1σ err	^{40}Ar 1σ err
Mary's Corner	<0.003	<0.002	28	227

Gas sample	^{84}Kr 1σ err	^{132}Xe 1σ err	$^{20}Ne/^{22}Ne$ 1σ err	$^{21}Ne/^{22}Ne$ 1σ err
Mary's Corner	19.98	1.22	9.698	0.0304

Gas sample	$^{38}Ar/^{36}Ar$ 1σ err	$^{40}Ar/^{36}Ar$ 1σ err	$^{86}Kr/^{84}Kr$ 1σ err	$^{130}Xe/^{132}Xe$ 1σ err
Mary's Corner	0.182	463.2	0.299	0.154

Run notes:

1. ASW (Air Saturated Water) computed for listed temperature at an elevation of 500 ft.

2. Gas sample 50 percent methane. Gas sample contains excess ^{40}Ar; excess ^{40}Ar masked in water sample by the water. Gas sample contains a little excess ^{20}Ne; excess Neon not seen in the water sample. Almost no CO_2. N/Ar value not the best.

3. 1σ error for noble gases is approximately 1–2 percent.

20120826-01 PMc (water)
N 46° 32.711' W 122° 49.474'
Elevation: 527 ft
Water temperature: approximately 32.2 °C
Specific conductance: **40.3 µS/cm**

We initially met with the Jackson Prairie Natural Gas Storage Facility manager, then followed one of the reservoir operators to Well #67. This well has a small storage tank on top. The reservoir operator opened the lower valve on the tank to release groundwater. He let the water flow for a few minutes to bleed pressure in the tank. Even so, the water sample contained a fair amount of gas bubbles. We then measured water temperature and specific conductance. The water and gas samples come from marine sandstone layers at a depth of approximately 600 m in the Chehalis sedimentary basin. Note, noble gas abundances reflect a mixture of local and distant sources as methane is piped from western Canada and Rocky Mountain sources, and injected into the Chehalis Basin for seasonal storage.

20120826-02 PMc (gas)
After collecting the water sample, the reservoir operator opened the upper nozzle on the storage tank to collect a gas sample. This required two attempts as the gas was under about 60 lbs of pressure and blew the hose off the sampling device on the first attempt to tighten the downstream clamp.

This well has been previously sampled for chemical analyses by Ivan Barnes (September 1983), and by Rodney Caldwell and Steve Hinkle (1993) as reported in Mariner and others (2006).

Pigeon Mineral Spring, Washington

Georges Peak 7.5-minute topographic quadrangle map. Sampled August 2013. Juan de Fuca slab depth approximately 53 km.

[Microsoft® Excel file of this table is available for download at http://pubs.usgs.gov/of/2014/1064/]

Water sample	CH_4 1σ err (ccSTP/g × 10^{-3})	N_2 1σ err (ccSTP/g × 10^{-2})	O_2 1σ err (ccSTP/g × 10^{-3})	Ne 1σ err (ccSTP/g × 10^{-8})
Pigeon	<0.02	1.75	<0.02	0.45
ASW at 20°C		1.17		18.17

Water sample	Ar 1σ err (ccSTP/g × 10^{-4})	Kr 1σ err (ccSTP/g × 10^{-8})	Xe 1σ err (ccSTP/g × 10^{-8})	$^{20}Ne/^{22}Ne$ 1σ err
Pigeon	0.55	2.29	0.57	10.62
ASW at 20°C	0.306	6.84	0.93	

Water sample	$^{40}Ar/^{36}Ar$ 1σ err	$^{86}Kr/^{84}Kr$ 1σ err	$^{130}Xe/^{132}Xe$ 1σ err
Pigeon	378.6	0.306	0.150
ASW at 20°C			

Run notes:

1. ASW (Air Saturated Water) computed for listed temperature at an elevation of 500 ft.
2. Only minor CO_2 noted.
3. 1σ error for noble gases is approximately 1–2 percent.

20130819-01 PMc (water)
N 46° 03.098' W 122° 37.369' ±19 ft
Elevation: 518 ft
Water temperature: approximately 14 °C
Specific conductance: **334 µS/cm**

This mineral spring is situated at the site of a former hotel built in 1906 for supposed healing properties of water. The mineral water was also bottled and sold for medicinal purposes. In late summer the spring has a slow seep rate. Spring water collects behind low concrete wall, which overflows and drains to the Kalama River, Washington. Water sample collected using siphon feed.

This mineral spring has been previously sampled for chemical analyses by Ivan Barnes and William Evans (April 1980), by Robert Mariner and William Evans (July 1980), by Ivan Barnes (November 1980), by Robert Mariner (July 1986), and by Rodney Caldwell (1993) as reported in Mariner and others (2006).

Boswell Mineral Springs, Oregon

Drain 7.5-minute topographic quadrangle map. Sampled August 2013. Juan de Fuca slab depth approximately 39 km.

[Microsoft® Excel file of this table is available for download at http://pubs.usgs.gov/of/2014/1064/]

Water sample	CH_4 1σ err (ccSTP/g × 10^{-3})	N_2 1σ err (ccSTP/g × 10^{-2})	O_2 1σ err (ccSTP/g × 10^{-3})	Ne 1σ err (ccSTP/g × 10^{-8})
Boswell	3.69	2.401	<0.02	4.32
ASW at 20°C		1.17		18.17

Water sample	Ar 1σ err (ccSTP/g × 10^{-3})	Kr 1σ err ccSTP/g × 10^{-8})	Xe 1σ err (ccSTP/g × 10^{-8})	$^{20}Ne/^{22}Ne$ 1σ err
Boswell	0.138	3.94	0.67	9.91
ASW at 20°C	0.306	6.84	0.93	

Water sample	$^{40}Ar/^{36}Ar$ 1σ err	$^{86}Kr/^{84}Kr$ 1σ err	$^{130}Xe/^{132}Xe$ 1σ err
Boswell	302.3	0.305	0.153
ASW at 20°C			

Run notes:

1. ASW (Air Saturated Water) computed for listed temperature at an elevation of 500 ft.
2. Light noble gases stripped; CH_4 noted; nitrogen rich sample.
3. 1σ error for noble gases is approximately 1–2 percent.

20130821-01 PMc (water)
N 43° 38.424’ W 123° 18.0669’
Elevation: 340 ft
Water temperature: approximately 10 °C

This mineral spring is situated at the site of a former hunting lodge built in early 1900s (with train access only) for supposed healing properties of water. The mineral water was also bottled and sold for medicinal purposes. The spring water collects in a concrete cistern, which overflows into a field that drains to Elk Creek, Oregon. Water sample collected using siphon feed. [Note, another spring collects in a man-made pond at a higher elevation. Water from the pond is filtered by double osmosis for drinking purposes.]

No known water samples previously collected from this mineral spring.

Cascadia Soda Spring, Cascadia State Park, Oregon

Cascadia 7.5-minute topographic quadrangle map. Sampled August 2013. Juan de Fuca slab depth approximately 59 km.

[Microsoft® Excel file of this table is available for download at http://pubs.usgs.gov/of/2014/1064/]

Water sample	CH_4 1σ err (ccSTP/g × 10^{-3})	N_2 1σ err (ccSTP/g× 10^{-3})	O_2 1σ err (ccSTP/g× 10^{-3})	Ne 1σ err (ccSTP/g × 10^{-8})
Cascadia	<0.02	<0.02	<0.02	1.94
ASW at 20°C		1.17		18.17

Water sample	Ar 1σ err (ccSTP/g × 10^{-3})	Kr 1σ err (ccSTP/g × 10^{-8})	Xe 1σ err (ccSTP/g × 10^{-8})	$^{20}Ne/^{22}Ne$ 1σ err
Cascadia	0.041	1.11	0.2	9.99
ASW at 20°C	0.306	6.84	0.93	

Water sample	$^{40}Ar/^{36}Ar$ 1σ err	$^{86}Kr/^{84}Kr$ 1σ err	$^{130}Xe/^{132}Xe$ 1σ err
Cascadia	293.8	0.306	0.153
ASW at 20°C			

Run notes:

1. ASW (Air Saturated Water) computed for listed temperature at an elevation of 500 ft.

2. Noble gases stripped by CO_2; very large bubble of CO_2 noted in bulk gas analysis. Note, we measured CO_2 but do not report its value here because it represents a combination of dissolved CO_2 and total inorganic carbon (DIC) that back reacts during sample extraction.

3. 1σ error for noble gases is approximately 1–2 percent.

20130823-01 PMc (water)
N 44° 23.957’ W 122° 28.816’
Elevation: 921 ft
Water temperature: approximately 18°C

This soda spring is situated at the site of a former hotel built in early 1900s for supposed healing properties of water. The spring is now contained within a state park. A park ranger opened the spring for access. The spring water collects in a metal cylinder, which seeps into Soda Creek, Oregon. We first attempted to collect a water sample using siphon feed, but the flow rate is extremely slow. Sample collected using syringe with a cloth to filter out fine red precipitate.

This soda spring has been previously sampled for chemical analyses by Robert Mariner (September 1985) as reported in Mariner and others (2006).

Sodaville Mineral Spring, Sodaville Park, Oregon

Waterloo 7.5-minute topographic quadrangle map. Sampled August 2013. Juan de Fuca slab depth approximately 48 km.

[Microsoft® Excel file of this table is available for download at http://pubs.usgs.gov/of/2014/1064/]

Water sample	CH_4 1σ err (ccSTP/g × 10^{-3})	N_2 1σ err (ccSTP/g × 10^{-3})	O_2 1σ err (ccSTP/g × 10^{-3})	Ne 1σ err (ccSTP/g × 10^{-8})
Sodaville	<0.02	<0.02	<0.02	16.91
ASW at 20°C		1.17		18.17

Water sample	Ar 1σ err (ccSTP/g × 10^{-3})	Kr 1σ err (ccSTP/g × 10^{-8})	Xe 1σ err (ccSTP/g × 10^{-8})	$^{20}Ne/^{22}Ne$ 1σ err
Sodaville	0.287	6.64	0.93	9.82
ASW at 20°C	0.306	6.84	0.93	

Water sample	$^{40}Ar/^{36}Ar$ 1σ err	$^{86}Kr/^{84}Kr$ 1σ err	$^{130}Xe/^{132}Xe$ 1σ err
Sodaville	296.2	0.304	0.15
ASW at 20°C			

Run notes:

1. ASW (Air Saturated Water) computed for listed temperature at an elevation of 500 ft.

2. Noble gases stripped by CO_2; very large bubble of CO_2 noted in bulk gas analysis. Note, we measured CO_2 but do not report its value here because it represents a combination of dissolved CO_2 and total inorganic Carbon (DIC) that back reacts during sample extraction.

3. 1σ error for noble gases is approximately 1–2 percent.

0130823-02 PMc (water)
N 44° 29.057’ W 122° 52.126’
Elevation: 478 ft
Water temperature: approximately 16°C

This mineral spring is situated at the site of a former hotel built in early 1900s for supposed healing properties of water. The spring is now contained within a town park. Spring water collects in a cistern, which overflows through metal pipe. Flow rate is about 1 L/min. Sample collected using siphon feed. Note, Sodaville water manager offered to open the cistern (within the adjacent shed), but the overflow pipe seemed adequate for sample collection.

This mineral spring has been previously sampled for chemical analyses by Robert Mariner and William Evans (September 1977) as reported in Mariner and others (2006).

Wilhoit Soda Spring, Wilhoit County Park, Oregon

Wilhoit 7.5-minute topographic quadrangle map. Sampled August 2013. Juan de Fuca slab depth approximately 56 km.

[Microsoft® Excel file of this table is available for download at http://pubs.usgs.gov/of/2014/1064/]

Water sample	CH_4 1σ err (ccSTP/g × 10^{-3})	N_2 1σ err (ccSTP/g × 10^{-3})	O_2 1σ err (ccSTP/g × 10^{-3})	Ne 1σ err (ccSTP/g × 10^{-8})
Sodaville	<0.02	<0.02	<0.02	0.87
ASW at 20°C		1.17		18.17

Water sample	Ar 1σ err (ccSTP/g × 10^{-3})	Kr 1σ err (ccSTP/g × 10^{-8})	Xe 1σ err (ccSTP/g × 10^{-8})	$^{20}Ne/^{22}Ne$ 1σ err
Sodaville	0.016	1.19	0.27	10.14
ASW at 20°C	0.306	6.84	0.93	

Water sample	$^{40}Ar/^{36}Ar$ 1σ err	$^{86}Kr/^{84}Kr$ 1σ err	$^{130}Xe/^{132}Xe$ 1σ err
Sodaville	301.8	0.308	0.145
ASW at 20°C			

Run notes:

1. ASW (Air Saturated Water) computed for listed temperature at an elevation of 500 ft.

2. Noble gases stripped by CO_2; very large bubble of CO_2 noted in bulk gas analysis. Note, we measured CO_2 but do not report its value here because it represents a combination of dissolved CO_2 and total inorganic carbon (DIC) that back reacts during sample extraction.

3. 1σ error for noble gases is approximately 1–2 percent.

20130823-03 PMc (water)
N 45° 03.141’ W 122° 34.094’
Elevation: 728 ft
Water temperature: approximately 18 °C

This soda spring is situated at the site of a former hotel built in early 1900s for supposed healing properties of water. People still collect spring water to drink as it is now contained within a county park. Soda water collects in a metal cylinder, which overflows into Rock Creek, Oregon. Moderate flow rate. This spring releases large gas bubbles every few minutes. Collected using siphon feed. Some gas in water sample.

Note, this park also contains a ‘sulphur’ spring, with water obtained using an old-fashioned hand pump. The pump, however, was broken in 2013. No seepage observed between pump and stream.

This mineral spring has been previously sampled for chemical analyses by Robert Mariner and William Evans (September 1977) as reported in Mariner and others (2006).

Acknowledgments

We would like to thank the Olympic National Park in Washington and the Cascadia, Sodaville, and Wilhoit Parks in Oregon for providing access to mineral and soda springs within their parks. We would also like to thank those private landowners who permitted access to mineral springs on their land in Washington and Oregon, namely, William Rountree and his neighbors, John and Martha Oyala, and Johna Cook, as well as the Jackson Prairie Natural Gas Storage Facility, Washington. We also would like to thank Robert Mariner and William Evans for assistance in locating remote mineral springs. Review comments by William Evans and Patrick Dobson improved this contribution.

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