Electronic Supplementary Material - Hydrogeology Journal

Understanding long-term groundwater flow at Pahute Mesa and vicinity, Nevada National Security Site, USA, from naturally occurring geochemical and isotopic tracers

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The Supplementary Material presented herein includes the following: (1) the geochemical and isotopic dataset used for the investigation; (2) an evaluation of major-ion variability with depth; (3) a multivariate statistical evaluation; and (4) references.

S1. Geochemical and Isotopic Dataset

The data used for the evaluation are presented in Tables S-1 to S-6. Well-completion information including location, land-surface elevation (Jackson and Fenelon, 2018), well depth (Navarro, 2019a), effective open interval [EOI], and hydrostratigraphy (i.e., primary and secondary HSUs) are presented in Table S-1. The EOI top is defined as the steady-state water-level elevation if the water level is below the EOI top, and as the top of the screen or sand/gravel pack otherwise. The EOI bottom is defined as the elevation of the screen or sand/gravel pack bottom. The primary and secondary HSUs are defined as the thickest and second-thickest HSU within the EOI, respectively. Primary water-producing units for each well are also identified by bold (Garcia et al., 2017). Table S-2 presents sampling information and results of field and other water-quality measurements. Tables S-3 through S-6 present geochemical and isotopic data (Navarro, 2019b). Tables S-2 through S-5 present average values when results for multiple samples exist for a given location. Table S-6 presents radionuclide activities for the most recent sample (DOE/EMNV, 2019; Navarro, 2019b).

Table S-1. Site Information for Selected Wells and Boreholes Located in the Pahute Mesa Area and Vicinity (Page 1 of 3)

Well Name	Well Interval Identifier	Easting (m) [a]	Northing (m) [a]	Land Surface Elevation (m amsl) [b]	Total Depth (m bgs) [c]	EOI		Primary HSU [f]	Secondary HSU [g]
						Top Elevation (m amsl) [d]	Bottom Elevation (m amsl) [e]		
ER-20-1	ER-20-1_p1	545113.2	4119467.9	1,883.9	629.4	1,277.7 [i]	1,254.5	**TCA**	None
ER-20-2-1	ER-20-2-1_p1	553210.7	4118447.2	2,043.7	769.3	1,348.1	1,275.6	**CHZCM**	None
ER-20-4	ER-20-4_m1	549676.1	4116492.4	1,748.4	1,066.5	1,283.8	681.9	CFCU	CHLFA1/**CHLFA4**
ER-20-5-1	ER-20-5-1_m1	546385.8	4119208.3	1,902.5	860.5	1,217.0	1,093.3	**TSA**	CHZCM
ER-20-5-3	ER-20-5-3_m1	546384.8	4119176.8	1,902.5	1,308.8	882.1	709.6	**CHLFA5**	None
ER-20-6-1	ER-20-6-1_p1	551363.0	4123691.8	1,973.5	975.4	1,230.7	1,075.3	CHLFA3	None
ER-20-6-2	ER-20-6-2_p1	551328.0	4123661.7	1,973.6	975.4	1,237.8	1,076.0	CHLFA3	None
ER-20-6-3	ER-20-6-3_p1	551295.7	4123578.9	1,970.8	975.4	1,228.3	1,115.3	**CHLFA3**	None
ER-20-7	ER-20-7_m1	546218.3	4118429.8	1,892.5	894.9	1,193.9	997.5	**TSA**	CHZCM/LPCU
ER-20-8	ER-20-8_m1 (p1)	546686.3	4116218.3	1,782.6	1,049.1	846.8	733.3	CHZCM	LPCU/**TSA**
	ER-20-8_m2 (p2)	546686.3	4116218.3	1,782.6	1,049.1	1,038.8	886.4	**TCA**	LPCU/MPCU
ER-20-8-2	ER-20-8-2_m1	546672.8	4116211.4	1,782.7	712.6	1,270.5	1,069.9	**SPA**	UPCU/MPCU
ER-20-11	ER-20-11_m1	545778.7	4116550.4	1,778.2	915.6	997.3	862.6	**BA**	UPCU/FCCU
ER-20-12	ER-20-12_m1	540925.1	4125952.8	1,907.6	1,384.8	714.0	522.9	PBRCM	None
	ER-20-12_p1	540925.1	4125952.8	1,907.6	1,384.8	888.6	772.2	BRA	CHZCM
	ER-20-12_p3	540925.1	4125952.8	1,907.6	1,384.8	1,142.5	1,009.3	CHLFA5	CHZCM
	ER-20-12_p4	540925.1	4125952.8	1,907.6	1,384.8	1,415.8	1,210.5	TMLVTA	TMWTA
ER-EC-1	ER-EC-1_m1-3	541729.8	4117659.7	1,836.6	1,524.0	1,148.4	361.4	**CHZCM** [j]	**CFCM**/LPCU
ER-EC-2A	ER-EC-2A_m3	538420.8	4110841.3	1,494.1	1,516.1	995.8	812.6	FCCM	None
	ER-EC-2A_m1-3	538420.8	4110841.3	1,494.1	1,516.1	995.8	-22.1	FCWTA1 [j]	**FCCM**/BWCU
ER-EC-4	ER-EC-4_m2-3	532759.4	4112356.0	1,450.7	1,062.8	1,160.6	751.2	**TCVA**	**TMUWTA**/FCCM
ER-EC-5	ER-EC-5_m1-3	538701.7	4104137.1	1,547.5	762.0	1,191.2	785.5	**ATWTA**	None
ER-EC-6	ER-EC-6_m2-4	544673.4	4115728.8	1,708.2	1,524.0	1,218.7	543.9	BA	TSA/LPCU
	ER-EC-6_m1-4	544673.4	4115728.8	1,708.2	1,524.0	1,218.7	213.2	CFCM	BA/CHZCM
	ER-EC-6_m2_a1	544673.4	4115728.8	1,708.2	1,524.0	674.3	543.9	**CHZCM**	**TSA**
	ER-EC-6_m4_a3	544673.4	4115728.8	1,708.2	1,524.0	1,218.7	1,114.5	**BA**	FCCU

Table S-1. Site Information for Selected Wells and Boreholes Located in the Pahute Mesa Area and Vicinity (Page 2 of 3)

Well Name	Well Interval Identifier	Easting (m) [a]	Northing (m) [a]	Land Surface Elevation (m amsl) [b]	Total Depth (m bgs) [c]	EOI		Primary HSU [f]	Secondary HSU [g]
						Top Elevation (m amsl) [d]	Bottom Elevation (m amsl) [e]		
ER-EC-8	ER-EC-8_m1-3	532763.8	4106141.8	1,320.9	609.6	1,128.2	711.3	**FCCM** [J]	**ATWTA**/BWCU
ER-EC-11	ER-EC-11_m1-2	544839.1	4116703.1	1,724.0	1,264.3	779.2	459.5	TSA	TCA/LPCU
	ER-EC-11_m1 (p1)	544839.1	4116703.1	1,724.0	1,264.3	629.8	459.5	**TSA**	CHZCM
	ER-EC-11_m2 (p2)	544839.1	4116703.1	1,724.0	1,264.3	749.9	692.3	**TCA**	None
	ER-EC-11_p3	544839.1	4116703.1	1,724.0	1,264.3	907.9	800.5	**BA**	FCCU
ER-EC-12	ER-EC-12_m1 (p2)	545099.1	4114013.6	1,686.2	1,240.2	714.5	537.1	**TSA**	CHZCM
	ER-EC-12_m2 (p3)	545099.1	4114013.6	1,686.2	1,240.2	1,121.1	849.8	**TCA**	LPCU/TMWTA
ER-EC-13	ER-EC-13_m1 (p1)	540102.3	4113553.2	1,577.4	914.4	894.6	760.5	**FCULFA4**	None
	ER-EC-13_m2 (p2)	540102.3	4113553.2	1,577.4	914.4	1,018.1	926.3	**FCULFA4**	None
ER-EC-14	ER-EC-14_m1 (p1)	543466.5	4110337.9	1,580.7	724.8	1,004.9	855.8	**RMWTA**	None
	ER-EC-14_m2 (p2)	543466.5	4110337.9	1,580.7	724.8	1,185.9	1,061.3	**RMWTA**	None
ER-EC-15	ER-EC-15_m1 (p1)	542769.3	4115426.7	1,635.3	991.8	796.4	643.3	**TSA**	CHZCM/CFCU
	ER-EC-15_m2 (p2)	542769.3	4115426.7	1,635.3	991.8	992.7	895.5	**TCA**	LPCU/UPCU
	ER-EC-15_m3 (p3)	542769.3	4115426.7	1,635.3	991.8	1,214.4	1,096.1	**CPA**	PBPCU
PM-2	PM-2_m1-o7	538256.7	4133028.2	1,704.4	2,678.6	940.6	-974.2	PBRCM	None
PM-3	PM-3_p1	539011.8	4121281.4	1,774.8	920.2	1,204.2	1,106.7	**TCA**	LPCU/UPCU
	PM-3_p2	539011.8	4121281.4	1,774.8	920.2	1,325.8	1,260.6	UPCU	None
U-20 WW	U-20 WW_m1	550614.2	4122711.6	1,971.3	996.1	1,279.1	975.2	**CHLFA4** [j]	**CHZCM**
UE-18r	UE-18r_o1	549321.8	4109762.2	1,688.0	1,525.2	1,191.5	162.8	**ATWTA** [j]	ATCCU/THCU
UE-19c WW	UE-19c WW_m1	560338.8	4124701.6	2,143.7	2,587.4	1,405.8	-443.8	BRA	PBRCM
UE-19h	UE-19h_m1	555488.5	4132881.6	2,066.6	1,129.3	1,423.1 [i]	1,369.5	BRA	None
UE-20bh 1	UE-20bh 1_o1	552402.2	4122007.3	2,022.8	856.5	1,349.0 [i]	1,166.3	**CHLFA5** [j]	**CHZCM**
UE-20d	UE-20d_o1Z	546102.8	4122275.1	1,905.9	1,369.2	1,273.8 [h,i]	536.8 [h]	**CHZCM** [j]	**CHLFA5**/UPCU
UE-20e 1	UE-20e 1_o1Z	548110.3	4129980.8	1,919.4	1,949.2	1,365.5 [i]	-29.8	CHLFA3	BRA/CFCM
UE-20f	UE-20f_o1Z	545400.8	4124900.3	1,864.2	4,171.5	506.1	-2,307.2	PBRCM [j]	BFCU/BRA

Table S-1. Site Information for Selected Wells and Boreholes Located in the Pahute Mesa Area and Vicinity (Page 3 of 3)

Well Name	Well Interval Identifier	Easting (m) [a]	Northing (m) [a]	Land Surface Elevation (m amsl) [b]	Total Depth (m bgs) [c]	EOI		Primary HSU [f]	Secondary HSU [g]
						Top Elevation (m amsl) [d]	Bottom Elevation (m amsl) [e]		
UE-20j WW	UE-20j Instrument Hole_o1Z	541284.9	4128082.4	1,799.2	1,734.3	1,411.8 [h, i]	64.9 [h]	PBRCM	BRA/TMLVTA

[a] Universal Transverse Mercator Zone 11, North American Datum 1927 in meters.
[b] Land-surface elevation in meters above mean sea level; source is Jackson and Fenelon (2018).
[c] Total drilled depth in meters below ground surface; source is the UGTA Borehole Index Database (Navarro, 2019a).
[d] EOI top elevation in meters above mean sea level; calculated as land-surface elevation minus depth to top of EOI.
[e] EOI bottom in meters above mean sea level; calculated as land-surface elevation minus depth to bottom of EOI.
[f] Primary HSU is defined as the thickest HSU within the well screen.
[g] Secondary HSU is defined as the second-thickest HSU within the well screen.
[h] Well is an open borehole, or the well screen interval is unknown, and the well is assumed to have an open borehole.
[i] Water table occurs the top of the open interval, and the depth to water defines the top of the EOI.
[j] Primary water-producing units for ER-EC-1 also include CPA, TCA, and TSA; ER-EC-2a_m1-3 also includes ATWTA; ER-EC-8_m1-3 also includes BWWTA; UE-20WW_m1 also includes CHLFA1; UE-18r_o1 also includes THLFA1 and RMWTA; UE-20d_o1Z includes TCA and TSA; UE-20F_o1z includes IA and CFCM (Garcia et al., 2017).

ATCCU = Ammonia Tanks caldera confining unit
ATWTA = Ammonia Tanks welded-tuff aquifer
BA = Benham aquifer
BFCU = Bullfrog confining unit
BRA= Belted Range aquifer
BWCU = Buttonhook Wash confining unit
BWWTA = Buttonhook Wash welded-tuff aquifer
CFCU = Crater Flat confining unit
CFCM = Crater Flat composite unit
CHLFA = Calico Hills lava-flow aquifer
CHZCM = Calico Hills zeolitized composite unit
CPA = Comb Peak aquifer
FCULFA = Fortymile Canyon upper lava-flow aquifer
FCCM = Fortymile Canyon composite unit
FCCU = Fluorspar Canyon confining unit
FCWTA = Fortymile Canyon welded-tuff aquifer
IA = Inlet aquifer
LPCU = Lower Paintbrush confining unit
MPCU = Middle Paintbrush confining unit
PBRCM = Pre-Belted Range composite unit
PBPCU = Post-Benham Paintbrush confining unit
RMWTA = Rainier Mesa welded-tuff aquifer
SPA = Scrugham Peak aquifer
TCA = Tiva Canyon aquifer
TCVA = Thirsty Canyon volcanic aquifer
THCU = Tannenbaum Hill confining unit
THLFA = Tannenbaum Hill lava-flow aquifer
TMLVTA = Timber Mountain lower vitric-tuff aquifer
TMUWTA = Timber Mountain upper welded-tuff aquifer
TMWTA = Timber Mountain welded-tuff aquifer
TSA = Topopah Spring aquifer
UPCU = Upper Paintbrush confining unit

Table S-2. Sampling Information, Field Measurements, and Miscellaneous Water-Quality Measurements (Page 1 of 3)

Location	Well Interval Identifier	Method [a]	Temp (°C)	pH (Field)	SC (Field) (µS/cm)	HCO_3 (Field) (mg/L)	DO (Field) (mg/L)	CO_3 (Field) (mg/L)	pH	SC (µS/cm)	TDS (mg/L)
ER-20-1	ER-20-1_p1	WH	32.4	8.24	614	--	3.0	--	8.38	693	--
ER-20-2-1	ER-20-2-1_m1	DIS BAIL[b]	29.0	8.51	--	--	--	--	8.55	662	559
ER-20-4	ER-20-4_m1	WH	41.1	7.56	--	93.1	6.0	--	8.35	250	200
ER-20-5-1	ER-20-5-1_m1	WH	34.3	8.30	--	--	3.5	--	8.35	515	469
ER-20-5-3	ER-20-5-3_m1	WH	35.4	8.62	386	--	4.2	--	8.51	365	480
ER-20-6-1	ER-20-6-1_m1	WH	27.9	8.16	--	--	--	--	8.20	298	227
	ER-20-6-1_p1	WH	20.9	8.12	--	--	--	--	8.20	288	229
ER-20-6-2	ER-20-6-2_m1	WH	24.4	7.83	--	--	--	--	5.93	310	--
	ER-20-6-2_p1	WH	26.0	8.16	--	--	--	--	8.42	287	291
ER-20-6-3	ER-20-6-3_m1	WH	28.5	8.44	--	--	--	--	8.44	304	227
	ER-20-6-3_p1	WH	25.9	8.42	--	102	--	--	8.65	281	205
ER-20-7	ER-20-7_m1	WH	33.6	8.20	540	--	5.5	--	8.50	506	370
ER-20-8	ER-20-8_m1	WH	45.1	8.36	--	87.8	4.9	9.6	8.55	410	275
	ER-20-8_m2	WH	36.1	8.32	379	104	4.9	4.8	8.55	433	285
ER-20-8-2	ER-20-8-2_m1	WH	42.6	8.22	383	--	3.1	--	8.49	444	--
	ER-20-8-2_p1	WH	33.2	8.56	472	113	2.5	5.8	8.65	440	290
ER-20-11	ER-20-11_m1	WH	38.9	8.33	429	131	4.4	3.8	8.55	530	375
ER-20-12	ER-20-12_m1	WH	39.7	7.87	784	--	2.1	--	8.17	774	498
	ER-20-12_p1	WH	26.6	7.91	689	--	3.0	--	--	--	--
	ER-20-12_p3	WH	26.4	8.48	695	128	6.6	1.9	8.30	800	525
	ER-20-12_p4	WH	27.3	6.81	979	157	6.6	--	7.80	--	--
ER-EC-1	ER-EC-1_m1-3	WH	34.4	7.78	888	102	4.4	--	8.08	785	517
ER-EC-2A	ER-EC-2A_m1-3	WH	40.4	7.80	--	--	--	--	7.80	615	420
	ER-EC-2A_m3	WH	35.9	7.90	674	148	4.0	--	8.33	664	438
ER-EC-4	ER-EC-4_m1-3	WH	38.6	7.86	792	--	3.4	--	7.75	781	500
	ER-EC-4_m2-3	WH	35.9	7.78	750	135	3.4	--	7.89	765	510
ER-EC-5	ER-EC-5_m1-3	WH	29.7	7.90	424	152	5.2	--	8.00	405	270

Table S-2. Sampling Information, Field Measurements, and Miscellaneous Water-Quality Measurements (Page 2 of 3)

Location	Well Interval Identifier	Method [a]	Temp (^{o}C)	pH (Field)	SC (Field) (μS/cm)	HCO_3 (Field) (mg/L)	DO (Field) (mg/L)	CO_3 (Field) (mg/L)	pH (Lab)	SC (μS/cm)	TDS (mg/L)
ER-EC-6	ER-EC-6_m1-4	WH	37.9	8.12	613	--	3.5	--	7.94	621	380
	ER-EC-6_m2-4	WH	34.5	8.24	--	134	3.3	--	8.32	590	383
	ER-EC-6_m2	WH	25.5	8.75	414	--	3.1	--	8.75	420	--
	ER-EC-6_m4	WH	27.1	8.33	567	--	3.0	--	8.50	600	395
ER-EC-8	ER-EC-8_m1-3	WH	36.7	7.88	696	162	4.8	--	8.07	635	413
ER-EC-11	ER-EC-11_m1-2	WH	38.7	7.46	--	--	3.2	--	8.54	542	335
	ER-EC-11_p1	WH	30.2	8.68	508	111	2.4	5.8	8.70	540	--
	ER-EC-11_p2	WH	28.0	7.57	574	126	1.8	10.6	8.70	550	--
	ER-EC-11_p3	WH	28.9	8.60	689	151	2.4	5.8	8.70	665	--
ER-EC-12	ER-EC-12_m1	WH	22.8	9.96	--	27.3	1.9	--	10.0	610	350
	ER-EC-12_m2	WH	38.8	8.33	404	94.1	2.9	--	8.53	396	250
ER-EC-13	ER-EC-13_m1	WH	38.1	7.34	605	160	5.2	--	8.20	680	430
	ER-EC-13_m2	WH	41.2	7.94	691	158	3.7	--	8.20	705	455
ER-EC-14	ER-EC-14_m1	WH	32.9	7.22	428	88.3	3.5	--	8.15	445	285
	ER-EC-14_m2	WH	33.8	7.84	453	150	3.5	--	7.90	450	305
ER-EC-15	ER-EC-15_m1	WH	50.2	7.85	754	293	1.6	--	8.20	830	530
	ER-EC-15_m2	WH	39.9	8.64	707	163	2.0	4.8	8.80	730	455
	ER-EC-15_m3	WH	46.0	7.99	777	151	3.8	--	8.05	750	485
PM-2	PM-2_m1-o7 (264 m)	DIS BAIL	--	--	--	--	--	--	--	--	--
	PM-2_m1-o7 (300 m)	DIS BAIL	--	--	--	--	--	--	--	--	--
	PM-2_m1-o7 (600 m)	DIS BAIL	--	7.9	813	--	--	--	--	--	--
	PM-2_m1-o7 (800 m)	DIS BAIL	--	--	--	--	--	--	--	--	--
PM-3	PM-3_p1	WH	32.1	7.38	767	127	2.7	--	7.80	845	550
	PM-3_p2	WH	27.5	7.82	738	130	2.3	--	8.02	802	520
U-20 WW	U-20 WW_m1	WH	31.5	7.02	--	101	4.6	--	7.51	585	1,083
UE-18r	UE-18r_o1	NA	26.3	7.77	--	--	--	--	7.88	402	299
UE-19c WW	UE-19c WW_m1	WH	36.5	8.15	--	--	--	--	8.15	222	245

Table S-2. Sampling Information, Field Measurements, and Miscellaneous Water-Quality Measurements (Page 3 of 3)

Location	Well Interval Identifier	Method [a]	Temp (^{o}C)	pH (Field)	SC (Field) (μS/cm)	HCO_3 (Field) (mg/L)	DO (Field) (mg/L)	CO_3 (Field) (mg/L)	pH	SC (μS/cm)	TDS (mg/L)
UE-19h	UE-19h_m1	NA	28.2	8.17	--	194	7.3	--	8.17	412	288
UE-20bh 1	UE-20bh 1_o1	NA	31.7	8.38	--	--	8.5	--	8.20	247	250
UE-20d	UE-20d_o1Z	NA	40.0	--	--	--	--	--	8.17	389	279
UE-20e1	UE-20e 1_o1Z	NA	47.2	--	--	--	--	--	8.10	434	289
UE-20f	UE-20f_o1Z	NA	48.4	--	--	--	--	--	7.20	519	341
UE-20j WW	UE-20j Instrument Hole_o1Z	NA	38.9	7.50	--	--	--	--	7.50	904	566

Source: Navarro, 2019b

[a] DIS BAIL = Discrete bailer; WH = Pumped sample from the wellhead.
[b] Sample was bailed at a 2,430-ft depth

-- = Data not reported or not analyzed
DO = Dissolved oxygen
NA = Not available
TDS = Total dissolved solids
μS/cm = Microsiemens per centimeter

Note: Value is an average when multiple measurements were reported.

Table S-3. Major-Ion Data (Page 1 of 3)

Location	Well Interval Identifier	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	Br (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Charge Balance [a]
ER-20-1	ER-20-1_p1	183	3.8	86.2	55.4	3.3	0.6	145	3.6	4.4	0.1	0.008
ER-20-2-1	ER-20-2-1_m1	473	18	12.0	10.7	7.0	--	187	5.2	1.6	0.7	-0.050
ER-20-4	ER-20-4_m1	110	--	16.9	4.7	8.0	0.6	52.0	1.2	4.2	0.05	-0.038
ER-20-5-1	ER-20-5-1_m1	168	6.2	40.7	24.1	10.6	0.3	110	5.3	6.8	0.3	0.023
ER-20-5-3	ER-20-5-3_m1	100	7.3	34.1	17.2	3.6	0.4	76.6	4.2	3.8	0.2	0.055
ER-20-6-1	ER-20-6-1_m1	85	3.6	34.1	13.5	3.1	0.1	58.7	2.3	5.8	0.4	0.032
	ER-20-6-1_p1	96	--	31.1	12.0	2.7	0.3	60.5	2.3	6.0	0.4	0.056
ER-20-6-2	ER-20-6-2_m1	109	--	33.0	13.2	4.0	0.1	58.1	3.8	8.2	0.7	0.006
	ER-20-6-2_p1	97	--	30.3	11.6	3.2	0.1	58.8	3.6	8.7	0.7	0.073
ER-20-6-3	ER-20-6-3_m1	87	--	32.7	13.4	2.8	0.1	52.7	3.1	9.5	0.8	0.050
	ER-20-6-3_p1	93	--	30.0	11.9	2.4	0.1	53.7	3.1	9.8	0.8	0.006
ER-20-7	ER-20-7_m1	177	--	51.0	30.3	6.7	0.4	103	4.5	5.0	0.2	-0.030
ER-20-8	ER-20-8_m1	134	<6	43.2	23.6	4.3	--	89.5	1.7	3.4	0.03	0.015
	ER-20-8_m2	131	<12	49.7	28.8	4.1	0.2	88.3	2.2	2.1	0.02	-0.026
ER-20-8-2	ER-20-8-2_m1	140	--	49.5	26.8	5.0	0.4	87.0	2.4	1.5	0.02	-0.052
	ER-20-8-2_p1	146	--	48.4	26.4	5.2	0.4	96.0	2.5	1.6	0.04	-0.011
ER-20-11	ER-20-11_m1	146	<12	64.4	40.9	3.1	0.8	111	2.6	2.8	0.02	-0.002
ER-20-12	ER-20-12_m1	135	--	113	84.2	1.9	0.4	147	4.3	17.0	0.3	0.025
	ER-20-12_p1	160	--	112	80.8	1.9	0.5	147	5.3	7.3	0.1	-0.030
	ER-20-12_p3	134	--	120	90.0	2.0	0.3	140	17	11.3	0.01	-0.017
	ER-20-12_p4	152	--	160	130	3.6	0.5	150	8.4	51	2.3	-0.011
ER-EC-1	ER-EC-1_m1-3	153	--	123	95.3	2.4	0.5	143	7.1	19.3	0.4	-0.034
ER-EC-2A	ER-EC-2A_m1-3	177	--	95.0	60.0	5.6	0.3	125	3.6	13.0	2.6	-0.036
	ER-EC-2A_m3	175	--	87.5	56.5	4.3	0.3	128	2.7	8.2	0.2	-0.038
ER-EC-4	ER-EC-4_m1-3	177	--	120	87.9	3.1	0.4	120	11.0	27.3	4.2	-0.055
	ER-EC-4_m2-3	158	--	111	80.8	3.3	0.4	128	10.3	27.4	4.3	0.011
ER-EC-5	ER-EC-5_m1-3	172	--	35.8	15.9	4.7	0.1	74.2	1.6	20.2	0.5	0.003

Table S-3. Major-Ion Data (Page 2 of 3)

Location	Well Interval Identifier	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	Br (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Charge Balance [a]
ER-EC-6	ER-EC-6_m1-4	146	--	69.7	49.3	3.1	0.3	132	2.9	4.1	0.02	0.053
	ER-EC-6_m2-4	154	--	75.4	51.6	2.6	0.2	121	2.5	4.3	0.1	-0.010
	ER-EC-6_m2	127	--	53.8	26.1	4.6	0.5	82.2	1.6	3.9	0.02	-0.046
	ER-EC-6_m4	171	--	77.5	52.0	2.9	0.4	121	2.5	4.4	0.02	-0.040
ER-EC-8	ER-EC-8_m1-3	181	6.0	81.3	48.5	5.4	0.2	118	6.1	10.1	0.4	-0.056
ER-EC-11	ER-EC-11_m1-2	140	--	70.0	43.2	3.1	0.2	100	0.7	3.9	0.01	-0.059
	ER-EC-11_p1	146	--	67.7	42.6	3.0	0.5	101	0.8	4.0	0.03	-0.056
	ER-EC-11_p2	134	--	67.6	43.1	3.1	0.5	101	1.0	3.9	0.03	-0.038
	ER-EC-11_p3	152	15.0	86.7	59.6	3.1	0.5	124	3.4	7.8	0.05	-0.063
ER-EC-12	ER-EC-12_m1	70.7	37.2	54.3	66.8	3.4	0.8	105	15.9	2.3	0.1	-0.048
	ER-EC-12_m2	155	4.8	35.8	16.0	4.7	0.3	79.3	0.5	3.3	0.02	-0.067
ER-EC-13	ER-EC-13_m1	177	--	88.9	50.7	5.0	0.5	130	2.7	12.9	--	-0.007
	ER-EC-13_m2	183	--	93.7	60.4	5.4	0.5	136	3.8	10.1	0.1	-0.030
ER-EC-14	ER-EC-14_m1	171	--	43.3	19.9	6.6	0.3	79.0	2.6	14.1	0.4	-0.041
	ER-EC-14_m2	171	--	43.5	20.0	6.4	0.3	75.4	2.1	13.0	0.4	-0.068
ER-EC-15	ER-EC-15_m1	323	--	82.0	35.2	13.5	0.3	176	4.8	7.1	0.03	-0.035
	ER-EC-15_m2	146	24.3	96.1	58.7	6.2	0.4	142	2.5	6.3	0.03	-0.047
	ER-EC-15_m3	195	--	95.9	63.5	6.2	0.5	141	3.3	7.1	0.04	-0.052
PM-2	PM-2_m1-o7 (264 m)	--	--	1.85	10.5	0.88	<0.01	120	4.3	1.9	0.46	--
	PM-2_m1-o7 (300 m)	295 [b]	--	1.65	10.6	1.0	<0.01	124	4.6	1.3	0.39	0.036
	PM-2_m1-o7 (600 m)	533 [b]	--	0.35	19.7	2.1	<0.01	264	4.8	0.6	0.20	0.106
	PM-2_m1-o7 (800 m)	2,241 [b]	--	0.37	69.9	<0.03	0.35	1,080	9.8	0.3	0.15	0.099
PM-3	PM-3_p1	146	--	126	106	2.7	0.9	134	10.5	32.7	2.6	-0.014
	PM-3_p2	145	--	117	94.2	2.8	1.0	125	13.5	25.8	2.2	-0.024
U-20 WW	U-20 WW_m1	105	3.6	30.6	11.7	2.3	0.1	58.3	1.8	6.1	0.4	-0.008
UE-18r	UE-18r_o1	231	8.6	23.0	8.3	2.7	--	76.2	4.7	18.8	0.6	-0.037
UE-19c WW	UE-19c WW_m1	67	4.4	9.7	3.8	7.4	--	49.2	0.6	1.8	0.1	0.060

Table S-3. Major-Ion Data (Page 3 of 3)

Location	Well Interval Identifier	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	Br (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Charge Balance [a]
UE-19h	UE-19h_m1	202	--	38.2	9.1	--	--	62.2	3.2	24.1	1.4	-0.031
UE-20bh 1	UE-20bh 1_o1	148	--	11.2	4.0	4.3	0.6	53.8	3.8	1.4	0.6	-0.088
UE-20d	UE-20d_o1Z	142	4.5	43.8	21.0	2.9	--	85.8	1.1	6.8	0.1	-0.004
UE-20e1	UE-20e 1_o1Z	125	1.0	42.5	38.5	4.6	--	97.5	2.9	0.3	--	0.004
UE-20f	UE-20f_o1Z	164	--	48.0	40.0	5.0	--	113	2.0	4.8	--	0.012
UE-20j WW	UE-20j Instrument Hole_o1Z	150	--	135	115	2.2	--	138	6.4	46.0	1.2	-0.005

[a] Charge balance is expressed as a fraction in milliequivalents per liter as the sum of the cations (Ca, Mg, Na, and K) minus the sum of the anions (HCO_3, CO_3, SO_4, Cl, F, and Br) divided by the sum of the cations plus the sum of the anions.

[b] Result was reported as DIC (mg/L as HCO_3)

-- = Data not reported or not analyzed.

Note: Value is an average when multiple measurements were reported.

Table S-4. Trace-Element Data (Page 1 of 3)

Location	Well Interval Identifier	SiO_2 (mg/L)	Al (mg/L)	Fe (mg/L)	Li (μg/L)	Sr (μg/L)	U (μg/L)	^{238}U (μg/L)
ER-20-1	ER-20-1_p1	55.4	0.115	0.38	--	10.8	1.1	0.9
ER-20-2-1	ER-20-2-1_m1	39.7	--	--	--	--	--	--
ER-20-4	ER-20-4_m1	49.4	0.005	--	62.5	3.1	1.7	1.7
ER-20-5-1	ER-20-5-1_m1	93.9	4.511	1.00	--	23.0	14.4	14.4
ER-20-5-3	ER-20-5-3_m1	76.9	6.476	2.81	67.4	26.3	5.9	5.5
ER-20-6-1	ER-20-6-1_m1	52.2	0.140	0.24	59.3	18.1	3.0	--
	ER-20-6-1_p1	50.7	0.319	0.13	55.3	15.1	1.0	3.0
ER-20-6-2	ER-20-6-2_m1	58.4	1.860	1.18	60.0	20.0	7.5	--
	ER-20-6-2_p1	54.1	2.004	3.26	47.3	17.7	3.0	7.7
ER-20-6-3	ER-20-6-3_m1	47.9	--	0.40	49.4	24.0	2.8	--
	ER-20-6-3_p1	42.9	0.165	0.42	48.9	24.8	3.0	2.7
ER-20-7	ER-20-7_m1	67.3	0.662	0.06	90.5	8.3	8.4	8.1
ER-20-8	ER-20-8_m1	52.1	0.033	0.01	102	4.4	2.7	2.5
	ER-20-8_m2	53.3	0.049	0.06	93.3	1.3	2.6	2.6
ER-20-8-2	ER-20-8-2_m1	48.7	0.049	0.02	106	2.1	2.5	2.4
	ER-20-8-2_p1	44.4	0.030	3.65	110	3.1	0.2	0.3
ER-20-11	ER-20-11_m1	52.1	0.039	0.02	101	4.2	3.9	3.5
ER-20-12	ER-20-12_m1	41.8	1.105	4.85	101	38.6	--	3.2
	ER-20-12_p1	59.7	--	5.01	84.4	14.0	--	--
	ER-20-12_p3	70.1	<0.015	--	110	4.9	--	0.3
	ER-20-12_p4	77.0	0.110	45.0	200	300	--	10.9
ER-EC-1	ER-EC-1_m1-3	51.6	0.377	0.45	136	18.1	8.8	9.3
ER-EC-2A	ER-EC-2A_m1-3	38.5	0.021	--	164	50.8	9.0	--
	ER-EC-2A_m3	45.5	0.009	0.12	187	25.5	7.0	6.9

Table S-4. Trace-Element Data (Page 2 of 3)

Location	ISPID	SiO_2 (mg/L)	Al (mg/L)	Fe (mg/L)	Li (μg/L)	Sr (μg/L)	U (μg/L)	^{238}U (μg/L)
ER-EC-4	ER-EC-4_m1-3	71.7	--	--	115	144	4.1	--
	ER-EC-4_m2-3	74.1	--	0.05	122	146	4.0	--
ER-EC-5	ER-EC-5_m1-3	39.5	0.008	0.003	106	133	3.2	--
ER-EC-6	ER-EC-6_m1-4	48.8	0.006	0.41	130	6.0	4.7	--
	ER-EC-6_m2-4	49.0	0.581	0.55	131	4.6	5.3	5.4
	ER-EC-6_m2	31.0	0.004	6.33	84.8	40.0	0.2	--
	ER-EC-6_m4	45.5	0.004	7.99	133	1.9	1.6	2.8
ER-EC-8	ER-EC-8_m1-3	50.7	0.004	0.14	183	5.8	4.8	4.9
ER-EC-11	ER-EC-11_m1-2	41.0	0.030	0.08	167	33.0	1.7	1.6
	ER-EC-11_p1	39.0	0.030	1.88	170	34.3	0.1	0.1
	ER-EC-11_p2	40.6	0.023	2.54	170	42.8	0.1	0.1
	ER-EC-11_p3	53.5	0.439	35.2	133	15.7	0.4	1.8
ER-EC-12	ER-EC-12_m1	8.6	0.400	0.53	111	31.7	0.0	0.2
	ER-EC-12_m2	32.0	0.231	0.21	121	9.9	2.3	2.6
ER-EC-13	ER-EC-13_m1	44.3	--	--	172	28.9	7.7	7.1
	ER-EC-13_m2	53.7	0.005	0.11	190	8.8	6.3	6.3
ER-EC-14	ER-EC-14_m1	49.2	0.022	0.11	113	40.8	2.1	2.1
	ER-EC-14_m2	42.8	0.039	0.00	103	44.3	2.1	2.0
ER-EC-15	ER-EC-15_m1	48.1	0.091	0.12	530	142	1.1	1.4
	ER-EC-15_m2	44.9	0.035	0.79	278	41.0	1.0	1.0
	ER-EC-15_m3	55.6	0.009	0.01	248	21.3	4.6	4.3

Table S-4. Trace-Element Data (Page 3 of 3)

Location	ISPID	SiO_2 (mg/L)	Al (mg/L)	Fe (mg/L)	Li (μg/L)	Sr (μg/L)	U (μg/L)	^{238}U (μg/L)
PM-2	PM-2_m1-o7 (264 m)	--	--	--	0.03	--	--	--
	PM-2_m1-o7 (300 m)	--	--	--	0.03	--	--	--
	PM-2_m1-o7 (600 m)	--	--	--	0.05	4,360	0.24	--
	PM-2_m1-o7 (800 m)	--	--	--	0.15	--	--	--
PM-3	PM-3_p1	55.9	0.001	3.41	149	111	0.5	0.5
	PM-3_p2	55.2	0.002	1.52	126	51.7	1.3	1.2
U-20 WW	U-20 WW_m1	48.7	0.050	0.17	66.3	21.5	2.2	--
UE-18r	UE-18r_o1	47.0	0.100	0.05	95.0	176	3.5	--
UE-19c WW	UE-19c WW_m1	43.4	0.153	0.14	57.3	--	--	--
UE-19h	UE-19h_m1	54.5	0.004	0.65	94.7	236	14.7	--
UE-20bh 1	UE-20bh 1_o1	56.6	0.542	0.26	--	3.5	0.9	--
UE-20d	UE-20d_o1Z	45.5	0.090	0.05	50.0	76.7	--	--
UE-20e1	UE-20e 1_o1Z	40.0	0.420	0.08	70.0	30.0	--	--
UE-20f	UE-20f_o1Z	47.0	0.070	0.56	--	--	--	--
UE-20j WW	UE-20j Instrument Hole_o1Z	44.0	0.010	4.80	--	--	8.5	--

-- = Not reported or not analyzed.

Note: Value is an average when multiple measurements were reported.

Table S-5. Environmental Tracers Data (Page 1 of 3)

Location	ISPID	$\delta^{2}H$ (‰)	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)	$\delta^{13}C$ DOC (‰)	^{14}C DOC (pmc)	^{14}C (pmc)	$^{36}Cl/Cl$ (ratio)	$^{87}Sr/^{86}Sr$ (ratio)	$^{234}U/^{238}U$ AR	$\delta^{34}S$ (‰)
ER-20-1	ER-20-1_p1	-115	-14.7	-3.6	--	--	16.2	5.15E-13	0.70994	2.79	19.1
ER-20-2-1	ER-20-2-1_m1	--	--	--	--	--	--	--	--	--	--
ER-20-4	ER-20-4_m1	-114	-15.1	-8.6	-23.0	53.05	18.6	6.53E-13	0.71050	5.35	12.7
ER-20-5-1	ER-20-5-1_m1	-115	-15.0	-3.2	--	--	6.7E+04	4.36E-09	0.71053	2.95	--
ER-20-5-3	ER-20-5-3_m1	-114	-15.2	-6.1	--	--	1.6E+03	2.36E-11	0.70874	2.11	7.4 [c]
ER-20-6-1	ER-20-6-1_m1	-113	-15.0	-6.5	--	--	72.2	9.47E-13	0.71086	4.33	--
	ER-20-6-1_p1	-113	-15.0	-7.3	--	--	22.3 [a]	1.56E-12	0.71016	4.05	--
ER-20-6-2	ER-20-6-2_m1	-113	-15.0	-7.1	--	--	301	1.69E-12	0.71058	2.37	--
	ER-20-6-2_p1	-111	-15.0	-7.6	--	--	30.5 [a]	8.23E-12	0.71029	2.52	--
ER-20-6-3	ER-20-6-3_m1	-113	-15.0	-7.5	--	--	16.1	4.63E-13	0.71078	4.99	--
	ER-20-6-3_p1	-110	-15.0	-7.5	--	--	22.5 [a]	1.52E-14	0.70974	4.69	--
ER-20-7	ER-20-7_m1	-115	-15.1	-2.0	--	--	6.0E+04	2.48E-09	0.71094	3.03	17.7
ER-20-8	ER-20-8_m1	-116	-15.3	-7.2	-26.3	87.1	37.6	1.15E-12	0.71071	4.04	17.8
	ER-20-8_m2	-115	-14.9	-4.4	-24.9	70.5	192	4.74E-12	0.71073	3.67	18.1
ER-20-8-2	ER-20-8-2_m1	-115	-15.0	-3.8	-26.9	89.8	121	3.00E-12	0.70959	3.89	18.0
ER-20-8-2	ER-20-8-2_p1	-114	-15.0	-4.3	--	--	107	3.79E-12	0.70874	3.85	18.0
ER-20-11	ER-20-11_m1	-115	-14.9	-2.6	--		3.2E+03	5.32E-11	0.71067	3.31	18.6
ER-20-12	ER-20-12_m1	-115	-14.7	-2.6	--	--	126	--	--	0.00	19.3
	ER-20-12_p1	-116	-14.7	-2.2	--	--	89.7	--	--	0.00	19.6
	ER-20-12_p3	-114	-14.6	-3.2	--	--	26.1	--	--	--	19.2
	ER-20-12_p4	--	--	--	--	--	--	--	--	--	--
ER-EC-1	ER-EC-1_m1-3	-115	-14.9	-4.2	-23.2	48.8	9.4	5.38E-13	0.71045	3.54	19.3
ER-EC-2A	ER-EC-2A_m1-3	-113	-15.0	-2.1	--	--	7.7	5.33E-13	0.70934	4.06	--
	ER-EC-2A_m3	-116	-14.9	-1.7	-24.3	36.3	9.8	5.02E-13	0.70910	5.01	18.9
ER-EC-4	ER-EC-4_m1-3	-112	-14.7	-2.1	--	--	5.0	5.61E-13	0.71006	2.87	--
	ER-EC-4_m2-3	-113	-14.7	-1.7	-12.9	48.82	5.9	4.80E-13	0.71013	2.89	18.8 [b]
ER-EC-5	ER-EC-5_m1-3	-113	-15.0	-3.0	-21.7	61.6	6.9	6.07E-	0.70918	6.42	16.1 [c]

Table S-5. Environmental Tracers Data (Page 2 of 3)

Location	ISPID	$\delta^{2}H$ (‰)	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)	$\delta^{13}C$ DOC (‰)	^{14}C DOC (pmc)	^{14}C (pmc)	$^{36}Cl/Cl$ (ratio)	$^{87}Sr/^{86}Sr$ (ratio)	$^{234}U/^{238}U$ AR	$\delta^{34}S$ (‰)
ER-EC-6	ER-EC-6_m1-4	-115	-15.0	-3.9	--	--	5.4	5.41E-13	0.70979	3.89	--
	ER-EC-6_m2-4	-116	-15.1	-3.3	-22.8	45.2	8.1	5.35E-13	0.71010	3.68	19.0
	ER-EC-6_m2	-115	-14.9	-3.4	-24.5	39.7	20.4	5.59E-13	0.70927	2.75	17.5
	ER-EC-6_m4	-115	-15.0	-2.9	--	--	23.9	5.27E-13	0.71029	3.62	19.1
ER-EC-8	ER-EC-8_m1-3	-114	-14.8	-1.5	-17.1	77.2	12.1	4.77E-13	0.70896	5.06	17.9
ER-EC-11	ER-EC-11_m1-2	-115	-15.3	-4.7	-23.1	52.2	19.9	5.55E-13	0.70987	4.03	18.7
	ER-EC-11_p1	-114	-14.8	-3.1	-25.1	57.3	28.2	5.61E-13	0.70970	3.87	18.8
	ER-EC-11_p2	-115	-15.0	-3.3	--	--	36.8	1.11E-12	0.70955	3.91	18.4
	ER-EC-11_p3	-115	-14.7	-2.4	--	--	330	3.98E-12	0.70931	3.09	18.8
ER-EC-12	ER-EC-12_m1	-96	-11.9	-11.6	-27.4	43.2	119	2.11E-12	0.70867	3.90	10.3
	ER-EC-12_m2	-113	-15.1	-5.8	-27.2	19.5	15.9	5.74E-13	0.71043	6.38	15.8
ER-EC-13	ER-EC-13_m1	-115	-14.8	-1.3	-30.1	42.9	71.6	5.28E-13	0.70971	4.28	18.5
	ER-EC-13_m2	-116	-15.2	-4.6	-25.2	43.3	12.5	5.20E-13	0.71014	4.06	18.6
ER-EC-14	ER-EC-14_m1	-115	-14.4	-2.6	-24.0	91.9	31.3	5.54E-13	0.70950	6.45	16.5
	ER-EC-14_m2	-115	-14.3	-2.1	-25.7	40.6	7.2	5.39E-13	0.70944	6.50	16.9
ER-EC-15	ER-EC-15_m1	-116	-14.9	0.2	-29.7	21.0	1.7	4.44E-13	0.70985	4.16	17.5
	ER-EC-15_m2	-117	-14.7	-2.4	-28.6	27.5	9.0	5.17E-13	0.70971	4.19	18.3
	ER-EC-15_m3	-116	-14.8	-1.9	-20.2	36.3	32.2	5.33E-13	0.70970	3.68	19.5
PM-2	PM-2_m1-o7 (264 m)	-80	-11.1	--	--	--	--	3.82E-11	--	--	--
	PM-2_m1-o7 (300 m)	-80	-11.1	-12.2	--	--	--	3.64E-11	--	--	--
	PM-2_m1-o7 (600 m)	-83	-11.4	-6.3	--	--	142	2.10E-11	0.70759	2.43	--
	PM-2_m1-o7 (800 m)	-105	-13.6	-1.6	--	--	--	7.19E-12	--	--	--
PM-3	PM-3_p1	-117	-14.7	-3.4	-26.6	55.9	68.4	5.57E-13	0.71056	3.26	20.0
	PM-3_p2	-115	-14.7	-5.1	-27.4	51.5	82.9	6.64E-13	0.71061	3.79	20.0
U-20 WW	U-20 WW_m1	-113	-14.7	-7.2	-26.1	--	8.9	5.67E-13	0.71126	4.76	--
UE-18r	UE-18r_o1	-111	-14.9	-4.6	--	19.0	8.2	6.36E-13	0.70910	--	--
UE-19c WW	UE-19c WW_m1	-111	-15.2	-5.3	--	--	8.1	6.26E-13	0.70943	--	--

Table S-5. Environmental Tracers Data (Page 3 of 3)

Location	ISPID	$\delta^{2}H$ (‰)	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)	$\delta^{13}C$ DOC (‰)	^{14}C DOC (pmc)	^{14}C (pmc)	$^{36}Cl/Cl$ (ratio)	$^{87}Sr/^{86}Sr$ (ratio)	$^{234}U/^{238}U$ AR	$\delta^{34}S$ (‰)
UE-19h	UE-19h_m1	-111	-14.6	-2.3	-28.5	43.0	10.1	4.79E-13	0.71140	6.74	--
UE-20bh 1	UE-20bh 1_o1	-113	-15.0	-10.5	-27.5		21.7	6.45E-13	0.70701	3.70	--
UE-20d	UE-20d_o1Z	--	--	--	--	--	--	--	--	--	--
UE-20e1	UE-20e 1_o1Z	--	--	--	--	--	--	--	--	--	--
UE-20f	UE-20f_o1Z	--	--	--	--	--	--	--	--	--	--
UE-20j WW	UE-20j Instrument Hole_o1Z	--	--	--	--	--	--	--	--	--	--

[a] Result is for a sample collected in 2017.

[b] Result is for a sample collected in 2018.

[c] Result is for a sample collected in 2019.

-- = Not reported or not analyzed.

Note: Value is an average when multiple measurements were reported.

Table S-6. Radionuclide Activities (pCi/L) for Most Recent Samples (Page 1 of 2)

Location	ISPID	Sampled Year	^{3}H	^{14}C	^{36}Cl	^{90}Sr	^{99}Tc	^{129}I	^{137}Cs	$^{239/240}Pu$
ER-20-1	ER-20-1_p1	2018	<2.9	--	--	--	--	--	--	--
ER-20-2-1	ER-20-2-1_p1	2018	<3.0	--	--	--	--	--	--	--
ER-20-4	ER-20-4_m1	2018	<3.0	0.017	9.8E-05	<0.38	<7.3	<0.8	<6.3	J <0.04
ER-20-5-1	ER-20-5-1_m1	2015	2.5E+07	165	5.7	<0.55	0.43	0.20	<6.7	0.40
ER-20-5-3	ER-20-5-3_m1	2015	8.4E+04	2.74	1.4E-02	<0.54	0.009	4.0E-04	<6.1	<0.05
ER-20-6-1	ER-20-6-1_m1	2017	<270	J <470	<20	--	<7.2	<0.51	--	<0.03
ER-20-6-2	ER-20-6-2_m1	2017	U 390	<390	<20	--	<7.2	<0.78	--	<0.02
ER-20-6-3	ER-20-6-3_m1	2017	<290	<390	<3.0	--	<6.8	<0.75	--	U <0.02
ER-20-7	ER-20-7_m1	2017	1.3E+07	<390	<3.3	<0.61	<7.6	<0.82	<6.7	0.05
ER-20-8	ER-20-8_m1	2011	267	0.06	9.2E-04	<0.47	<7.1	3.5E-05	<0.05	<0.001
	ER-20-8_m2	2017	6.4E+03	<380	<3.1	<0.41	<8.1	<0.91	<8.9	--
ER-20-8-2	ER-20-8-2_m1	2017	3.7E+03	<390	<3.2	<0.42	<7.8	<0.90	<9.3	--
ER-20-11	ER-20-11_m1	2017	2.0E+05	<470	<3.4	<0.36	<7.9	<1.3	--	<0.02
ER-20-12	ER-20-12_m1	2017	4.1E+04	<400	<3.4	<0.57	<7.7	<0.82	--	<0.02
	ER-20-12_p1	2017	2.6E+04	J <420	<3.3	<0.49	<8.4	<0.86	<6.9	<0.04
	ER-20-12_p3	2017	283	--	--	--	--	--	--	--
	ER-20-12_p4	2017	5.8E+04	--	--	--	--	--	--	--
ER-EC-1	ER-EC-1_m1-3	2016	<2.9	--	--	--	--	--	--	--
ER-EC-2A	ER-EC-2A_m3	2016	<2.9	0.025	9.2E-04	<0.97	<8.2	<1.1	<4.0	<0.04
ER-EC-4	ER-EC-4_m2-3	2018	<2.7	0.015	1.3E-03	<0.94	<6.9	<0.85	<5.5	<0.09
ER-EC-5	ER-EC-5_m1-3	2003	<320	<340	3.0E-04	<0.55	<5.2	<3.5	<8.0	<0.03
ER-EC-6	ER-EC-6_m1-4	2000	<270	--	--	--	--	--	--	--
	ER-EC-6_m2-4	2003	<380	--	--	--	--	--	--	--
	ER-EC-6_m2_a1	2018	J <2.8	0.016	4.0E-04	<0.40	<7.4	<0.78	<7.0	J <0.04
	ER-EC-6_m4_a3	2015	4.2	J <330	<3.1	<0.42	<6.8	J <0.66	<6.3	<0.04
ER-EC-8	ER-EC-8_m1-3	2016	<4.5	0.047	7.7E-04	<0.89	<8.0	<0.87	<7.4	<0.05
ER-EC-11	ER-EC-11_p1	2017	10.9	<420	--	<0.46	<7.3	<1.4	<8.0	<0.03
	ER-EC-11_m2	2017	11.8	<410	<3.1	<0.50	<7.3	<1.4	<9.1	<0.03
	ER-EC-11_p3	2017	1.8E+04	<470	<3.3	<0.35	<7.5	<1.5	<9.5	<0.01
ER-EC-12	ER-EC-12_m1	2012	4.2	0.14	4.6E-03	U 0.67	<5.8	3.7E-04	<0.02	<0.04
	ER-EC-12_m2	2016	<3.0	0.03	2.9E-04	<0.74	<5.3	<0.98	<5.1	<0.06
ER-EC-13	ER-EC-13_m1	2013	<3.0	0.14	9.8E-04	<0.42	<6.2	1.8E-07	<0.06	<0.03
	ER-EC-13_m2	2012	<2.5	0.03	1.0E-03	<0.28	J <6.5	1.3E-07	<0.08	<0.02

Table S-6. Radionuclide Activities (pCi/L) for Most Recent Samples (Page 2 of 2)

Location	ISPID	Sampled Year	^{3}H	^{14}C	^{36}Cl	^{90}Sr	^{99}Tc	^{129}I	^{137}Cs	$^{239/240}Pu$
ER-EC-14	ER-EC-14_m1	2014	<2.0	0.07	3.6E-04	1.10	<4.5E-04	1.8E-07	<7.3	<0.004
	ER-EC-14_m2	2014	<2.2	0.02	3.6E-04	<0.32	J 0.006	1.1E-07	<8.7	<0.004
ER-EC-15	ER-EC-15_m1	2014	<2.0	0.01	5.3E-04	<0.37	<0.34	1.5E-06	<7.6	<0.004
	ER-EC-15_m2	2014	<2.1	0.02	1.0E-03	<0.33	J 0.002	7.1E-06	<6.6	<0.004
	ER-EC-15_m3	2013	<2.2	0.08	1.1E-03	<0.37	<4.2E-04	1.2E-06	<8.9	<0.004
PM-2	PM-2_m1-o7 (264 m)	2005	4.9E+04	--	1.3E-02	--	--	--	--	--
	PM-2_m1-o7 (300 m)	2005	4.8E+04	--	1.3E-02	--	--	9.7E-04	<0.004	--
	PM-2_m1-o7 (600 m)	2005	7.7E+04	0.911	1.4E-02	--	<7.6E-02	6.5E-04	--	-- [a]
	PM-2_m1-o7 (800 m)	2005	2.6E+05	--	1.7E-02	--	--	--	0.006	--
PM-3	PM-3_p1	2018	192	0.04	1.9E-03	<0.42	<8.0	<3.1	<8.6	<0.046
	PM-3_p2	2018	574	0.08	2.4E-03	<0.44	<8.1	<2.5	<7.5	<0.045
U-20 WW	U-20 WW_m1	2018	<3.2	--	--	--	--	--	--	--
UE-18r	UE-18r_o1	2017	<188	--	--	--	--	--	--	--
UE-19c WW	UE-19c WW_m1	1999	<22	--	--	--	--	--	--	--
UE-19h	UE-19h_m1	1999	1,970	--	--	--	--	--	--	--
UE-20bh 1	UE-20bh 1_o1	1999	3.2	--	--	--	--	--	--	--
UE-20d	UE-20d	1966	ND	--	--	--	--	--	--	--
UE-20e 1	UE-20e 1	1966	ND	--	--	--	--	--	--	--
UE-20f	UE-20f_1	--	--	--	--	--	--	--	--	--
UE-20j WW	UE-20j Instrument Hole_o1Z	--	--	--	--	--	--	--	--	--

[a] Pu detected but may have been the result of sample contamination (Zavarin, 2006).

-- = Not analyzed
J = Result is estimated.
ND = Not detected (detection limit not available)
U = Result was above the detection limit, but below the detection limit plus error and is considered a non-detect. Note: Non-detects are reported as "< detection limit."

S2. Evaluation of major-ion variability with depth

A comparison of major-ion variability with depth for each well that samples multiple depth intervals is presented in Fig. S-1. To allow visual comparison of all ions on the same scale, the major-ion concentration for each sample was first standardized to provide a mean of zero and a standard deviation of one for each major ion. This is achieved for each major ion by subtracting the mean and then dividing by the standard deviation for all samples included in the study. In Fig. S-1, cations (Na, Ca, K, and Mg) are identified using circles, and anions (HCO_3, Cl, SO_4, and F) are identified using squares. The elevation, presented on the Y axis, is associated with the middle of the screened interval. The primary HSU is identified by color (Fig. S-1).

At most wells or well clusters where groundwater geochemical data from multiple depths exists, the data show relatively little variation with depth. Notable exceptions to this generalization exist at (1) ER-20-12, ER-20-5, and ER-EC-6 where the shallowest sample has high concentrations of many analytes compared to the deeper intervals; and (2) ER-EC-15, where the greatest concentrations of HCO_3, F, and Na are observed in groundwater sampled from the deepest interval (ER-EC-15_m1). In summary, although the are some differences in major ion chemistry in different completion intervals at a given well, clear cut, study-area-wide vertical trends are not obvious through visual inspection of the major-ion data presented in Fig. S-1.

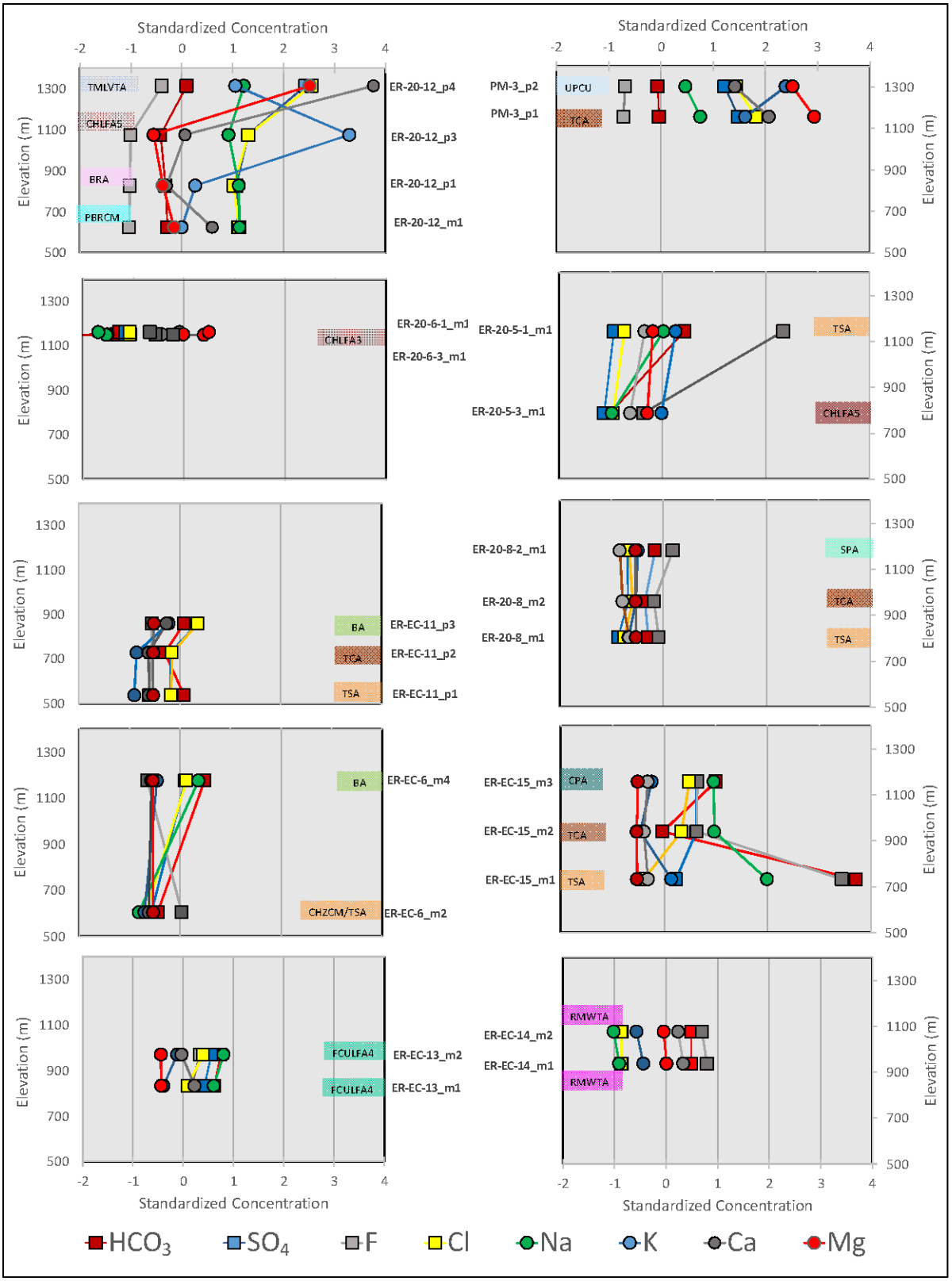

Fig. S-1. Vertical differences in major ions at key multi-completion wells.

S3. Multivariate Statistical Evaluation

Multivariate statistics provide useful tools for examining similarities and differences between groundwater samples based on the large suite of analytical results. The objective of these analyses is to evaluate trends within the geochemical and isotopic data that are potentially indicative of a groundwater flow path or simply represent the different hydrogeologic units through with the groundwater has flowed. This section provides the results of two clustering analyses used to investigate spatial trends within the geochemical and isotopic dataset. The analytes responsible for the clustering results are also evaluated.

The software program STATISTICA (STATISTICA, 2016, Version 13.2), was used for the statistical analyses. The data presented in Tables S-2 to S-6 were included in the analysis. All groundwater sample locations, except ER-EC-12_m1, are included in the analysis. The chemistry of the ER-EC-12_m1 groundwater sample is anomalous when compared to all other samples and therefore would bias the statistical results if included in the analyses.

Correlation Matrix

A correlation matrix, showing the correlation coefficient (r) for each combination of analytes is presented in Table S-7. Correlation coefficients range between -1 and +1, with a positive coefficient indicating a direct linear relationship and a negative coefficient indicating an inverse linear relationship. A value of 1 or -1 indicates a perfect correlation, and the closer the coefficient is to either −1 or 1, the stronger the correlation. The correlation matrix is presented to support interpretations of the cluster analyses.

The full matrix is shown even though it is symmetrical across its diagonal, with values of 1.0 along the diagonal (gray-shaded cells) indicating perfect correlation of a variable with itself; therefore, many redundant r values are shown (Table S-7). Presentation of the full matrix is thought to simplify visual inspection for correlations. Correlation coefficients greater than 0.4 and less than -0.4 are shown in bold. Some observations from Table S-7 include the following:

- Temperature is most correlated ($r \geq 0.64$) with HCO_3, F, and Li.
- SC is highly correlated ($r \geq 0.85$) with SO_4, Cl, and Na, which is expected in these groundwaters and also shows a positive correlation ($r \geq 0.62$) with K, Ca, and $\delta^{34}S$, and an inverse correlation ($r = -0.70$) with $\delta^{2}H$.
- SO_4 is almost perfectly correlated with Cl ($r = 0.97$) and is also highly correlated ($r \geq 0.70$) with SC, Na, K,

Table S-7. Correlation matrix for groundwater analytes.

Analyte	pH	T	SC	HCO_3	SO_4	F	Cl	Br	Na	K	Ca	Mg	SiO_2	Li	Sr	U	δ^2H	$\delta^{18}O$	$\delta^{13}C$	$\delta^{34}S$	$^{87}Sr/^{86}Sr$	$^{234}U/^{238}U$ AR	^{14}C	^{14}C	^{3}H
pH	**1.00**	0.10	0.34	0.30	0.29	0.12	0.31	0.14	0.16	**0.45**	**0.64**	**0.51**	0.32	0.13	0.42	0.23	0.38	0.32	0.28	0.08	0.12	0.38	0.06	0.06	0.05
Temp	0.10	1.00	0.24	**0.65**	0.02	**0.67**	0.13	0.26	**0.43**	0.10	0.20	0.28	0.20	**0.64**	0.17	0.30	0.22	0.19	**0.50**	0.17	0.04	0.18	0.05	0.05	0.05
SC	0.34	0.24	1.00	0.42	**0.94**	0.09	**0.85**	**0.48**	**0.93**	**0.69**	**0.62**	**0.49**	**0.43**	**0.59**	**0.53**	0.17	**0.74**	0.03	**0.52**	**0.70**	0.18	0.30	0.15	0.14	0.14
HCO_3	0.30	**0.65**	0.42	1.00	0.12	**0.85**	0.06	0.25	**0.59**	0.13	0.03	0.10	0.22	**0.81**	**0.52**	0.18	0.26	0.08	**0.77**	0.16	0.03	0.17	0.07	0.08	0.08
SO_4	0.29	0.02	**0.94**	0.12	1.00	0.22	**0.97**	**0.60**	**0.80**	**0.73**	**0.70**	**0.58**	0.39	0.32	0.36	0.19	**0.69**	0.03	0.29	**0.83**	0.20	0.39	0.20	0.20	0.20
F	0.12	**0.67**	0.09	**0.85**	0.22	1.00	0.41	**0.45**	0.29	0.13	0.20	0.28	0.05	**0.73**	**0.48**	0.01	0.12	0.00	**0.64**	**0.47**	0.18	0.27	0.16	0.17	0.17
Cl	0.31	0.13	**0.85**	0.06	**0.97**	0.41	1.00	**0.70**	**0.66**	**0.78**	**0.76**	**0.68**	0.42	0.11	0.27	0.18	**0.63**	0.01	0.10	**0.86**	0.29	0.41	0.16	0.16	0.15
Br	0.14	0.26	**0.48**	0.25	**0.60**	**0.45**	**0.70**	1.00	0.28	**0.67**	**0.61**	**0.71**	0.29	0.14	0.27	0.15	0.42	0.04	0.15	**0.67**	**0.45**	**0.48**	0.07	0.08	0.08
Na	0.16	**0.43**	**0.93**	**0.59**	**0.80**	0.29	**0.66**	0.28	1.00	**0.46**	0.32	0.18	0.39	**0.75**	**0.46**	0.22	**0.65**	0.24	**0.62**	**0.58**	0.13	0.35	0.09	0.09	0.09
K	**0.45**	0.10	**0.69**	0.13	**0.73**	0.13	**0.78**	**0.67**	**0.46**	1.00	**0.85**	**0.88**	**0.55**	0.07	0.38	0.14	0.38	0.13	0.19	**0.58**	0.36	0.24	0.05	0.05	0.05
Ca	**0.64**	0.20	**0.62**	0.03	**0.70**	0.20	**0.76**	**0.61**	0.32	**0.85**	1.00	0.91	0.35	0.01	**0.50**	0.06	**0.52**	**0.44**	0.10	**0.46**	0.26	0.04	0.12	0.11	0.11
Mg	**0.51**	0.28	**0.49**	0.10	**0.58**	0.28	**0.68**	**0.71**	0.18	**0.88**	**0.91**	1.00	0.33	0.11	**0.47**	0.12	0.37	0.33	0.03	**0.48**	0.32	0.08	0.05	0.05	0.05
SiO_2	0.32	0.20	**0.43**	0.22	0.39	0.05	0.42	0.29	0.39	**0.55**	0.35	0.33	1.00	0.01	0.03	**0.51**	0.36	0.08	0.31	**0.44**	**0.44**	0.34	**0.53**	**0.52**	**0.52**
Li	0.13	**0.64**	**0.59**	**0.81**	0.32	**0.73**	0.11	0.14	**0.75**	0.07	0.01	0.11	0.01	1.00	**0.66**	0.08	**0.43**	0.10	**0.72**	0.04	0.13	0.02	0.17	0.17	0.17
Sr	0.42	0.17	**0.53**	**0.52**	0.36	**0.48**	0.27	0.27	**0.46**	0.38	**0.50**	**0.47**	0.03	**0.66**	1.00	0.36	**0.52**	0.27	**0.44**	0.09	0.03	0.01	0.15	0.15	0.14
U	0.23	0.30	0.17	0.18	0.19	0.01	0.18	0.15	0.22	0.14	0.06	0.12	**0.51**	0.08	0.36	1.00	0.04	0.31	0.23	0.09	0.29	0.01	**0.46**	**0.46**	**0.46**
δ^2H	0.38	0.22	**0.74**	0.26	**0.69**	0.12	**0.63**	0.42	**0.65**	0.38	**0.52**	0.37	0.36	**0.43**	**0.52**	0.04	1.00	0.17	0.38	**0.54**	0.08	0.21	0.13	0.13	0.13
$\delta^{18}O$	0.32	0.19	0.03	0.08	0.03	0.00	0.01	0.04	0.24	0.13	**0.44**	0.33	0.08	0.10	0.27	0.31	0.17	1.00	0.03	0.15	0.17	**0.54**	0.31	0.31	0.30
$\delta^{13}C$	0.28	**0.50**	**0.52**	**0.77**	0.29	**0.64**	0.10	0.15	**0.62**	0.19	0.10	0.03	0.31	**0.72**	**0.44**	0.23	0.38	0.03	1.00	0.10	0.25	0.08	0.05	0.05	0.05
$\delta^{34}S$	0.08	0.17	**0.70**	0.16	**0.83**	**0.47**	**0.86**	**0.67**	**0.58**	**0.58**	**0.46**	**0.48**	**0.44**	0.04	0.09	0.09	**0.54**	0.15	0.10	1.00	0.20	**0.64**	0.13	0.13	0.13
$^{87}Sr/^{86}Sr$	0.12	0.04	0.18	0.03	0.20	0.18	0.29	**0.45**	0.13	0.36	0.26	0.32	**0.44**	0.13	0.03	0.29	0.08	0.17	0.25	0.20	1.00	0.26	0.39	0.38	0.38
$^{234}U/^{238}U$ AR	0.38	0.18	0.30	0.17	0.39	0.27	0.41	**0.48**	0.35	0.24	0.04	0.08	0.34	0.02	0.01	0.01	0.21	**0.54**	0.08	**0.64**	0.26	1.00	0.24	0.23	0.23
^{14}C	0.06	0.05	0.15	0.07	0.20	0.16	0.16	0.07	0.09	0.05	0.12	0.05	**0.53**	0.17	0.15	**0.46**	0.13	0.31	0.05	0.13	0.39	0.24	1.00	**1.00**	**1.00**
$^{36}Cl/Cl$	0.06	0.05	0.14	0.08	0.20	0.17	0.16	0.08	0.09	0.05	0.11	0.05	**0.52**	0.17	0.15	**0.46**	0.13	0.31	0.05	0.13	0.38	0.23	**1.00**	1.00	**1.00**
^{3}H	0.05	0.05	0.14	0.08	0.20	0.17	0.15	0.08	0.09	0.05	0.11	0.05	**0.52**	0.17	0.14	**0.46**	0.13	0.30	0.05	0.13	0.38	0.23	**1.00**	**1.00**	1.00

- Ca, and $\delta^{34}S$. Cl is similarly highly correlated with these analytes.
- A few analytes such as $\delta^{18}O$, strontium ratio ($^{87}Sr/^{86}Sr$), U, and $^{234}U/^{238}U$ AR have very little correlation with other analytes.
- A perfect correlation (r = 1.00) is observed between test-related radionuclides (^{3}H, ^{14}C, and ^{36}Cl) indicating all three radionuclides were introduced to groundwater by nuclear testing.

Cluster Analysis

Two types of cluster analyses, hierarchical and K-means clustering, were performed on these data. Standardized data were used for both analyses to ensure equal influence for each analyte in the clustering process regardless of the overall magnitude of the observed concentrations in each sample. Standardized values are the measured values minus the mean, divided by the standard deviation. Only naturally present groundwater constituents were included in the analysis; no test-derived radionuclides were used.

Hierarchical cluster analysis, or tree clustering, is used to form clusters of samples that are similar to each other within the cluster and dissimilar between clusters. The Ward's method was used to form clusters by using an analysis of variance approach to evaluate the distances between clusters. In short, this method attempts to minimize the sum of squares of any two (hypothetical) clusters that can be formed at each step. In general, this method is regarded as very efficient and tends to create clusters of small size (STATISTICA, 2016).

The results of this analysis are presented in Fig. S-2. In Fig. S-2, the linkage distance indicates the relative similarity between each sample within each cluster and also between other clusters. For instance, the cluster on the left - containing all sampled intervals of ER-EC-1, ER-EC-4, ER-20-12, PM-3, and UE-20j - has the largest linkage distance (~38) to the cluster containing the remaining samples. This is consistent with all previous evaluations (Rose et al., 2006; Kwicklis et al., 2005) showing that samples from the western portion of the study area are unique with respect to the other sampling locations. Within this cluster, completions within a given well tend to cluster together with a much lower linkage distance (<5). All samples from the ER-20-6 wells along with UE-20 WW form a single cluster. Other clusters on the right of Fig. S-2 are formed with small linkage distances between many sampling

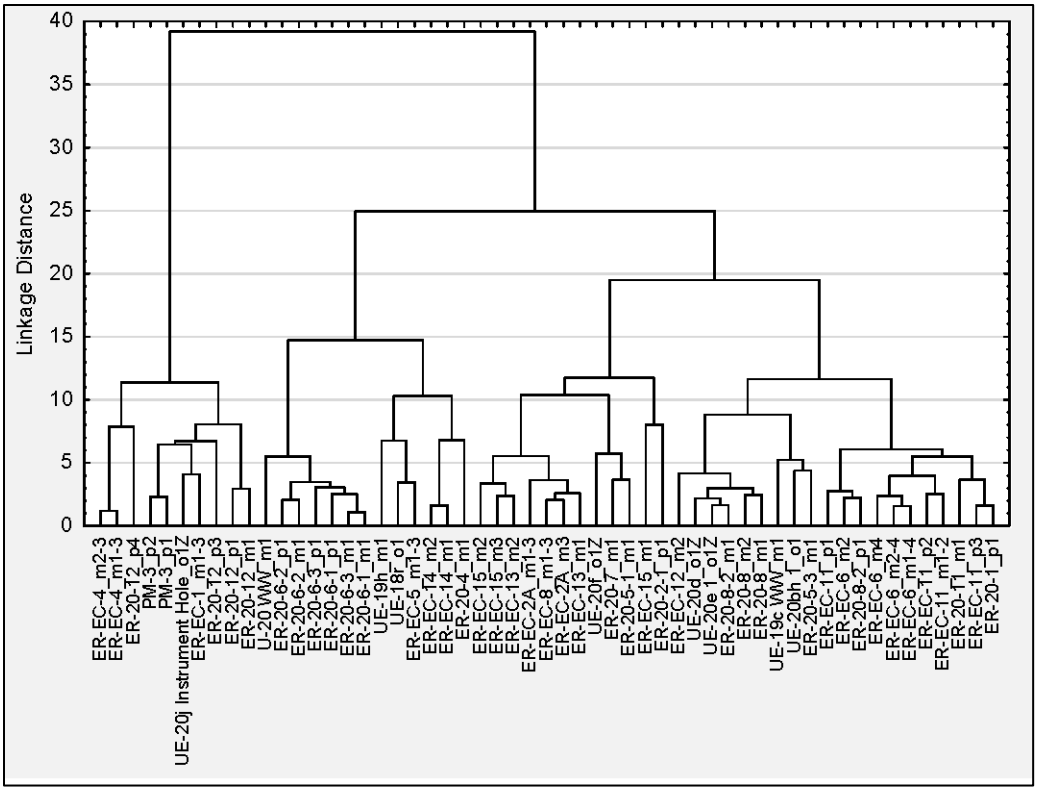

Fig. S-2. Hierarchical Cluster Analysis Results

locations, indicating the groundwater chemistries of these locations are similar. In most cases, samples collected from different completions within the same well either cluster directly together or are grouped together within the same larger cluster. Two exceptions to this are that (1) ER-EC-15_m1 clusters separately from ER-EC-15_m2 and ER-EC-15_m3, and (2) ER-20-5-1 clusters separately from ER-20-5-3.

The multivariate statistical technique known as "K-means cluster analysis" identifies grouping patterns within a sample set based on similarities in the groundwater chemistry data. Using this technique, the variance for each parameter within each cluster is minimized, and the variance between the different clusters is maximized. Using this approach, a total of five K-means clusters were identified. The samples contained in each cluster are identified in Table S-8 and are presented spatially in Fig. S-3.

For visual clarity, variably sized symbols are used in Fig. S-3 to identify different completions within the well that were assigned to different clusters. The sample ID for each sampling location is also color coded to match the cluster color. In general, clusters are grouped spatially within the study area. Table S-9 presents the Euclidean

Table S-8. Samples within clusters identified using K-means cluster analysis.

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
ER-20-11_m1	ER-20-4_m1	ER-20-2-1_p1	ER-20-1_m1_a	ER-20-12_p4
ER-20-5-1_m1	ER-20-5-3_m1	ER-EC-15_m1	ER-20-12_m1	ER-EC-4_m1-3
ER-20-7_m1	ER-20-6-1_m1		ER-20-12_p1	ER-EC-4_m2-3
ER-20-8-2_m1	ER-20-6-1_p1		ER-20-12_p3	PM-3_p1
ER-20-8-2_p1	ER-20-6-2_m1		ER-EC-1_m1-3	PM-3_p2
ER-EC-11_m1-2	ER-20-6-2_p1		ER-EC-11_p3	UE-20j Instrument Hole_o1Z
ER-EC-11_p1	ER-20-6-3_m1			
ER-EC-11_p2	ER-20-6-3_p1			
ER-EC-13_m1	ER-20-8_m1			
ER-EC-13_m2	ER-20-8_m2			
ER-EC-14_m1	ER-EC-12_m2			
ER-EC-14_m2	ER-EC-5_m1-3			
ER-EC-15_m2	ER-EC-6_m2			
ER-EC-15_m3	U-20 WW_m1			
ER-EC-2A_m1-3	UE-18r_o1			
ER-EC-2A_m3	UE-19c WW_m1			
ER-EC-6_m1-4	UE-19h_m1			
ER-EC-6_m2-4	UE-20bh 1_o1			
ER-EC-6_m4	UE-20d_o1Z			
ER-EC-8_m1-3				
UE-20e 1_o1Z				
UE-20f_o1				

distances (i.e., relative similarities) between the different clusters. The means of the standardized concentration for each analyte for each of the five clusters are presented in Fig. S-4. Each cluster is described below:

- Cluster 1 contains the largest number of sampling locations (Table S-8), which are in the central-to-southwestern portion of the study area (Fig. S-3). This cluster is most similar to clusters 2 and 4, with reported Euclidean distances of 0.5 (Table S-9). The mean for each analyte within this cluster is mostly distributed in the middle of all other cluster means (Fig. S-4), suggesting that these ground waters may be mixtures of groundwater within the other clusters. Samples from all completions accessing the shallow

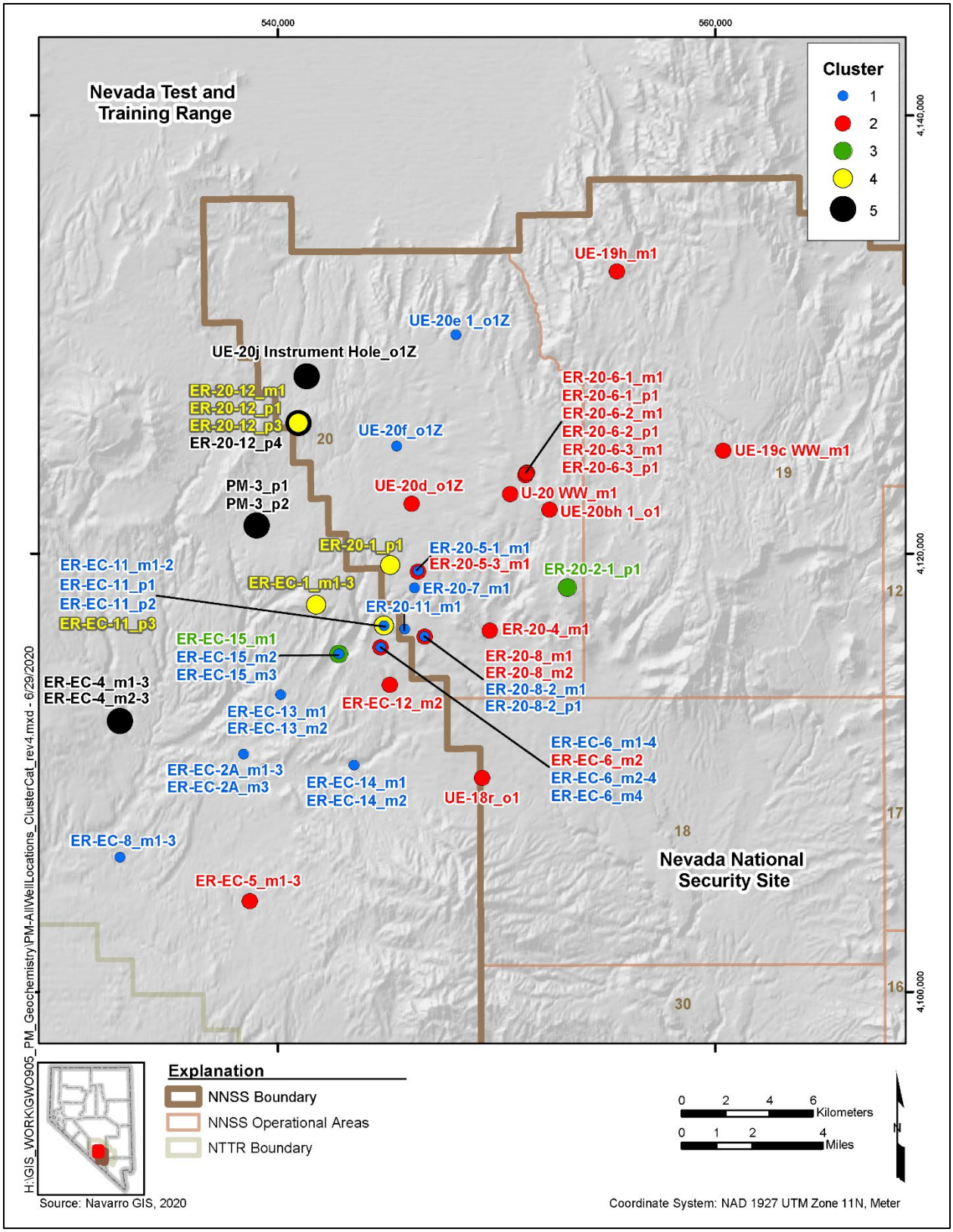

Fig. S-3. K-mean cluster results.

Table S-9. Euclidian distance between clusters.

Cluster	1	2	3	4	5
1	0.0	0.5	1.6	0.5	1.6
2	0.7	0.0	2.9	1.3	2.5
3	1.3	1.7	0.0	2.4	3.3
4	0.7	1.2	1.5	0.0	1.0
5	1.3	1.6	1.8	1.0	0.0

Note: Distances below diagonal and squared distances above the diagonal.

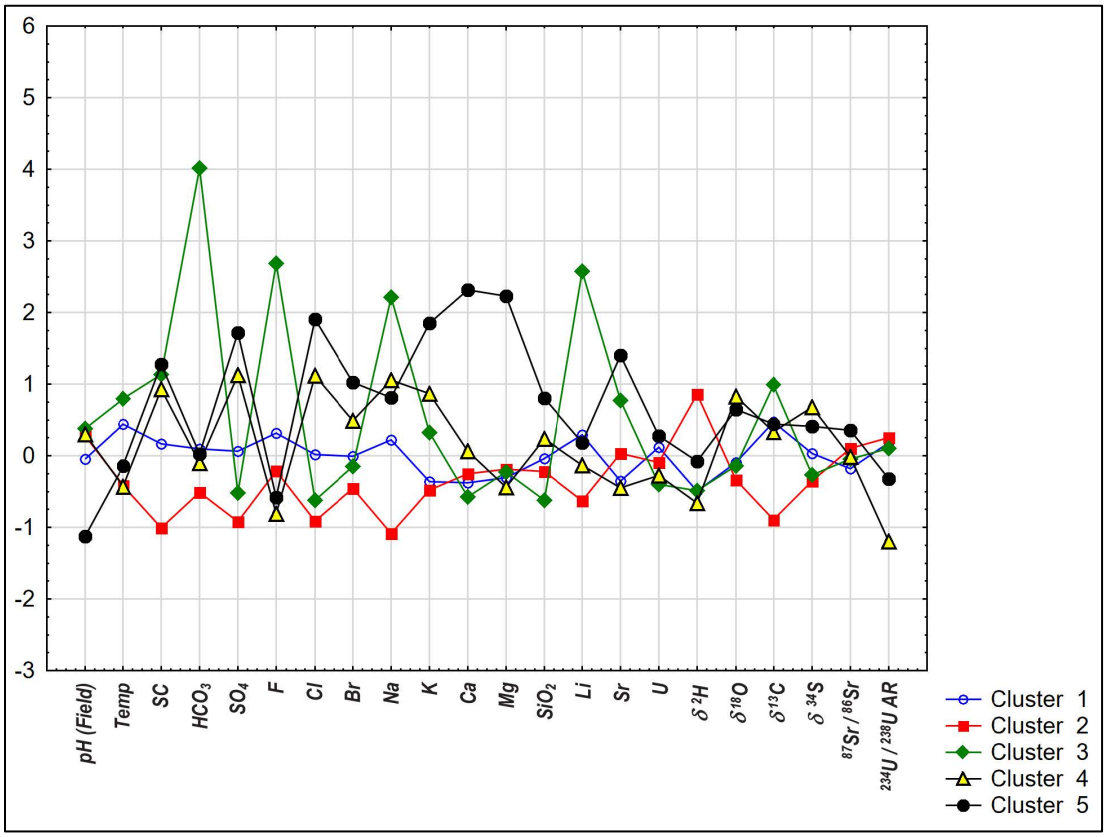

Fig. S-4. Cluster means (standardized concentration)

interval of ER-EC-6 (_m1-4, _m2-4, and m_4) cluster together but separate from the deeper ER-EC-6_m2 completion, suggesting the composite groundwater samples (_m1-4 and _m2-4) are primarily produced from the shallow interval (_m4). Cluster 1 contains groundwater samples from ER-20-5-1, ER-20-7, ER-20-11, and ER-20-8-2, which is consistent with the high ^{3}H concentrations in each of these locations. The deeper, rather than shallow, intervals of ER-EC-11 are included in Cluster 1.

- Cluster 2 contains locations in the eastern portion of the study area (Fig. S-3). It is most similar to Cluster 1 (Table S-8). This cluster has a lower mean SC, temperature, $\delta^{18}O$, $\delta^{13}C$, $^{234}U/^{238}U$ AR, Li, and most major

ions (HCO_3, SO_4, Br, Na, K) when compared to the other clusters (Fig. S-4). All ER-20-6 wells and both lower intervals of ER-20-8 (_m1 and _m2) are included within this cluster (Table S-8).

- Cluster 3 is unique when compared to the other clusters. Only two samples are included in the cluster (Table S-8), and the locations are not spatially similar (vertically or laterally) (Fig. S-3). This cluster is most different from the other clusters; Euclidean distances range from 1.3 to 3.3 (Table S-9). This cluster has a higher mean temperature, HCO_3, F, Na, and Li when compared to the other clusters (Fig. S-4). As shown in Table S-7, these analytes are all highly correlated. The groundwater temperature at ER-EC-15_m1 (50.2 °C) is greater than all other groundwater included in this evaluation. This is not the case for groundwater of ER-20-2-1 (29.0 °C).
- Cluster 4 includes locations in the northwestern portion of the study area (Fig. S-3). It includes the shallow interval of ER-EC-11 (_p3) and the deep intervals of ER-20-12 (_m1, _p1, and _p3), along with ER-20-1 and ER-EC-1 (Table S-8). Although this cluster is most similar to Cluster 1 (Table S-9), the means for each analyte appear in the same pattern as those in Cluster 5, with the exception of pH, K, Ca, Mg, and Sr (Fig. S-4).
- Cluster 5 contains locations in the western portion of the study area (Fig. S-3). This cluster is distinguishable based on a lower mean pH and a much higher mean SC, SO_4, Cl, Br, K, Ca, Mg, SiO_2, and Sr when compared to the other clusters (Fig. S-4).

In summary, the cluster analyses allow for simultaneous evaluation of all analytes, thus building confidence in the results. Each analyte (or analyte group) provides information regarding a different geochemical or isotopic process (water-rock interaction, groundwater mixing, recharge), allowing for a more complete geochemical evaluation than comparison of individual analytes alone. The statistical analyses identified spatial trends within the dataset consistent with those shown in the main body of the paper for Cl and SO_4. Groundwater samples collected from the northwest (ER-20-12, PM-3, ER-EC-4, UE-20j) are unique with respect to most analytes. Vertical differences in groundwater chemistry were shown at several locations: ER-20-5-1 and ER-20-5-3; ER-EC-15_m1 compared to ER-EC-15_m2 and ER-EC-15_m3; ER-20-8 and ER-20-8-2 using K-means clustering; and ER-EC-6_m2 compared to ER-EC-6_m4, ER-EC-6_m1-4, and ER-EC-6_m2-4. Information gained from these analyses, along with Cl and SO_4 contours, supports the flow path investigation presented in the main body of the paper.

S4. ESM References

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