Geochemistry and hydrology of perched groundwater springs: assessing elevated uranium concentrations at Pigeon Spring relative to nearby Pigeon Mine, Arizona (USA)

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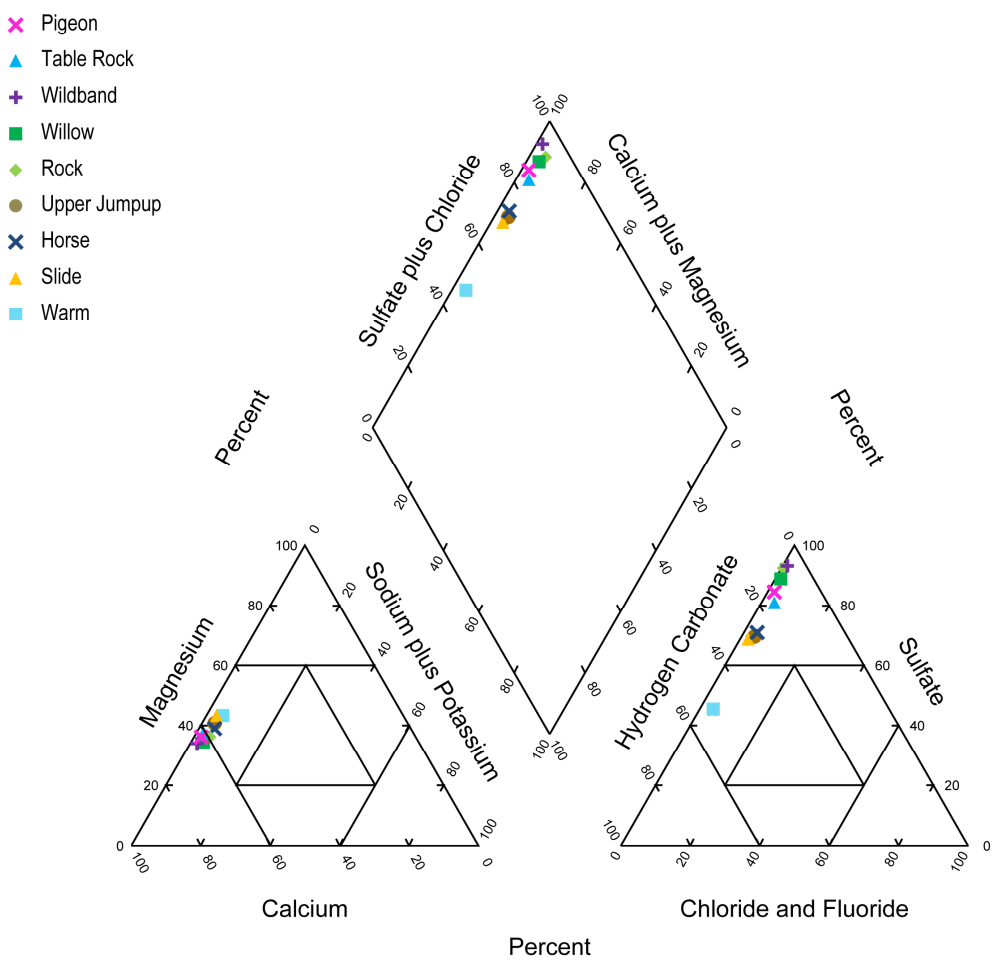

Figure S1. Piper plot representing major ion composition for spring samples.

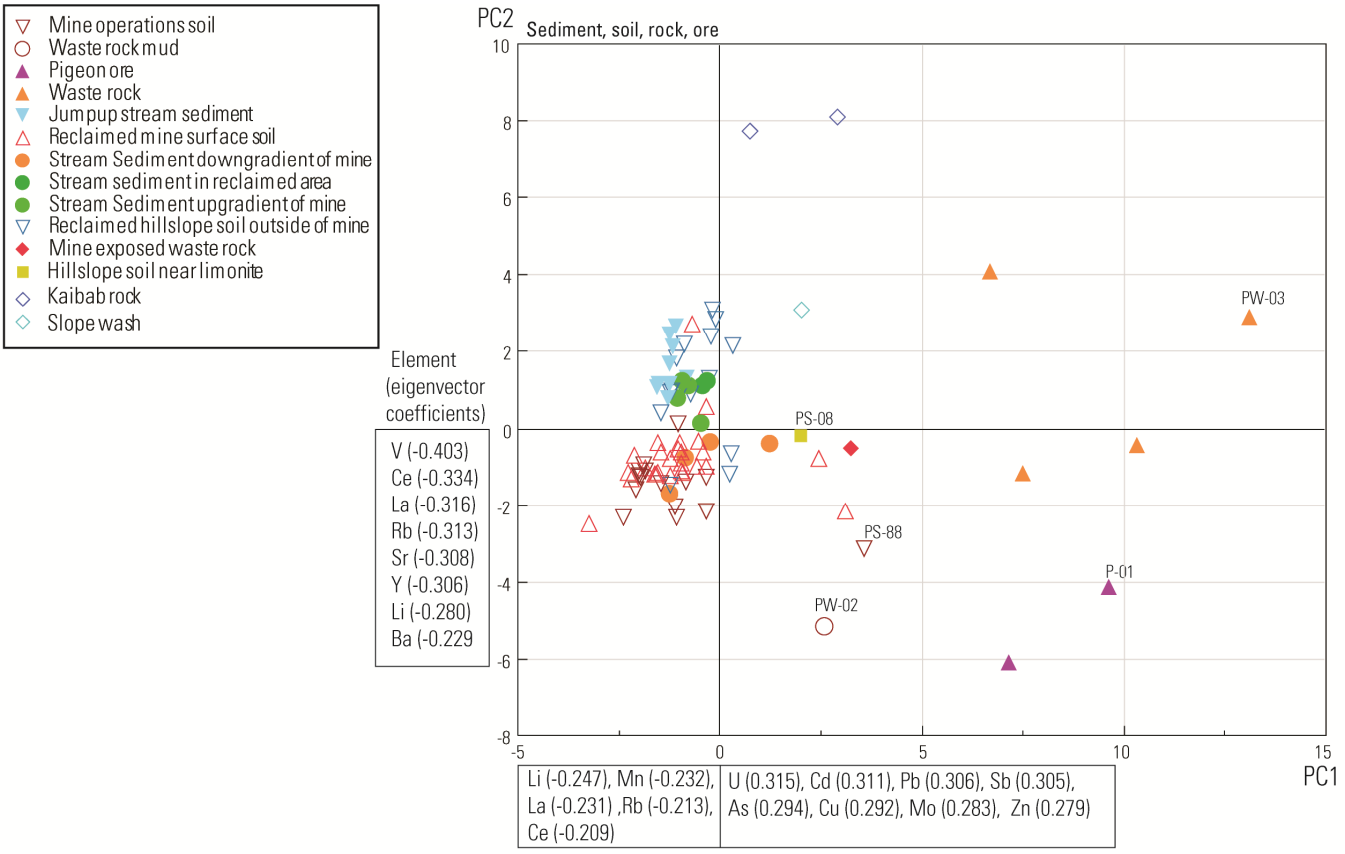

Figure S2. Principal component (PCA) analysis of solid samples from Otton et al., 2010, numbers next to element names on the sides of the graph represent the eigenvector coefficients.

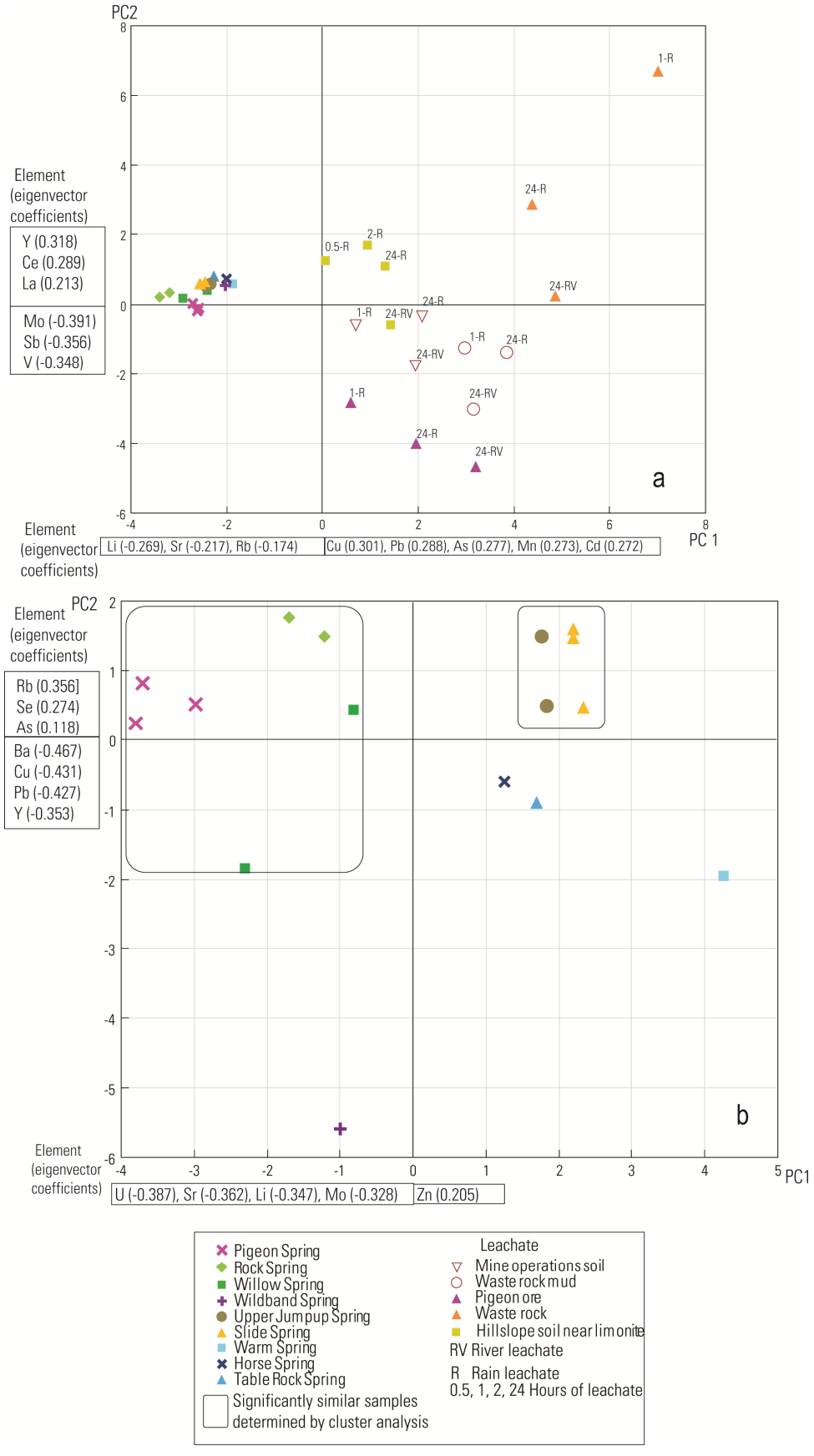

Figure S3. Principal component (PCA) analysis of **a**) leachate samples from Otton et al., 2010 with recent spring samples and **b**) recent spring samples only. Numbers next to element names on the sides of the graph represent the eigenvector coefficients.

Table S1 Water chemistry results for spring samples collected between 2009 and 2015.

Sample Number	USGS ID	Site Name	Date	Time	Water Temperature	Barometric pressure	Specific conductance	Dissolved oxygen	pH (field)	Discharge
					C	mmHg	uS/cm	mg/L	units	gal/min
1	363450112325001	Upper Jumpup Spring	8/27/2009	14:30	13.4	-	709	5	7.4	1.3
2	363450112325001	Upper Jumpup Spring	7/7/2015	16:45	13.3	636	1020	8.4	6.6	-
3	363901112341601	Horse Spring	8/25/2015	16:10	18.2	644	1250	7.3	7.5	-
4	363922112334501	Slide Spring	8/27/2009	15:15	15.6	-	1200	2.6	7.3	89.8
5	363922112334501	Slide Spring	7/27/2011	15:45	15.5	639	1150	8	7.5	67
6	363922112334501	Slide Spring	8/25/2015	10:45	15.6	644	1120	6.4	7.8	32
7	364101112340601	Rock Spring	9/2/2009	10:30	18.2	674	2460	7.7	7.9	0.11
8	364101112340601	Rock Spring	8/3/2011	12:00	19.8	647	2520	7.5	7.2	-
9	364143112184501	Warm Spring	8/26/2015	9:35	11.4	599	545	8.5	7	3.8
10	364210112310501	Willow Spring	3/15/2012	10:30	11.1	646	2610	8.9	8.2	0.75
11	364210112310501	Willow Spring	11/7/2012	11:00	12.2	646	2860	8.8	8	1.14
12	364242112274701	Table Rock Spring	8/27/2015	10:00	17.9	638	1447	7.72	7.75	-
13	364259112303201	Wildband Spring	11/6/2012	14:00	15	645	3250	9.4	8.3	0.3
14	364327112303101	Pigeon Spring	3/15/2012	12:00	8.3	642	2640	0.3	7	0.06
15	364327112303101	Pigeon Spring	11/7/2012	10:00	11.8	644	2750	6.2	7.2	-
16	364327112303101	Pigeon Spring	9/10/2014	13:30	20	631	2610	4.7	6.9	-

Table S1 Water chemistry results for spring samples collected between 2009 and 2015, continued.

Sample Number	Carbonate	Hydrogen carbonate	Alkalinity mg/L as CaCO3	Al	As	B	Ba	Be	Bi	Ca	Cd	Ce	Cl	Co	Cr	Cs	Cu
	mg/L	mg/L		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L
1	-	195	160	0.21	1	40	11	<0.02	<0.006	137	<0.002	0.0023		<0.2	3.1	0.17	0.13
2	0.1	189	155	2.5	0.97	40	11	<0.004	0.08	125	0.010	0.0015	16	0.019	3.2	-	0.49
3	0.8	222	183	1.8	0.63	56	13	0.005	0.08	150	0.011	0.0026	20	0.37	2.3	-	1.1
4	-	232	190	0.23	0.77	63	10	<0.02	<0.006	147	<0.002	<0.0006		<0.2	2.9	0.091	0.22
5	-	232	191	0.7	0.73	67	10	0.007	0.05	139	0.014	0.0007	13	<0.4	3.1	0.11	0.04
6	0.2	221	182	0.8	0.64	65	10	<0.004	0.07	140	0.014	<0.0004	16	0.026	3.0	-	0.84
7	1	154	128	0.66	0.41	230	8.6	0.007	<0.006	404	<0.001	0.0012		<0.2	0.7	0.017	<0.007
8	-	141	116	<1	0.7	271	8.7	<0.1	0.18	424	<0.03	0.003	12	<0.4	<2	0.9	<0.08
9	0.4	183	151	2.0	0.34	22	17	<0.002	0.02	58	<0.003	0.0009	8.4	0.15	2.4	-	1.8
10	-	171	140	<0.2	0.73	159	12	<0.01	<0.005	438	0.009	0.0002	22	<0.9	<0.09	0.017	<0.08
11	1	244	202	<1	0.58	175	14	<0.008	<0.03	482	0.003	0.0027	20	0.04	<0.3	0.95	1.7
12	0.5	159.9	132	1.7	0.30	60	9.3	<0.005	<0.05	208	0.041	<0.0006	25	<2	<0.2	-	1.2
13	0.9	150	125	2.1	0.75	171	23	<0.007	<0.02	639	0.014	0.0024	23	<0.04	<0.4	0.045	1.6
14	-	297	244	0.2	0.76	173	12	<0.01	<0.005	436	0.01	0.0046	22	0.9	0.09	0.041	<0.08
15	0.3	292	240	<0.2	0.51	144	12	0.003	<0.006	455	0.0054	0.0023	21	0.05	0.77	0.082	0.5
16	0.2	294	242	2	0.6	179	11	<0.06	<0.1	442	<0.03	0.008	20	<8	<2	-	0.6

Table S1 Water chemistry results for spring samples collected between 2009 and 2015, continued.

Sample Number	Dy	Er	Eu	F	Fe	Ga	Gd	Hg	Ho	K	La	Li	Lu	Mg	Mn	Mo
	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L
1	<0.0004	<0.001	<0.001	-	<2	0.0017	<0.0004	-	0.0003	1.6	0.0008	8.7	<0.0001	59	<0.02	4.3
2	0.0004	<0.0003	<0.0001	0.21	25	0.0021	<0.0003	0.2	<0.00006	1.6	0.0016	8.5	0.00009	59	<0.1	4.2
3	0.0005	0.0005	0.00078	0.28	8.8	0.0013	0.0004	0.4	<0.00006	1.7	0.0020	12	<0.00007	66	1.6	3.1
4	<0.0004	<0.001	<0.001	-	<2	0.002	<0.0004	-	<0.0003	1.9	0.0002	13	<0.0001	65	<0.02	2.4
5	<0.001	<0.0007	<0.001	0.27	3	-	0.0008	1	0.0003	1.9	<0.0007	13	<0.0003	71	0.06	3.1
6	<0.0002	<0.0003	<0.0001	0.31	4.5	0.0016	<0.0003	0.4	<0.00006	2.1	0.0004	13	<0.00007	68	<0.1	2.5
7	0.0007	0.0006	<0.001	-	4	0.0023	<0.0004	-	0.0001	4.8	0.0008	63	<0.0001	150	0.038	8.7
8	<0.004	<0.005	<0.002	0.56	6	-	<0.007	0.7	<0.002	5.3	0.002	75	<0.002	158	0.12	9.8
9	0.0001	0.0002	<0.00005	0.17	1.0	0.0018	<0.0002	0.5	<0.00003	0.79	0.0010	3.1	<0.00003	29	0.19	0.48
10	0.0007	0.001	0.0005	0.71	<2	-	<0.0007	-	0.00013	3.9	0.0005	37	<0.0002	154	<0.02	18
11	0.0007	<0.0008	<0.0003	0.65	<7	-	0.0006	<0.1	0.00024	3.9	0.0034	47	<0.0003	167	2.5	17
12	<0.0004	<0.0005	0.0006	0.64	8	0.003	<0.0005	0.3	<0.0001	2.4	0.0008	12	<0.0001	79	0.5	7.4
13	0.0009	<0.0007	<0.0003	0.77	<15	-	0.001	<0.1	<0.0002	1.7	0.0021	38	<0.0002	206	<0.7	22
14	0.0015	0.0011	0.0005	0.45	4	-	0.001	-	0.00033	5	0.0033	40	<0.0002	160	4.1	12
15	0.00061	0.0007	<0.00007	0.49	<1	-	0.0002	<0.1	0.00018	5.2	0.0033	33	<0.00006	171	2.5	9.2
16	<0.002	0.002	0.0022	0.52	7	0.01	<0.001	-	<0.0005	5.3	0.005	35	<0.0004	152	1	10

Table S1 Water chemistry results for spring samples collected between 2009 and 2015, continued.

Sample Number	Na	Nd	Ni	P	Pb	Pr	Rb	Re	S	SO4	Sb	Sc	Se	SiO2	Sm	Sn	Sr	Tb
	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L
1	9.6	0.0006	<0.3	<5	0.01	0.0005	2	0.22	159	401	0.016	<0.4	19	9.8	<0.0009	0.011	1160	<0.0002
2	10	0.0012	<2	<3	0.11	0.0003	1.9	-	122	393	0.042	-	19	10	<0.0005	0.11	1086	<0.00006
3	10	0.0014	<2	<3	0.088	0.0003	1.6	-	140	484	0.26	-	20	10	<0.0005	0.06	1587	0.00007
4	9.3	<0.0005	<0.3	<5	0.004	<0.0002	2	0.24	165	428	0.015	<0.4	21	9.8	<0.0009	<0.008	1640	<0.0002
5	11	0.002	<1	<3	<0.1	<0.0002	1.9	0.24	159	416	<0.2	<0.2	18	11	<0.002	<0.4	1618	<0.0002
6	11	<0.0008	<2	16	0.062	<0.0002	1.9	-	136	429	0.032	-	20	10	<0.0005	0.07	1558	0.00007
7	35	0.0007	<0.3	<8	0.006	<0.0002	4	0.47	534	1660	0.03	<0.4	12	13	<0.0009	<0.008	6130	0.0004
8	35	<0.007	<1	<11	<0.08	<0.002	4.2	0.5	622	1632	<0.6	<0.1	12	13	<0.01	1	5928	<0.0009
9	5.5	0.0007	0.90	4	0.026	0.00014	0.72	-	38	128	0.22	-	3.3	8.8	<0.0003	0.05	471	0.00004
10	28	0.0011	<1	<2	0.015	0.00013	1.8	0.63	582	1435	0.1	<0.5	26	13	0.0013	<0.03	5087	<0.0001
11	34	<0.0009	<4	<4	0.061	0.0005	2.2	0.66	581	1635	0.2	-	12	14	<0.0009	<0.3	5620	<0.0002
12	14	<0.001	7	<4	0.14	<0.0003	1.7	-	214	693	0.19	-	15	13	<0.0008	0.04	1916	<0.00009
13	28	0.002	<4	<6	0.33	0.0005	0.38	0.45	762	2069	<0.1	-	5.3	20	<0.0006	<0.3	6321	<0.0001
14	17	0.0034	<1	<2	0.019	0.00076	3.6	3.5	561	1325	0.082	<0.5	72	12	0.0022	0.04	4814	0.0004
15	22	0.0021	<4	12	0.019	0.00048	4.7	3.6	562	1520	0.04	-	51	14	0.0008	1.7	4982	0.00004
16	16	0.004	<15	<30	0.15	<0.001	5.6	3.4	472	1448	0.05	-	69	13	<0.003	-	5198	<0.0004

Table S1 Water chemistry results for spring samples collected between 2009 and 2015, continued.

Sample Number	Te	Th	Ti	Tl	Tm	U	V	W	Y	Yb	Zn	Zr
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
1	<0.008	0.002	<0.2	0.095	<0.0001	3.9	0.86	<0.002	0.01	0.0009	13	0.026
2	<0.006	0.0056	<0.6	0.18	<0.00008	3.8	0.86		0.013	0.0004	15	1.6
3	<0.006	0.0021	<0.6	0.16	<0.00008	3.7	1.3		0.018	0.0004	25	2.7
4	0.011	0.004	<0.2	0.081	<0.0001	2.8	1.2	<0.002	0.012	<0.0007	15	0.041
5	<0.03	0.025	<0.5	0.12	<0.0002	2.7	1.2	0.009	0.011	<0.0006	16	1.1
6	<0.006	0.0031	<0.6	0.16	<0.00008	2.8	1.3		0.017	<0.0002	17	4.6
7	0.009	0.007	<0.2	0.02	<0.0001	14	0.5	<0.001	0.037	<0.0005	1	0.1
8	<0.1	0.16	<0.3	0.1	<0.002	16	<0.4	0.05	0.03	<0.003	6.6	0.64
9	<0.003	0.0012	<0.3	0.034	<0.00004	0.86	2.0		0.0056	<0.0001	2.9	1.3
10	<0.002	0.0074	<0.6	0.013	<0.0002	14	0.65	0.008	0.051	0.0003	1.8	0.057
11	0.06	0.031	<2	0.021	<0.0003	18	0.7	<0.03	0.068	0.0013	3.8	0.11
12	<0.01	0.0052	<1	0.46	<0.0001	6.6	0.39		0.019	<0.0004	17	3.4
13	0.007	0.015	<1	0.004	0.00019	8.7	0.99	<0.01	0.13	0.0004	3.8	0.14
14	0.009	0.016	<0.6	0.009	0.0003	92	1.6	0.007	0.054	0.001	2.5	0.061
15	0.008	0.0049	<0.3	0.024	<0.00006	74	1	<0.005	0.056	0.00034	2.8	0.13
16	<0.04	<0.02	-	0.06	<0.0005	73	1.9	-	0.042	<0.002	10	0.0089

Table S1 Water chemistry results for spring samples collected between 2009 and 2015, continued.

Sample Number	Total nitrogen	Organic nitrogen	Ammonia	Nitrite	Nitrate	Ammonia plus organic nitrogen	Nitrate plus nitrite	Orthophosphate	Phosphorus, unfiltered	Phosphorus, filtered	Orthophosphate
	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L as N	mg/L as N	mg/L as N	mg/L as PO4	mg/L as P	mg/L as P	mg/L as P
1	< 1.5	< 0.10	< 0.02	< 0.002	1.43	< 0.10	1.43	E 0.018	< 0.04	< 0.04	E 0.006
2	< 1.4	< 0.07	< 0.01	< 0.001	1.32	< 0.07	1.32	0.021	< 0.02	< 0.02	0.007
3	1.4	0.1	0.01	< 0.001	1.25	0.11	1.25	0.017	0.07	< 0.02	0.006
4	< 1.4	< 0.10	< 0.02	< 0.002	1.29	< 0.10	1.29	E 0.015	< 0.04	< 0.04	E 0.005
5	-	-	-	-	-	-	-	-	-	-	-
6	< 1.2	< 0.07	< 0.01	< 0.001	1.17	< 0.07	1.17	0.017	< 0.02	< 0.02	0.005
7	< 0.14	< 0.10	< 0.02	< 0.002	< 0.040	< 0.10	< 0.04	E 0.019	< 0.04	< 0.04	E 0.006
8	-	-	-	-	-	-	-	-	-	-	-
9	< 0.45	< 0.07	< 0.01	< 0.001	0.379	< 0.07	0.379	0.016	< 0.02	< 0.02	0.005
10	< 0.11	< 0.06	0.01	< 0.001	< 0.040	< 0.07	< 0.040	0.014	< 0.02	< 0.02	0.005
11	< 0.11	< 0.06	0.01	< 0.001	< 0.040	< 0.07	< 0.040	0.017	< 0.02	< 0.02	0.005
12	-	-	0.0412	0.00153		0.111	0.341		<0.02	<0.02	0.00682
13	< 0.26	0.2	0.02	< 0.001	< 0.040	0.22	< 0.040	0.02	0.02	< 0.02	0.006
14	0.4	0.19	0.07	< 0.001	0.14	0.26	0.14	0.581	0.16	0.2	0.19
15	0.26	0.09	0.03	< 0.001	0.141	0.12	0.141	0.06	< 0.02	0.02	0.02
16	< 0.22	< 0.05	0.02	< 0.001	0.147	< 0.07	0.147	0.017	< 0.02	0.02	0.006

Table S1 Water chemistry results for spring samples collected between 2009 and 2015, continued.

Sample Number	Tritium	Tritium	^{238}U	^{234}U	^{235}U	$^{234}U/^{238}U$	Carbon-14	Carbon-14 (normalized)	Carbon-14 counting error	Strontium-87/Strontium-86 ratio	delta Carbon-13	$\delta^{2}H$	$\delta^{18}O$
	pCi/L	TU	pCi/L	pCi/L	pCi/L	ratio	pmC	pM	pM	per mil	per mil	per mil	per mil
1	<0.3	<0.09	-	-	-	4.584	22.11	21.44	0.19	0.7079	-6.24	-90.34	-12.23
2	-	-	1.26	5.7	0.09	-	21.30	20.67	0.08	-	-6.31	-	-
3	0.3	0.09	1.22	5.8	0.11	-	15.48	15	0.1	0.70779	-5.61	-89.8	-11.89
4	0	0	-	-	-	5.59	8.86	8.59	0.09	0.70778	-6.01	-88.69	-11.67
5	0.3	0.09	0.89	4.7	R 0.00045	5.479	-	-	-	-	-	-87.9	-11.71
6	0.35	0.11	0.94	4.9	0.11	-	9.38	9.1	0.1	0.70774	-6.26	-88.2	-11.74
7	1.35	0.42	-	-	-	2.434	48.35	46.76	0.3	0.70785	-5.02	-90.91	-11.87
8	0.8	0.25	4.3	10.7	0.27	2.42	-	-	-	-	-	-90.2	-11.81
9	1.4	0.43	0.304	1.97	0.032	-	41.98	40.9	0.1	0.70796	-8.34	-96.8	-13.26
10	1.9	0.59	3.56	8.5	0.31	2.313	67.38	65.32	0.2	0.7078	-6.01	-91.2	-12.05
11	1.7	0.53	5.3	12.2	0.27	2.304	66.32	64.64	0.16	0.70781	-8.69	-90.7	-12.1
12	1.47	0.46	2.21	3.98	0.192	-	30.07	29.1	0.2	0.70834	-4.92	-85.56	-11.71
13	1.8	0.56	3.02	6.3	0.15	2.121	105.76	102.3	0.27	0.70778	-4.94	-79.8	-9.61
14	1.3	0.40	28.9	41.4	2.3	1.399	13.60	13.12	0.11	0.70852	-3.77	-90.9	-12.05
15	0.9	0.28	24	32.9	1.21	1.404	11.20	10.81	0.14	0.70852	-3.69	-91.2	-11.96
16	0.8	0.25	25	36	1.26	-	13.45	12.99	0.07	-	-4.15	-89.2	-11.84

Table S2 Saturation indices determined from PHREEQC.

Sample Number	Spring Name	Date	Barite	Calcite	Chalcedony	Coffinite	Dolomite	Fe(OH)3(a)	Fe3(OH)8	Goethite	Gypsum	Halite	Hematite	Quartz	U(OH)2SO4	U3O8(c)	U4O9(c)	UF4 (c)	UF4:2.5H2O	UO2(a)	UO3 (gamma)	Uraninite (c)
1	Upper Jumpup Spring	8/27/2009	-0.06	0.04	-0.09	-8.41	-0.1	-0.21	-4.27	5.25	-0.9	-8.39	12.46	0.37	-26.27	-14.2	-25	-43	-33.74	-12.05	-7.5	-7.7
2	Upper Jumpup Spring	7/7/2015	-0.06	-0.81	-0.08	-6.53	-1.76	-1.09	-6.12	4.36	-0.94	-8.38	10.68	0.38	-22.79	-11.8	-19	-39	-29.12	-10.18	-7.24	-5.83
3	Horse Spring	8/25/2015	-0.05	0.28	-0.15	-9.23	0.46	0.88	-1.21	6.53	-0.83	-8.3	15.03	0.3	-27.38	-15.3	-27	-44	-35.08	-13.02	-7.6	-8.44
4	Slide Spring	8/27/2009	-0.14	0.06	-0.12	-8.68	-0.01	-0.45	-4.96	5.09	-0.87	-8.44	12.15	0.34	-26.39	-15	-26	-43	-33.11	-12.39	-7.73	-7.93
5	Slide Spring	7/27/2011	-0.15	0.24	-0.07	-9.15	0.41	0.46	-2.4	6.01	-0.91	-8.44	13.98	0.39	-27.32	-15.8	-27	-44	-35.03	-12.91	-7.86	-8.46
6	Slide Spring	8/25/2015	-0.14	0.52	-0.12	-9.93	0.94	0.99	-1.13	6.54	-0.89	-8.35	15.03	0.34	-28.64	-16.7	-30	-46	-36.72	-13.64	-7.99	-9.19
7	Rock Spring	9/2/2009	-0.06	0.74	-0.03	-9.37	1.31	0.83	-1.77	6.48	-0.16	-7.93	14.93	0.42	-28.03	-14.4	-27	-44	-35.21	-13.28	-7.06	-8.69
8	Rock Spring	8/3/2011	-0.09	0.06	-0.05	-7.51	-0.03	0.02	-3.55	5.72	-0.16	-8.04	13.42	0.4	-24.84	-11.3	-21	-41	-31.32	-11.47	-6.42	-6.81
9	Warm Spring	8/26/2015	-0.07	-0.67	-0.12	-7.85	-1.49	-1.28	-7.02	4.11	-1.57	-8.88	10.15	0.36	-25.19	-14.4	-23	-42	-32.16	-11.38	-7.92	-7.13
10	Willow Spring	3/15/2012	0.19	1.03	0.05	-9.78	1.75	0.72	-2.24	6.09	-0.15	-7.85	14.12	0.53	-28.88	-16	-29	-47	-36.89	-13.46	-7.65	-9.23
11	Willow Spring	11/7/2012	0.25	1.03	0.08	-9.66	1.77	1.14	-0.8	6.55	-0.1	-7.81	15.05	0.55	-28.39	-16.3	-29	-46	-36.22	-13.42	-7.84	-9.13
12	Table Rock Spring	8/27/2015	-0.13	0.47	-0.03	-9.16	0.77	1.1	-0.81	6.73	-0.61	-8.07	15.43	0.42	-27.79	-14.5	-27	-44	-34.71	-13.06	-7.18	-8.49
13	Wildband Spring	11/6/2012	0.43	1.21	0.19	-10.26	2.14	1.34	-0.55	6.87	0.04	-7.86	15.69	0.65	-29.78	-16.7	-31	-47	-38.03	-14.25	-7.68	-9.83
14	Pigeon Spring	3/15/2012	0.24	0.06	0.06	-6.15	-0.2	-0.97	-6.01	4.29	-0.17	-8.05	10.51	0.55	-22.77	-10.4	-17	-39	-29.14	-9.72	-6.71	-5.63
15	Pigeon Spring	11/7/2012	0.18	0.3	0.08	-6.99	0.35	-1.22	-7.05	4.18	-0.14	-7.98	10.31	0.56	-24.15	-11.6	-20	-40	-30.84	-10.74	-6.83	-6.47
16	Pigeon Spring	9/10/2014	-0.02	0.12	-0.05	-6.91	0.06	-0.76	-5.6	4.95	-0.18	-8.15	11.88	0.4	-23.7	-10.7	-19	-39	-29.65	-10.87	-6.4	-6.2

Table S3 Principal component (PCA) values.

Water

Eigenvalues

PC	Eigenvalue	%Variation	Cum.%Variation
1	8.3	46.1	46.1
2	4.04	22.5	68.6
3	2.82	15.7	84.3
4	0.919	5.1	89.4
5	0.577	3.2	92.6

Eigenvectors

(Coefficients in the linear combinations of variables making up PC's)

Variable	PC1	PC2	PC3	PC4	PC5
As	0.277	-0.287	0.035	-0.035	0.105
Cd nc	0.272	0.089	-0.301	0.052	0.344
Sr	-0.217	0.135	-0.412	-0.026	-0.149
Ba	0.26	-0.245	0.097	0.137	-0.144
Ce nc	0.226	0.289	0.06	-0.474	-0.002
Li nc	-0.269	0.026	-0.222	-0.253	-0.359
La nc	0.222	0.213	0.256	-0.454	-0.032
Sb nc	0.194	-0.356	-0.08	-0.191	0.397
Y nc	0.238	0.318	-0.046	-0.317	0.025
Cu nc	0.301	0.134	-0.197	0.174	-0.001
Mn nc	0.273	0.188	-0.159	0.166	-0.088
Pb nc	0.288	0.12	-0.114	0.028	-0.497
Zn	0.239	0.195	-0.25	0.244	0.223
U	0.257	-0.222	-0.245	0.016	-0.269
Mo nc	0.154	-0.391	-0.134	-0.179	-0.108
Rb	-0.174	-0.21	-0.308	-0.426	0.219
V nc	0.169	-0.348	0.084	-0.096	-0.32
Se nc	-0.121	-0.023	-0.532	-0.062	-0.025

Table S3 Principal component (PCA) values, continued.

Springs

Eigenvalues

PC	Eigenvalue	%Variation	Cum.%Variation
1	6.18	34.3	34.3
2	3.57	19.8	54.2
3	2.6	14.5	68.6
4	1.69	9.4	78
5	1.53	8.5	86.6

Eigenvectors

(Coefficients in the linear combinations of variables making up PC's)

Variable	PC1	PC2	PC3	PC4	PC5
As	-0.009	0.118	-0.068	0.562	0.246
Cd nc	0.102	-0.141	0.1	-0.348	0.552
Sr	-0.362	-0.041	0.232	0.042	0.055
Ba	-0.005	-0.467	-0.119	0.212	-0.2
Ce nc	-0.281	-0.019	-0.333	-0.032	0.009
Li nc	-0.347	0.025	0.274	0.025	-0.018
La nc	-0.317	-0.11	-0.301	-0.142	-0.034
Sb nc	-0.029	-0.026	0.183	-0.466	-0.224
Y nc	-0.257	-0.353	0.136	0.21	0.04
Cu nc	0.089	-0.431	-0.152	-0.275	-0.042
Mn nc	-0.245	-0.042	-0.286	-0.275	-0.062
Pb nc	-0.043	-0.427	-0.042	0.024	0.382
Zn	0.205	0.091	-0.212	-0.124	0.489
U	-0.387	0.049	-0.074	-0.06	0.024
Mo nc	-0.328	-0.137	0.245	0.093	0.194
Rb	-0.264	0.356	-0.069	-0.158	-0.019
V nc	0.046	-0.081	-0.54	0.169	-0.161
Se nc	-0.225	0.274	-0.277	0.028	0.29

Table S3 Principal component (PCA) values, continued.

Solids

Eigenvalues

PC	Eigenvalue	%Variation	Cum.%Variation
1	8.19	48.2	48.2
2	4.72	27.8	75.9
3	1.34	7.9	83.8
4	0.884	5.2	89
5	0.541	3.2	92.2

Eigenvectors

(Coefficients in the linear combinations of variables making up PC's)

Variable	PC1	PC2	PC3	PC4	PC5
As	0.294	-0.15	0.109	-0.061	0.01
Cd nc	0.311	-0.086	0.211	0.043	0.215
Sr	0.121	-0.308	-0.243	0.568	0.073
Ba	-0.045	-0.229	-0.692	-0.074	0.224
Ce nc	-0.209	-0.334	0.115	0.099	-0.08
Li nc	-0.247	-0.28	0.204	0.056	0.117
La nc	-0.231	-0.316	0.015	-0.14	-0.292
Sb nc	0.305	-0.145	-0.026	-0.12	-0.317
Y nc	-0.099	-0.306	-0.332	-0.499	-0.17
Cu nc	0.292	-0.132	-0.222	0.136	0.304
Mn nc	-0.232	-0.169	0.171	-0.37	0.62
Pb nc	0.306	-0.164	-0.026	0.026	-0.137
Zn	0.279	-0.197	0.234	-0.076	0.319
U	0.315	-0.143	0.006	-0.165	0.025
Mo nc	0.283	-0.162	0.192	-0.32	-0.202
Rb	-0.213	-0.313	0.208	0.145	-0.01
V nc	-0.07	-0.403	0.162	0.243	-0.156

Table S4 Pigeon Mine material leachate chemistry, PW-03, PS-88 and PW-02 are reported in Otton et al. 2010.

Sample Name	USGS ID	Sample Type and leachate duration	Description (from Otton et al. 2010)
P-01-1-R	Pigeon Ore	Ore Rain Leachate (1 hr)	
P-01-24-R	Pigeon Ore	Ore Rain Leachate (24 hr)	
P-01-24-RV	Pigeon Ore	Ore River Leachate (24 hr)	
PW-03-1-R	PW-03	Waste Rock Rain Leachate (1 hr)	Waste rock at south edge of reclaimed mine operations area Pigeon
PS-88-1-R	PS-88	Waste Rock Rain Leachate (1 hr)	N-S soil transect across mine operations area (former waste rock pile)
PW-02-1-R	PW-02	Waste Rock Rain Leachate (1 hr)	Grey mud on soil, mine operations area, former waste rock pile Pigeon
PW-03-24-R	PW-03	Waste Rock Rain Leachate (24 hr)	Waste rock at south edge of reclaimed mine operations area Pigeon
PS-88-24-R	PS-88	Waste Rock Rain Leachate (24 hr)	N-S soil transect across mine operations area (former waste rock pile)
PW-02-24-R	PW-02	Waste Rock Rain Leachate (24 hr)	Grey mud on soil, mine operations area, former waste rock pile Pigeon
PS-08-24-R	PS-08	Limonite Rain Leachate (24 hr)	Surface soil on hillslopes outside of Pigeon Mine reclaimed area (limonite)
PS-08-0.5-R	PS-08	Limonite Rain Leachate (30 min)	Surface soil on hillslopes outside of Pigeon Mine reclaimed area (limonite)
PS-08-2-R	PS-08	Limonite Rain Leachate (2 hr)	Surface soil on hillslopes outside of Pigeon Mine reclaimed area (limonite)
PW-03-24-RV	PW-03	Waste Rock River Leachate (24 hr)	Waste rock at south edge of reclaimed mine operations area Pigeon
PS-88-24-RV	PS-88	Waste Rock River Leachate (24 hr)	N-S soil transect across mine operations area (former waste rock pile)
PW-02-24-RV	PW-02	Waste Rock River Leachate (24 hr)	Grey mud on soil, mine operations area, former waste rock pile Pigeon
PS-08-24-RV	PS-08	Limonite River Leachate (24 hr)	Surface soil on hillslopes outside of Pigeon Mine reclaimed area (limonite)

Table S4 Pigeon Mine material leachate chemistry, PW-03, PS-88 and PW-02 are reported in Otton et al. 2010, continued.

Sample Name	Al ug/L	As ug/L	Ba ug/L	Be ug/L	Bi ug/L	Ca mg/L	Cd ug/L	Ce ug/L	Co ug/L	Cr ug/L	Cs ug/L	Cu ug/L	Dy ug/L	Er ug/L	Eu ug/L	Fe ug/L	Ga ug/L	Gd ug/L	Ge ug/L
P-01-1-R	5.9	910	63	<0.05	<0.2	28.5	0.74	<0.01	89.2	<1	0.13	0.74	<0.005	<0.005	<0.005	<50	<0.05	<0.005	0.06
P-01-24-R	4.8	4600	131	<0.05	<0.2	48.8	2.92	<0.01	68.1	<1	0.23	26.6	<0.005	<0.005	<0.005	<50	<0.05	<0.005	0.23
P-01-24-RV	2.2	8520	262	<0.05	<0.2	40.2	3.78	0.01	272	5.1	0.38	9.5	0.005	<0.005	0.005	<50	<0.05	<0.005	0.51
PW-03-1-R	5.8	18.2	25.9	<0.05	<0.2	409	14.6	7.11	7.72	<1	< 0.02	3870	1.59	0.54	0.72	266	0.1	2.56	0.1
PS-88-1-R	38.9	50.5	140	<0.05	<0.2	13.9	0.09	0.07	0.74	<1	< 0.02	9.6	0.02	0.005	<0.005	<50	0.07	0.01	<0.05
PW-02-1-R	303	489	166	<0.05	<0.2	7.96	0.19	0.52	4.71	1	0.03	16.8	0.063	0.04	0.01	75	0.21	0.079	0.05
PW-03-24-R	2.5	29.7	61.5	<0.05	<0.2	599	16.3	0.39	13.6	<1	< 0.02	3270	0.12	0.052	0.03	<50	<0.05	0.18	0.1
PS-88-24-R	257	88.6	165	<0.05	<0.2	19.9	0.21	0.42	3.26	<1	0.02	11.8	0.05	0.02	0.008	103	0.1	0.04	<0.05
PW-02-24-R	657	799	133	<0.05	<0.2	14	0.74	0.83	12	1.4	0.07	19.6	0.11	0.05	0.03	186	0.33	0.1	0.06
PS-08-24-R	369	47.9	147	0.05	<0.2	11.5	0.11	0.51	0.72	1	0.03	2	0.063	0.02	0.01	138	0.2	0.063	<0.05
PS-08-0.5-R	289	15.1	8.6	<0.05	<0.2	5.9	0.08	0.36	0.28	<1	0.04	1	0.04	0.02	0.01	258	0.2	0.04	-
PS-08-2-R	485	24.1	11.1	<0.05	<0.2	7.1	0.08	0.7	0.53	1.4	0.08	1.6	0.068	0.04	0.02	603	0.21	0.098	-
PW-03-24-RV	<2	807	81.8	<0.05	<0.2	621	5.5	0.04	11.2	11	0.09	870	0.03	0.02	0.009	<50	<0.05	0.04	0.2
PS-88-24-RV	142	193	88.4	<0.05	<0.2	24	0.32	0.17	1.98	11.1	0.02	14.5	0.02	0.01	<0.005	<50	0.09	0.03	<0.05
PW-02-24-RV	280	1310	137	0.09	<0.2	18.7	1.44	0.2	5.33	9.8	0.04	19.4	0.03	0.02	<0.005	57	0.2	0.02	0.1
PS-08-24-RV	163	80.3	228	<0.05	<0.2	15.8	0.05	0.21	0.35	10.8	0.03	2.2	0.03	0.009	0.01	<50	0.1	0.03	<0.05

Table S4 Pigeon Mine material leachate chemistry, PW-03, PS-88 and PW-02 are reported in Otton et al. 2010, continued.

Sample Name	Ho ug/L	K mg/L	La ug/L	Li ug/L	Lu ug/L	Mg mg/L	Mn ug/L	Mo ug/L	Na mg/L	Nb ug/L	Nd ug/L	Ni ug/L	P ug/L	Pb ug/L	Pr ug/L	Rb ug/L	SO4 mg/L	Sb ug/L	Sc ug/L	Se ug/L
P-01-1-R	<0.005	0.96	<0.01	2.3	<0.1	2.8	2.3	507	0.83	<0.2	<0.01	623	0.03	0.06	<0.01	2.45	77	49.5	<0.6	6.8
P-01-24-R	<0.005	1.24	0.02	3.1	<0.1	3.9	0.7	1700	0.68	<0.2	<0.01	291	0.05	0.09	<0.01	3.8	119	349	<0.6	13
P-01-24-RV	<0.005	2	0.04	1.7	<0.1	4.44	2.3	2620	-	0.41	<0.01	1180	0.1	0.5	<0.01	5.16	123	553	0.8	29.7
PW-03-1-R	0.25	0.2	0.85	0.9	<0.1	2.29	108	2.5	0.66	<0.2	12.4	96.3	<0.01	12.7	1.92	0.32	1050	1.08	<0.6	8.6
PS-88-1-R	<0.005	0.91	0.04	3	<0.1	1.72	1.2	28.5	2.4	<0.2	0.05	7	0.1	0.4	0.01	0.18	30	1.96	<0.6	1
PW-02-1-R	0.02	1.17	0.26	2.4	<0.1	0.97	2.8	106	4.27	<0.2	0.36	18.6	0.3	3.8	0.08	0.54	10	7.25	<0.6	2.5
PW-03-24-R	0.02	0.2	0.08	1.9	<0.1	3.21	186	9.3	2	<0.2	0.57	182	0.02	2.1	0.09	0.22	1600	1.92	<0.6	16.7
PS-88-24-R	0.008	1.55	0.22	4.6	<0.1	2.67	4.7	122	2.19	<0.2	0.29	18	0.1	2.1	0.06	0.48	38	3.35	<0.6	1.2
PW-02-24-R	0.02	3.03	0.41	5.3	<0.1	1.76	7.6	503	1.65	<0.2	0.52	40.1	0.2	4.5	0.12	1.09	6	13.3	0.6	2.9
PS-08-24-R	0.01	0.78	0.42	4.3	<0.1	2.15	8.3	<2	2.22	<0.2	0.39	3.3	0.3	0.58	0.1	0.42	6	0.65	<0.6	<1
PS-08-0.5-R	0.006	1	0.29	<0.1	-	0.95	2.7	<2	0.33	<0.2	0.26	1.3	0.2	0.24	0.06	0.57	<2	0.49	<0.6	<1
PS-08-2-R	0.02	1	0.59	<0.1	-	1.2	5.7	<2	0.33	<0.2	0.51	2	0.2	0.45	0.13	0.89	<2	0.63	<0.6	<1
PW-03-24-RV	0.006	0.54	0.02	<0.1	<0.1	3.56	161	34.3	-	0.23	0.1	153	0.04	18.8	0.01	0.97	1500	3.07	0.7	33.2
PS-88-24-RV	<0.005	3.14	0.09	0.7	<0.1	3.71	2.2	234	-	<0.2	0.1	16.3	0.2	0.93	0.03	0.94	28	4.38	<0.6	3.6
PW-02-24-RV	0.006	5.19	0.11	1.5	<0.1	2.82	3	1050	-	<0.2	0.13	24.7	0.4	2	0.03	1.36	<2	18.5	0.6	6.7
PS-08-24-RV	0.006	2.4	0.17	<0.1	<0.1	3.09	2.4	4	-	<0.2	0.17	2.1	0.4	0.2	0.04	0.92	3	1.24	<0.6	<1

Table S4 Pigeon Mine material leachate chemistry, PW-03, PS-88 and PW-02 are reported in Otton et al. 2010, continued.

Sample Name	SiO2 mg/L	Sm ug/L	Sn ug/L	Sr ug/L	Ta ug/L	Tb ug/L	Th ug/L	Ti ug/L	Tl ug/L	Tm ug/L	U ug/L	V ug/L	W ug/L	Y ug/L	Yb ug/L	Zn ug/L	Zr ug/L
P-01-1-R	0.8	<0.01	0.03	64.2	0.02	<0.005	<0.2	0.8	0.5	<0.005	143	1.9	1.8	<0.01	<0.005	2.3	<0.2
P-01-24-R	6	<0.01	0.04	118	0.07	<0.005	<0.2	1.4	3.9	<0.005	608	4.1	13.5	<0.01	<0.005	8.4	<0.2
P-01-24-RV	9.9	<0.01	0.2	153	0.07	<0.005	<0.2	2.1	5.8	<0.005	10500	9	37.2	0.07	<0.005	76	0.69
PW-03-1-R	<0.2	2.87	0.01	567	0.07	0.32	<0.2	9.4	<0.1	0.04	167	<0.5	<0.5	7.33	0.22	1220	<0.2
PS-88-1-R	1.9	0.01	0.02	20.1	<0.02	<0.005	<0.2	1.1	<0.1	<0.005	59.6	1	<0.5	0.07	<0.005	6.7	<0.2
PW-02-1-R	3.8	0.09	0.06	20.3	<0.02	0.01	<0.2	5.8	0.1	<0.005	401	7.2	0.97	0.48	0.03	8.5	0.4
PW-03-24-R	1.8	0.11	0.02	850	0.2	0.02	<0.2	14	<0.1	<0.005	1020	<0.5	0.79	1.18	0.03	1520	<0.2
PS-88-24-R	5	0.05	0.01	30	0.02	0.006	<0.2	2.7	0.2	<0.005	171	1.4	0.51	0.26	0.01	17	0.2
PW-02-24-R	7.3	0.13	0.02	30.7	0.04	0.02	<0.2	5.1	0.2	0.005	1270	9.8	3.2	0.6	0.03	18.3	0.66
PS-08-24-R	5.9	0.07	0.04	23.1	0.06	0.009	<0.2	1.8	<0.1	<0.005	7.97	1.7	<0.5	0.48	0.02	10.3	<0.2
PS-08-0.5-R	3.6	0.04	-	11.7	<0.02	0.005	<0.2	2.4	<0.1	<0.005	2.5	1.2	<0.5	0.24	<0.01	5	-
PS-08-2-R	5.8	0.1	-	13.7	<0.02	0.01	<0.2	3.4	<0.1	<0.005	3.51	1.7	<0.5	0.54	0.03	5.1	-
PW-03-24-RV	7.2	0.02	0.2	932	0.07	<0.005	<0.2	14.2	0.3	<0.005	18800	3.4	8.59	0.37	0.01	352	0.81
PS-88-24-RV	6.6	0.02	0.04	38.1	0.04	<0.005	<0.2	1.7	1	<0.005	1290	4.5	0.88	0.14	0.01	11.8	0.2
PW-02-24-RV	8.8	0.02	0.06	53	0.03	<0.005	<0.2	2.7	0.61	<0.005	5480	13.1	5.51	0.18	0.007	13.2	0.5
PS-08-24-RV	7.1	0.03	0.03	31.6	0.03	<0.005	<0.2	1.6	<0.1	<0.005	60.4	4.4	<0.5	0.24	0.01	24.2	<0.2

References

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