Characterization of Natural Waters at the Sanford Underground Research Facility

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Introduction

The Sanford Underground Research Facility, formerly the Homestake Gold Mine, is located in Lead, SD, and several experiments in the fields of physics, geology, and biology have found homes in its deep-underground environment. The facility accumulates large amounts of natural water that must be continuously directed to and pumped from the lower levels to prevent flooding. Detailed analyses of water samples taken at sites throughout the facility can provide insight as to how the water may be flowing as well as data of use to biologists attempting to characterize unique lifeforms living at or around these sites. This study examines 13 samples taken at or around the 1700' and 4850' levels of the facility and provides temperature, pH, and solute data. EPA sampling guidelines were employed.

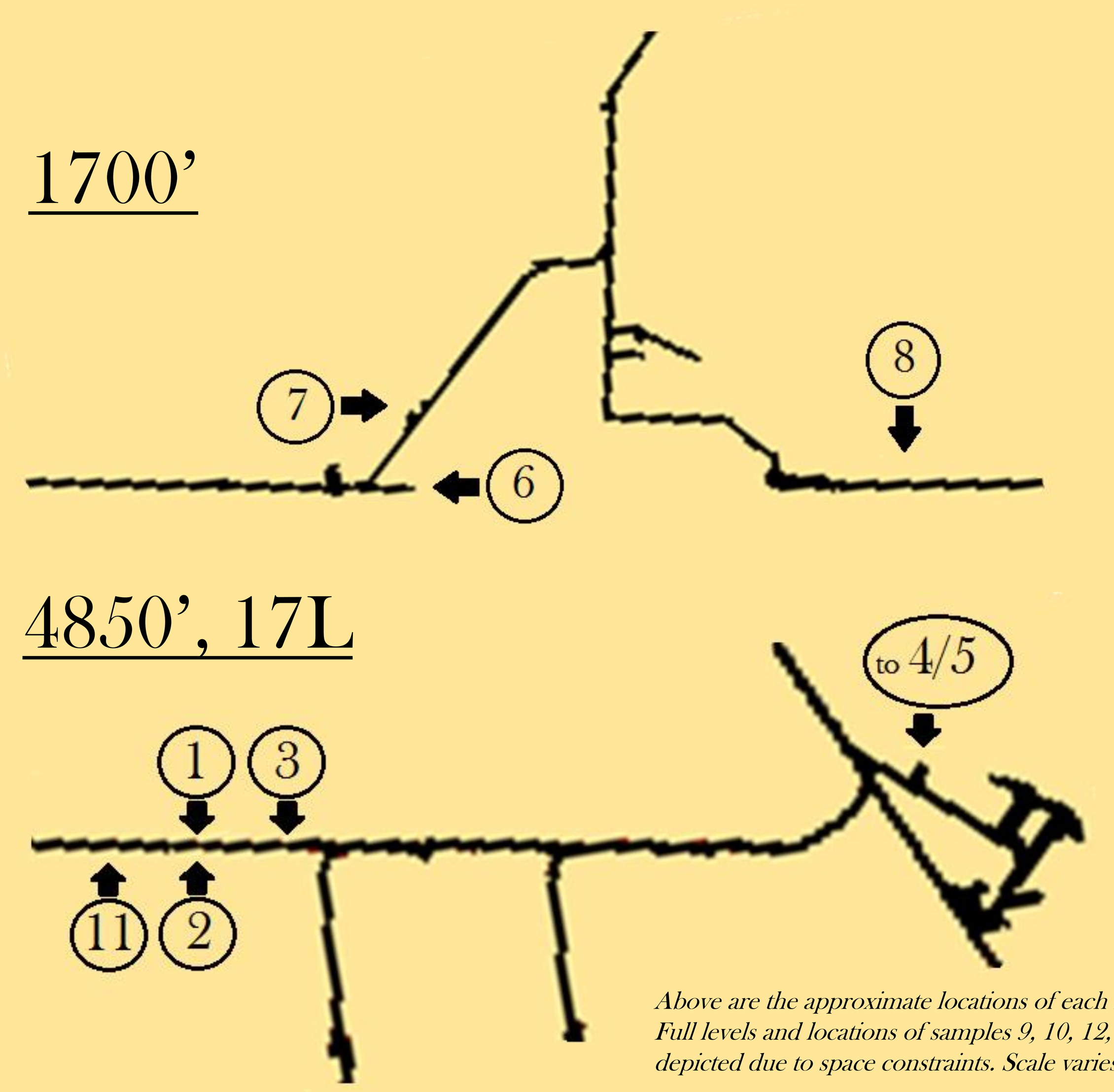
Data

	T_W	TDS	pH	Cl^-	NH_4^+	NO_3^-	SO_4^{2-}	Alk	Ca	Mg	*GH*	K	Na
Unit:	˚C	ppm	---	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm
LOD:	-40	1	0	0.1	0.1	62	10	5	0.07	0.01	0	0.03	2.84
Sample 1	33.7	815	7.7	19.8	1.7	<LOD	261	611	6.47	10.50	59	22.94	282.63
2	33.5	502	8.4	8.7	0.4	63	89	461	1.34	1.28	9	7.25	238.02
3	31.5	703	8.2	19.7	0.8	n/a	143	623	2.53	5.13	27	12.65	235.37
4	26.2	939	8.1	13.0	0.7	<LOD	485	600	32.60	87.50	442	18.59	286.98
5*	26.2	937	8.1	13.3	0.8	<LOD	465	555	33.09	86.81	440	17.20	290.76
6*	11.7	620	8.1	88.2	2.8	751	476	163	164.23	262.28	1490	18.88	110.50
7	15.0	1670	7.5	43.9	1.4	193	2390	287	171.53	533.76	2626	40.97	50.00
8	14.5	1138	7.9	70.0	2.2	156	1081	332	139.90	74.00	654	7.95	32.99
9	14.2	1523	8.0	22.5	2.1	474	2125	236	187.35	333.49	1841	23.40	177.61
10*	n/a	n/a	n/a	16.8	1.2	370	2141	133	166.67	375.03	1961	59.55	266.37
11	33.3	473	8.6	6.8	0.4	<LOD	87	471	n/a	11.58	n/a	n/a	n/a
12	21.9	1950	8.2	236.5	0.7	<LOD	4202	65	n/a	585.38	n/a	n/a	n/a
13	22.4	1391	7.9	68.9	0.3	<LOD	769	589	n/a	47.49	n/a	n/a	n/a

	Ag	As	Ba	Cr	Cu	Hg	Mn	Ni	Sb	Se	Tl	V	Y
Unit:	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
LOD:	0.69	0.76	17.31	0.63	1.11	22.19	0.73	4.67	1.65	8.29	1.44	0.48	0.66
Sample 1	<LOD	4.27	352.9	2.91	10.01	49.75	4.25	9.63	3.33	24.51	2.89	1.02	1.34
2	<LOD	1.77	925.6	2.16	6.84	45.76	2.31	<LOD	3.43	23.83	2.90	0.97	1.33
3	<LOD	2.57	506.3	4.24	7.95	46.11	2.97	<LOD	3.33	25.81	2.89	1.03	1.33
4	3.59	14.65	190.0	3.50	10.62	<LOD	35.84	13.80	5.96	50.00	<LOD	1.06	1.34
5*	<LOD	8.87	142.4	3.11	7.63	<LOD	21.31	11.40	3.31	25.27	2.89	0.99	1.32
6*	<LOD	4.56	90.25	3.62	4.58	44.44	10.29	31.50	5.92	42.84	2.99	1.23	1.33
7	<LOD	6.67	127.2	3.41	4.48	44.39	156.7	25.99	3.40	40.94	2.89	1.19	1.34
8	<LOD	3.32	258.2	2.93	3.87	<LOD	47.27	37.50	4.39	102.77	2.98	1.54	1.47
9	<LOD	16.39	115.9	3.11	5.52	45.06	21.68	28.69	3.48	55.17	2.94	1.12	1.34
10*	<LOD	45.15	177.4	3.13	7.12	<LOD	2047	27.76	3.32	33.29	2.89	1.14	1.33
11	<LOD	1.69	688.2	4.18	6.52	45.22	2.25	<LOD	3.33	25.87	2.89	1.01	1.33
12	<LOD	2.79	76.6	2.58	45.69	45.76	203.0	29.50	3.33	69.90	2.89	1.94	1.36
13	<LOD	24.01	142.1	5.44	24.69	<LOD	137.7	59.66	3.34	39.20	2.89	1.29	1.33

Method Summary

Temperature	Temperature Probe[1]
Total Dissolved Solids	Conductivity Probe[1]
pH, NH_4^+	Ion-selective Electrode[1]
NO_3^-, SO_4^{2-}	UV-Visible Spectroscopy[2]
Alkalinity, Cl^-	Titration[1, 2]
Ca, K, Mg, Na	Flame Atomic Absorbance[2]
Ag, As, Ba, Cr, Cu, Hg, Mn, Ni, Sb, Se, Tl, V, Y	Inductively-coupled Mass Spectrometry[2]



Above are the approximate locations of each samples site. Full levels and locations of samples 9, 10, 12, and 13 are depicted due to space constraints. Scale varies by level.

References

1- Gastineau, Robyn, et al. *Water Quality with Vernier*. 2nd ed., Vernier Software & Technology, 2015.

2- Eaton, Andrew D, et al., editors. *Standard Methods for the Examination of Water -- and Wastewater*. 21st ed., American Public Health Association, 2005.

Conclusion

'n/a' in the table above indicates data was not able to be collected due to sampling restrictions, sample contamination, or equipment failure. '*' indicates the sample was first filtered through a peristaltic pump.

Water from the selected sites is slightly basic with varying alkalinity. Water composition varies dramatically across sample sites, even adjacent sites, particularly sulfate and chloride values. Concentrations of nitrogen-containing compounds are low. General hardness values from sites at 4850' 17L are low. The manganese concentration of sample 10, taken from the 5000' reservoir, is remarkably high.

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