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2018 - Heavy Metals in Little Cottonwood Canyon Soil - Poster Presentation

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Heavy Metals in Little Cottonwood Canyon Soil

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Abstract

This study examines possible sources of the heavy metals found in Little Cottonwood Canyon, particularly the zinc and cadmium in Little Cottonwood Creek. Soil samples were collected and analyzed for heavy metal concentrations. These samples were collected from waste rock piles near the abandoned Flagstaff mine north of Alta, Utah, and about a half mile north of Little Cottonwood Creek. Of the twelve samples collected, seven heavy metals were detected. The highest concentrations of arsenic, cadmium, lead, and zinc were found in the largest waste rock pile. Concentrations of these metals were lower in the surrounding soil. This suggests that the concentrations of heavy metals in the waste rock piles relates to the concentrations of heavy metals in the surrounding soil. This data is reason to further investigate the degree of spreading of the heavy metals found in these waste rock piles, in order to determine if this is the source of zinc and cadmium in Little Cottonwood Creek.

Background

- Little Cottonwood Canyon (LCC) was home to a large mining industry in the 1870s. Most of the mines were concentrated on the northern slopes of the canyon, in close proximity to Alta (Butler and Loughlin, 1915).
- Abandoned mines can result in an excess of heavy metals in soil. These heavy metals may be transported into water sources via runoff. Factors that affect the ability of transport include the slope and climate of the region (Utah Department of Environmental Qualities [UDEQ], 2012).
- The Clean Water Act regulates the quality of surface water in the United States. Section 303(d) of the Clean Water Act requires states to identify its impaired waters. Little Cottonwood Creek is on Utah's 303(d) list due to the heavy metals found in the creek (UDEQ, 2016).
- The heavy metals of concern in Little Cottonwood Creek are zinc, cadmium, and copper. Concentration of dissolved zinc levels exceed the amount necessary for a cold-water fishery (Wham and Judd, 2002).
- Preliminary data showed impairment due to cadmium in five test spots spanning the creek. In addition, elevated levels of zinc were found at three test spots located on the upper portion of the creek. The source of zinc and cadmium are still unknown (Wingert, 2016).

Research Question

Are the waste rock piles on the northern slopes of Little Cottonwood Canyon a possible source of zinc and cadmium in Little Cottonwood Creek?

Methods

- Twelve soil samples were collected from the north-east side of Alta, west of Grizzly Gulch near Flagstaff mine.
- Each sample contained five separate scoops of soil collected within a five-meter radius of the recorded soil sample location. These five scoops of soil were combined and homogenized into one sample and the same process repeated for each of the 12 soil samples.
- Samples were sieved for two minutes through a size 60 sieve, and analyzed with handheld X-ray fluorescence (XRF) analyzer (XL2 Niton^{TM}). Each sample was analyzed for 60 seconds with the XRF analyzer per EPA method 6200 (Sacket and Martin, 1998).

Results

- In the twelve soil samples, seven heavy metals were detected (Figure 1).
- Five samples contained arsenic, seven samples contained cadmium, and ten samples contained copper. All of the twelve samples contained lead, and zinc (Figure 1).
- Arsenic ranged from 45 ppm to 1500 ppm (Figure 2).
- Cadmium ranged from 26 ppm to 119 ppm (Figure 3).
- Lead ranged from 355 ppm to 12800 ppm (Figure 4).
- Zinc ranged from 227 ppm to 15000 ppm. (Figure 5).
- Soil sample 10 contained the highest concentration of arsenic, cadmium, and zinc. This sample was taken from the center of the largest waste rock pile (Figure 6, 7, and 9).
- The highest concentration of lead was found in soil sample 12. This sample was collected from the northern edge of the largest waste rock pile (Figure 8).

HEAVY METALS IN LCC SOIL SAMPLES							
Sample Number	Antimony (ppm)	Arsenic (ppm)	Cadmium (ppm)	Copper (ppm)	Lead (ppm)	Manganese (ppm)	Zinc (ppm)
ss01	109.27	0	26.95	98.72	2774.2	1774.09	3716.58
ss02	91.83	0	0	49.34	2126.22	306.01	1782
ss03	0	0	0	184.13	355.09	869.26	226.64
ss04	60.83	0	64.62	0	682.34	346.17	1531.34
ss05	48.05	0	49.94	0	1060.69	597.63	1696.75
ss06	89.47	0	27.27	108.72	2772.92	1766.61	3500.17
ss07	104.2	0	26.45	67.77	3053.57	2158.87	3104.53
ss08	0	45.83	0	43.49	639.81	615.33	615.78
ss09	139.85	**837.03**	42.38	335.19	12269.83	1986.42	13476.56
ss10	115.83	**1491.07**	118.42	488.97	10050.06	1404.01	14952.66
ss11	0	65.83	0	68.05	693.56	932.79	1414.63
ss12	91.4	**1279.72**	0	1502.07	12799.87	1472.92	4675.34
HUMAN RISK CRITERIA FOR HEAVY METALS IN SOIL FOR CAMPER (Ford, 2004)							
Metal	Antimony* (ppm)	Arsenic* (ppm)	Cadmium* (ppm)	Copper* (ppm)	Lead* (ppm)	Manganese* (ppm)	Zinc* (ppm)
Concentration	50	20	70	5000	1000	19000	40000

Figure 1: Concentrations of all heavy metals found in soil samples and the risk management criteria for each metal found.

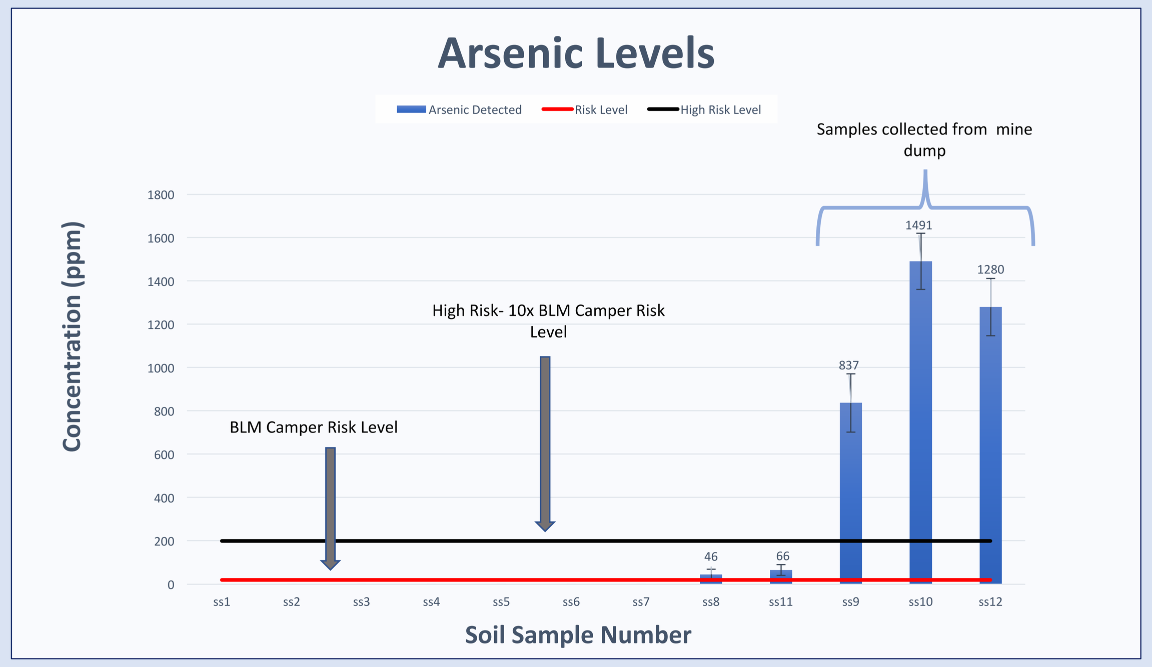

Figure 2: Amount of arsenic found in each soil sample.

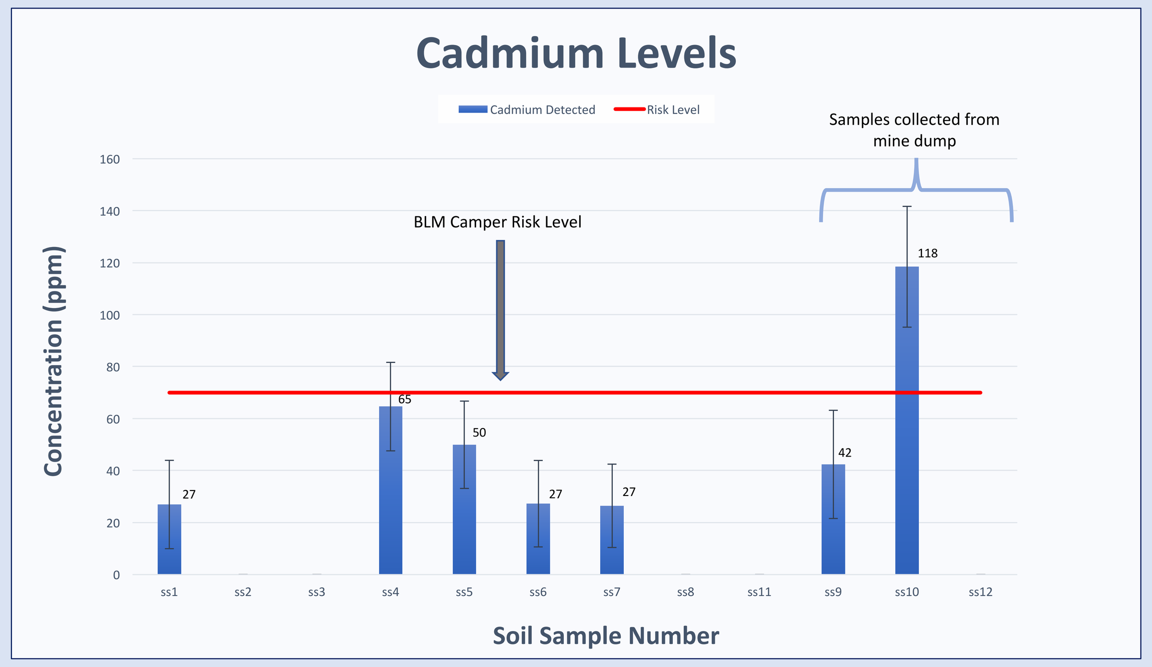

Figure 3: Amount of cadmium found in each soil sample.

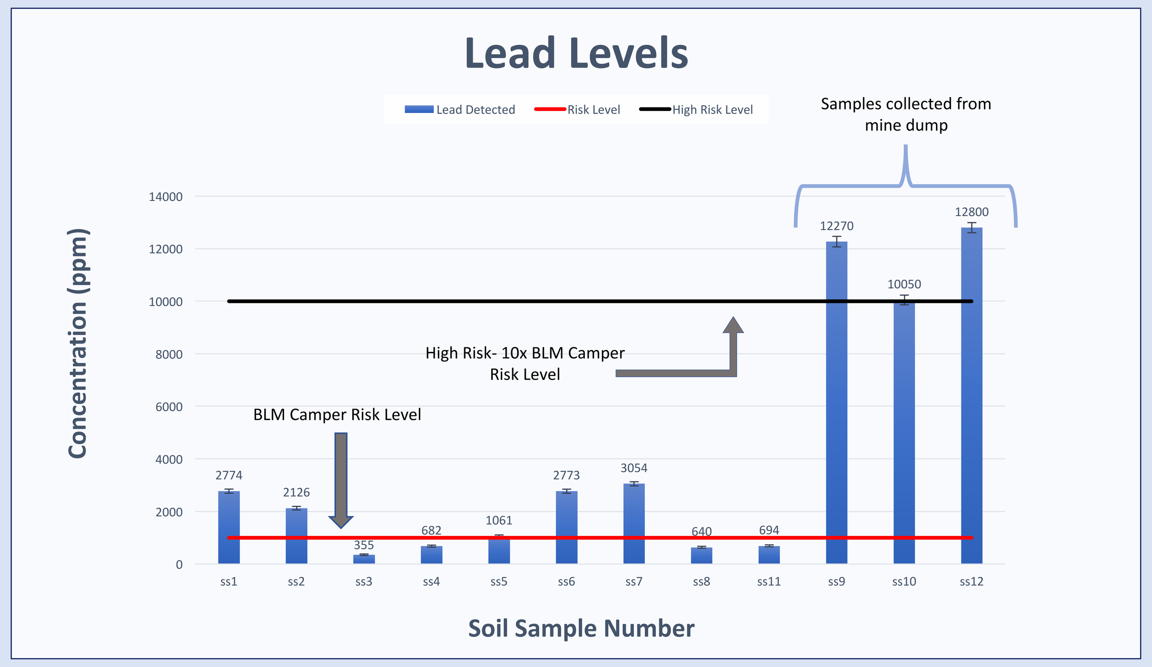

Figure 4: Amount of lead found in each sample.

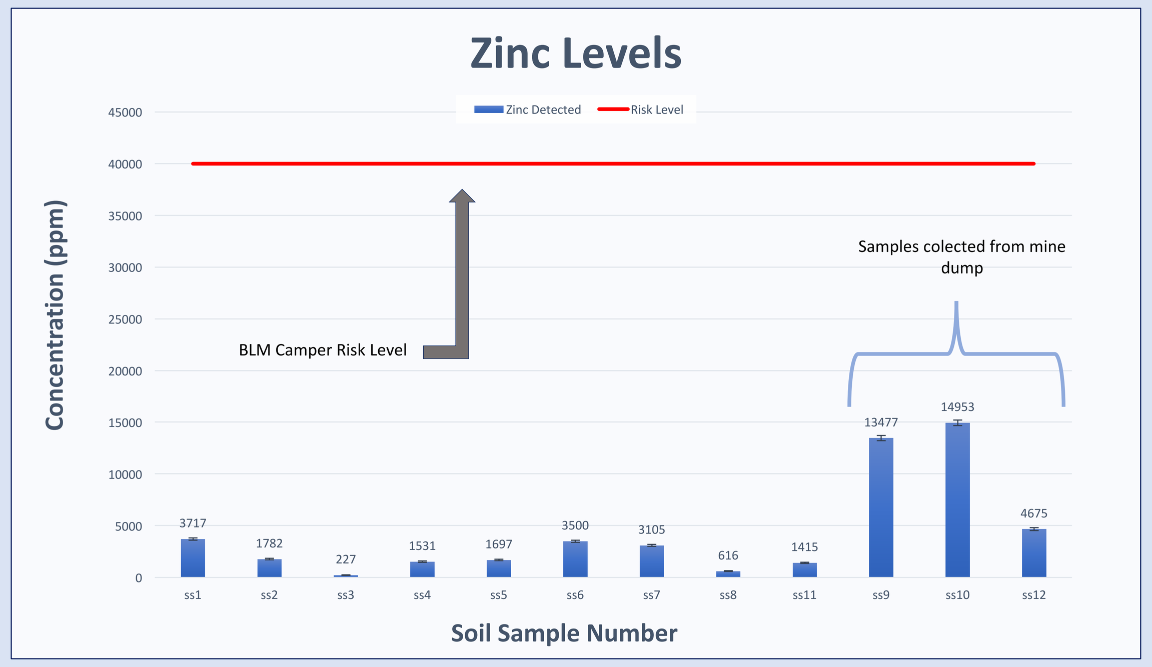

Figure 5: Amount of zinc found in each sample.

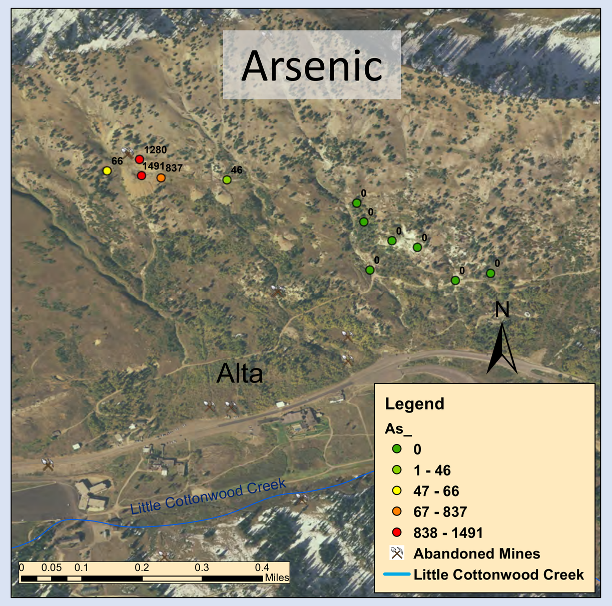

Figure 6: Concentration of arsenic in each soil sample location.

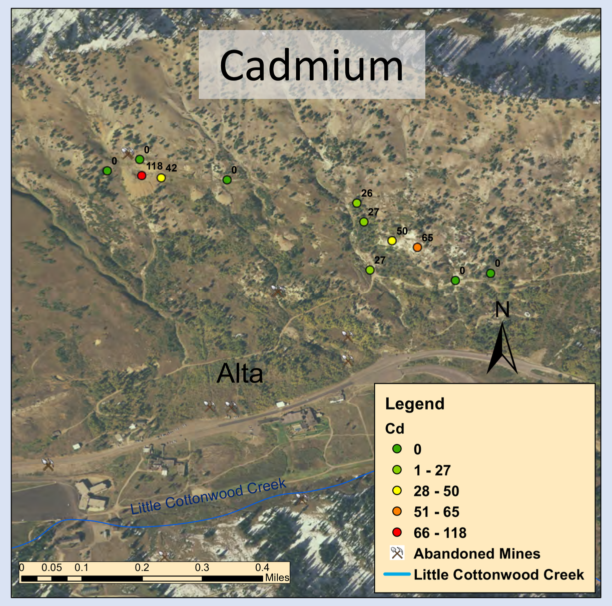

Figure 7: Concentration of cadmium in each soil sample location.

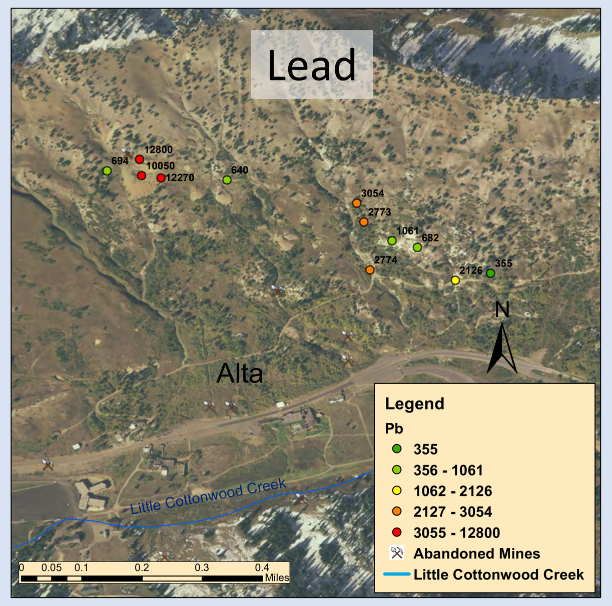

Figure 8: Concentration of lead in each soil sample location.

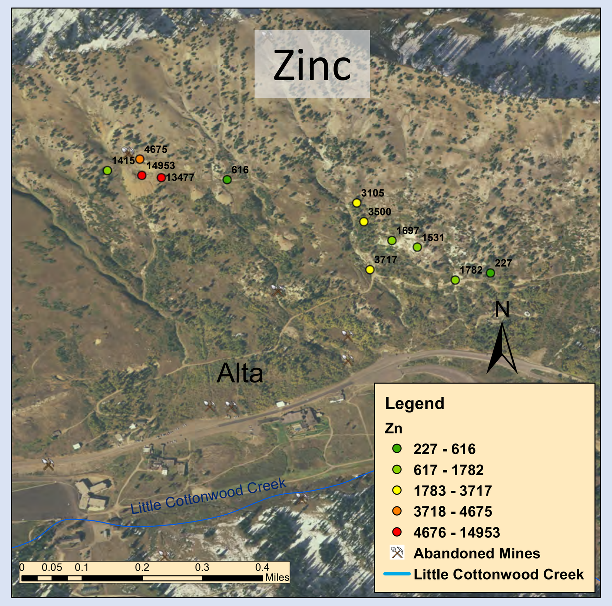

Figure 9: Concentration of zinc in each soil sample location.

Discussion

- The purpose of this study is to identify if the waste rock piles on the northern slopes of Little Cottonwood Canyon are a possible source of zinc and cadmium in Little Cottonwood Creek.
- Nine samples collected from surrounding soil had cadmium concentrations ranging from 0 ppm to 65 ppm. Cadmium concentration of the three samples collected on the pile ranged from 0 to 118 ppm (Figure 3). One sample exceeded Risk Management Criteria (RMC) for a camper (Ford, 2004).
- Zinc levels ranged from 227 ppm to 3717 ppm in the nine samples collected in the surrounding soil. The concentration of zinc ranged from 4675 ppm to 14953 ppm in the three samples collected on the pile (Figure 5).
- According to RMC standards amounts of arsenic and lead are rated at high risk in the three samples collected from the waste rock pile. Soil samples collected from the surrounding areas of the samples that were rated as high risk also contained lead and arsenic in them, but at much lower concentrations (Figure 6, Figure 8).
- Heavy metals found in the waste rock pile were found in higher concentrations than the metals found in the surrounding soil. This suggests that there is a possible correlation with the heavy metals in the waste rock piles and the heavy metals in the surrounding soil.

Future Studies

Further analysis should be done by collecting soil samples directly below the waste rock piles. This would further test how heavy metal concentrations relate to the concentrations in the waste rock piles, due to the possible erosion taking place. Data shows that there is zinc and cadmium in this area, but this type of further analysis is needed to determine if transport of the metals is likely, better determining if this is a possible source of the zinc and cadmium found in Little Cottonwood Creek.

Conclusions

1. The highest concentrations of zinc and cadmium were found in the largest waste rock pile. Zinc and cadmium were found in lower concentrations in the surrounding soil.
2. The same heavy metals found in the waste rock piles that were at high risk concentrations, were also found in the surrounding soil.
3. Zinc and cadmium concentrations are below high-risk levels for humans in the soil, but it is inconclusive whether they are a possible source of the zinc and cadmium found in Little Cottonwood Creek.
4. It is recommended that future studies test soil directly below the waste rock piles to obtain more information about the erosion and degree of spreading of heavy metal concentrations.

References

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