Bioaccumulation of Heavy Metals in Exposed Mine Tailings by the Creosote Bush

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Overview

This research examines the potential for bioaccumulation (fig. 6) of the heavy metals left behind in the tailings of abandoned mines in Southern Nevada. Bioaccumulation occurs when a substance, like a toxic metal from the mine tailings, enters a plant in larger than natural quantities (Merriam-Webster). During the separation process in mining, the desired product is removed and kept for economical uses, the remaining materials (rocks, dust, and other waste materials) are left outside the mine exposed to the environment. The exposed tailings materials become mobile by wind, rain, and gravity during mass movement events. Meteoric water transports these elements in the subsurface where they are ultimately picked up and absorbed by plant species, such as the biomass of the creosote bush (Sims et al., 2016). Nelson, NV has been an area of focus due to the extensive mining of the region. This location is an important site for understanding the impact of bioaccumulation of harmful metals in native species.

Introduction

Mars has transitioned into an arid environment (Fairen et al., 2010), like that found in Nelson, NV and more broadly the Mojave and Sonoran deserts of the American southwest (fig. 3). By examining the uptake of elements from the biological parts of the creosote bush (fig. 5 & 8) from ground water movement, it may be possible to demonstrate where water once flowed on Mars by mineral, or more specifically, heavy metal distribution in detritus. This research serves to address the concerns of environmental bioaccumulation of potential toxic substances and provide a better understanding of arid environment transport and mobilization of minerals for bioaccumulation.

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Index Map of Research Location

Figure 1

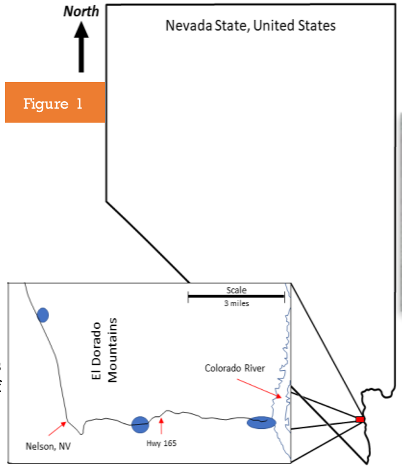


Figure 2

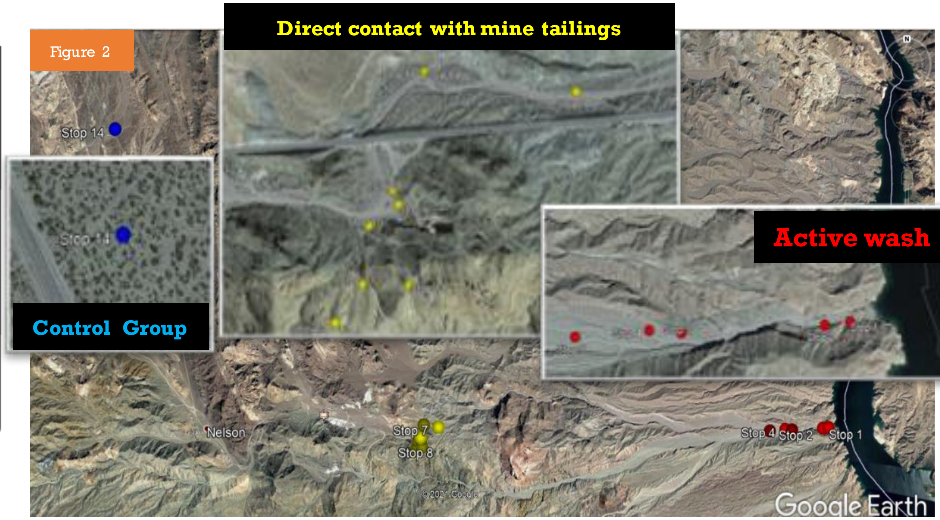
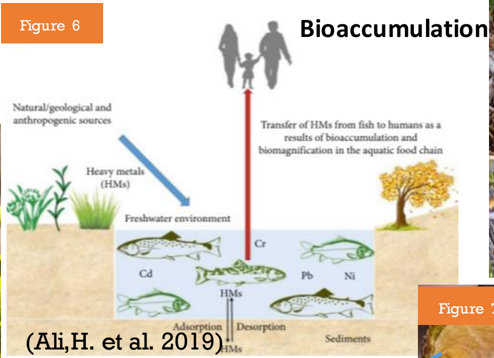


Table 1	Latitude	Longitude	Color	Location
Stop 1	35.70729	-114.70860	red	wash
Stop 2	35.70719	-114.70966	red	wash
Stop 3	35.70690	-114.71560	red	wash
Stop 4	35.70704	-114.71691	red	wash
Stop 5	35.70685	-114.71991	red	wash
Stop 6	35.08160	-114.78541	yellow	tailing
Stop 7	35.70790	-114.78272	yellow	tailing
Stop 8	35.70651	-114.78600	yellow	tailing
Stop 9	35.70630	-114.78589	yellow	tailing
Stop 10	35.70602	-114.78640	yellow	tailing
Stop 11	35.70523	-114.78652	yellow	tailing
Stop 12	35.70474	-114.78696	yellow	tailing
Stop 13	35.70522	-114.78572	yellow	tailing
Stop 14	35.74813	-114.84082	blue	control

Figure 3

Figure 4

Figure 6

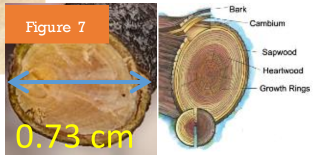


(Ali, H. et al. 2019)

Figure 5

Figure 8

Figure 7



Methods

Samples were collected along and within the Eagle Wash to its terminus at the Colorado River system near Nelson's Landing (fig. 1). Sample locations were chosen based on the downstream proximity from the Jubilee, Eldorado and Techatticup Mine system (table 1). Three creosote sample groups were collected for this research. The first was in the active wash at Nelson's Landing close to the wash terminus. The second was in direct contact with the mine tailings of Jubilee Mine, and finally a control group northwest of the Eagle Wash outside of known mineral and heavy metal concentrations (fig. 2).

Samples were taken of whole branches of the creosote bush, including leaves and active flowers, cut with a pocketknife and subsequently further parsed into smaller segments a few grams in size (fig. 7). Where applicable, only branches that exhibited active growth (yellow flowers with green leaves, fig.8) were collected due to potential increased probability of recent uptake of heavy metals that may dissipate through time.

All samples were further processed to represent each segment of the plant, and each plant was collected based on these features. Such as leaves, pith, heartwood, sapwood, cambium, and bark (Fig. 7) based on evidence that plants may have differential material uptake throughout the organism.

Results

Samples results are still pending for this specific research. However, past research has shown the ability for creosote to absorb heavy metals at differing biological locations throughout the creosote bush. Such as the bark and heartwood, for example. We expect to find increased concentrations of heavy metals/pollutants in the tailing samples with less concentrations in the active wash samples, approximately 4 miles downstream from the mine tailings, and no representative concentrations in the control group. This will allow assessment of background concentrations of mobilized heavy metals and other elements in association with fluvial processes in an arid environment.

Conclusion

Further study on the bioaccumulation of heavy metals on the arid Nevada environment plays an important analogy in understanding how elements could be mobilized on Mars. Furthermore, bees, flies and an iguana(fig. 4) were observed on the bushes in all the sample collecting areas which are consumed by higher trophic level species of the food chain. The insects and iguana are a concern for element uptake into the food web creating a vector for bioaccumulation. Lastly, this research may also provide pathways for bioremediation of toxic spill sites in arid environments by way of phytotechnology (Tsao, 2003) and potentially creating systems of reusability, or recycling, of once mobile environmental toxicants.

Acknowledgement

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