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Heavy metals in particulate matter in Spokane County

Delaney M. White
Eastern Washington University, dwhite47@eagles.ewu.edu

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Delaney White[1] and Carmen Nezat[1,2]
[1]Environmental Science Program, [2]Department of Geology
Eastern Washington University, Cheney, WA

Introduction

Particulate matter is a mixture of solid particles and liquid droplets found in air (EPA, 2018). It falls into two categories, PM2.5 (particles with a diameter less than 2.5 µm) and PM10 (particles with a diameter less than 10 µm). For comparison, the width of a human hair is 50-70 µm. The U.S. EPA set a national air quality standard for particulate matter levels. The daily standard for PM2.5 is 35 µg/m^3 while the standard for PM10 is 150 µg/m^3. Currently, the Spokane Regional Clean Air Agency has seven air quality monitoring stations around Spokane County that monitor total levels of PM2.5 and PM10. The monitoring stations, high volume air samplers, pull in air at a controlled rate and collect particles on a filter.

Fig. 1 Photo of high-volume air sample

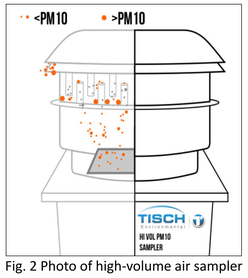

Fig. 2 Photo of high-volume air sampler

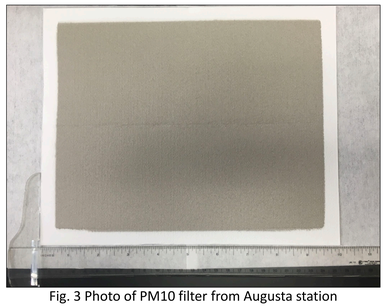

Fig. 3 Photo of PM10 filter from Augusta station

The objective of this research is to examine the heavy metal composition of the particulate matter including elements such as lead, copper, and zinc.

Samples

The samples are from two sites; Turnbull National Wildlife Refuge and Spokane Community College. The filters we analyzed were from August 28th of 2013 and 2014.

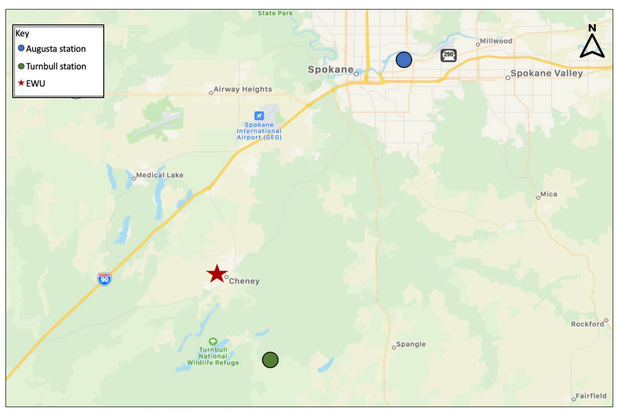

Fig. 4 Map of Turnbull and Augusta monitoring stations

Preliminary Data

XRF analysis of PM2.5 and PM10 quartz filters was conducted. This analysis provided a qualitative view of the particulate matter on the filters. The resulting graph showed peaks for silicon, calcium, titanium, iron, nickel, and copper. It is hypothesized that the silicon peak is due to the filters being composed of quartz, a silicon-based material.

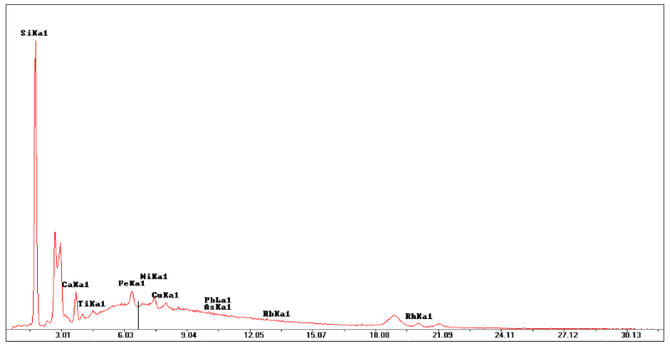

Fig. 5 XRF graph of air filter. Peaks indicate presence of element.

XRF analysis of 5 filters resulted in different heights of peaks, suggesting variable elemental composition of the particulate matter. XRF analysis only allows for a qualitative assessment and further analysis using ICP-OES is required to determine the concentrations of the elements.

The SRCAA records daily averages for PM2.1 and PM10. Below is a graph of the average PM10 collected per day for the month of August from 2013 and 2014. For reference, the national air quality standard set by the EPA for PM10 is 150 µg/m^3.

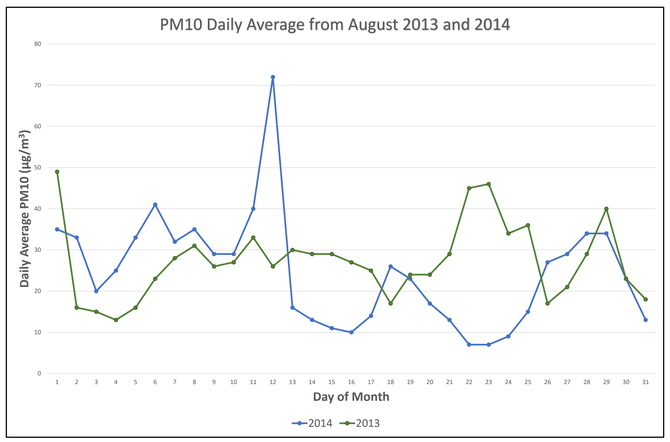

Fig. 6 Graph of PM10 collected per day in August of 2013 and 2015

References

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Methods

- 4 sample sizes were cut from the Whatman 8x1 inches quartz filter using an X-acto knife: 1x8 in., 0.5x8 in, and two 1x1 in.

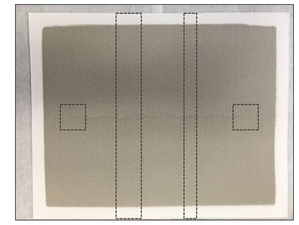

Fig. 7 Diagram of how samples were cut

- Each sample was weighed and placed into an individual Teflon digestion vessel, the 1x8 in. strip and 0.5x8 in. strip were folded accordion style to fit.
- 10 mL of concentrated nitric acid (Certified ACS) was added to each vessel
- The vessels were assembled, sealed, and microwaved using a CEM MARS 5 digestion oven.

Fig. 8 Digestion vessel assembly

Fig. 9 Assembled digestion vessel

Fig. 10 CEM Mars 5 digestion oven

- The digest solution was diluted with ultrapure water and filtered through a Whatman 0.45 µm membrane into a 120mL acid washed bottle.
- The digest solutions will be analyzed for heavy metals using a Thermo Scientific iCAP 6200 Inductively Coupled Plasma - Optical Emission Spectrometer (ICP-OES).

Fig. 11 Thermo Scientific iCAP 6200 ICP-OES

Future Research

Compare the elemental concentrations of particulate matter
- between urban and rural sites.
- with the chemical composition of local soils
- over an extended time period (e.g. year to year)

Acknowledgements

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