What are the levels of heavy metals present in conifer needles and their relationship to the proximity of Oil Sands open pit developments in Northern Alberta?

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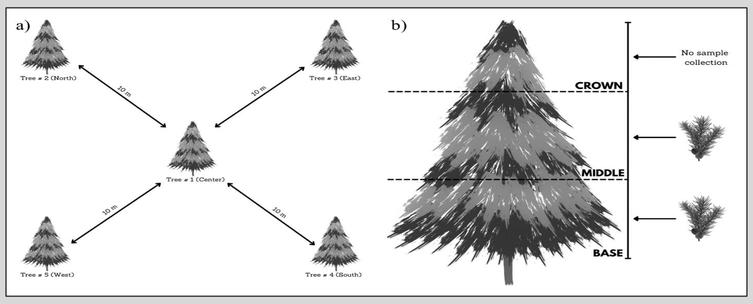
01. INTRODUCTION

Heavy metal accumulation has been occurring since the development of the first open-pit mines in the mid 1960s. The open-pit mining method can cause multiple environmental health concerns. Leakage from tailings ponds has been occurring since the generation of these ponds.

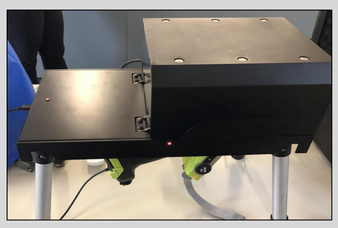
The hypotheses of this study was that metal concentrations would be significantly greater at the sample plots closer in proximity to the open pit mining activities north of Fort McMurray. While the height, diameter, and location of the sample (base or middle) of the tree won't have any significant effects on concentration.

02. EXPERIMENTAL

A central tree was chosen where the four remaining trees were selected from surrounding locations of the four normal directions ten meters away from the center tree. 60 sets of conifer needles were sampled, collected in triplicates from the six sites.



Conifer needles were cleaned with tap, distilled, and deionized water in respected order to remove dust particles. After the needles were dried, they were pulverized. XRF technology was utilized to screen for heavy metal concentrations in the conifer needles.

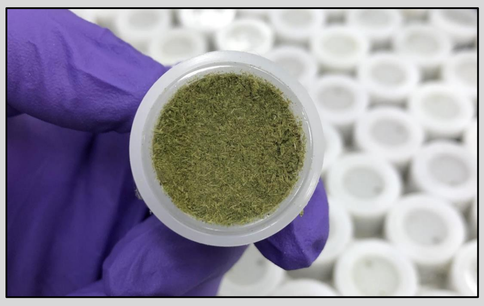


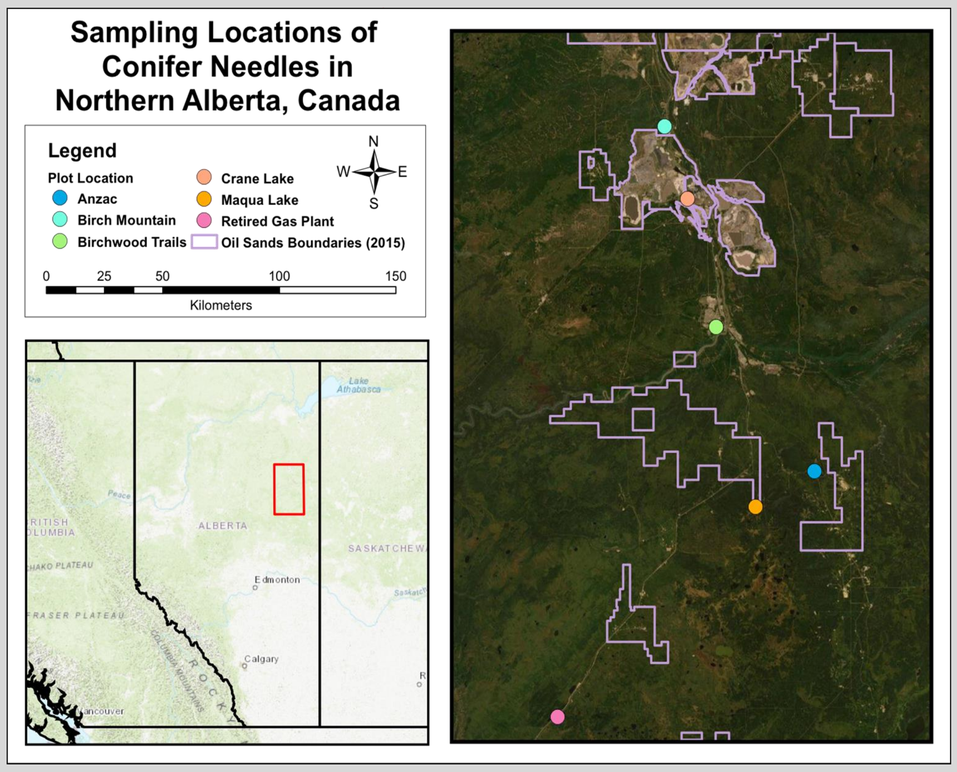
04. CONCLUSIONS

In conclusion, metals such as titanium, strontium, cadmium, zinc, and manganese were greater within proximity to the open pit operations. While palladium had similar concentrations at the plots closer the open pit mines and the plot within the city of Fort McMurray. The hypothesis was correct about the five metals closer to the open pit mines, however, was inconclusive towards the results from palladium. While the results for height and diameter of the tree shown to have little effect on concentration.

Further research and experimenting into soil and water samples will strengthen the results that the open pit mining operation and tailings ponds have increased the concentration of these metals.

To examine impacts of Oil Sands open-pit operations in Northern Alberta, needles of white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*) were collected from six locations within the RMWB; Anzac (AN), Birch Mountain (BM), Birchwood Trails (BW), Crane Lake (CL), Gas Plant (GP), and Maqua Lake (ML). Two sample plots were located north of Fort McMurray near the open-pit mines, one within city limits, and the remaining three were located south of Fort McMurray. Heavy metals that were researched within this study were; cadmium, manganese, palladium, strontium, titanium, and zinc.





03. RESULTS & DISCUSSION

Table 1. Mean content of palladium, zinc, cadmium, manganese, titanium, and strontium in the needles of white spruce (*P. glauca*) and balsam fir (*A. balsamea*) and generalized toxic concentrations found in various plant species presented in parts per million (ppm) of dry matter.

Metals	Site Data						Literature Data		
	CL	BM	BW	GP	ML	AN	Poland[1]	Quebec[2]	Toxic Concentrations[3]
Cd	19.46	19.20	18.85	19.03	18.92	18.71	0.53	0.11	5.00 - 30.00
Mn	229.83	493.10	815.31	3989.69	607.81	646.76	48.50	507.00	400.00 - 1000.00
Pd	4.74	4.70	4.69	4.48	4.58	4.47	—	—	3.00
Sr	84.69	40.66	42.25	29.55	30.37	66.77	21.50	15.03	30.00
Ti	47.36	45.48	35.24	26.87	36.44	42.42	15.20	—	20.00
Zn	224.32	107.20	72.67	207.52	119.51	130.97	63.30	42.46	100.00 - 400.00

All sites were found to be within the range of toxic concentrations for cadmium, palladium, strontium, and titanium except for the retired gas plant (GP) for manganese.

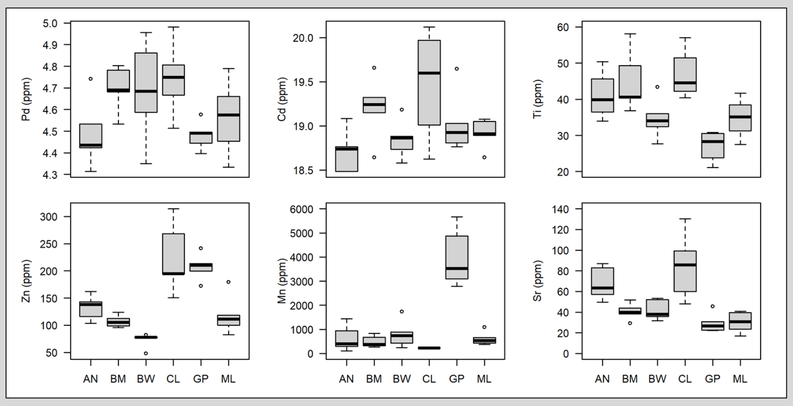


Figure 1. Box-plots of the logged concentrations (ppm) of each trace metal found at the six sites in Northern Alberta.

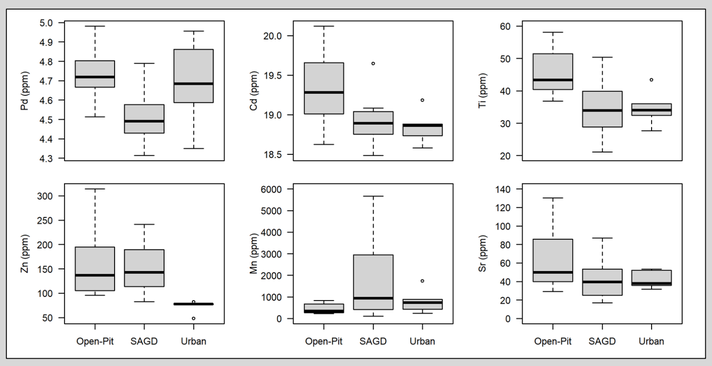


Figure 2. Box-plots for the Kruskal-Wallis test of trace elements vs. source of extraction

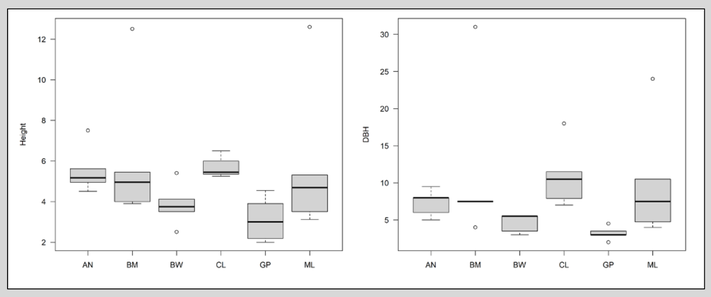


Figure 3. Box plots of tree height and DBH at each site of sample retrieval..

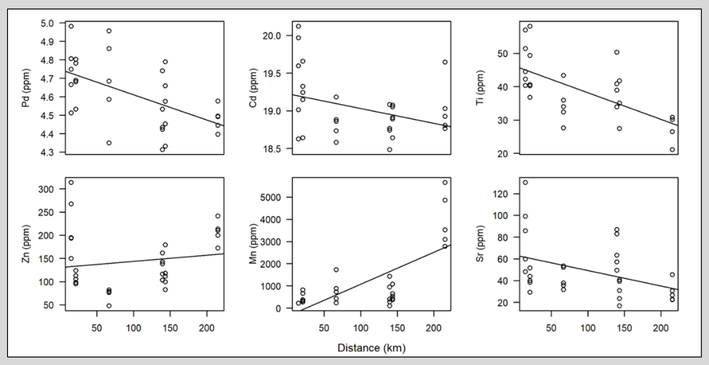


Figure 4. Correlation analysis of the logged concentrations (ppm) for six trace elements

Discussion

These results are consistent to the studies that report that titanium, strontium, cadmium, zinc and manganese concentrations are significantly higher at open pit mines. The Earth's crust is naturally formed with these six metals and various concentrations. Concentrations of these metals are greater at the open mine due to leaking from the tailings ponds. This is due to the unearthing, the placement of overburden onto the surface, and the placement of heavy metals in tailings ponds after the upgrading process.

Palladium concentrations were greater within the city of Fort McMurray and north at the open pit mines due to the source being vehicle exhaust. Zinc concentrations were greater within the BW trails due to controls burns. While manganese concentrations were high at the retired gas plant due to previous forest fires causing it to accumulate.

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