

# Impact of permafrost melting on Arsenic (As) mobility in groundwater in Fairbanks, Alaska

Amelia T. Jones

CIT Senior Honors Research Program 2015-2016

Carnegie Mellon University

Civil and Environmental Engineering

## ABSTRACT

Thawing permafrost in the arctic is allowing subsurface flows to contact constituents of minerals that were once sequestered in ice. To investigate the variability of arsenic concentrations in groundwater as a function of active layer thaw depth, arsenic concentrations from Fairbanks groundwater wells were plotted against measurements of annual active layer thaw depth from nearby permafrost monitoring sites. The results show a potential emerging relationship between a thawing active layer and increasing arsenic concentrations in groundwater in the Fairbanks area.

## INTRODUCTION

- The permafrost active layer, the top section that thaws seasonally, has been increasing in thaw depth, potentially exposing constituents, such as minerals containing naturally occurring arsenic, in the soil.
- Fairbanks, AK obtains 100% of its drinking water from groundwater, which poses water quality concerns as more arsenic, a hazardous drinking water contaminant, is potentially exposed due to melting permafrost.

## METHODS

- Obtained data from the Circumpolar Active Layer Monitoring (CALM) program, which observes the long-term response of the active layer of permafrost to climate change program, at sites near Fairbanks to establish a trend for permafrost thaw.

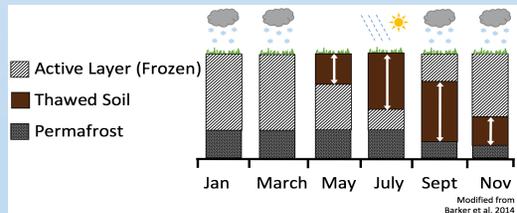


Figure 1: Schematic depicting the freezing and thawing process in the Arctic.

- Obtained data from the State of Alaska Department of Environmental Conservation (DEC) and Department of Natural Resources (DNR) on arsenic concentrations in groundwater wells and subsurface soil composition to establish a trend for the mobility of arsenic in groundwater.
- Five wells were selected for individual analysis based on quantity of arsenic measurements and proximity to CALM sites.

## RESULTS

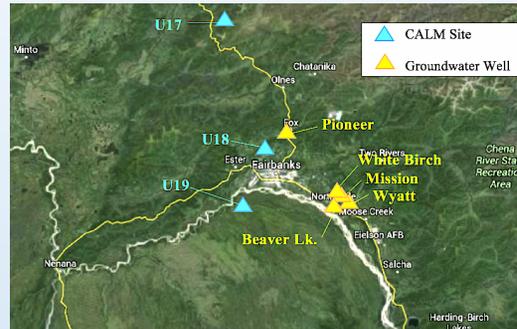


Figure 2: Map of study area in Fairbanks, AK with CALM sites and groundwater well locations identified.

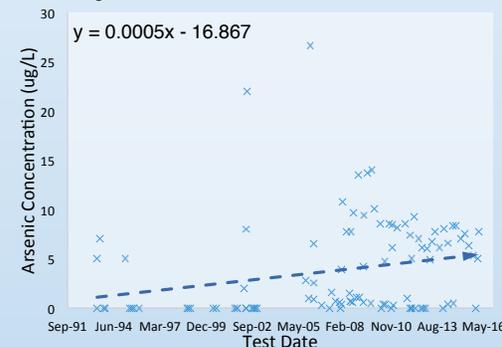


Figure 4: Arsenic concentration (ug/L) from 1993 to 2016 for groundwater wells in Fairbanks, AK with more than one test result.

Well ID	Date	Result	Unit	Thaw Depth at CALM site (cm)		Correlation between [As] and thaw depth	
				U18	U19	U18	U19
Pioneer	28-Jun-95	0	ug/L	58	-	0.142	NA
	16-Oct-98	0		51	-		
	28-Feb-02	2		56	-		
	01-Nov-07	0.56		67	-		
	26-Aug-09	0.521		55	-		
White Birch	01-Nov-11	0.965	98	72	0.310	0.902	
	15-May-95	0	58	79			
	22-Nov-98	0	51	65			
	28-Sep-01	0	59	59			
	30-Dec-05	0.972	63	70			
Mission	17-Jun-93	0	58	79	0.979	0.648	
	09-Apr-02	0	56	61			
	19-Apr-06	0.838	59	67			
	02-Jun-08	0.722	58	79			
	09-Apr-02	0	56	61			
Wyatt	19-Apr-06	2.49	59	67	0.904	0.083	
	02-Jun-08	0.693	58	79			
	17-Jun-93	5	-	66			
	09-Apr-02	8	56	61			
	19-Apr-06	6.52	59	67			
Beaver Lk.	02-Aug-07	0.695	67	83	0.048	-0.870	
	13-Jul-10	0.29	59	78			
	05-Mar-13	4.92	131	77			

Table 1: Correlation coefficients for arsenic concentrations in five individual groundwater wells as a function of active layer thaw depth in Fairbanks, AK.

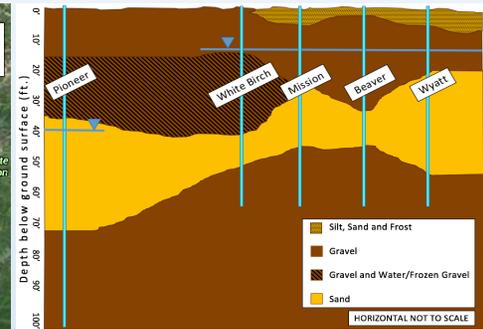


Figure 3: Schematic subsurface soil profile of the five selected groundwater wells in Fairbanks, AK.

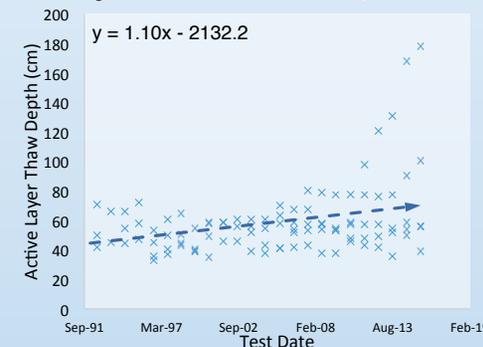


Figure 5: Permafrost end-of-season active layer thaw depth (cm) from 1990 to 2015 for all CALM sites in Fairbanks, AK.

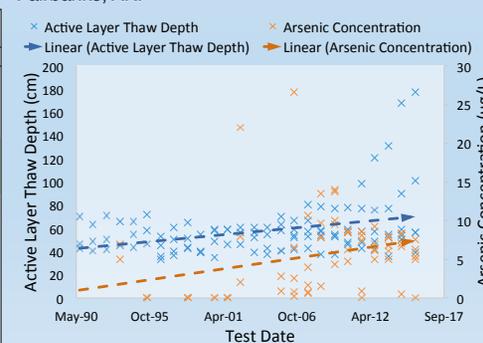


Figure 6: Permafrost end-of-season active layer thaw depth (cm) and arsenic concentration (ug/L) for all sites and wells in Fairbanks, AK.

## CONCLUSIONS

- In Fairbanks, based on data from the CALM program, active layer thaw depth is increasing at a rate of about 1.10 cm/yr, and up to 22.14 cm/yr at some specific CALM sites, exposing previously frozen, metal-rich soils.
- Arsenic concentrations in three of five individually analyzed wells correlate with a coefficient of greater than 0.9 with an increase in active layer thaw depth at a nearby CALM site.
- Results from this study indicate that groundwater contact with arsenic in thawed soils may be allowing the constituent to mobilize into the drinking water supply.

## FUTURE RESEARCH

- Going forward, a full survey of permafrost abundance near groundwater wells should be considered to determine the impact thawing may have on the nearby groundwater.
- Further, an up-to-date survey of arsenic presence in the soil in the Fairbanks area is recommended to assess the risk this constituent potentially poses to drinking water.
- Increased frequency and quantity of arsenic testing is recommended for all wells in the Fairbanks area, especially at the end of the melt season (July, Aug) when this constituent is likely to have been exposed by thawing permafrost.

## ACKNOWLEDGEMENTS

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