SAMMS: Sub-Arctic Metal Mobility Study

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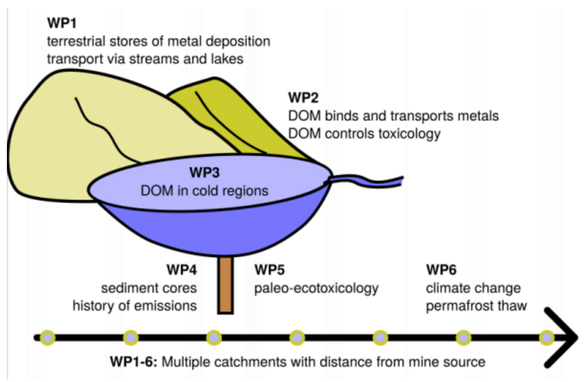
What is *SAMMS*?

- Sub-Arctic Metal Mobility Study (SAMMS) was developed in response to concerns about the uncertainties of the extent of the mobility and toxicity of legacy pollution from Yellowknife's Giant Mine
- As climates warm, the rates of decomposition for organic matter will accelerate, in turn increasing dissolved organic matter (DOM) loading into freshwater
- The possibility remains that much of these emissions are trapped within the soils of wetlands, streams, and lakes in the area. Using a whole catchment, interdisciplinary approach with multiple investigators
- ***SAMMS will characterize the transport and behaviour of dissolved organic matter and metals through terrestrial and aquatic systems along an 80-km air shed between the Giant Mine and Whati***



Work packages comprising SAMMS:
1) terrestrial stores of historical metal deposition and transport to aquatic ecosystems, 2) DOM quantity and quality, metal binding, and toxicology, 3) modelling of DOM quantity and quality in cold regions, 4) metal depositional history, pathways, and processes in lake sediments, 5) paleo-ecotoxicology and ecosystem structure, and 6) climate change effects including permafrost thaw.

Past Studies and Rationale

- SAMMS stemmed from previous lake sediment core findings that suggest potential far-field pollution from Giant Mine
  - In the Slave River Delta ~160 km SE, elevated lake sediment As concentrations (~20 mg/kg) during the 1950s are likely associated with maximum emissions
- Lake water surveys identified an emission footprint restricted to a ~20 km radius of the mine [b, d]
  - These studies, while a great asset, are perhaps not reflective of emissions that may be stored in the landscape beyond a 20 km radius[a]

Northern Partners

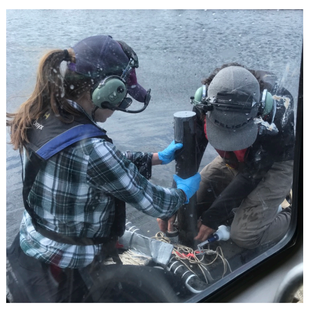
- Giant Mine Oversight Board
- GNWT- Environment and Natural Resources
- Indigenous and Northern Affairs Canada
- Tlicho Government
- Yellowknives Dene First Nation
- Wekeezhii Land and Water Board
- North Slave Metis Alliance

Ongoing Analyses

Porewater
→ Determining temporal trends of As flux to lake sediments and the remobilization risk of As to the water column

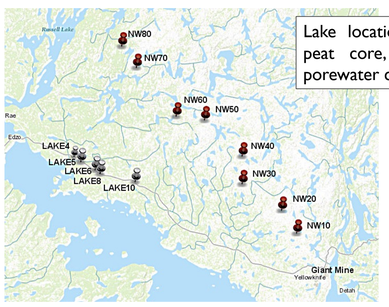
Peatlands
→ Understanding the role of peat in sequestering metals in burned and non-burned catchments

Terrestrial-aquatic links
→Understanding mechanisms governing movement of metals from terrestrial to aquatic environments through seasonal fluxes in water/soil chemistry



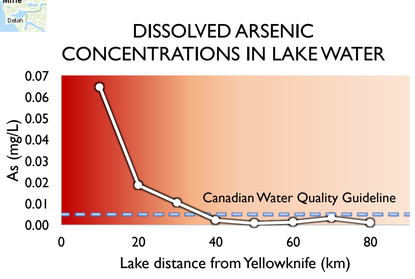
Lake sediments
→Characterizing spatiotemporal patterns of contaminant deposition and defining pre-industrial baseline conditions

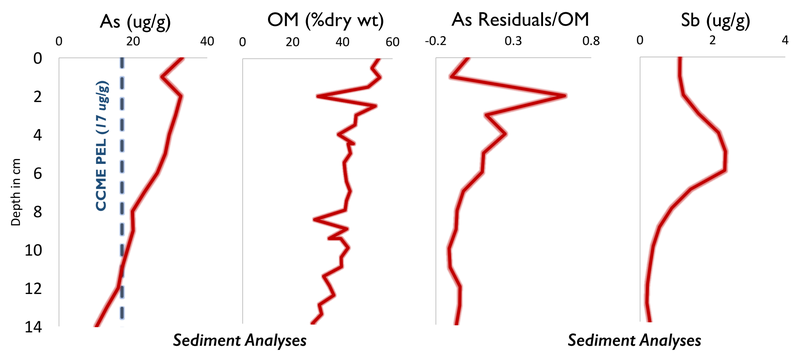
Preliminary Results



Lake locations for sediment core, peat core, water chemistry and porewater collection

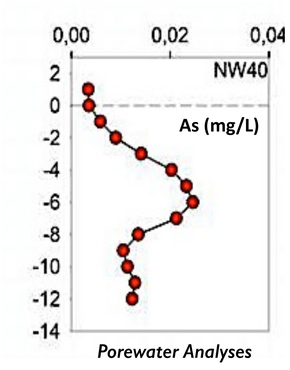
Graph of arsenic concentrations dissolved in water from the 8 lakes along our 80-km transect. Arsenic concentrations decline exponentially with distance from Yellowknife and are elevated above the Canadian Water Quality Guideline within 30 km.





"NW40": Lake located 40-km from Yellowknife

- *Affected by 2014 forest fires*
- *Organic matter profile may be indicative of increasing productivity levels and possible enrichment of OM from post-burn runoff*



Achieving GWF's Goals

SAMMS is ***predicting water futures*** *in cold regions*

- By generating knowledge of pre-industrial baselines which are imperative for characterizing present and future loadings of metals in NWT where mining projects have closed, are currently operating, and are proposed for development
- Understanding the role of a changing climate in exacerbating the transport of metals to aquatic systems
- *Looking at the bigger picture:*
  Using a multidisciplinary approach to tackle a complex problem with experts from different fields and universities

Addressing the Sustainable Development Goals

6 CLEAN WATER AND SANITATION

SAMMS *is* ***helping ensure access to safe water resources and sanitation***

- Arsenic is a known carcinogen released during the gold smelting process
- Mining activities on Yellowknife Bay released over 20,000 tonnes of arsenic trioxide into the atmosphere
  - Dispersed from the mine site and settled into many lakes, rivers, and soils
- Uncertainties exist about the size of the area that received legacy pollution from Giant Mine
  - Characterizing legacy stores and understanding the mechanisms behind its release are crucial for protecting clean water

References

[a]Galloway et al. 2015. Geological Survey of Canada, Open File 7908.
[b]Houben AJ et al. 2016. PLoS ONE 11(4): e0150960
[c]MacDonald LA et al. 2016. Sci Total Environ 544: 811-823.
[d]Palmer MJ et al. 2015. Northwest Territories Geological Survey, NWT Open File 2015-06

https://specialprojects.wlu.ca/samms/