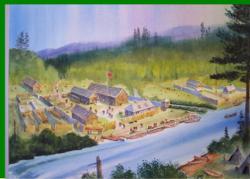


# Legacy Mercury Contamination of the Fur Trade: A Closer Look

Reece Banta (banta.reece@uwlax.edu)

Mentor: Dr. Kristofer Rolfhus (Chemistry Dept.) (krolfhus@uwlax.edu)  
University of Wisconsin-La Crosse

Artist's Rendition of Fort Charlotte



Fort Charlotte Present Day

## Abstract

Mercury (Hg) is an environmental pollutant and potent neurotoxin. Previous studies (2016, 2019) indicated toxic levels of Hg contamination in soils at Grand Portage National Monument, MN (GRPO). It's believed the contamination is linked to vermillion, a mercury-bearing cinnabar-ore, and a trading item used by French Voyageurs in the 1700-1800s. Soil samples were again collected from trade depots, Forts Charlotte and XY, in September 2019 and analyzed for total Hg concentration, with the goal of providing a more thorough concentration map of the site. Stable isotopes will be employed to confirm whether the contamination is connected to the vermillion-ore residue. Combustion studies were conducted on the September 2019 samples to determine how controlled burns would affect Hg in such contaminated soils. All results will be made available to GRPO staff to help determine how best to protect native populations and visitors from contamination.

## Methods

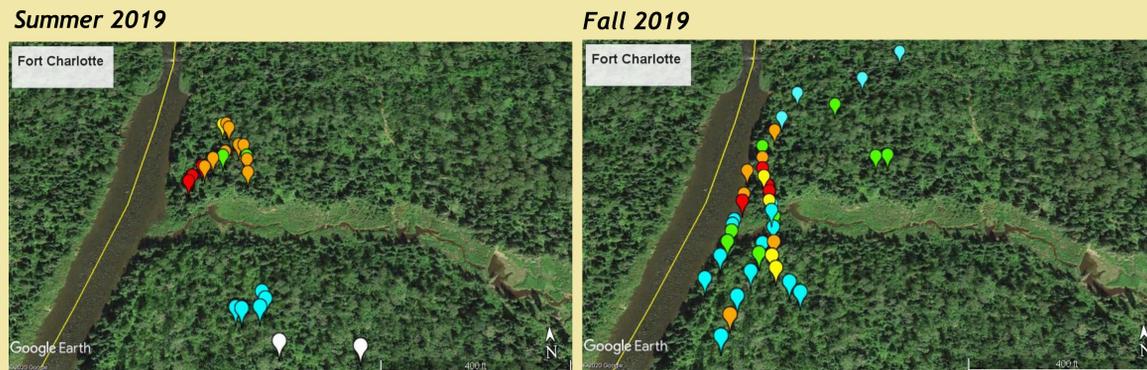
### Total Hg Concentration:

- ~45 soil samples collected from two sites at Fort Charlotte (NW Company & XY Company) in late May
- Analyzed for Hg concentrations at UW-L via atomic absorption spectrophotometer
- Samples will be sent to WI State Lab of Hygiene for stable isotope analysis on ICP-mass spectrometer

### Combustion Study:

- 5 soil samples with a wide range of Hg concentrations
- Samples placed in muffle furnace for 1, 3, and 5 hours at both 250 °C and 500 °C

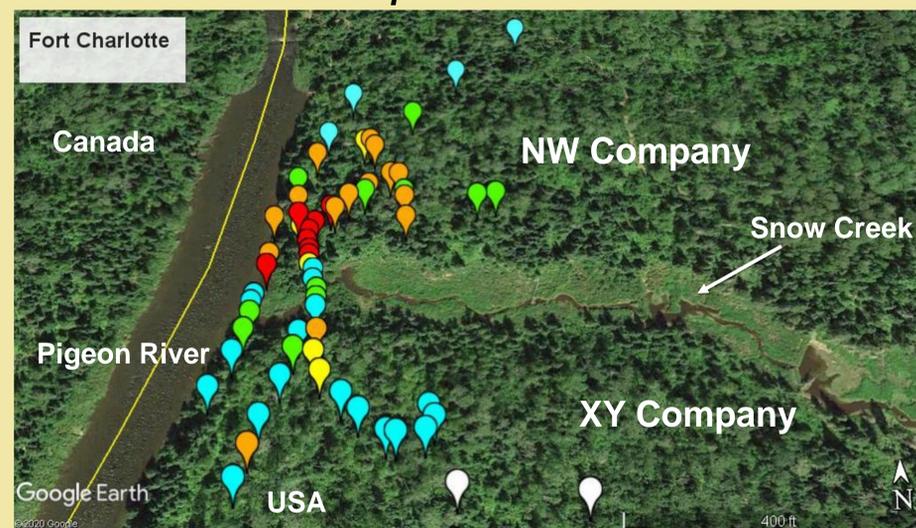
## Results - Fort Charlotte Hg Concentration Maps



Key: ○ < 100 ○ 100-300 ○ 300-600 ng/g (or ppb)  
○ 600-1000 ○ 1000-5000 ○ > 5000

(average ambient background = 100 ng/g)

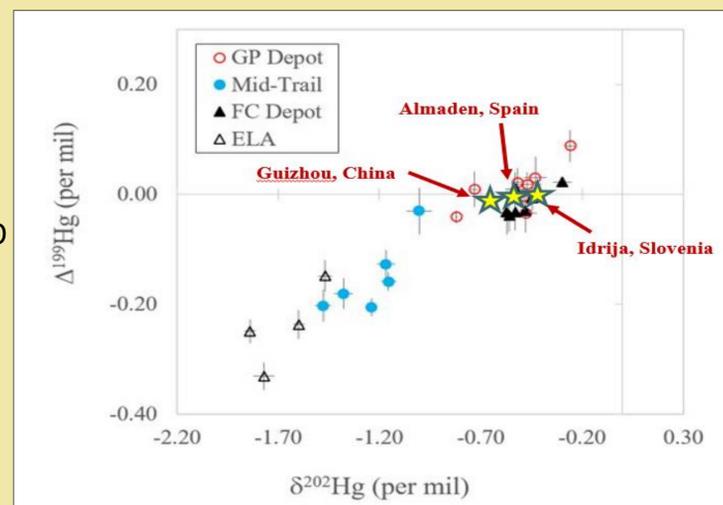
## Combined 2019 Samples



## Results - Stable Isotopes

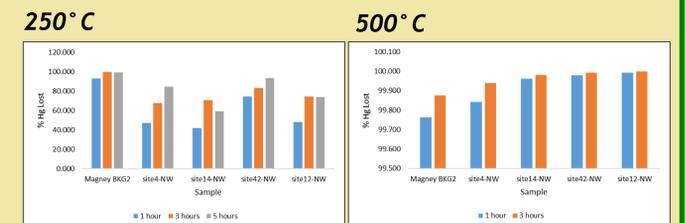
Stable Isotopic "Thumbprint" of Hg found in GRPO soils from Rolfhus et al. 2016 study

- Ratios of different isotopes in samples correspond to processes of heat, pressure, and time.
- Soil samples from GRPO in 2016 overlap with signatures from European/Asian mines, suggesting possible sources of the contamination.



## Results - Combustion Study

- Magney BKG2 used as a control (ambient background Hg concentration)
- Increasing Hg concentration: site4 - site12



## Conclusions

- Results produced a more thorough concentration map of the site.
- Mercury levels on the NW side were much higher than ambient; the highest concentrations were over 100x higher than background levels.
- Background concentrations were reached on the NW side.
- Mercury levels on the XY side were higher than ambient; the highest concentrations were over 30x higher than background levels.
- Concentrations approach the Canadian threshold for Hg toxicity in soils (>10,000 ng/g, Mahbub, K.R., et al. (2017))
- Combustion study indicated significant loss in Hg concentration in contaminated soils (up to 99.999%) at 250 °C and 500 °C; this behavior differs from that of ambient background soils especially at lower temperatures.
- GRPO soil samples from 2016 indicate Hg may have come from a European/Asian mine; we will attempt to confirm with our samples.

## References

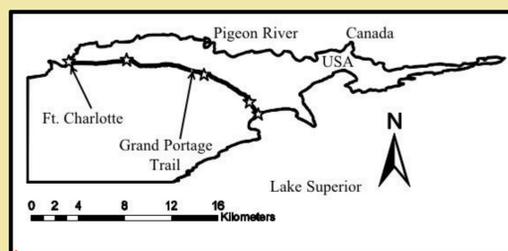
Mahbub, K.R., Subashchandrabose, S.R., Krishnan, K. et al. Appl Microbiol Biotechnol (2017) 101: 2163.  
Rolfhus, K.R., J.G. Wiener, R.J. Haro, M.B. Sandheinrich, S.W. Bailey, and B.R. Seitz (2015). Sci. Tot. Environ. 514:192-201.

## Acknowledgements

- UW-L DDF (College of Health and Science)
- Grand Portage National Monument
- National Park Service
- Ryan Lepak, James Hurley (UW-Madison)
- David Krabbenhoft (USGS)
- WI State Lab of Hygiene



Sampling at Fort Charlotte



Location of Grand Portage, MN



Vermillion sample from the Minnesota Historical Society