Determination and Quantification of Lead Content in Mammut americanus Dentine Material by Anodic Stripping Voltammetry

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### Background

A 120,000-200,000 year old mastodon tusk of species *Mammut americanus*, recovered from Hampton, Iowa in 1933 (right) was tested for lead using a lead test from Home Depot. The lead test was returned positive, so Anodic Stripping Voltammetry (ASV) was undertaken to determine the concentration of lead in the dentine material of the tusk.

The lead concentration is of interest because lead could affect both the health of the conservator and researchers and also inform about the diet of the mastodon. Tusk dentine material (left) functions similarly to human teeth, and studies have shown that 90% of lead in the human body concentrates in the hard tissues: skeleton and teeth. Lead accumulation in teeth occurs because the calcium phosphate in teeth interacts with the stable Pb isotope, causing the calcium to be permanently replaced by the lead. This enables teeth to be excellent records of the level of lead in the diet and environment of the organism.

### Importance of Lead

- Lead acts as a neurotoxin, and can bioaccumulate in the body.
- Potential lead exposure of the mastodon would most likely have come from its food sources.
- Mastodons consumed vegetation.
- Plants absorb lead from the soil they are grown in.
- The level of lead in the mastodon tusk will reveal information about both the diet of the mastodon and the environment in which it lived.

### Methodology

- **ASV** is a highly selective technique that is widely used to determine lead content in liquids.
- The technique uses three electrodes to make electrochemical measurements by ramping the electrode potential over time (right).
- Reaction takes place at working electrode.
- The standard electrode contains an internal standard reference for cell potential.
- The counter electrode balances changes in the cell’s potential caused by changes at the working electrode.
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- The counter electrode balances changes in the cell’s potential caused by changes at the working electrode.
- The large peak at -0.2 V is caused by matrix effects from the tusk material.
- The lead peak can be seen around -0.7 V.
- Noise can be seen along the baseline, and is averaged and represented as error below. The signal to noise ratio of the sample was ~14.

### Results

- The lead content should not pose any imminent risks to those working on the tusk.
- The EPA limit in bare soil is 1.2 ppt, so the soil near where the tusk was removed should be checked for lead content.
- The detectable presence of lead indicates that the mastodon lived in a relatively lead-enriched environment, though without values of lead in other tusks to compare to it cannot be determined if this is standard for the time and location.
- The concentration of lead in the dentine material was found to be 1.4±0.1 parts per thousand (w/w).
- Based on the calibration curve, the concentration of lead in the dentine material was determined to be 1.4±0.1 parts per thousand (w/w).

### Conclusions

- The concentration of lead in the dentine material was found to be 1.4±0.1 parts per thousand (w/w).
- Lead could not be detected using EDX, which indicates that the lead in the tusk is unevenly distributed.
- The detectable presence of lead indicates that the mastodon lived in a relatively lead-enriched environment, though without values of lead in other tusks to compare to it cannot be determined if this is standard for the time and location.
- The EPA limit in bare soil is 1.2 ppt, so the soil near where the tusk was removed should be checked for lead content.
- The lead content should not pose any imminent risks to those working on the tusk.

### References


### Acknowledgements

- Roy J Carver Charitable Trust and the UNI museum for making this opportunity possible.
- Nicholas Bonde for his EDX data.
- Dr. Martin Chin for Potentiostat.
- Dr. Joshua Sebree.