Do the orchard soils of Mount Desert Island region harbor residuals of historical arsenical pesticides use?

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MDI Biological Laboratory

DARTMOUTH TOXIC METALS SUPERFUND RESEARCH PROGRAM

Introduction

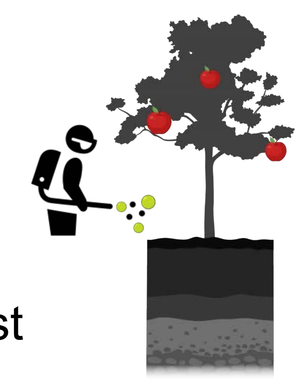
Chronic long-term exposure to low levels of As can cause a number of adverse health effects and it is therefore important that we are aware of the different pathways of ingestion. Arsenic in soils may leach into shallow dug wells or may be taken up by vegetables in a garden.

The focus of this study is on the soils of the northern MDI/Trenton, ME region. We targeted locations of old apple orchards or blueberry fields. In Figure 1, soil sampling sites can be seen together with the bedrock geology and arsenical pesticide application estimates.

Ellsworth Schist

Sources of As in Maine soil:

- Igneous and metasedimentary bedrock weathering products
- Residuals of arsenical pesticides and lumber treatment products used in the past



According to a 2013 USGS Soil Chemistry Report, the average background arsenic (As) levels in US soils are 6.4mg/kg; the average As levels in Maine soils are **8.6mg/kg**.

Goals

- **Develop a soil sampling method that will be used by secondary school students in a ME-based citizen science project**
- **Learn about arsenic abundance in soils of orchards and blueberry farms in the MDI region**

Methods

We sampled the top 4" of soil (Figure 2) at sites that have potentially been applied with arsenical pesticides as well as 3 control sites where pesticides were most likely not applied. At each site, we collected 2 samples (plus a duplicate) at a distance of 2 feet from 2 different apple trees (A, B) and one composite sample (C) containing five subsamples from around the site.

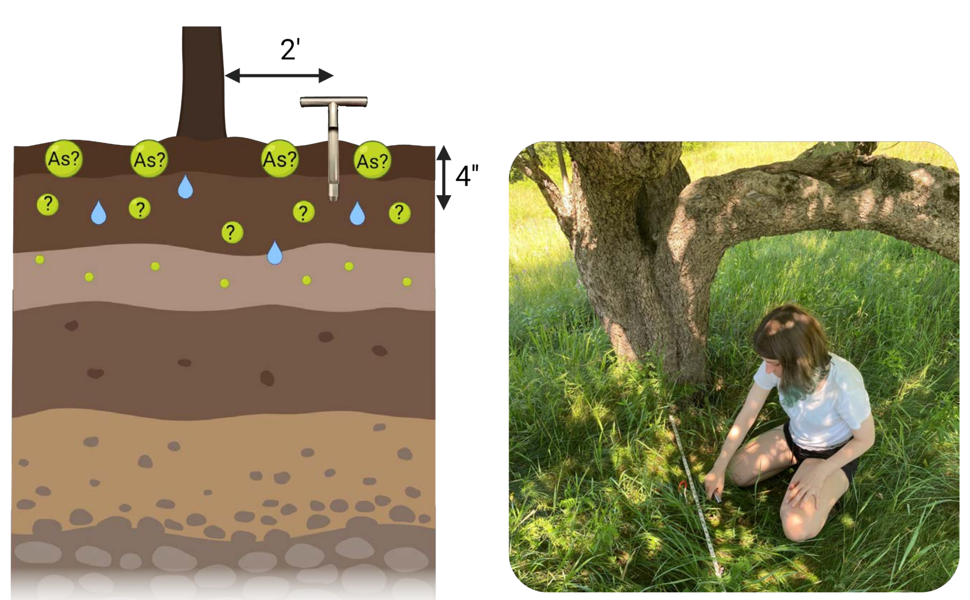
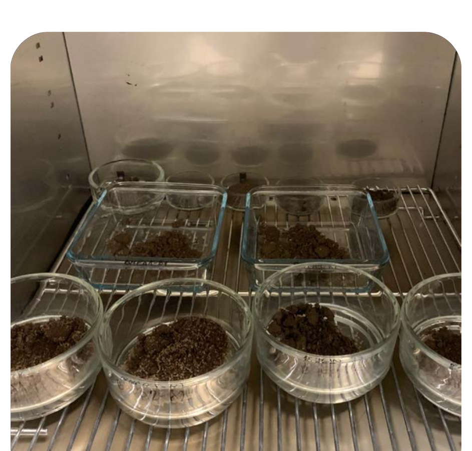


Figure 2 *Simple soil sampling method developed for the Orchards, Gardens and Fields citizen science project*



Soil samples were dried at 70°C for 24 hours, sieved to <2mm, and sent off for analysis at Dartmouth College's Trace Element Analysis Core Lab. The samples were dissolved following the EPA 3050B procedure and analyzed by Inductively Coupled Plasma Mass Spectrometry following the EPA 6020a procedure.

Support

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All About Arsenic Project

This subproject is a part of the larger All About Arsenic (AAA) citizen science project hosted at the MDI Biological Laboratory Community Lab. The aim of AAA is to improve **public health** and build **data literacy** of students by engaging them in research.

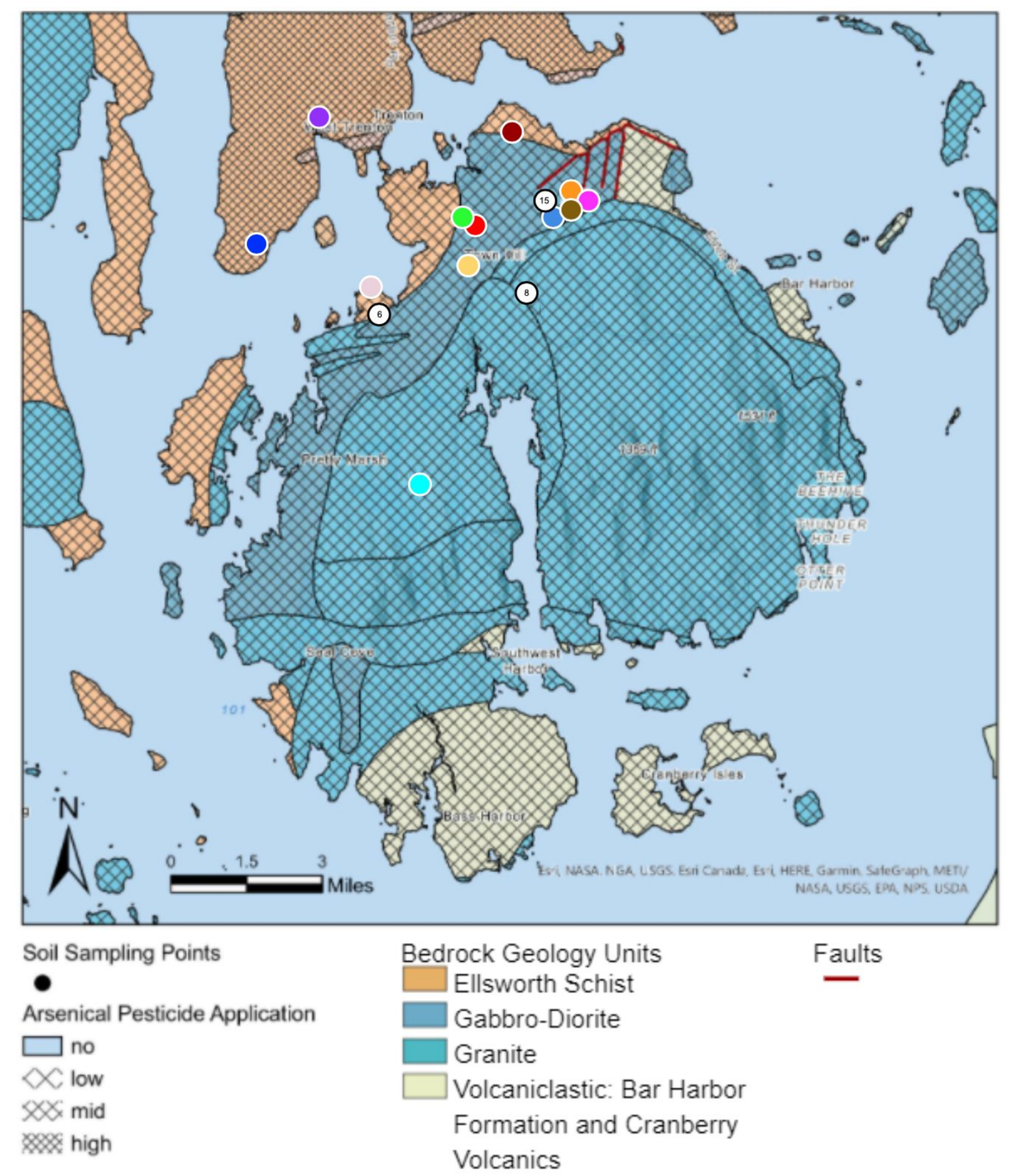

Figure 1 *Map of Mount Desert Island (MDI) showing the bedrock geology units (Osberg, Hussey, and Boone, 1985), arsenical pesticide application estimates (Robinson and Ayotte, 2006).*

Take Home Points

- In the near surface soil, arsenic may occur naturally as bedrock weathering products and anthropogenically from residuals of arsenical pesticides or lumber treatment products.
- While the small family orchards of northern MDI studied here **DO NOT** have elevated concentrations of As in the soil compared to the Maine background soil As, the larger orchard and the old blueberry field **MAY CONTAIN** residuals of As from pesticides.
- The soil sampling method developed for this study will be used by students participating in the ***Orchards, Gardens and Fields*** citizen science project planned for spring 2022.
- ***Know the story of your garden (geology, land-use) to avoid arsenic exposure!***

Results

The soil arsenic concentrations from 15 sites are shown in Figure 3. We compare our soil geochemical data to a Maine soils dataset. Background Maine soils have an average As value of 8.6mg/kg and a range of 1.7-30.2mg/kg (USGS, 2013).

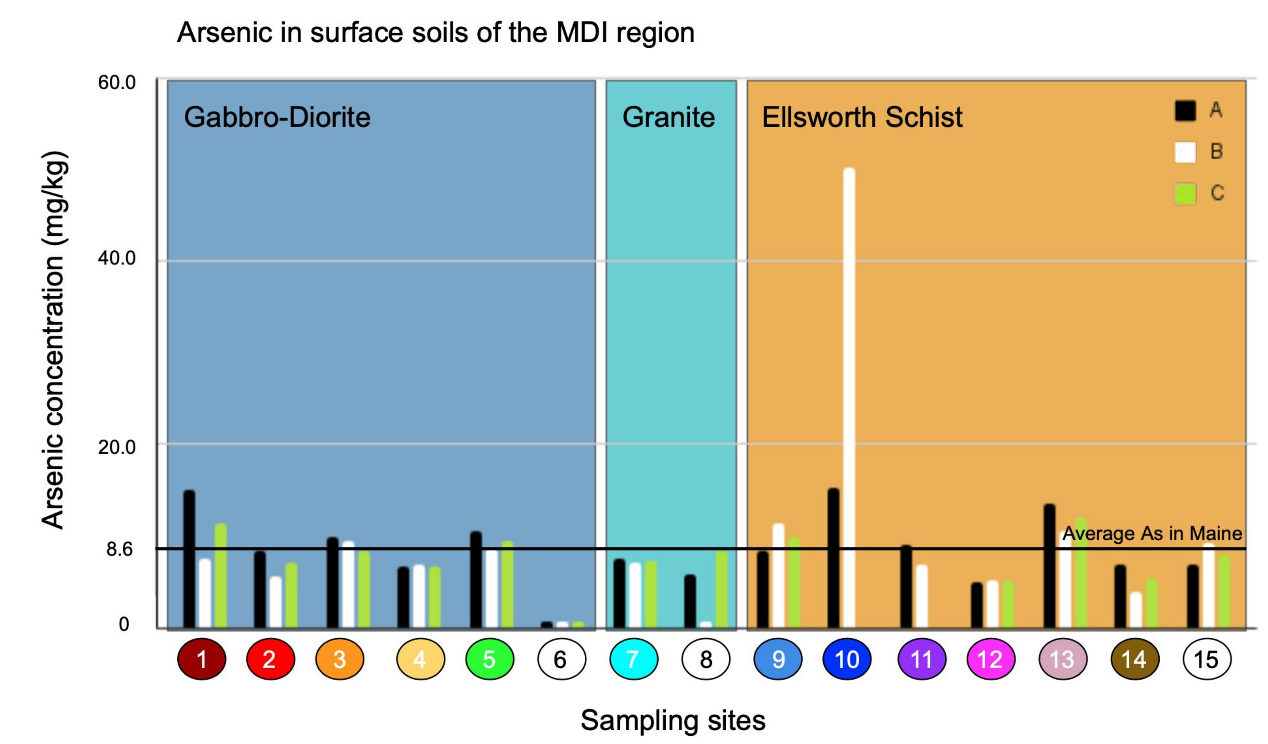

Figure 3 *Bar graph showing arsenic concentrations in soils (mg/kg) at different sites. Samples A and B are averages for the two field duplicates collected next to apple trees or blueberry bushes. The C sample for each site is the composite sample from around the site. The black horizontal line shows the average background levels of arsenic in Maine and US soils measured by the USGS in 2013. The colored dots correspond to sites in Figure 2, white dots indicate control sampling sites.*

The arsenic values in soils at the majority of our sites are around the Maine average (USGS) and they are similar to concentrations measured at control sites for each bedrock type (sites 6, 8, and 15). An exception to this is site 10 where we measured elevated levels of arsenic directly below a high-bush blueberry bush of an old blueberry farm. At site 1, the largest apple orchard, arsenic levels are slightly elevated.

Site	As (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Preserve Orchard Composite	11.5	134.2	93.1
Preserve Background Composite	0.7	13.5	18.0
USGS ME Average	8.6	35.4	68.9
USGS ME Max	30.2	233.0	218.0
USGS ME Min	1.7	7.2	21.0
USGS ME Median	8.0	22.9	65.0

Figure 4 *Table showing elevated As, Pb and Zn levels in an old orchard site of a local Preserve compared to a forested site with no agricultural history at the same preserve.*

Two sites within a Preserve, both located on the Ellsworth Schist, yield very different As concentrations. The As, Pb and Zn from the orchard at the site are elevated compared both to the control sample collected in a forested area on the property and to Maine averages (Figure 4).

We dug soil pits at a few sites to map the soil stratigraphy and collect samples at various depths to see how metal abundance changes with depth. At nearly all sites (Figure 5) metals were more abundant in the top ~5" inches (the O horizon or uppermost A horizon), or they remain fairly constant throughout the depth profile. This gives us confidence that the soil sampling method we developed for students collecting surface samples should therefore work well.

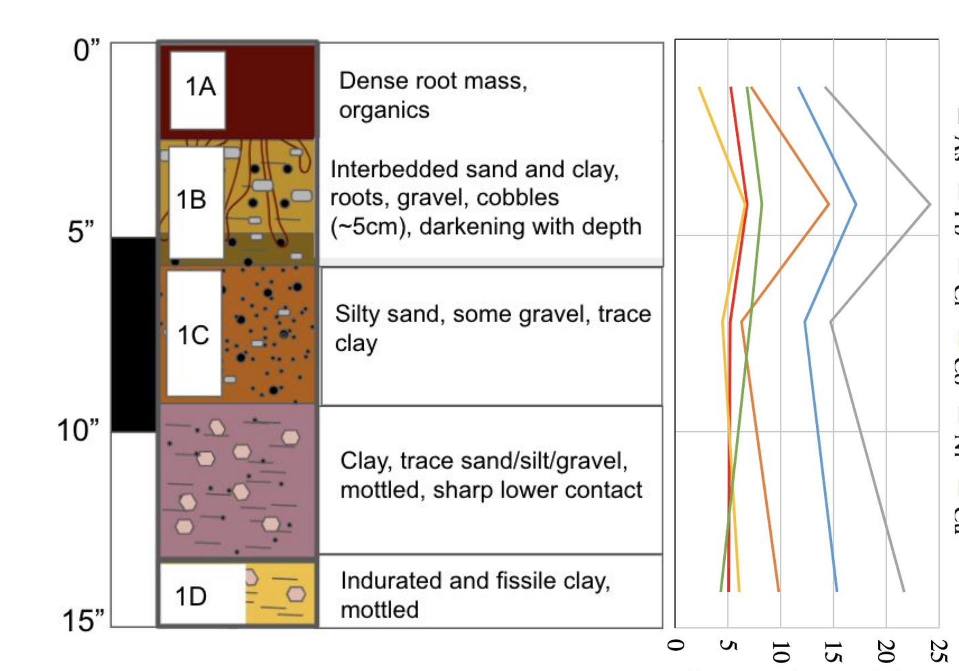

Figure 5 *Soil stratigraphy and metal abundance through a depth profile.*

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