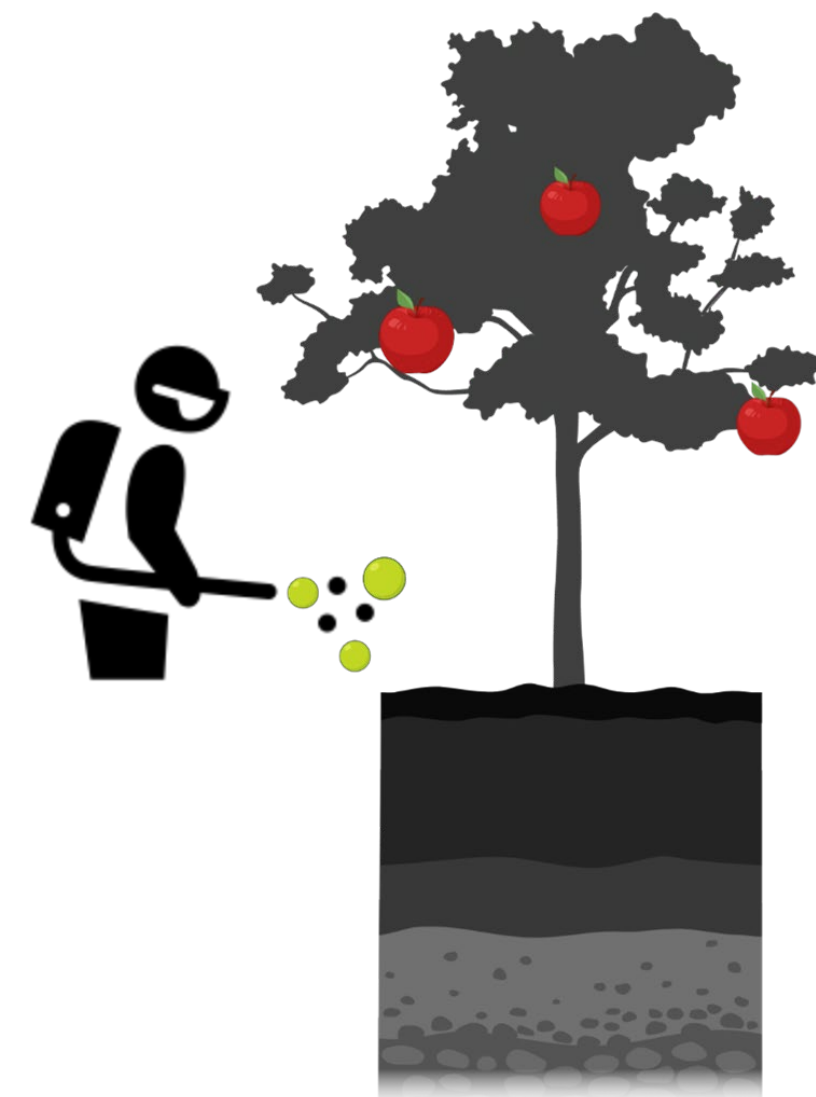


Do the orchard soils of northern Mount Desert Island harbor residuals of historical arsenical pesticides use?

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Background



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

Sources of Arsenic (As) in Maine soil:

- Igneous and Metasedimentary Bedrock
- Residuals of arsenical pesticides and lumber treatment products from the past

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. I chose to study soils in old apple orchards on northern MDI as there are many and the All About Arsenic (AAA) project at MDIBL has studied As in well water in this area extensively. In [Figure 1](#), soil sampling sites can be seen together with the bedrock geology and arsenical pesticide application estimates.

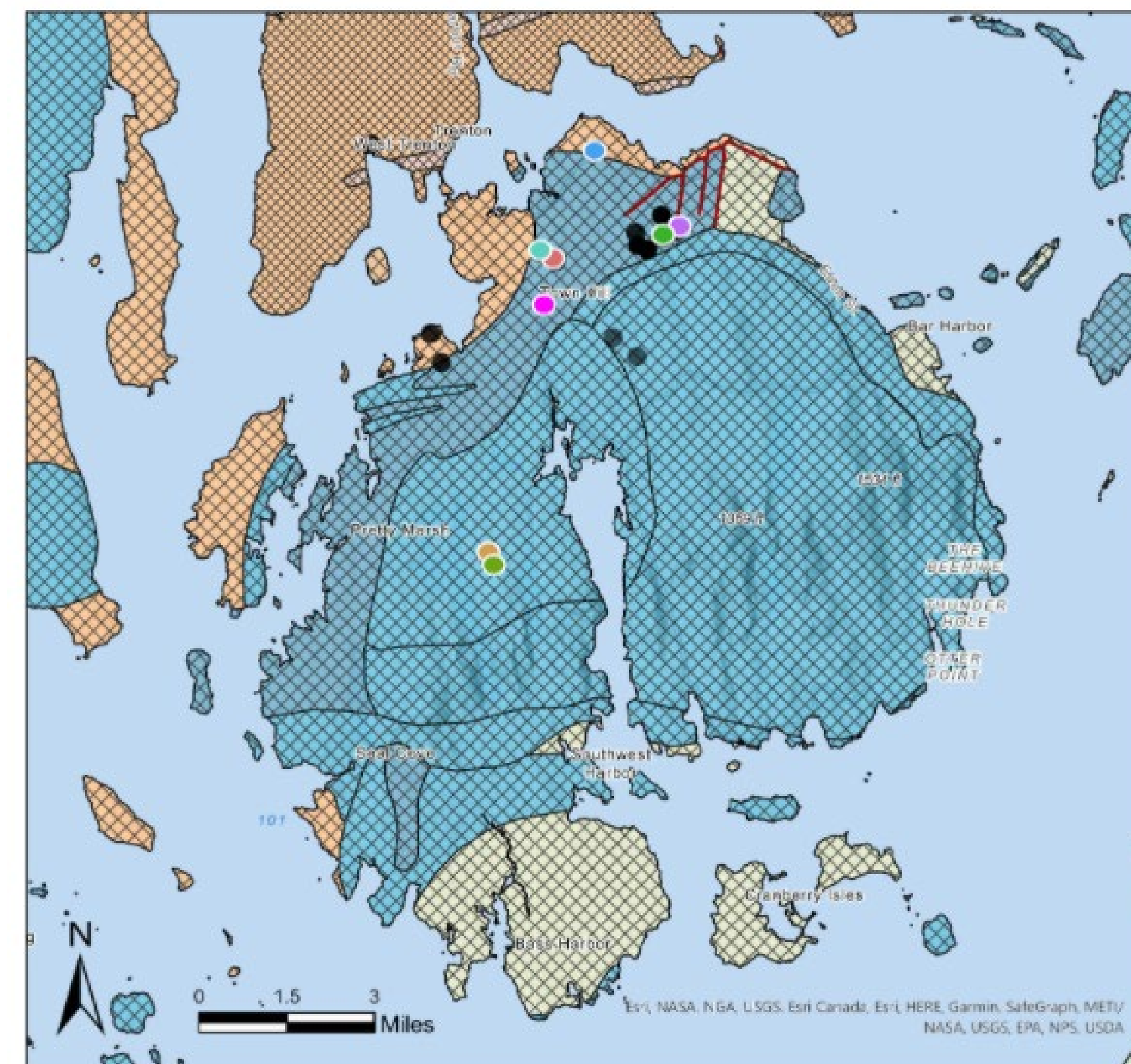


Figure 1 Map of Mount Desert Island (MDI) showing the bedrock geology units (Osborn Hussey, and Boone, 1985), arsenical pesticide application estimates (Robinson and Ayotte, 2006) and color coded soil sampling sites - colors correspond sample sites shown in Figure 3.

Hypothesis

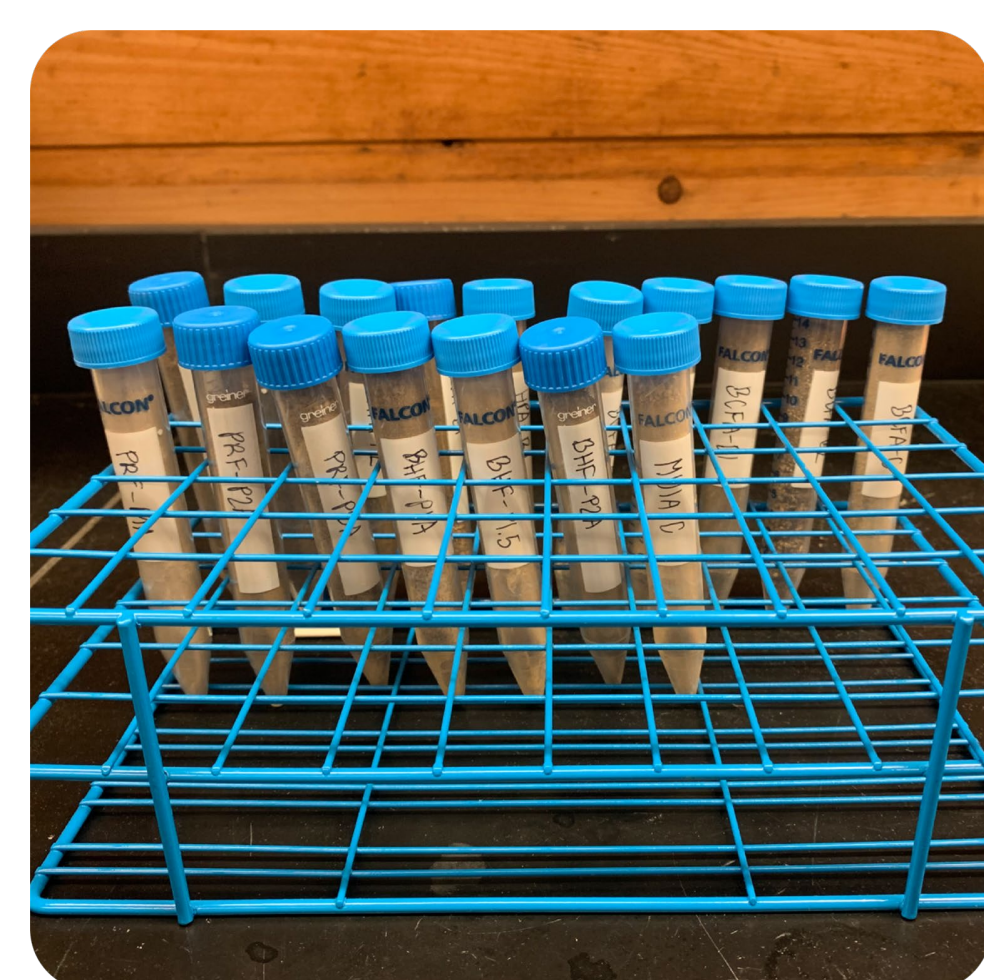
The top layer of soil in old apple orchards where pesticides containing As may have been used will contain higher levels of arsenic relative to background levels in Maine soils.

Methods



We sampled the top 4" of soil (see [Figure 2](#)) within clusters of old apple trees on northern MDI that could have potentially been sprayed with arsenical pesticides. At each site, we collected 2-3 samples (plus a duplicate) at a distance of 2 feet from upto 3 different apple trees (A, B, D) and one composite sample (C) containing five subsamples from around the orchard.

I dried the soil samples at 70°C in an oven for at least 24 hours, sieved them to <2mm, and sent them 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.



We also collected soil samples in locations with no agricultural history to establish local background arsenic levels. As our non-orchard sample results are not back yet from analysis, we use the 2013 USGS Soil Chemistry Report to compare with our orchard soil results.

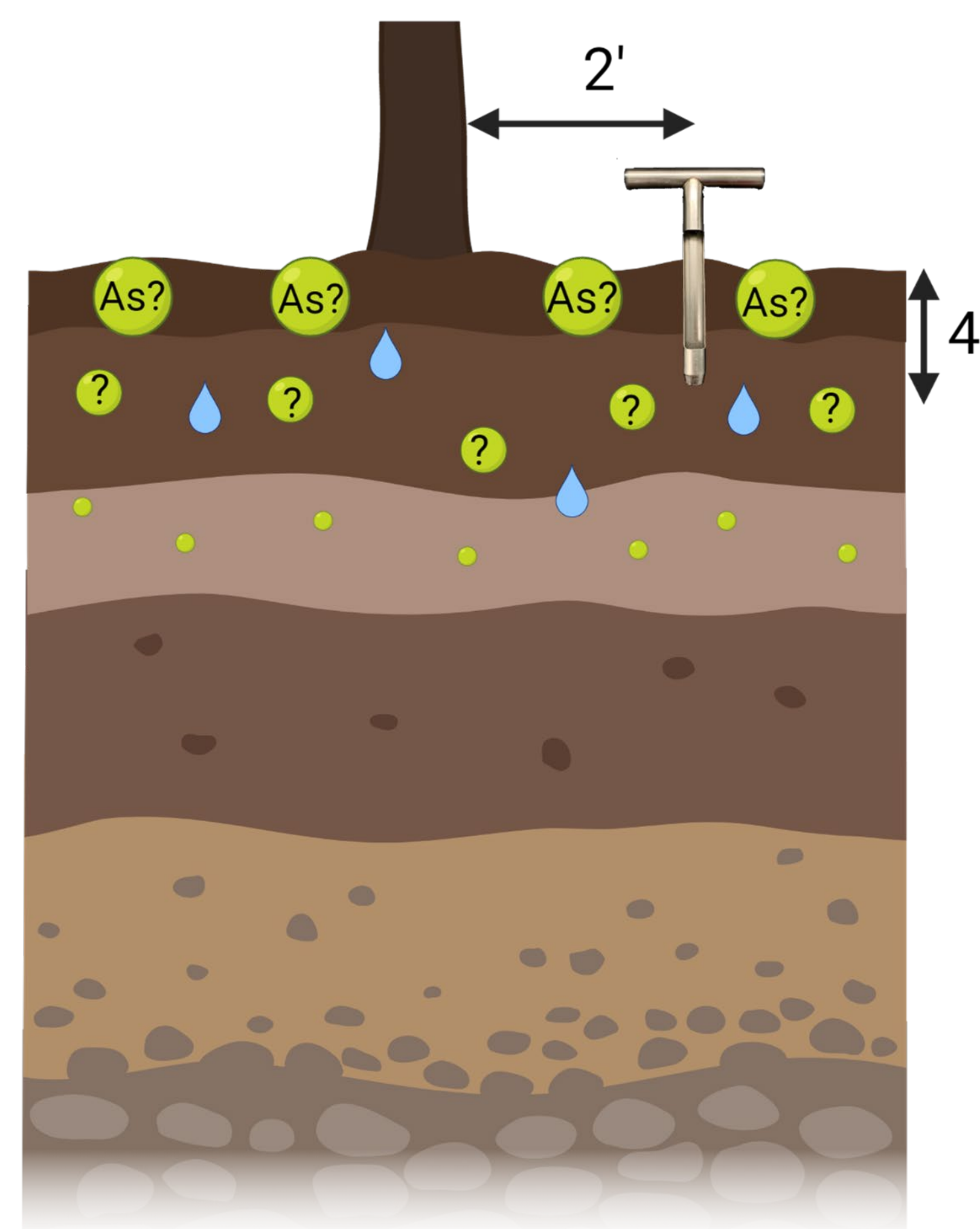


Figure 2 A diagram showing the soil sampling method.

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 levels of As in the soil compared to the Maine background As levels, the larger orchard **MAY HAVE** residuals of As from pesticides.
- The developed soil sampling method could be used by students for the *Orchards, Gardens and Fields* citizen science project planned for next year.
- **Know the story of your garden (geology, land-use) to avoid arsenic exposure!**

All About Arsenic Project

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

As a part of my independent project, I considered which soil sampling and processing methods would be most suitable for middle and high school students so that they can collect soil data in addition to well data as part of a new citizen science project called *Orchards, Gardens, and Fields*.

Results

So far, we have received the first half of the soil results. These are shown in [Figure 3](#). We compare our data to data from soils around Maine that have an average As value of 8.6mg/kg and a range of 1.7-30.2mg/kg (USGS, 2013).

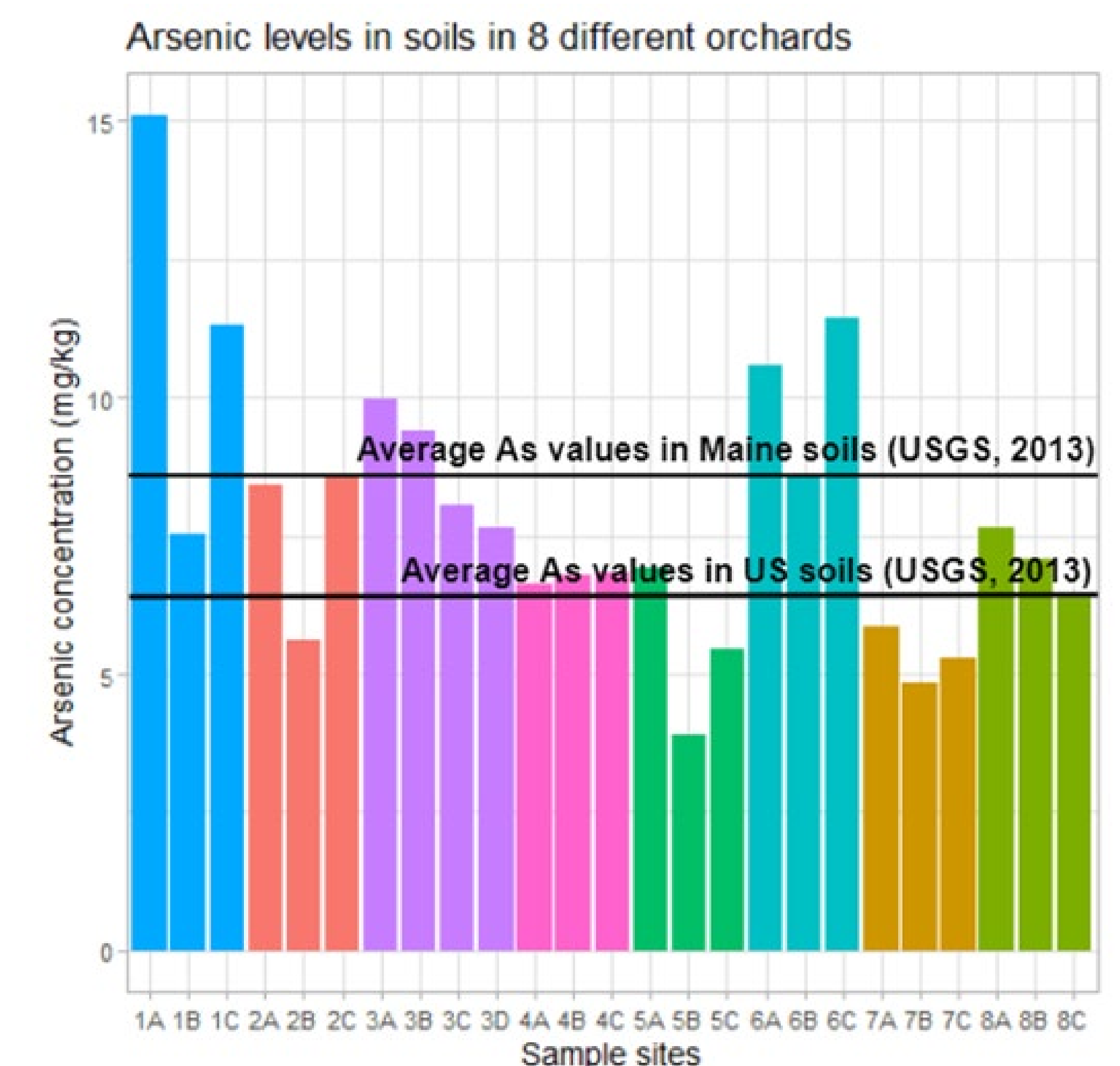


Figure 3 A bar graph showing arsenic concentrations in soils (mg/kg) at different sites. Samples from the same site share a color. Samples A and B (and D) are averages for the two field duplicates collected 2' from a tree, which were generally around the same value with max 8% difference. The C sample for each site is the composite sample from around the orchard. The black line shows the average background levels of arsenic in Maine and US soils measured by the USGS in 2013.

Arsenic levels in the soils in most of the orchards are similar to the background levels of As in Maine suggesting no residuals of As pesticides. It is important to note though that majority of them have elevated levels of As compared to the US average. This As likely comes from the bedrock.

For Site 1, a larger orchard (more than 20 trees) yields the highest As levels in soil suggesting there are residuals of arsenical pesticides present. This property is located on Ellsworth Schist, therefore As may be related to weathering products from the rock which is known to have high As levels. However, as there is low As in the drilled well water at this property (which would be high if bedrock had As), it is possible that As in the soil may have come from historical pesticide use.

References

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- Smith, D.B., Cannon, W.F., Woodruff, L.G., Solano, Federico, Kilburn, J.E., and Fey, D.L., (2013), Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, 19 p., <https://pubs.usgs.gov/ds/801/>. Diagrams were created with BioRender.com. Map was created using Esri ArcGIS Pro.

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