

# Investigating Magnetic Susceptibility in Soil Associations within the Puyallup Watershed

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## INTRODUCTION

- Magnetic susceptibility (MS) is a measurement of the concentration of ferrimagnetic minerals in the soil. Magnetic properties are useful for fingerprinting sediment sources (Walling et al. 1979; Hatfield and Maher 2009). This study took inspiration from a previous study that fingerprinted upland soil sediment in the United Kingdom (Hatfield and Maher 2009).
- Soils are grouped into associations based on their parent material (Fig 1). The study sites were chosen to better understand the mineralogical differences between lowland and glacial sediment as these sites represent a variety of parent materials.

Soil Associations by Parent Material

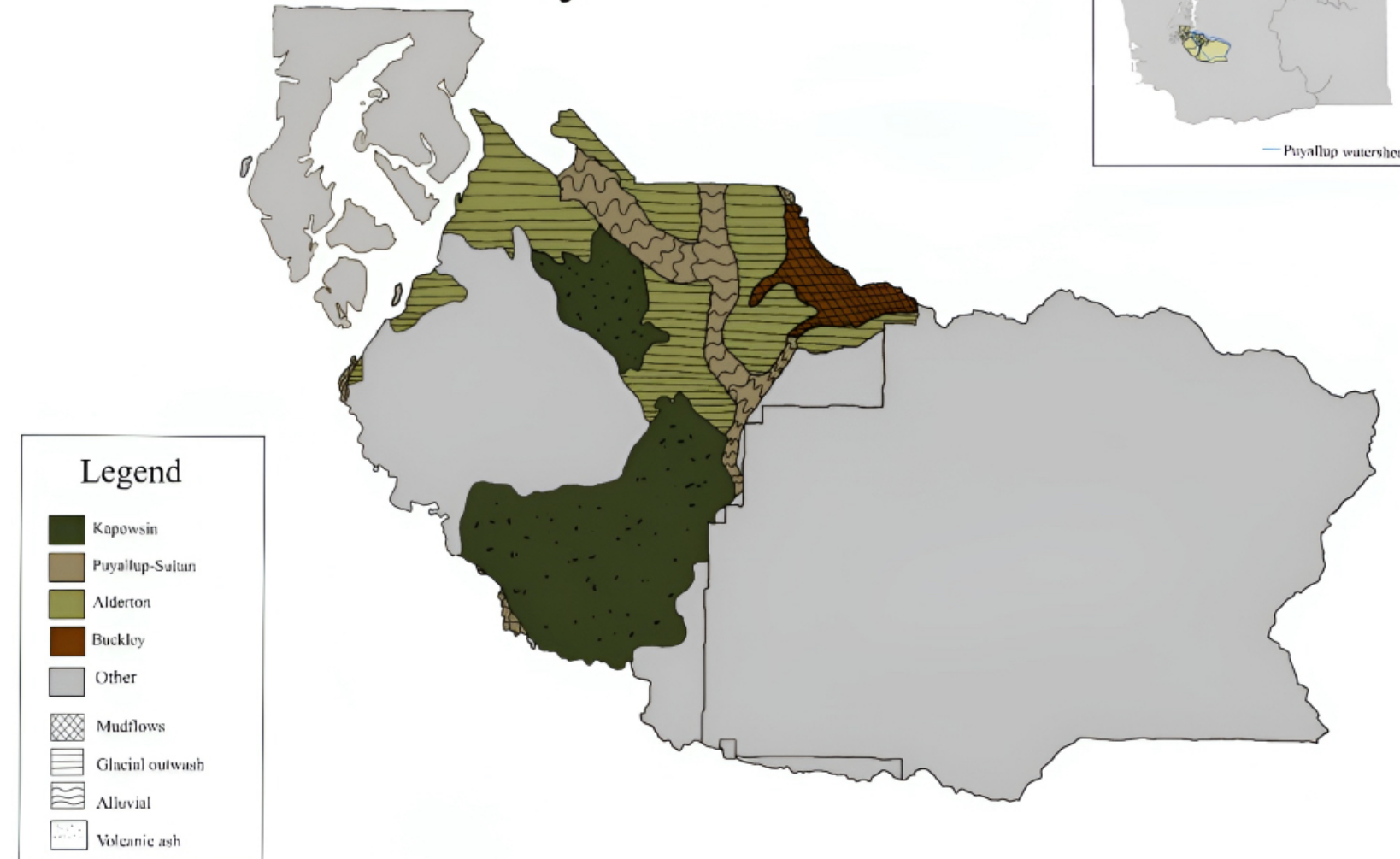


Fig 1. Soil associations in the Puyallup watershed and their parent materials.

## METHODS

- Two sample cores were collected near native vegetation, when possible, at each location (n=10). The dried cores were separated into 2 cm lengths.
- 62 topsoil samples collected from the Alderton association by Pierce College students.
- Magnetic susceptibility was measured at a high (4.65kHz) and low (0.465 kHz) frequency on a Bartington MS-2B susceptometer.



Fig 2. Cores were collected, using soil corers, from the Puyallup, Kapowsin, and Buckley associations.

## ALDERTON RESULTS

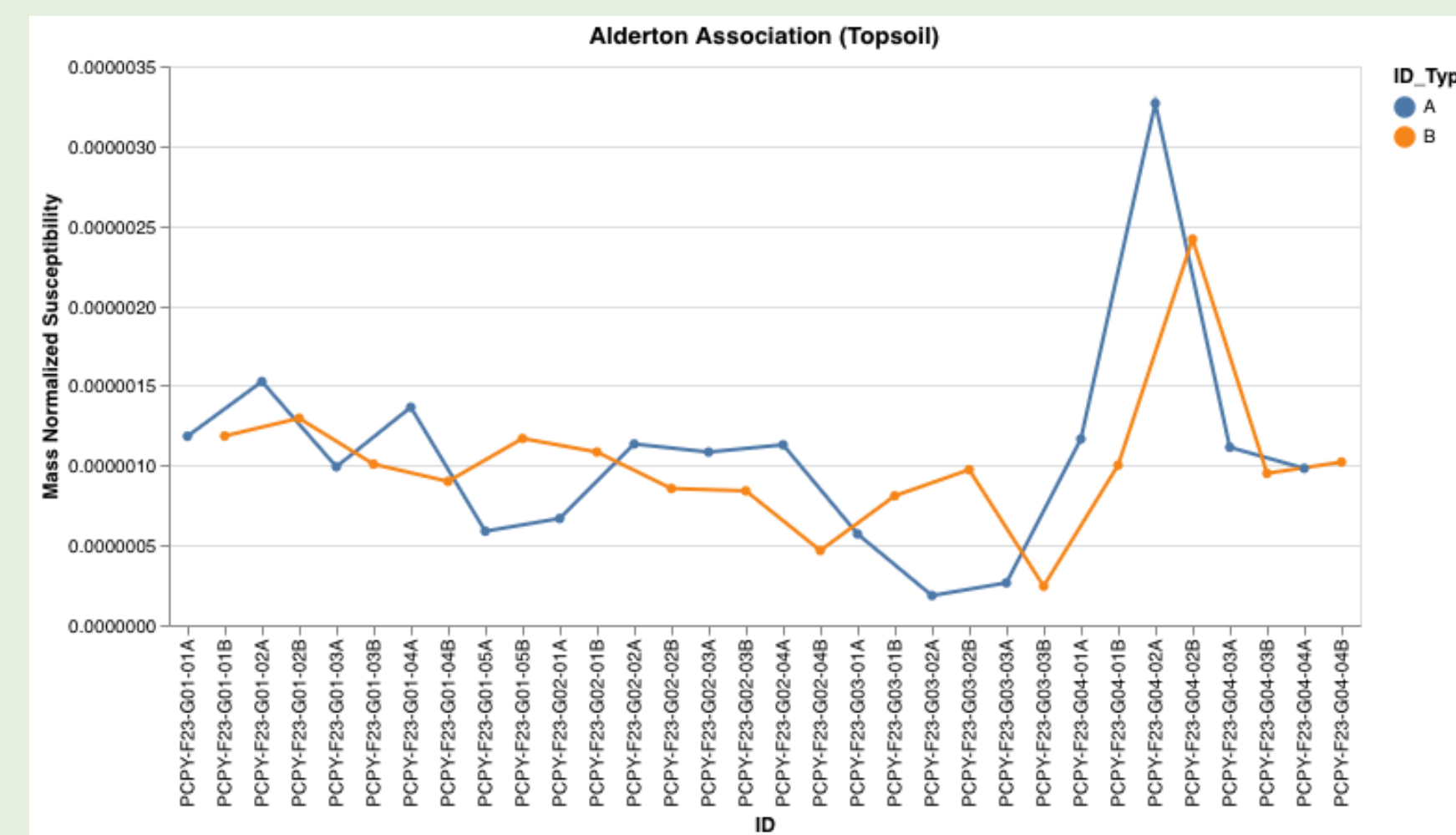


Fig 3. Low frequency (LF) mass normalized susceptibility measurements of 62 topsoil samples that were collected by Pierce college students in various locations in the Alderton association.

## SAMPLE CORE RESULTS

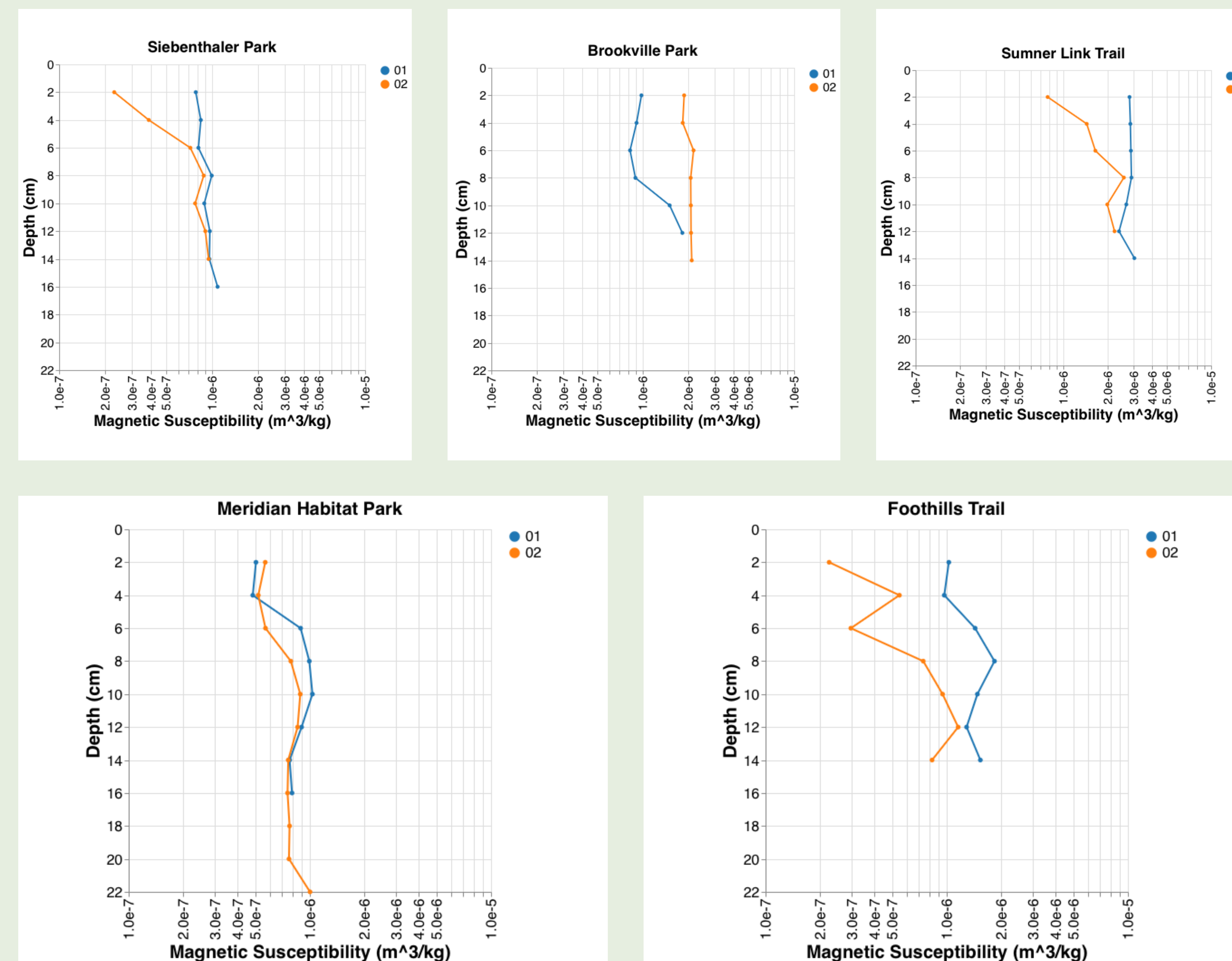


Fig 4-8. LF mass normalized susceptibility measurements of the soil core samples from the Puyallup association. The depth of the soil core was recorded in cm while the frequency (x-axis for each graph) was measured in  $m^3/kg$ . Puyallup associations, besides Siebenthaler Park, had the highest concentration of ferrimagnetic minerals in the soil. Siebenthaler Park, Brookville Park, and Sumner Link Trail were located in the Puyallup association, Meridian Habitat Park was located in the Kapowsin association, and Foothills Trail was located in the Buckley association.

## RESULTS

- The Puyallup association (Sumner Link) had the highest average magnetic susceptibility ( $2.3 \times 10^{-6} m^3/kg$ ) with the exception of Siebenthaler Park, which had the lowest average susceptibility besides Kapowsin ( $0.81 \times 10^{-6} m^3/kg$ ). The Kapowsin association had the lowest average magnetic susceptibility ( $0.77 \times 10^{-6} m^3/kg$ ).

## CONCLUSION

- Parent material lithology has been found to determine the initial concentration of magnetic minerals in soils which can be enhanced through environmental processes (Singer and Fine 1989).
- Puyallup associations had high MS which was expected. Puyallup soils consist of silty loam/fine sand from alluvial sources. Alluvial sediment is typically rich with iron-oxides (Liu et al 2012). Then, this sediment with high MS accumulates in thick successions over time (Liu et al 2012).
- Alderton had lower MS than Puyallup and Buckley, and its parent material consists of glacial till. The MS of glacial till largely depends on the sources of glacial material as variability in MS could result from environmental factors and way of deposition (Gurney and White 2005). Alderton does receive a significantly less amount of annual precipitation ( $\sim 1000$  mm) than the other sites which could result in lower relative magnetic susceptibility: waterlogging tends to reduce MS and magnetic enhancing processes (USDA 2018; Singer and Fine 1989).
- The Kapowsin association had the lowest MS which was expected since much of these soils consist of sediment from volcanic ash.
- Siebenthaler Park was a location in the Puyallup association, and besides Kapowsin, it had the lowest magnetic susceptibility. There was a lack of native vegetation (mainly grass with few trees) at this site compared to the others. Vegetation causes various processes in the soil that can contribute to the MS, as the presence of organic matter allows for processes that reduce iron (Hanesch and Scholger 2005). Considering this, it was important to sample near vegetation when possible.
- Measuring the MS of soil samples is useful to distinguish lowland and glacial sediment sources so that the origin of sediment within the watershed, and thus the geologic history, soil composition, and hydrology, of the watershed can be further understood.

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Scan me!

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