Elemental Analysis of Suspended Sediment Transport From Glacier to Commencement Bay

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Introduction

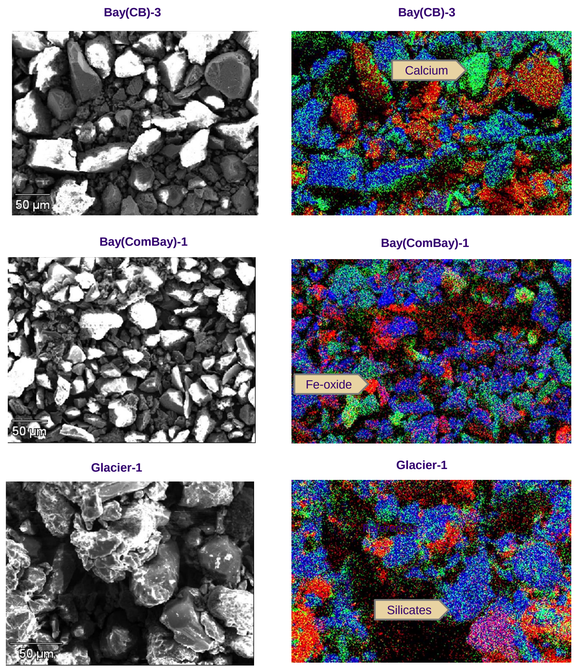
The Puyallup River flows from glaciers on the west side of Mount Rainier (Fig 1). It discharges water and sediment into Commencement Bay where sediment is usually deposited. Human-induced climate change is causing glaciers to melt, potentially increasing the river's suspended sediment load as retreating ice exposes unstable debris and as glacial melt increases. Here we track the sediment sources by comparing the mineralogy of Commencement Bay sediment with sediment from Emmons Glacier on Mount Rainier (Garzanti et al). We expect to see more Fe-oxides in the glacier sediment than that of Commencement Bay.

Figure 1: Map shows the river system in Pierce County along with the location of Commencement Bay and Emmons glacier.

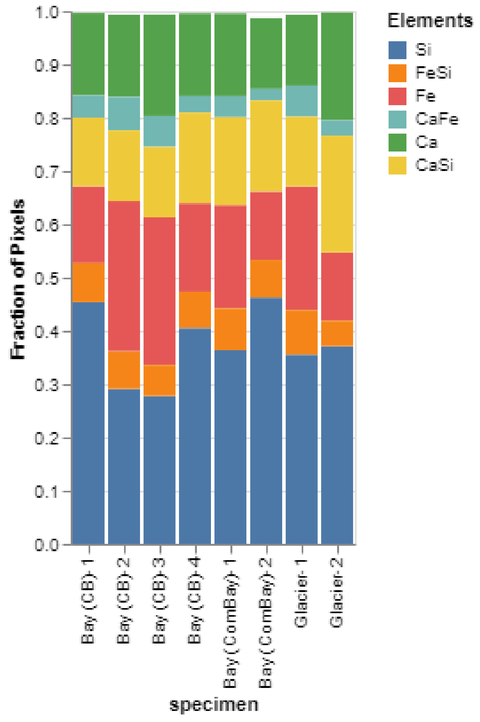
Methods

- EG samples were collected with a shovel and CB samples were collected using a Van Veen grab sampler.
- Sediments were separated into sand, silt, and clay-sized particles by sieving (for sand, >63 um) and settling (silt, 63 -4 um; clay <4 um)
- Sediment samples were placed in a Hitachi S-3400N scanning electron microscope (SEM) for elemental analysis with an accelerated voltage of 17kV and probe current of 80.
- Image J was used to convert elemental maps into color composites with each color representing an element (Red: Fe, Green: Ca, Blue: Si)
- Color composites were then placed into Python software for image analysis which counted the pixels of each color.

Results



Images on the left-hand side are taken from SEM microscope. Color composites on the right-hand side were processed using imageJ.



Metals were chosen to distinguish between three common minerals: iron oxide, iron silicates, and calcium carbonates. Samples collected from Emmons Glacier showed an average of 18±7% of all spot analyses containing only Fe, 36±1% containing only Si, and 17±5% containing only Ca. Samples collected from Commencement Bay showed an average of 22±7% containing Fe, 9±5% containing Si and 16±2% containing Ca.

Discussion

Our original hypothesis was that iron minerals would be more abundant in glacial sediment than elsewhere. However, silicates appear to be the dominant minerals found in all of the samples. These results are inconsistent with the magnetic susceptibility (Snedden,G. et al) of these samples which states that there was a higher concentration of iron oxides in the Emmons Glaciers samples. This may be due to how these samples were processed. When the elemental analysis of our samples were performed, only a microscopic portion of the sample was tested as opposed to the sample as a whole. As a result, the sections that were chosen may or may not have had as many iron oxides in that specific area as opposed to other parts of the sample.

Conclusion

- Samples from Emmons Glacier did not contain more iron oxides than those collected from Commencement Bay.
- Since only microscopic pieces of the sample were tested, this not the best generalization of whole area.

Future Study

The elemental analysis of these suspended sediments can provide environmentally significant information about sediment sources in the Puyallup River for comparison of any future changes. With the ever-changing climate, the deposition of sediment has many variables associated with it such as rain, wind, erosion, etc. Due to these variables, ideally, analysis can be done at different times of the year to compare if any of these factors may have any effect.

References

Garzanti E, Andó S, France-Lanord C, Censi P, Vignola P, Galy V, Lupker M. 2011. Mineralogical and chemical variability of fluvial sediments 2. Suspended-load silt (Ganga–Brahmaputra, Bangladesh). Earth Planet Sci Lett. 302(1–2):107–120. doi:10.1016/j.epsl.2010.11.043.

Snedden, G. Selkin, P. (2023) Magnetic Properties of Suspended Sediments Throughout the Puyallup Watershed.

Acknowledgements

We would like to thank Amy Repolgle at the University of Puget Sound for training us on the SEM. Claire Todd, Cheryl Greengrove, and Julie Masura for the collection of our Emmons Glacier samples. Gracelyn Snedden for her work on the magnetic susceptibility of these samples.