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Comparing 40-year sediment records of aquatic ecosystem evolution in two large lakes in the blast zone of Mount St. Helens

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Introduction

- The 1980 eruption of Mount St. Helens sterilized Spirit Lake and dammed Coldwater Creek, forming Coldwater Lake.
- Sprit Lake has a floating log mat covering 20% of the surface from trees felled during the eruption.
- Ecosystem recovery related to patterns of log mat coverage has been studied extensively at Spirit Lake.
- New work at Coldwater Lake provides an important point of comparison in a lake without woody debris.

Figure 1: Site location. Mount St. Helens, Coldwater Lake, and Spirit Lake

- The two lakes together provide a unique opportunity to study how volcanic eruptions alter freshwater environments.

Field Work

Figure 2a: Sample locations at Coldwater Lake; 2b: Coldwater Lake, Mount St. Helens National Monument; 2c: Sampling surface sediment

- Took four sediment cores using a gravity corer at various flat benches around the lake.
- Cores were taken at 9m, 30m, 48m, and 50m water depth; each core was around 30cm long.
- Took three surface sediment dredge samples between 3-8m depth.
- Took two plankton tow samples at the lake surface

Lab Work

Figures 3a-d: Common diatom taxa found in Coldwater Lake. (1) Navicula sp. (2) Cyclotella sp. (3) Achnanthes minutissima (4) Hannaea Arcus (5) Anomoeneis vitrea (6) Gomphonema acuminatum

- Extruded and sectioned the cores into 1cm intervals
- Dried and weighed subsamples for organic geochemical analysis
- Cleaned, prepped, and diluted subsamples to make diatom slides
- Identified and counted diatoms from 16 samples

Part One: Temporal Changes in Coldwater Lake Diatom Assemblages

Figure 4: Changes in diatom taxa from the top to the bottom of the deepest core taken at Coldwater Lake.

- Younger sediment displays much more diversity in diatom taxa, as well as a higher abundance of diatoms overall, implying that nutrients and substrate in the lake have increased overtime as the lake has developed.
- There is less change in diversity between the top few centimeters of sediment than between the bottom few centimeters, implying that the lake has become relatively stable in recent years.

Future Work

- Subsamples will be analyzed for %C and %N at the CU boulder isotope lab in order to track the change in organic matter through time and support preliminary conclusions made from diatom analysis.
- Diatom results will continue to be analyzed in order to better understand how changes in dominant taxa indicate changes in the lake ecosystem.

Part Two: Spatial Variability in Coldwater Lake Diatom Assemblages

Figure 5a: Diatom diversity with depth in deepest and shallowest cores taken at Coldwater Lake. Figure 5b: Ratio of pelagic to benthic taxa at Coldwater Lake.

- The diversity of taxa in Core 4 has increased overtime, while taxa diversity in Core 2 has remained similar to the top 10cm of Core 4.
- While Core 4 has had a slightly higher ratio of pelagic to benthic diatom taxa overtime, both cores are consistently dominated by benthic taxa. No pelagic diatoms were seen when studying wet plankton tow samples.

- The diatom patterns between the two cores indicate that the environment in the shallow water at Coldwater Lake is more dynamic than the environment at depth. The shallow water likely has greater sediment input, more sunlight leading to more substrate for benthic diatoms to attach to, and greater nutrients and other input from vegetation and animal life.
- With this in mind, Core 2, at a much shallower water depth than Core 4, likely represents a shorter temporal window than Core 4.
- The fact that both cores are consistently dominated by benthic taxa implies that Coldwater Lake has likely been a typical alpine oligotrophic lake for much of its existence, with too few nutrients dissolved in the water to support a high planktonic assemblage.

Part Three: Comparing Coldwater Lake and Spirit Lake Diatom Assemblages

- Spirit Lake has a much higher level of pelagic diatoms than Coldwater Lake, implying that Coldwater likely has lower concentrations of nutrients needed to sustain planktonic taxa.
- The P/B ratios at Coldwater and Spirit Lakes are not more similar in more like environments (i.e., shallow with no log mat), implying that the presence of the log mat is not the only factor causing differences in the ecosystem recovery history of the two lakes.
- Spirit Lake had a eutrophic period in its recovery marked by a notable spike in abundance of planktonic diatoms. Coldwater lake is lacking this spike, implying that it either never went eutrophic, or that our cores didn't reach far enough back in the sediment record to see this.

Sample Location	P/B Average
SL shallow, no log mat	0.580
CWL shallow, no log mat	0.225
SL deep, with log mat	0.448
CWL deep, no log mat	0.392
SL Average	0.507
CWL Average	0.302

Table 1: Ratios of pelagic to benthic taxa in various locations in Spirit and Coldwater Lakes.

- Much of the differences between the two lakes can be explained by the differences in their geologic formations. Spirit Lake was directly in the path of the debris flow, causing an influx of nutrients, while Coldwater Lake was formed as a brand-new lake on top of a stream bed.
- Despite these differences, both lakes appear to have stabilized and reached ecological equilibrium after their recovery from the eruption of Mount St. Helens.

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