# The Change in Carbon Isotopes Throughout Devonian age Sedimentary Rock

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## Abstract

The Devonian Period (419 to 359 million years ago) was an interval of significant change in the Earth's history. In particular, the proliferation of land plants and the evolution of trees led to the initiation of an ice-house climate by the end of the period. By using sedimentary rocks from Montana as a proxy to track the global carbon cycle, we can infer information about the climate and environment of the Devonian age. Our study is focused on carbon isotopes stored in the limestone rocks of the Jefferson Formation. We will also be measuring the carbon isotopic values of organic carbon stored in these rocks. We will pair this geochemical data with environmental interpretation based on the different rock types we observed. With this information, we can reconstruct the Devonian carbon cycle. Here we present some initial results about the processing of samples and reconstruction of environments.

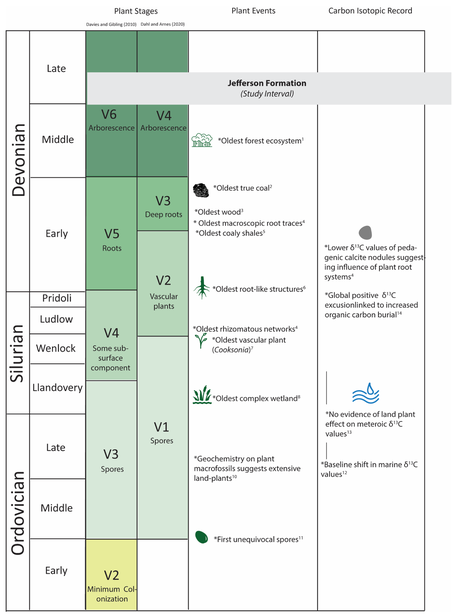




**Figure 1:** Timescale with terrestrial plant stages as identified by Davies and Gibling (2010) and Dahl and Arnes (2020). Major events in lant plant evolution and influence on the carbon isotopic record are tied to the timescale. The Jefferson Formation is placed within this framework. [1]Stein et al., 2020, [2]Glasspool and Scott, 2000, [3]Gerrienne and Gensel, 2011, [4]Driese and Mora, 2001, [5]Kennedy et al., 2013, [6]Gensel et al., 2001, [7]Edwards et al., 1983, [8]Tomescu and Rothwell, 2006, [9]Tomescu et al., 2009, [10]Kenrick et al., 2012, [11]Adiatma et al., 2019, [12]Jones et al., 2015, [13]Malkowski and Racki, 2009.

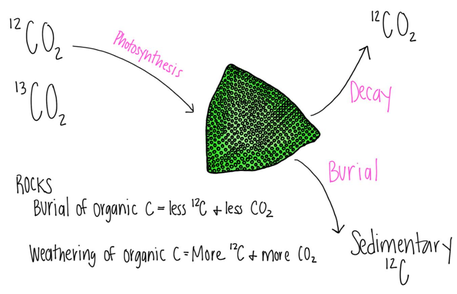



**Figure 2:** Visual of the carbon cycle; organic and carbonate carbon.

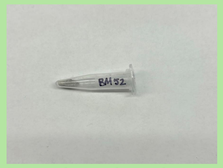
## Reconstructing Ancient Atmospheres

### Geochemical Data Collection

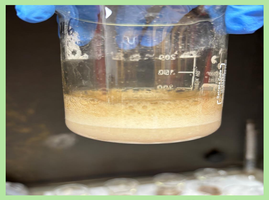
Sample of the Jeferson formation that makes up Baker Mountain. This sample would then be further broken down to a 2-gram sample for further processing.

The 2-g samples were then rinsed in DI water, the clean samples were then dehydrated in lab oven.

The dehydrated samples were then crushed into a powder using Mortar and Pestle.




Dry powder sample was then placed in small vial for further Carbon isotopic analysis.



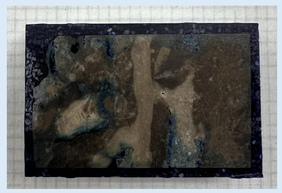
Sample mid-reaction, as HCl dissolves the rock materials leaving behind the organic Carbon to be further analyzed.

Powdered samples were then transported into a labeled beaker to be acidified by HCl solution.

### Geological Data Collection

Test sample from the Jefferson formation with HCl to determine lithology; Dolomite or Calcite, and log in Excel.

Drill Jefferson sample in area of interest to obtain ~1ml of powder for testing.

Send samples to be analyzed for Carbon isotope data and create thin-section samples.

Place powder in a labeled test tube, and transfer to a larger sample bag labeled "Dolomite" or "Calcite" once logged.

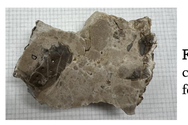


**Figure 3:** Breccia sample collected from the Jefferson formation

**Figure 4:** Mudstone with algal structures collected from the Jefferson formation

**Figure 5:** Example of deep mudstone from a marine environment

**Figure 6:** Example of stromatolites collected from the Jefferson formation

**Figure 7:** Wacke with arugose coral and stromatoporoids collected fro m the Jefferson formation

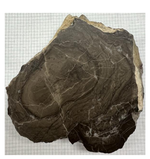


**Figure 8:** Mudstone with stromatolites collected from the Jefferson formation

## Geochemical Data

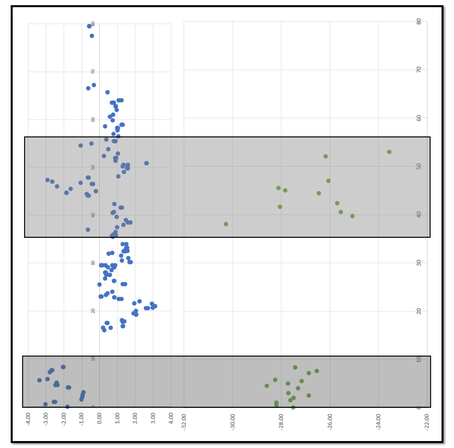


**Figure 9:** The data above shows how Carbon is cycled throughout the Devonian period from samples collected on Baker Mt. The Y-axis shows the meterage point along the outcrop, and the X-axis shows the relative Carbon value. As highlighted, the values correspond, showing how Carbon is moved throughout both the geologic (blue points) and biologic systems (green points).

## Conclusion

- The data collected from geological and geochemical sampling indicates that the shift observed in carbon isotopes is due to the carbon cycle, and not diagenetic processes.
- This can be observed in Figure 9, where a direct relationship between both sets of data was noted.
- We need to do more research, and in the Summer, we will be traveling to Bozeman, Montana to study these rocks further in the Sawtooth Mt. range.

**Figure 10:** Alyssa and Mackenzie in the field, working within a playa of an epicontinental sea in the western US.

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