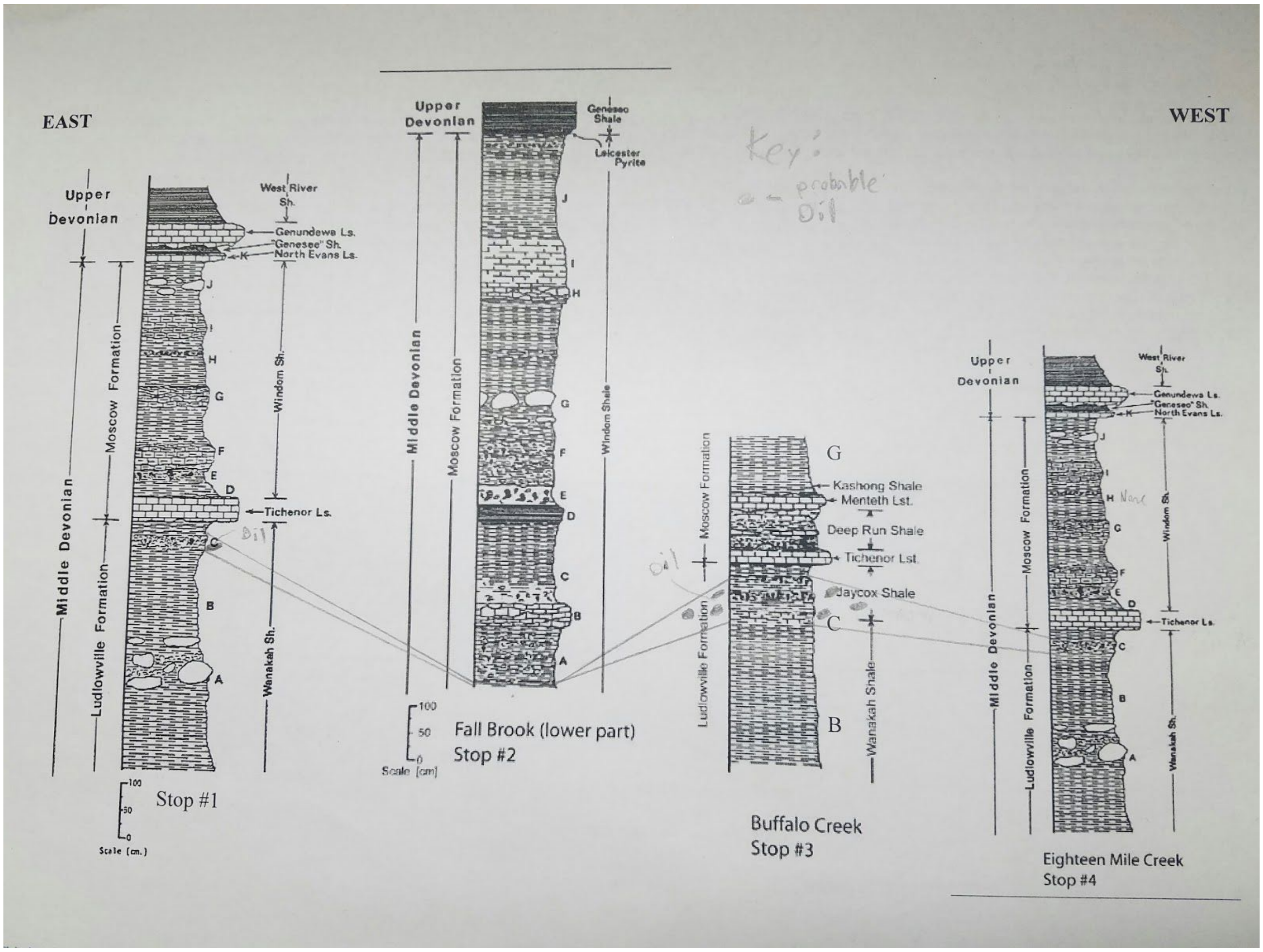
1) Petroleum Research

In an attempt to find oil, samples were collected from sites across WNY. I analyzed these samples for microfossil specimens, and determined the thermal maturity of those I found. Moderate maturity is ideal when looking for fossil fuels, as the carbonate material needs a certain amount of heat to turn to useful fuels, but too much and it will all burn up. The concentration of fossils in comparison to clastic materials was also recorded for each sample as 'Density'. The data collected is shown in the chart below.

Stop	Sample	Density (%)	Color	Thermal Maturity	Probability of Oil
Stop 1	B	40	Amber	Moderate	Likely
	C	0	N/A	N/A	Unlikely
	G	2	Clear	Low	Unlikely
Stop 2	F	0	N/A	N/A	Unlikely
	J	10	Deep Red	High	Unlikely
Stop 3	B	60	Amber	Moderate	Likely
	C	0	N/A	N/A	Unlikely
	G	10	Amber	Moderate	Unlikely
Stop 4	B	0	N/A	N/A	Unlikely
	C	5	Deep Red	High	Unlikely
	H	2	Deep Red	High	Unlikely

By analyzing this data, the most likely place to find fossil fuels would be near Stop 3, to the depth from which sample B was taken. This is due to Stop 3 sample B's high concentration of fossils and their moderate thermal maturity. Similarly it is likely there is oil at Stop 1, as Stop 1 contains the same rock layer at a similar thermal maturity, however fossils were not as abundant at this location. That is why it is my recommendation to drill at or near Stop 3 to the depths of 3 to 3.8m. These sites are marked on the correlated stratigraphic columns shown on the next page.



EAST
WEST
Upper Devonian
Middle Devonian
Moscow Formation
Ludlowville Formation
West River Sh.
Genundewa Ls.
"Genesee" Sh.
North Evans Ls.
Windom Sh.
Tichenor Ls.
Wanakah Sh.
Oil
Stop #1
Scale (cm.)
Geneseo Shale
Leicester Pyrite
Windom Shale
Fall Brook (lower part)
Stop #2
Scale (cm)
Key:
probable Oil
Kashong Shale
Menteth Lst.
Deep Run Shale
Tichenor Lst.
Jaycox Shale
Wanakah Shale
Buffalo Creek
Stop #3
Eighteen Mile Creek
Stop #4

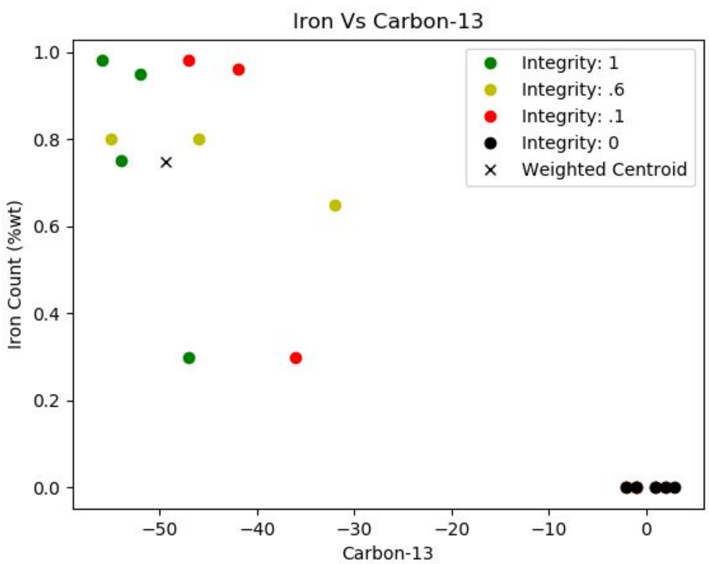
2) Paleoecological Research

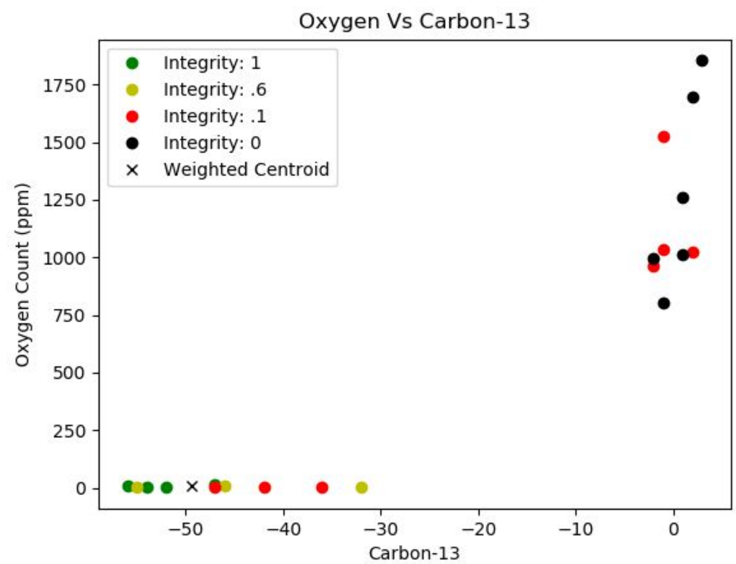
Sample	Lithology	Species Found			
		In Situ	Quantity	Disarticulated	Quantity
3	Gypsum	Ogygopsis klotzi	Very Abundant	N/A	None
7	Grey Shale	Basal Panarthropoda, Asaphiscus wheeleri	Abundant	Ogygopsis klotzi	Four
8	Gypsum	Basal Panarthropoda, Asaphiscus wheeleri	Moderate	N/A	None
10	Gypsum	Basal Panarthropoda, Asaphiscus wheeleri	Scarce	Ogygopsis klotzi	One
15	Breccia	N/A	None	Ogygopsis klotzi	Moderate
23	Breccia	N/A	None	Ogygopsis klotzi	Moderate
34	Breccia	N/A	None	Ogygopsis klotzi, Basal Panarthropoda, Asaphiscus wheeleri	High counts of Ogygopsis klotzi, very few of others.

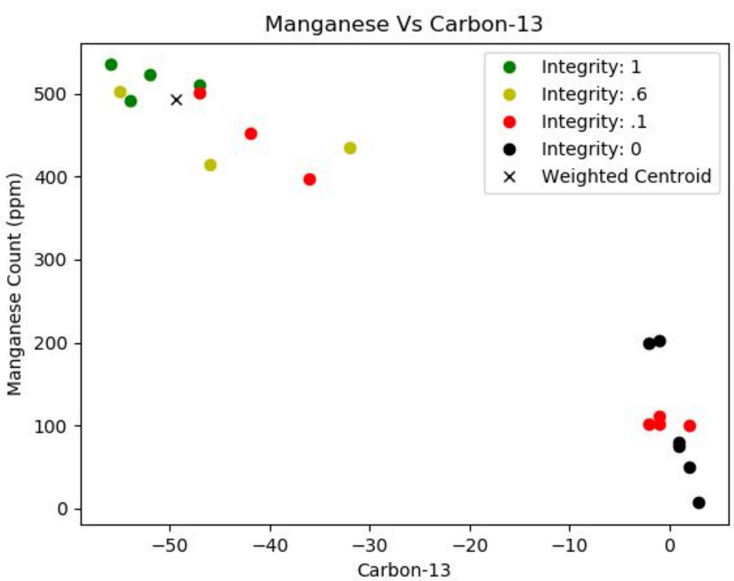
Gypsum is known to form from hypersaline marine environments as a result of evaporation. Due to the presence of in situ fossils of all three species in gypsum, we can conclude that all the trilobites lived in a hypersaline environment. However, Basal Panarthropoda and Asaphiscus wheeleri were also found in situ and quite abundantly in a layer of grey shale as well. Given the abundance of well preserved fossils, they were likely preserved by an anoxic environment. This means that these two species of trilobite could also inhabited anoxic environments. The disarticulated fossils can be explained by tectonic activity caused by the faults when the graben-horst structure formed.

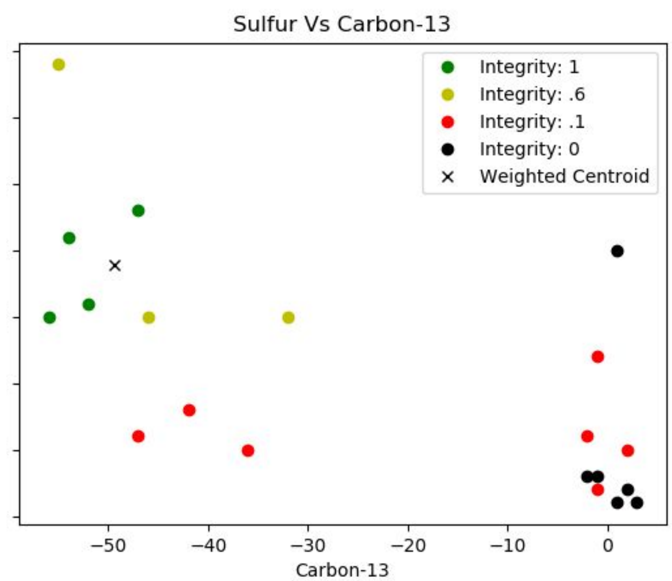
3) Quality of Preservation

The integrity of each sample was evaluated based on the Preservation Index of ammonite nacre. Using a rubric, numerical values for the integrity were discerned which act as the probability that the sample yields accurate geochemistry results. This is due to the fact that samples with a low integrity value show obvious signs of degradation, and therefore may give false data when tested as the original material would have been replaced. Below are some plots of the geochemistry value, with the color denoting each sample integrity.





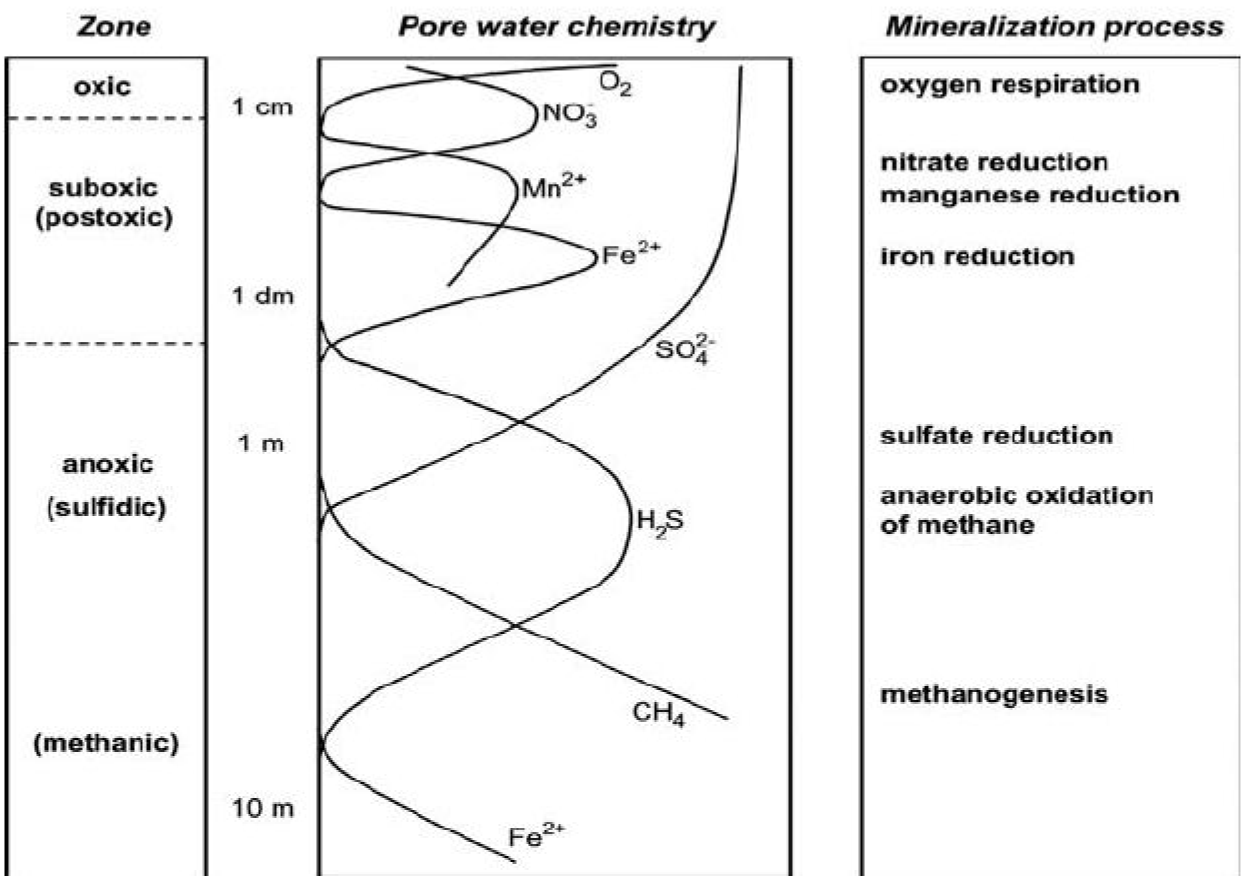




The plots clearly show that some of the data with low integrity lie similarly to data with an integrity of 0, meaning either all or nearly all the original material that is being tested has been replaced. This means that these data points clearly hold inaccurate data, and therefore will be excluded from further calculations.

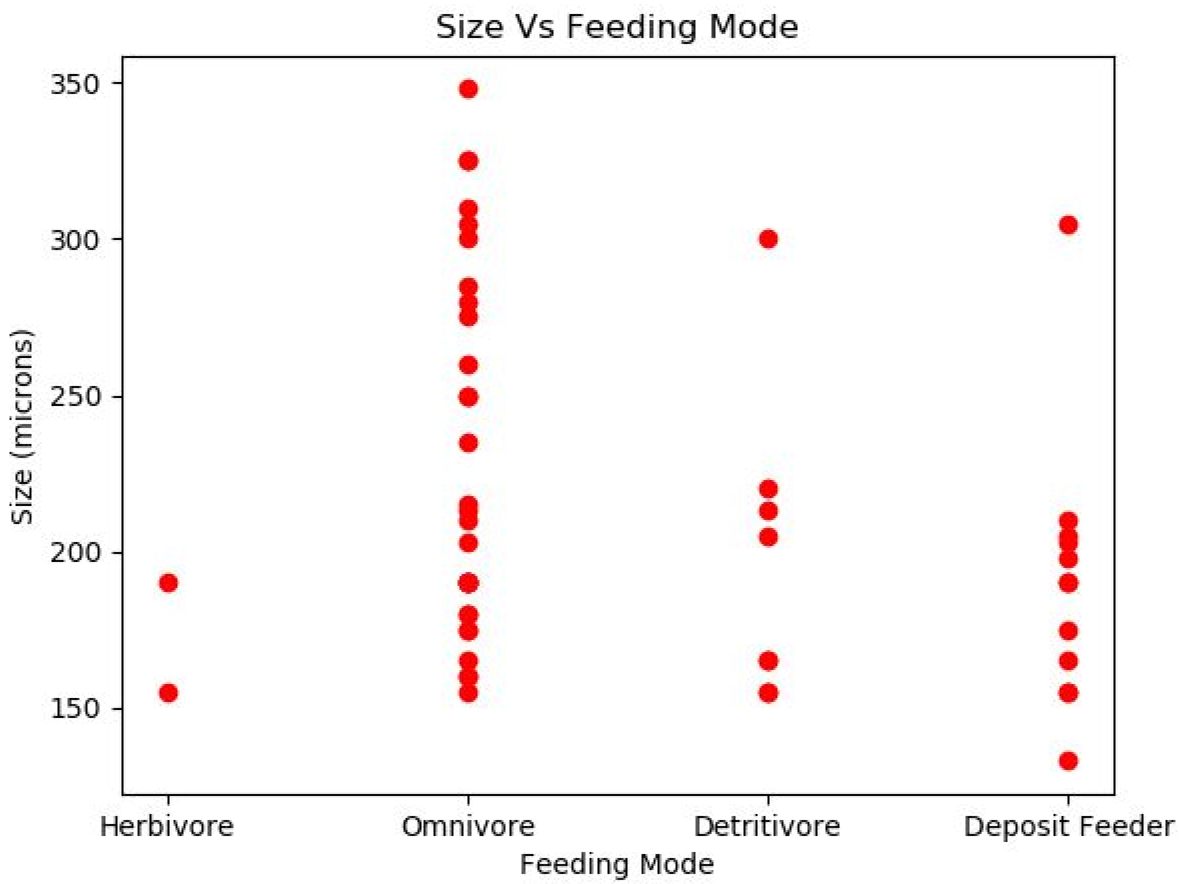
Now that inaccurate data has been removed, the plots also denote the centroid of the data. This centroid is weighted according to integrity of each sample, just to ensure quality samples hold precedence over those that show signs of degradation. This centroid is a good indicator of what the original substance likely had, therefore I would publish the value of -49 as the proper Carbon-13 data.

By analyzing the plots, it is clear the preservational setting was dysoxic, and Mn-reducing. This is evident by the lack of oxygen and the fact that the Manganese ppm ranges between 350-600. Some samples showed extremely high values of Iron however meaning it was not Fe-reducing. This leads me to believe that it was in the top half of the suboxic zone, at a depth of 2-5 cm according to the graph below.



4) Population Ecology

A) Is there a relationship between an organism's average size and it’s feeding mode?



Above is a graph showing the average size of each species against their feeding mode in an attempt to see if there are any correlation. Omnivores seem to be very diverse in size, which may be due to the diversity of their diet. They are also the only creatures to regularly grow larger than 250 microns, which may be because they have more food available to them, or because they simply need to be larger in order to be able to prey on other creatures. It is also interesting to note that a large number of deposit feeders seem to be gravitating towards 200 microns, perhaps that is the optimal size for deposit feeders to be able to thrive in this environment for some reason.

B) How diverse is each ammonite zone?

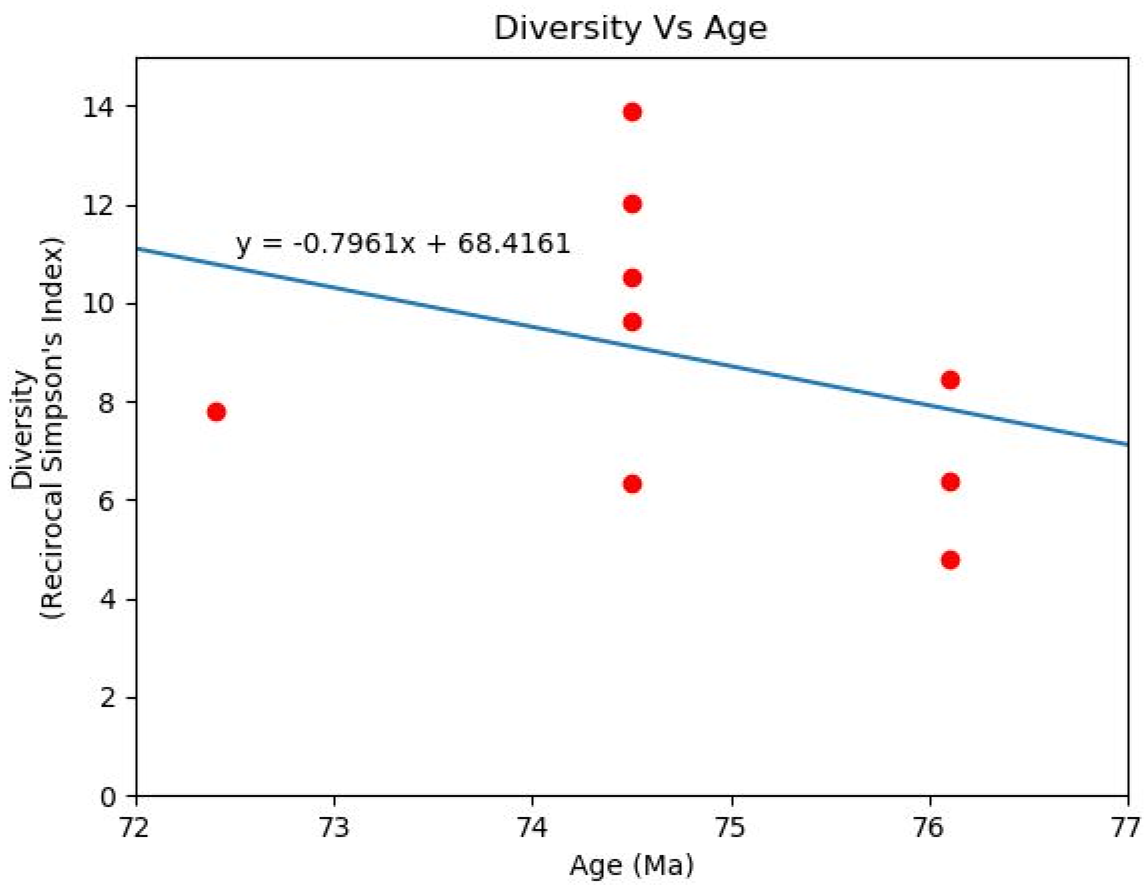
Traditionally the Simpson's Index is a value between zero and one, which represents the probability of choosing any two organisms in an ecosystem and having them be the same species. This implies that a lower value represents a more diverse ecosystem while higher values represent ecosystems dominated by few species. This is rather counter intuitive, so in this case we will be using the reciprocal variant of the simpsons index. This will result in a range of numbers from one to N, where N is the total number of unique species present, and larger numbers represent a more diverse ecosystem.

The Simpson's Reciprocal Index of diversity for each ammonite zone was calculated using with the formula: $D = 1/(\sum(n(n-1))/(N(N-1)))$, where n represents the number of samples found for each species, while N represents the total number of samples found. The results are recorded below, and the ammonite zones have reordered from most diverse, to least diverse.

3528b:	**13.893129770992367**
3528c:	**12.033185840707965**
3994:	**10.503432494279176**
3528a:	**9.630350194552529**
3418:	**8.447098976109215**
3545:	**7.811158798283262**
3546:	**6.376190476190477**
3503:	**6.359223300970874**
3551:	**4.786764705882353**

C) Is there a local relationship between diversity and the age of these ammonite zones?

These diversity values of each ammonite zone were then plotted against their age, resulting in the graph below.



Linear regression was applied to find the line of best fit, which shows there is a negative relationship between the diversity of the ecosystems and their age. Considering the nature of age, this actually means that the data collected from older samples depicts a less diverse ecosystem than compared to newer samples. From this we can conclude that during the Late Cretaceous Period the ecosystems inhabiting current day South Dakota were growing more diverse. This suggests that living conditions at the time were favorable to many organisms, allowing more species to be able to thrive.