An Abrupt Global Climate Change Event in Earth History -Evidence from the Ocean-

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1. INTRODUCTION

Calcium carbonate and carbon Isotope ratios are excellent indicators of past climate and microorganism existence. This in turn can help us determine what the climate was like millions of years ago. Cores taken from the Walvis Ridge in the Atlantic Ocean near the cape coast of South Africa have been used to determine the Earth's past climate. The Calcium carbonate readings can help us determine where the CCD was in relation to the depth of the ocean sediment. The location of the CCD is an excellent indication of the acidity and temperature of the ocean water at that time. A decline in temperature would result in the CCD rising, but with the Walvis Ridge cores we see a rise in temperature and a rise in the CCD. This is counter intuitive but can be explained with a rise in acidity.

2. MAP AND SITE DESRIPTION

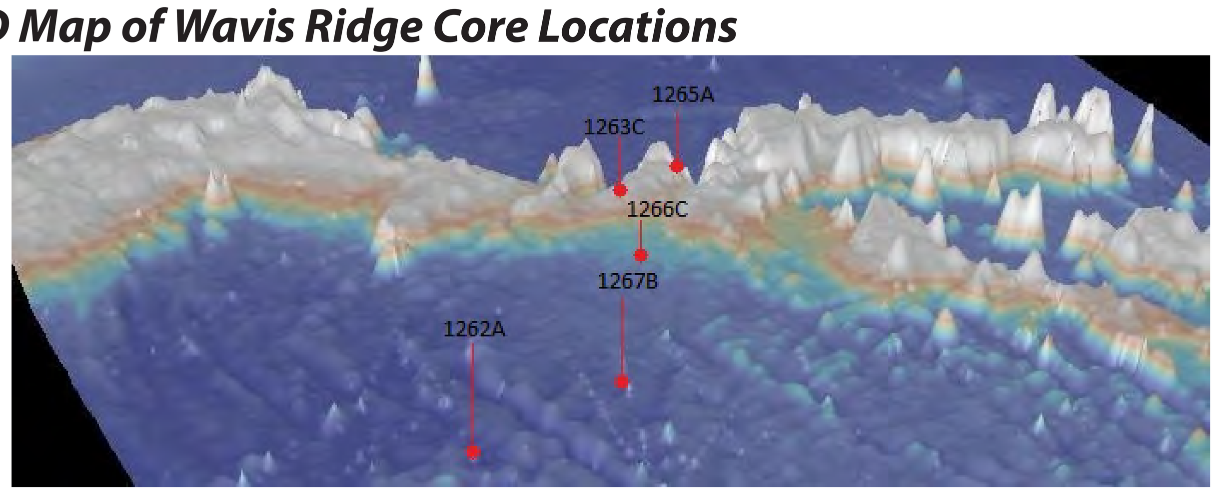
The images below depict the drill site locations of the cores examined. They are from the leg 208 cruise.

-The first is a 3D image with vertical exaggeration of 20.

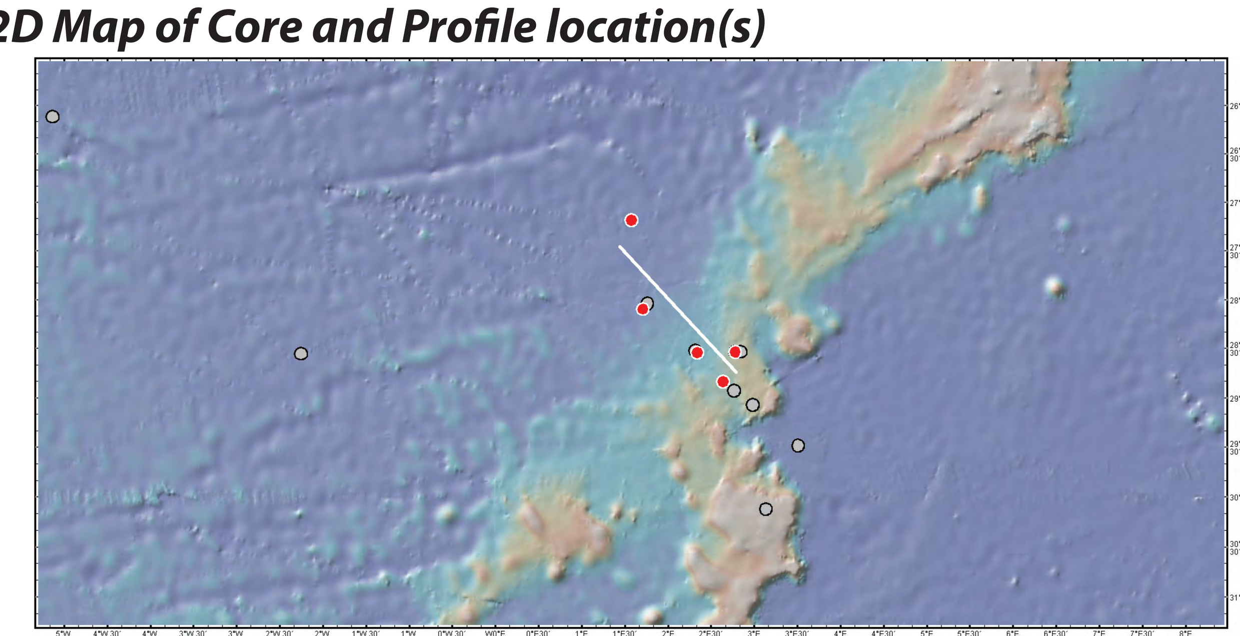
-The second image is a 2D map showing were the profile line was taken between the cores.

-The last image is a profile view showing the approximate elevations of the areas were the drilling took place.

3D Map of Wavis Ridge Core Locations



2D Map of Core and Profile location(s)



Cross-section profile

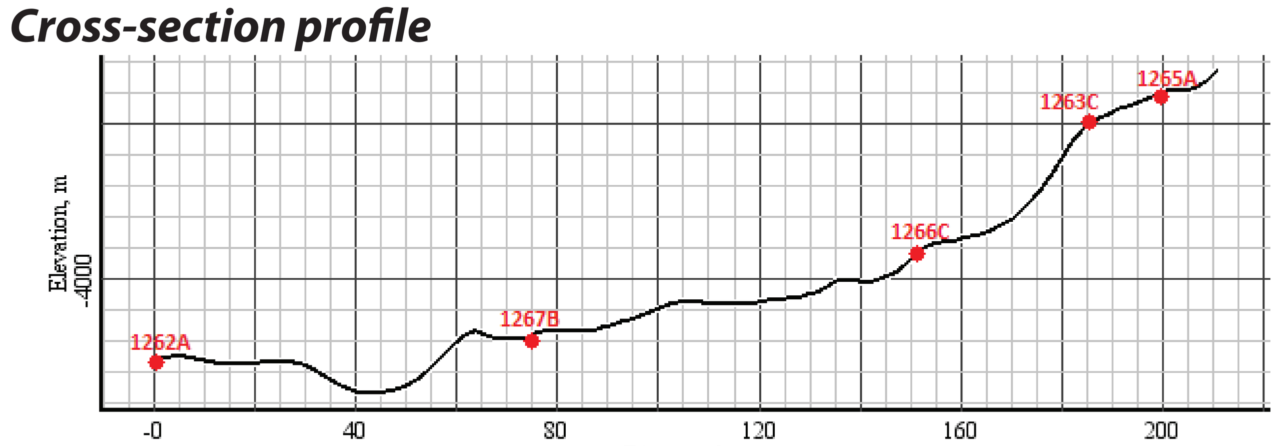


Figure 1. Walvis Ridge Core Locations

3. CORES AND CORRESPONDING DATA AS TAKEN FROM LEG 208

These images below belong to the cores that were taken from Walvis Ridge off the Cape Coast of Southern Africa. The blue graph to the right of the core denotes $CaCO_3$ by weight within the sediment taken from the cores when analyzed. The second graph is the δC^{13} ratio compared to δC^{12}. These graphs are essential for determining the amount of change within the oceans and can help us determine ocean temperatures and acidity levels at the time of deposition. The cores, ordered from left to right, descend in depth below the ocean's surface from shallower to deeper respectively. The pink bar that spans the graphs is the area of interest for the the discussion.

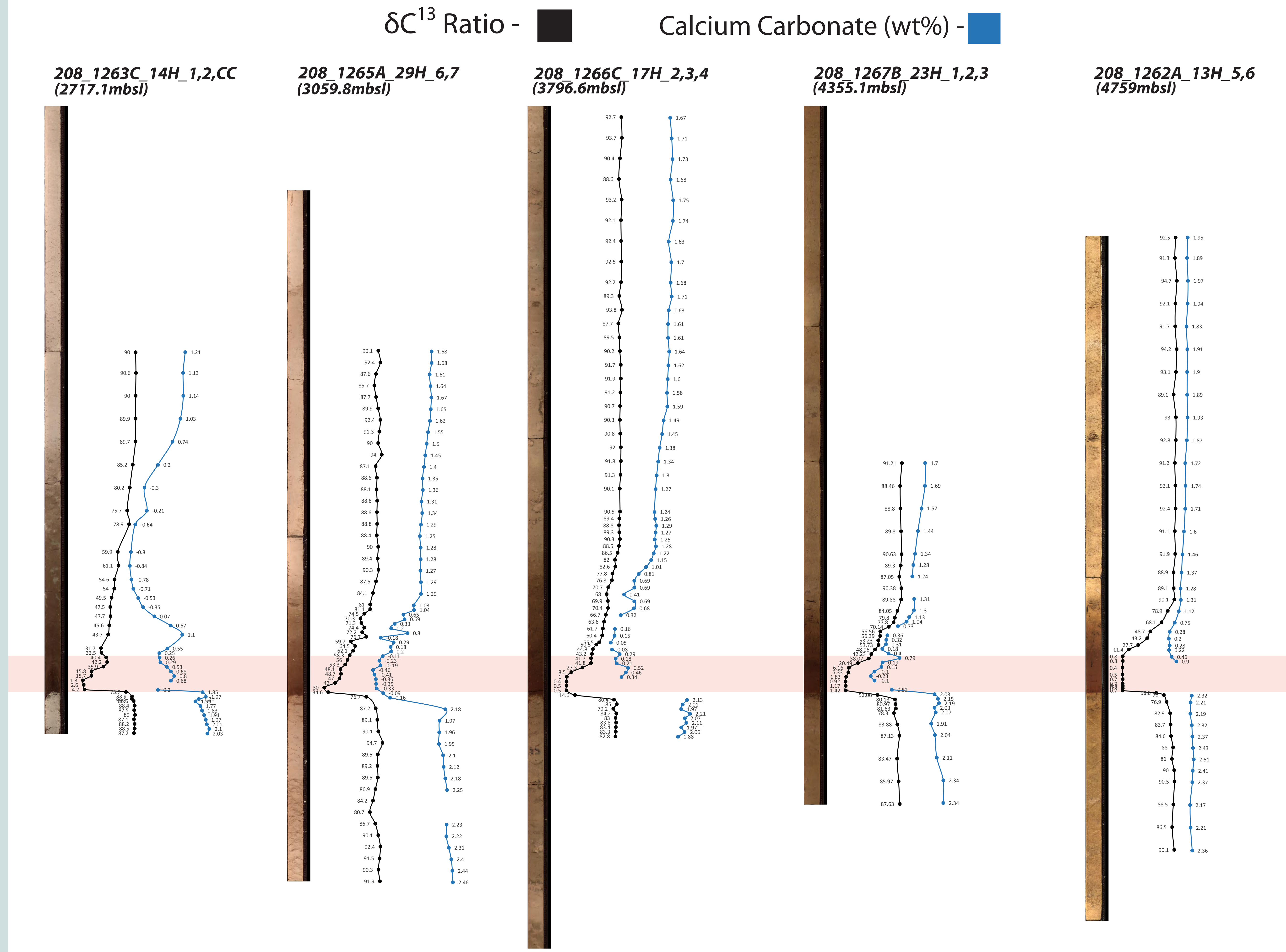


Figure 2. Walvis Ridge Cores From Leg 208 and Corresponding δC^{13}/ Calcium Carbonate Values.

4. DISCUSSION

As stated in the intro there is a rise in the ocean temperature and the CCD rises. There is also an assumed rise in the acidity levels. The temperature rising is reflected by the rise in CO_2 which also increases the acidity. But what could cause all three to rise? There are several possible reasons for these rises.

- **High volcanism.** With this we would get a spike in particulate matter in the atmosphere, which would lockout solar energy and lower global temperatures over a relatively short period of time. It would also raise greenhouse gasses over prolonged periods of volcanism. While the drop in temperature would be relatively short lived as the particles settled out of the sky. The gasses left behind by such an event would be much longer lasting and have greater impact. The large amount of CO_2 produced by this event would make its way into the ocean raising its acidity and the CCD along with it. As we can see in figure 2, the CCD raises and the record of carbonates dissolved, lost to history.

- **Large scale die off of micro-marine organisms.** Another way to increase the CCD as we have seen would be to kill off large amounts of micro-organisms. This would raise overall respiration ratios in the ocean leading to higher CO_2 levels and thus raise the CCD. When combined with added CO_2 in the atmosphere this cycle could easily and rapidly change life in the ocean. During such an event, surviving marine organisms would preferentially consume δC^{12} over δC^{13}, but with large amounts off biomass out of the equation and not consuming δC^{12} we would expect to see a much lower δC^{13} ratio values. The δC^{12} for the most part would remain unconsumed. This can be seen in the core record found in figure 2. Alongside this ratio is the Calcium Carbonate by (wt %) that shows a drop in the carbonates production in the record when above the CCD. this again reinforces the idea of a larger die off of organisms.

- **Yet another idea would be a combination of the two ideas above**. That large scale volcanic events rapidly dumped large amounts of particulate matter and greenhouse gasses into the atmosphere. The resulting loss of solar energy due to ash blocking sunlight, starved the oceans micro-organisms reliant on sunlight killing large portions of them. During this sudden drop in temperature and deaths of organisms the oceans acidity began to rise due to the high amount of respiration from dead organisms. The net lack of photosynthesis also contributes to the high CO_2 levels and ocean acidity. After the sky's cleared the ocean may have experienced such large scale changes in chemistry and lack of life that it took these organisms a longer period of time to recover before eventually returning the ocean's lycocline and CCD to their pre-event levels.

5. CONCLUSION

There is no complete certainty as to why exactly the levels of CO_2 rose so fast. The above discussion consists of plausible reasons for the results and information recorded in the cores. The findings in the graphs are the only information we know for certain. To determine more accurately we would need cores from this time period from all over the world. However, more information and reserch is required in order to determin the cause definitivly.