A stable isotope history of Cambrian carbonates from the Georgina Basin, Northern Australia. E. A. Browning[1] and J. F. Lindsay[2], R. A. Socki[3], [1]Mount Holyoke College South Hadley, MA 01075 (eabrowni@mtholyoke.edu), [2]Lunar and Planetary Center, Houston, TX 77058 [3]NASA-Johnson Space Center, ESCG Houston, TX 77058.

Introduction: The Georgina Basin is one of a group of basins collectively known as the Centralian Superbasin because they were connected for a brief period near their formation, around 780 to 750 Ma [1]. The Georgina Basin provides a comprehensive stratrigraphic record of the Cambrian period because of the intracratonic setting which allowed for large amounts of carbonate rocks to accumulate and kept them from becoming greatly deformed [2].

Samples from a drillcore (BN04DD01) were examined for this work. This drillcore is from the Georgina Basin in Northern Australia (Figure 1), which covers the Cambrian period. Isotopic data from this core was compared to other cores in the Australia basins, namely the Daly Basin, which can confirm a model set forth by Lindsay et al. [1] that supports two periods of active tectonics during the Cambrian which appear in the isotopic ratios: the Late Templetonian-Floran event and the Ordian-Early Templetonian event.

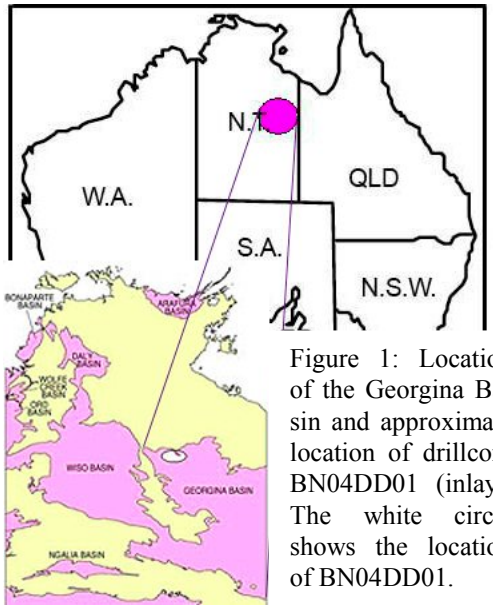

Figure 1: Location of the Georgina Basin and approximate location of drillcore BN04DD01 (inlay). The white circle shows the location of BN04DD01.

The use of the ratio between stable isotopes ^{12}C and ^{13}C are useful in identifying major tectonic events in Earth's history. ^{12}C is preferentially taken up during photosynthesis and other natural chemical and biological processes, and thus, living organisms are often depleted in ^{13}C [3]. As a consequence, seawater is enriched in ^{13}C. The break-up and formation of supercontinents is thought to bury large amounts of organic carbon, thus raising the ^{13}C levels in the ocean [1]. In the time period these rocks were laid down, the breakup of the supercontinent Rodinia and the formation of Pangea were influencing the $\delta^{13}C$ levels [4] and two periods of relatively high amounts of $\delta^{13}C_{carb}$ have been found in this drillcore, which are linked to these tectonic events.

Methods: Drillcore BN04DD01 was drilled on Brunette Downs to a depth of 521.3 meters and a high-sensitivity gamma-ray log was recorded [5]. A total of 26 samples were analyzed during the course of this project from various depths throughout the well. Thin sections from 10 representative samples of various depths were analyzed microscopically for signs of diagenesis and chemical alteration. The stable isotopes of carbon and oxygen were measured following a modified technique of McRea [6]. Carbonate samples were analyzed after addition of 100% orthophosphoric acid in a specially-designed carbonate extraction vessel. CO_2 gas given off by the samples was collected on a vacuum extraction line. The CO_2 was analyzed on a Finnigan Delta S stable isotope mass spectrometer and the $\delta^{13}C_{PDB}$ and $\delta^{18}O_{PDB}$ were recorded. Data are reported relative to the VPDB scale. Calibration to VPDB was via NASA-1, a working laboratory standard analyzed against NBS-19 (TS Limestone).

Discussion: Figures 2c and 2d show the results of the isotopic data of the $\delta^{13}C_{PDB}$ and $\delta^{18}O_{PDB,}$ respectively. There are two areas of relatively high $\delta^{13}C_{carb}$ at about 110m and 330m. Spikes of similar magnitude and age range were seen in the Daly Basin and labeled as the Late Templetonian-Floran event and Ordian-Early Templetonian event (Figure 2e) [1]. We interpret these high $\delta^{13}C_{carb}$ values are showing the same events, that is, the peak at 110m corresponding to the Late Templetonian-Floran event and the peak

at 330m analogous to the Ordian-Early Templetonian event (Figures 2c, 2d, 2e).

There is an anomalous spike in the $\delta^{13}C_{carb}$ at 208.5m, which does not fit in well with the overall trend of the line. We interpret this spike as either contamination or diagenetic alteration of that sample. An alternative interpretation is that the spike could be due to minor tectonic activity at that time, since a spike of similar magnitude is also seen in the Daly Basin at approximately the same age [1].

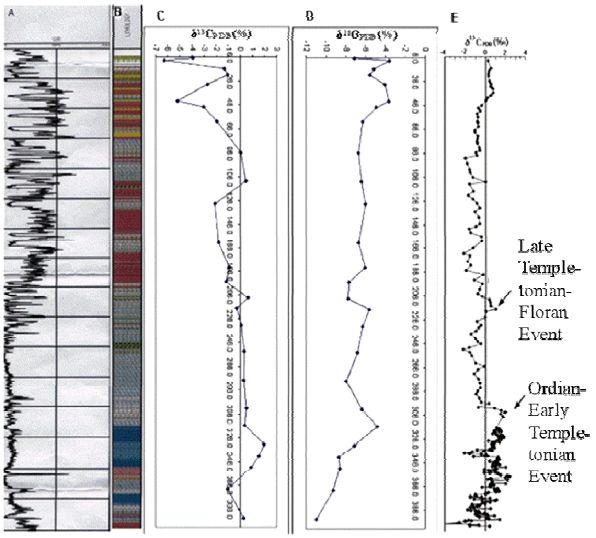

Figure 2: The Georgina and Daly Basins show 2 major tectonic events: (a) Gamma ray log of drillcore. (b) Lithology of drillcore indicating different sediment types. (c) $\delta^{13}C_{PDB}$ graph of the 26 samples. (d) $\delta^{18}O_{PDB}$ graph of the 26 samples. (e) The Daly Basin $\delta^{13}C_{PDB}$ graph done by Lindsay et al. showing the 2 tectonic events seen in BN04DD01 [1].

Thin sections and chemical analyses did not show evidence of significant alteration, however there was much more diagenetic quartz present in the sediments at the top of the drillcore. Figure 3 is the crossplot of the $\delta^{13}C_{PDB}$/ $\delta^{18}O_{PDB}$ data which shows a clustering of the points with no covariance. We interpret this lack of carbon and oxygen isotope covariance as an indication that there is little diagenetic alteration to the carbon isotopes in these samples. However, the data points at the top of the well (6.5m to 42m) show deviations from the trends in both the $\delta^{13}C$ and $\delta^{18}O$, probably due to a significant amount of alteration throughout these samples.

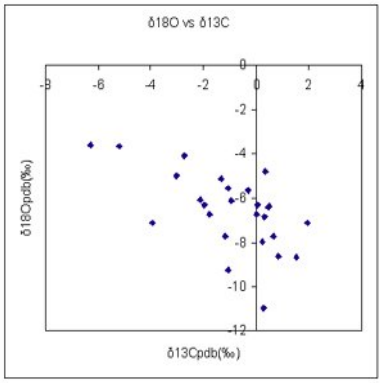

Figure 3: Crossplot of $\delta^{18}O_{PDB}$(‰) versus $\delta^{13}C_{PDB}$(‰). Clustering of points indicates little diagenetic alteration

Conclusions: It was thought, prior to the start of this project that BN04DD01 would match up with the Daly Basin drillcores because of the proximity and age range of the sediments. This data agrees with that hypothesis and provide further support for these events. This report suggests that there were periods of major tectonic activity taking place during those times which saw removal of large amounts of ^{12}C from the global carbon budget. Future research on this drillcore could focus on completing the remaining samples that were taken from it but not analyzed during the course of this project. This would provide a better idea of the magnitude of the variations in $\delta^{13}C_{carb}$ which would provide stronger evidence for the proposal that the peaks are signs of significant geologic events. Furthermore, the anomalous point at 208.5m could be reanalyzed to test its accuracy and points around there could determine whether this is a bad data point or an actual spike in the $\delta^{13}C_{carb}$.

References: [1] Lindsay, J. F. et al. (2005) *Precambrian Research*. 143, 113-133. **[2]** Lindsay, J. F. (2002) *Basin Research* 14 (2), 207-223. **[3]** Fuare, Gunter and Mensing. *Isotopes: Principles and Applications*. Third Edition. John Wiley & Sons, Inc. New Jersey. 2005. **[4]** Eriksson, P.G. et al. (2004) *Developments in Precambrian Geology* 12, 388-403. **[5]** Kruse P. D. (2003) *Northern Territory Geological Survey, Record* Georgina Basin stratigraphic drilling and petrography, 1999-2002. 2003-005. **[6]** McRea, J.M. (1950) *Journal of Chemical Physics.* 63 (4), 563-568.