HIGH-RESOLUTION RECONSTRUCTION OF CYCLIC PALAEOCOMMUNITIES CHANGES THROUGH DEEPER TIME AT CHICXULUB IMPACT CRATER

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Introduction

Cyclic changes in the Earth's eccentricity, axial tilt, and precession are influenced by the distribution of solar insolation (i.e., Milankovitch cycles) leading to changes in the global climate which can exert a significant effect on marine and terrestrial biota [1, 2]. It has been shown that there is also a relationship between the number of subseafloor bacterial cells and Milankovitch cycles in the deep biosphere[3]. Previous research from recent sediments revealed that the diversity and metabolism of bacterial communities in the subsurface responded sensitively to changing oceanographic conditions driven by rapid climate oscillations, but whether microbial responses to deep-time climate variability can be recorded from the deep biosphere remains unknown[4]. The aim of this project is to use advanced molecular biological tools to investigate what fraction of deep biosphere microbial communities in Cenozoic sediments overlaying the Chicxulub Impact Crater (Yucatan, Mexico) did not undergo further selection after burial, and form a genomic record of environmental changes associated with Milankovitch cyclicity.

Biomarkers, molecular fossils, are originated from previously living organisms, particularly lipids, carrying a wide range of information on three domains of life – eukaryotes, bacteria, and archaea[5]. A few studies on microbial diversity in modern environments have shown that DNA, carrying detailed taxonomic information[6], can be preserved for at least hundreds of thousands of years in the geological record. In this study, biomarker and isotopic analysis combined with DNA analysis/parallel 16S rRNA gene profiling will be used to explore the relationship between microbial and planktonic communities and to test the utility of the DNA analysis for deep-time microbial ecosystem reconstructions. The samples for this study were taken at ~20 kyr resolution from Hole M0077A (~506-518 mbsf; spanning 5 consecutive Milankovitch cycles between 48.3-48.8 Ma ago) at the Chicxulub impact crater during International Ocean Discovery Program (IODP) Expedition 364.

Results

25 sub-samples were taken approximately every 50cm for Rock-Eval analysis, showing a significant cyclical pattern. The cores with relatively low total organic carbon (TOC) values (1-2 wt.%) have a hydrogen index (HI) and oxygen index (OI) ranging from 233 to 466, 109 to 240 respectively, indicating the dominant type of kerogen as type II/III, while the cores with relatively high TOC values (2-4 wt.%) have a HI and OI ranging from 248 to 394, 59 to 187 respectively, indicating the dominant type of kerogen as type II.

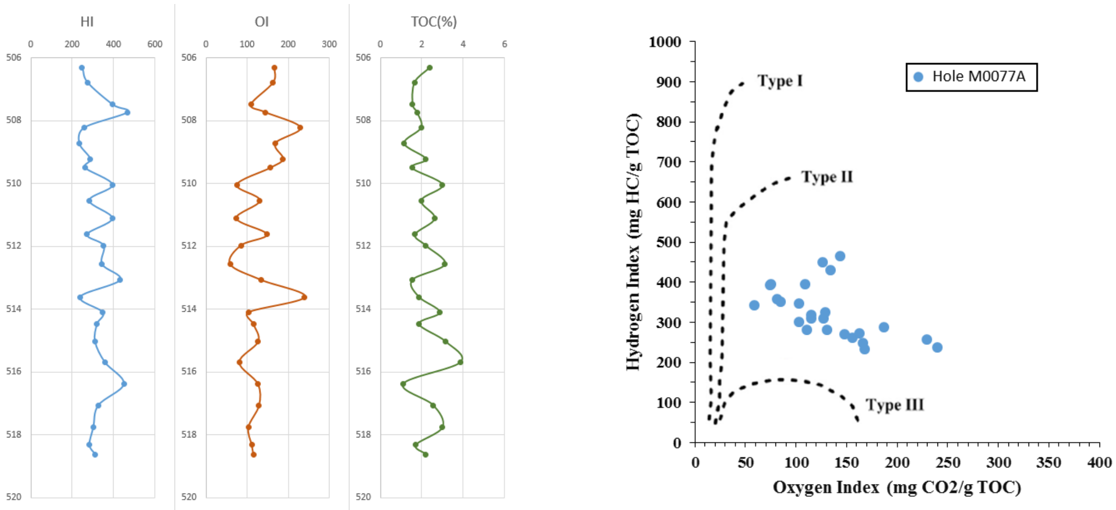

Figure 1 Left: High-resolution variations in HI, OI and TOC through sub-samples from Hole M0077A. Right: Units in digram for HI and OI TOC through sub-samples from Hole M0077A.

Conclusions

The cyclical pattern seen from the preliminary results shows that the collected cores from Hole M0077A at the Chicxulub Crater has Milankovitch cycles at high resolution timescale.

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