MICROBIAL MAYHEM IN THE NASCENT CHICXULUB CRATER

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The Chicxulub crater (Yucatán Peninsula, Mexico) was formed by an asteroid impact 66 Ma ago and is thought to have caused the Late Cretaceous mass extinction event (e.g. Schulte et al., 2010, Hildebrand, 1991) which led to 76% of species world-wide including all non-avian dinosaurs (Sepkoski, 1986) becoming extinct and also caused a collapse in phytoplankton productivity in the world's oceans (Zachos and Arthur, 1986).

In 2016, the peak ring of the Chicxulub crater core was recovered by the International Ocean Discovery Program and International Continental Drilling Program Expedition 364 ("*Chicxulub: Drilling the K-T Impact Crater*"). Samples from this core were extracted and analysed for lipid biomarker and sulfur isotopes of pyrite. Here, we present the results of a detailed investigation of the lipid biomarker composition to reconstruct the origin, recovery and development of non-fossilized microbial life forms and associated paleoenvironmental conditions in the nascent crater from the days after the impact to up to 4 million years later.

A tsunami that flooded the crater within a day after the impact (Gulick et al. 2019) deposited the upper part of the so-called suevite sequence and carried debris containing cyanobacteria, archaea, dinoflagellates and all types of anaerobic photosynthetic sulfur bacteria, likely originating from microbialites that inhabited the coast of the carbonate platform prior to impact (Figure). The redeposited coastal cyanobacteria predominantly were diazotrophic heterocystous bacteria of the order Nostocales, as evidenced by their characteristic C_{26}-glycolipids. A potential archaeal input from coastal environments is indicated by severely enhanced squalane over *n*-alkane ratios in the upper suevite layer. The coastal anaerobic sulfur bacteria were composed of Chlorobiaceae and Chromatiaceae, as revealed by the presence of their specific biomarkers from carotenoid pigments, namely isorenieratane, okenane, and chlorobactane.

In addition, re-deposited (woody, recognized by the presence of charcoal) terrestrial organic matter was degraded *in situ* in the tsunami layer by fungi, as evidenced by enhanced concentrations of perylene (cf. Grice et al., 2009).
As tsunami energy declined, land-derived material and nutrients fed the crater's microbial ecosystem for the following ca. 30 kyr and led to non-heterocystous pelagic cyanobacterial blooms, recognized by the presence of 2α-methylhopanes. A major change towards an oligotrophic sea occurred 200 kyr after impact supporting nitrogen-fixing heterocystous cyanobacteria. The cyanophyte community structure by then had changed and diversified, as recognized by the occurrence of C_{32}-heterocystous glycolipids, abundant in cyanophytes of the order Stigonematales. About 300 kyr after the impact with the onset of the Danian-C2 hyperthermal event (~65.7 Ma ago) during deposition of hemipelagic limestones abundant carotenoid biomarkers of photosynthetic sulfur bacteria suggests that the water-column in the crater became episodically stratified allowing for the development of photic zone euxinia. The $\delta^{34}S$ of sedimentary pyrite are in general agreement, although a potential impact from later diagenesis is under investigation. In the well mixed upper water column a concomitant spread of dinoflagellate algae is noted by increasing abundance of dinosteranes.
The microbial life near the Chicxulub crater recovered quickly under harsh conditions post impact and subsequently continued to experience rapid changes in environment.

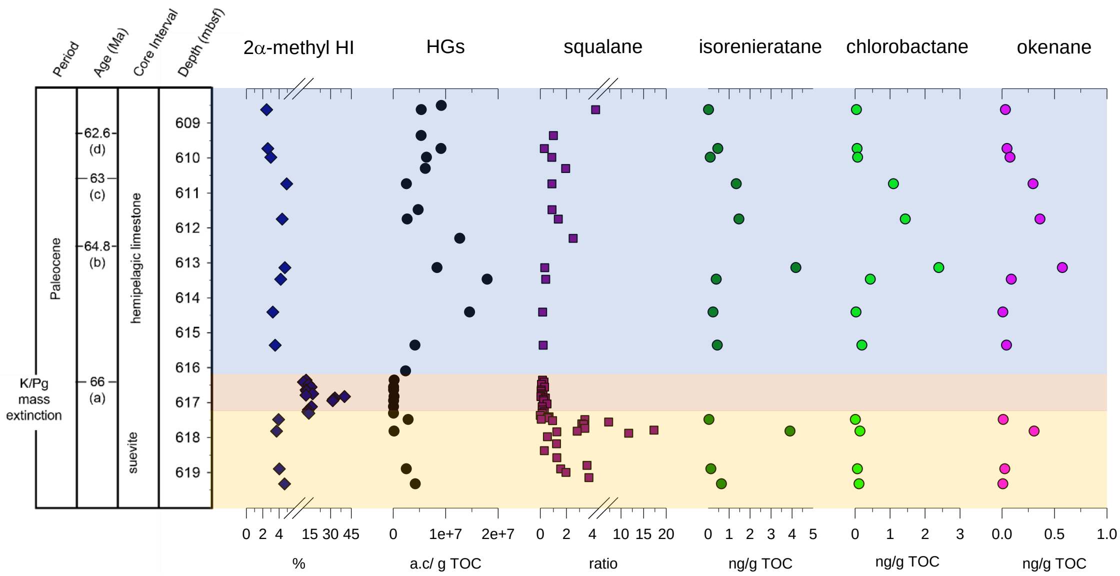

Figure Select biomarker distributions throughout the Chicxulub crater

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