Impact enhanced habitats in the Chicxulub impact crater and the extraterrestrial relevance

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Abstract

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Impact events are known to be able to cause severe disruption to surface-dwelling organisms. One case is the Chicxulub impact, associated with the end-Cretaceous mass extinction (66 Mya ago). The International Ocean Discovery Program and International Continental Scientific Drilling Program (IODP/ICDP) Expedition 364 drilled into the Chicxulub crater peak ring, a discontinuous topographic ring later buried by Cenozoic sediments, and recovered a continuous core from 505.7 to 1,334.7 meters below the modern seafloor (mbsf). This drill core, M0077A allowed us to investigate the present-day microbial community within the crater and to determine how the impact has influenced the distribution of microbes within the impact structure and overlying sedimentary rocks.

The Chicxulub impact caused geological disruption and reorganization that shapes the deep subsurface biosphere to this day. The abundance of microorganisms changes according to the impact-formed lithological units and is influenced by the physical alteration to the rocks caused by impact. The high-porosity impact suevite emplaced within the first hours of the Cenozoic exhibits an enhanced microbial biomass. Cell abundances were raised at impact-caused geological interfaces in the suevite and deeper target rocks, which we attribute to enhanced fluid flow and mineralogical interfaces. These observations show that the impact, despite its deleterious surface effects at the end-Cretaceous, produced enhanced subsurface habitat for microbes. Molecular analysis revealed distinct taxonomically and metabolically diverse microbial communities associated with the different crater units.

Our observations have application to the search for life on other planetary bodies, particularly Mars. A substantial number of large impact craters on that planet have been preserved since its early history because of the lack of plate tectonics. The observations in Chicxulub show that impact-induced geological interfaces, that would have favoured fluid flow and thus the accessibility of nutrients and energy in the subsurface, are propitious places to focus scientific exploration missions to investigate habitable environments and to test the hypothesis

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of the presence of life on Mars.