CHICXULUB CRATER IMPACT INDUCED HYDROTHERMAL SYSTEM INVESTIGATIONS.

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Introduction: Impact hydrothermal systems can host an ecosystem conducive to thermophilic life as demonstrated at both the Chesapeake Bay impact structure, USA, and the 66 ma Chicxulub impact structure, México. However, impactite stratigraphy and deformation during the crater modification stage may partition, channelize, or impede such flow affecting timescales of cooling. In both craters, modern cell counts show a greater number of active cells within impact materials versus the overlying geology [1,2]. At Chicxulub, DNA was isolated from suevite samples and thermophilic bacteria were cultured demonstrating a living thermophilic ecosystem, if significantly reduced from what likely existed 66 Ma [2]. Here we discuss observations of the peak ring thermal history as it pertains to potential duration of the hydrothermal system, permeability of impact materials, structure and stratigraphy of the impact crater, and future work planned to model and better image the hydrothermally altered impact basin.

Interdisciplinary Observations: International Ocean Discovery Program-International Continental Scientific Drilling Program Site M0077 drilled into the peak ring of Chicxulub providing samples from the granitoid peak ring and overlying melt rock, unsorted suevite, and sorted suevite. Full waveform seismic velocity analysis [3] shows a clear relationship between these drilled units and the velocity structure of the infilled crater materials with highest velocity melt rock adjacent to lower velocity granitoid peak ring. Sorted suevite that drapes all units of impactites forms a distinctly lower velocity layer but also exhibits upflow zones or diapiric structures. Mapping the stratigraphy from Site M0077 to the central basin where these zones are present shows the Paleocene section and some of the Eocene section are disturbed or pinch out against these zones.

Core plugs from sorted suevite, suevite, melt rock, cataclastically deformed granite and macroscopically intact granite were measured for permeability. Granitoid samples with porosities >10% exhibited millidarcy permeabilities whereas the sorted suevite exhibited microdarcy permeabilities despite having porosities up to 30% [4] with melt rock exhibiting the lowest values. Geo- and thermos-chronology of the peak ring granitoids at IODP Site M0077 have yielded a number of surprising insights including a dominantly Carboniferous age (zircon U-Pb) of the peak ring granitoids implying emplacement as a subduction related volcanic arc [6], Jurassic dolerite dikes emplaced during the opening of the Gulf of Mexico (apatite U-Pb) [7,8], the Cretaceous-Paleogene impact age preserved in shocked and metamict zircons (U-Pb and (U-Th)/He) [9] and Paleocene to early Eocene ages from U-Th/He.

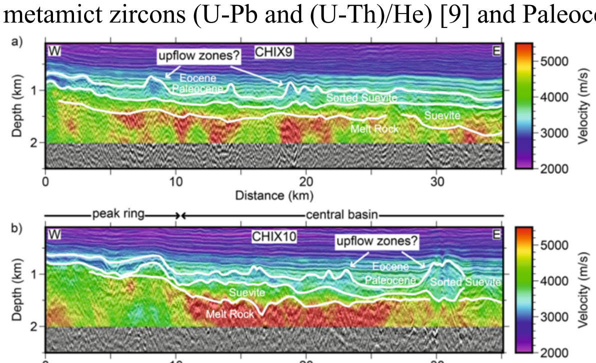

Figure 1. Full waveform inversion (FWI) velocity model overlain on depth converted seismic image for seismic lines CHIX9 (a) and CHIX10 (b). Eocene Paleocene labels are consistent with mapping of the drilled section at Site IODP Site M0077 as are the impactite sequences- sorted suevite, suevite, and melt rock. Potential diapiric or upflow zones are labeled. Modified from [3].

Preliminary Conclusions: Multiple lines of evidence suggest an impact-generated hydrothermal system was present at the Chicxulub crater for >11 million years post-impact. The low permeability of the sorted suevite may have reduced exchange with overlying, cooler seawater especially when later buried by low-porosity limestones. Such density inversions combined with continued hydrothermal activity may have generated instabilities creating the seismically observed diapiric structures that appear to have occurred into the Eocene. Future modeling seeks to examine this cooling history for assessment of habitability.

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