CRETACEOUS-PALEOGENE BOUNDARY DEPOSIT WITHIN THE CHICXULUB IMPACT STRUCTURE: RESULTS FROM IODP-ICDP EXPEDITION 364.

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Introduction: Precise understanding of processes that occur from the moment of large bolide impact to final crater formation including interaction with local, regional, and global environments present challenges for geologic and geophysical interpretation. A key challenge is unravelling the time scales for emplacement of individual impact deposits which can vary by at least seven orders of magnitude.

The terrestrial Chicxulub impact at the Cretaceous-Paloegene (K-Pg) boundary provides the unique opportunity to study depositional processes related to a large impact at a full range of distances from the impact site due to relative youth of the impact and the unique preservation of the impact structure itself beneath 100s of meters of Cenozoic carbonates [1]. Distally, the K-Pg boundary deposit is mm-cm in scale [2], whereas within the Gulf of Mexico, collapse breccias caused by the impact energy and tsunami are 100s m thick [3]. Within the crater itself the boundary deposit is likely more complex due to the combination of dynamic processes over the full range of timescales.

New Borehole Samples and Data: The International Ocean Discovery Program (IODP) with cofunding from the International Continental Scientific Drilling Program (ICDP) drilled into the offshore portion of the Chicxulub impact crater in April-May, 2016 [4]. Hole M0077A recovered core from 505.7-1334.73 meters below seafloor (mbsf) (see Morgan et al., this conference). Site M0077A was located near the top of Chicxulub's topographic peak ring providing a unqiue setting for examining the K-Pg boundary within the crater.

The Chicxulub cores were scanned at 0.3 mm by a dual energy X-Ray CT medical scanner at Weatherford Laboratories in Houston and these scans were processed by Enthought Inc. CT facies were assigned to different intervals within the cores for use in interpreting variability of the lithology and this analyses was insightful in terms of units within the uppermost Chicxulub peak ring deposits. CT depth values (mCCSF-A) are artificially lengthened relative to drillers depth (called mbsf) due to overlaps in cores not being accommodated.

The cores include Eocene and Paleocene carbonates from 505.7- 617.34 mbsf and these Cenozoic deposits include the complete sequence of biotic recovery post-impact. From 617.34 mbsf to 618.15 mbsf a siltstone is present that appears distinct from the limestone that overlies it (Figure 1, left). This interval is being examined for its fossil content and grain size as a possible 80 cm equivalent to the <1 cm K-Pg deposit that in distal sites includes shocked minerals, condensates, and iridium enrichment. Samples are being processed in multiple laboratories internationally to investigate the geochemistry of this transitional layer and the top and bottom zones of this layer in particular.

Just below this transitional layer is the peak ring wherein the top unit consists of suevite and impact melt rock from 617.34 to 747.14 mbsf. The uppermost suevite is shown in Figure 1 below the transitional layer. In core photo and CT images (Figure 1, right) evidence of dipping layers and cross-cutting relationships are observed. At 618.75 mCCSF-A (~618.35 mbsf) is the base of the uppermost interval clear dipping and cross-cutting beds. From 618.75 to 625.85 mCCSF-A layers exhibit variable CT intensity but are internally consistent; variable dips are present suggesting cross bedding in intervals and vertical structures are present. From 625.85 to 629.5 mCCSF-A the suevite exhibits larger dark CT specks. 633.8-634.6 mCCSF-A show slightly coarser, mottled texture. A zone from 637.4-637.7 mCCSF-A exhibits clear layering and from 639.3-639.7 mCCSF-A there are faint possible layers. From 640-658 mCCSF-A evidence of grading upwards based on visible clasts with increasing prevalence of both dark and light clasts. The interval of 658-665.7 mCCSF-A is more poorly sorted and the matrix is darker in CT intensity. From 666-693.25 mCCSF-A again evidence of grading upwards but clasts sizes are larger than in prior intervals. The interval from 693.25-696.1 mCCSF-A exhibits coring issues with either the matrix washed away or no core recovered.

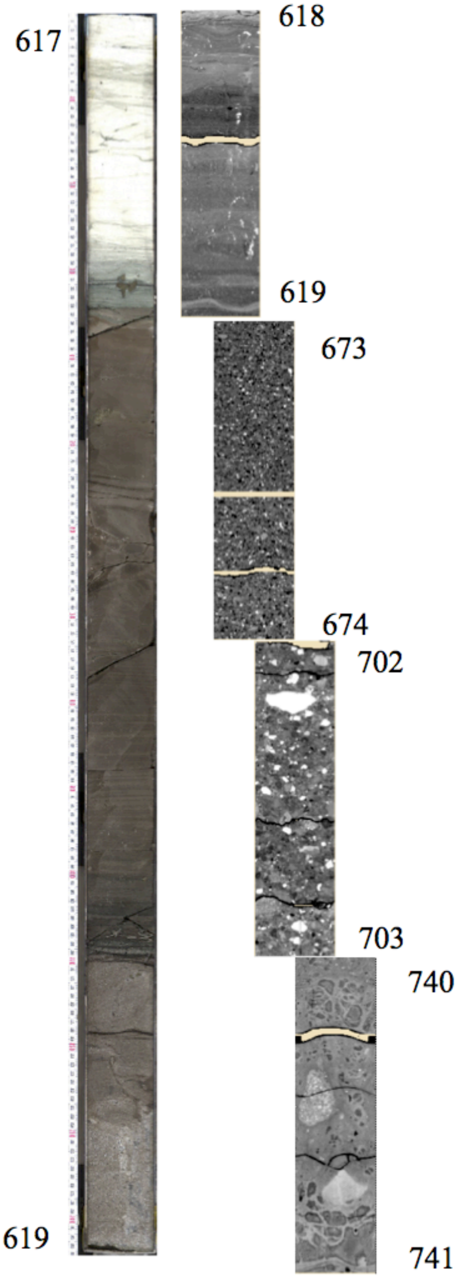

Figure 1. Example core photos (left, shown in mbsf) and CT images (right, shown in mCCSF-A) from Hole M0077A. Pale yellow intervals are core gaps and depths are rounded to nearest meter.

A clear layer is present from 696.15 – 696.3 mCCSF-A followed the interval from 696.3 – 698 mCCSF-A where it no longer is obviously coarsening downward. At 698.15 mCCSF-A is the first multi-centimeter large clast (medium intensity). From 698 to 706 mCCSF-A large clasts are prevalent with the similar medium gray matrix as shallower intervals. From 706-709.95 mCCSF-A very large clasts are present and the matrix changes to more uniform and lower CT number. 709.95-723 mCCSF-A exhibits alternating intervals of clast rich and clast poor sections where matrix changes from uniform lighter gray indicative of impact melt and the medium gray mottled texture from higher up in the section. From 723 to 741.35 mCCSF-A different bands of largely uniform matrix dominated rock indicative of impact melt but with occasional large (several cm) clasts or “ghosts” of clasts within the matrix. From 741.35 to 746 mCCSF-A the images exhibit an unusual texture of higher CT geometric bands surrouding central zones of lower CT intensity that may be clasts. At 746 mCCSF-A is the first evidence of a granitoid zone that becomes the dominate material by 748.9 mCCSF-A.

Initial Interpreations as to Emplacement Processes: The suevite and impact melt rock interval from the upper portion of the Chicxulub peak ring shows numerous distinct units and patterns. Initial interpretaton is that the higher energy deposits present at the top of the suevite may have been emplaced by tsunami (multiple resurges) based on the dipping layers. The intervals that are graded deeper in the suevites imply the ocean waters re-entered the Chicxulub basin rapidly after its formation. This is likely due to the absence of a crater rim to the northeast, however the ungraded more massive intervals also present are consistent with emplacement without settling through water. The presence of both kinds of deposits as discrete units yield insight into the role of ocean re-entry into the crater basin in the impactites emplacement. The deepest intervals with larger clasts and a matrix dominated by impact melt are impactites that initially stayed within the transient crater cavity and were dynamically emplaced onto the peak ring immediately after its formation and prior to reentry of ocean waters. Future works seeks to quantify the timescale of emplacement from impact melts through the transitional layer..

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