IODP-ICDP EXPEDITION 364: DRILLING THE PEAK RING OF THE CHICXULUB IMPACT STRUCTURE. J. V. Morgan[1], S. P. S. Gulick[2] and Expedition 364 scientists, [1]Department of Earth Science and Engineering, Imperial College London, SW7 2BP, UK (j.morgan@imperial.ac.uk) [2]Institute for Geophysics, Jackson School of Geosciences, Univesrity of Texas at Austin, TX 78758-4445, USA (sean@ig.utexas.edu)

Introduction: During April and May 2016, the International Ocean Discovery Program (IODP) and International Continental Scientific Drilling Program (ICDP) jointly drilled the peak ring within the Chicxulub impact structure in Mexico. The objectives were to investigate: (1) the nature and formational mechanism of peak rings and test between two contrasting models [1-3], (2) how rocks are weakened during large impacts, (3) the nature and extent of postimpact hydrothermal circulation, (4) the deep biosphere and habitability of the peak ring, and (5) the recovery of life in a potentially, sterile zone. Other key targets included: sampling the transition through a rare midlatitude section that might include Eocene and Paleocene hyperthermals and/or the Paleocene/Eocene Thermal Maximum (PETM); the composition and character of the impact breccias, melt rocks, and peak-ring rocks; the sedimentology and stratigraphy of the Paleocene–Eocene Chicxulub impact basin infill; the chronology of the peak-ring rocks; and any observations from the core that may help us constrain the volume of dust and climatically active gases released into the stratosphere by this impact.

Drilling: A single hole, M0077A (Figure 1), was drilled at ~21° 27', 89° 57' [1], using a jack-up platform, the *L/B Myrtle*, contracted from Montco Offshore. An Atlas Copco mining rig was cantilevered from the bow of the platform, and drilling services were provided by DOSECC (Drilling, Observation and Sampling of the Earths Continental Crust). The downhole logging program was managed by the European Petrophysics Consortium (EPC), and the University of Alberta, Canada, and the University of Texas at Austin, USA, were contracted to carry out the VSP (vertical seismic profile) measurements. Open-hole drilling occurred from the seabed to ~500 m depth, and core was recovered between 505.70 and 1334.73 mbsf (meters below sea floor) using a PQ3-sized bit. The core diameter is ~83 mm and core recovery was close to 100 %.

Offshore Science Party: Wireline logging and VSP data were acquired in three phases: between ~0-503 m, 506 – 699 m, and 700 – 1334 m depth. Logging tools recorded: spectral and total natural gamma ray, sonic velocity, acoustic and optical borehole images, electrical resistivity, induction conductivity, magnetic susceptibility, caliper, borehole fluid parameters and seismic travel time versus depth from the VSP.

Petrophysical properties were measured at surface using a Multi-Sensor Core Logger (MSCL), and included gamma density, electrical resistivity, magnetic susceptibility, and natural gamma ray

A visual description of the core was undertaken through a transparent liner. Samples were taken at or close to the core ends for microbiological, geochemical, and biostratigraphic analyses.

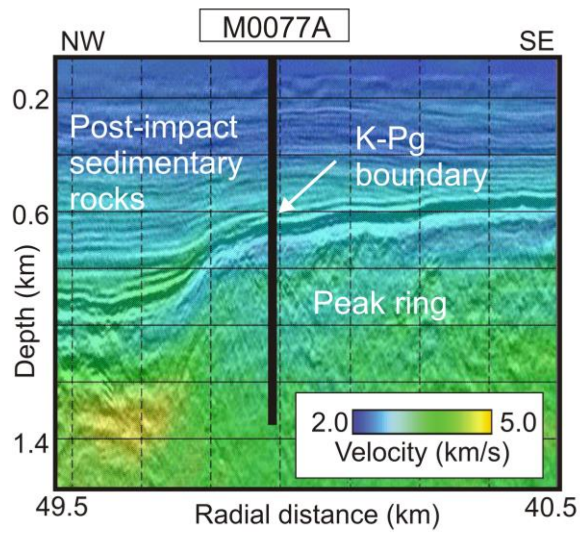

Figure 1. Drill Site M0077A located on a depth-converted seismic reflection profile ChicxR3 [4]. Color is seismic velocity obtained using full-waveform inversion [5]. Redrawn from [1].

Onshore Science Party (OSP): The core was sent to Weatherford International Limited in Houston, Texas, for CT scanning, and these data were processed by Enthought, Inc., and made available to scientists at the OSP. The core was then sent to the Bremen Core Repository (MARUM, University of Bremen), Germany, for the OSP which took place between September and October 2016. The core was split into two halves, a working half and an archive half, and a suite of standard IODP analyses were conducted on the core. All standard measurements will be released after a 1-year moratorium. Mesurements include: line scans, color reflectance scans, biostratigraphic and palaeomagnetic analyses to establish an age model for the recovered core, geochemical analyses to determine the compositon and abundance of major, minor and trace elements, and physical property measurements (P-wave velocity, porosity and density using helium pycnometry, and thermal conductivity). During the OSP science party members selected samples from the working half of the core for post-cruise research.

Description of recovered core: Above the peak ring, post-impact sedimentary rocks of Eocene and Paleocene age were encountered between 505.70 and 617.34 mbsf (gray in Figure 2). The peak-ring rocks are comprised of suevite (blue) above clast-poor impact melt rock (green) from 617.34 to 747.14 mbsf, which overlie shocked felsic basement rocks (pink) and preimpact mafic and felsic igneous dikes (yellow) as well as suevite and impact melt rock between 747.14 and 1334.73 mbsf (Figure 2).

Discussion: Prior to drilling geophysical models of the Chicxulub peak ring suggested that the peak ring was formed from rocks with a relatively low seismic velocity and density [5, 6]. This appeared to conflict with a model for peak-ring formation that predicted the peak ring be formed of uplifted basement rocks [7], since crystalline basement typically has quite high velocities and densities. Drilling confirmed that the Chicxulub peak ring is formed from felsic basement rocks which have an unexpectedly low velocity (3.9-4.5 km/s) and density (2.2-2.45 g/cc) (Figure 2). The peak-ring rocks must have been uplifted since, outside the crater, the basement is covered by 2-3 km of Cretaceous sedimentary rock [8]. The basement rocks that form the peak ring are highly fractured and shocked, and their emplacement above downthrown Cretaceous sediments is consistent with the dynamic collapse model of peak-ring formation [1, 7].

Summary: Expedition 364 was successful on several fronts: all the the high-priority targets were drilled, there was excellent core recovery, and the recovered core and wireline logs are of excellent quality. This suggests that, data acquired during Expedition 364, will allow us to accomplish many of the goals of the expedition.

References: [1] Morgan J. V. et al. (2016) *Science*, 354, 878-882. [2] Baker D. M. H. et al. (2016) *Icarus*, 273, 146-163. [3] Kring D.A. et al. (2016) *Nat. Comm.*, 10.1038/ncomms13161 [4] Gulick S. P. S. et al. (2008) *Nat. Geosci.*, 1, 131-135. [5] Morgan J. V. et al. (2011) *JGR*, 116, doi: 10.1029 2011JB008210. [6] Pilkington M. et al. (1994) *JGR*, 99, 13147-13162. [7] Collins G. S. et al. (2008) *EPSL* 270, 221-230. [8] Hildebrand A. et al. (1991) *Geology* 19, 867-871.

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Expedition 364 Scientists: Elise Chenot, Gail Christeson, Philippe Claeys, Charles Cockell, Marco J. L. Coolen, Ludovic Ferrière, Catalina Gebhardt, Kazuhisa Goto, Sean Gulick, Heather Jones, David A. Kring, Johanna Lofi, Christopher Lowery, Claire Mellett, Joanna Morgan, Rubén Ocampo-Torres, Ligia Perez-Cruz, Annemarie Pickersgill, Michael Poelchau, Auriol Rae, Cornelia Rasmussen, Mario Rebolledo-Vieyra, Ulrich Riller, Honami Sato, Jan Smit, Sonia Tikoo, Naotaka Tomioka, Jaime Urrutia-Fucugauchi, Michael Whalen, Axel Wittmann, Long Xiao, Kosei Yamaguchi, William Zylberman.

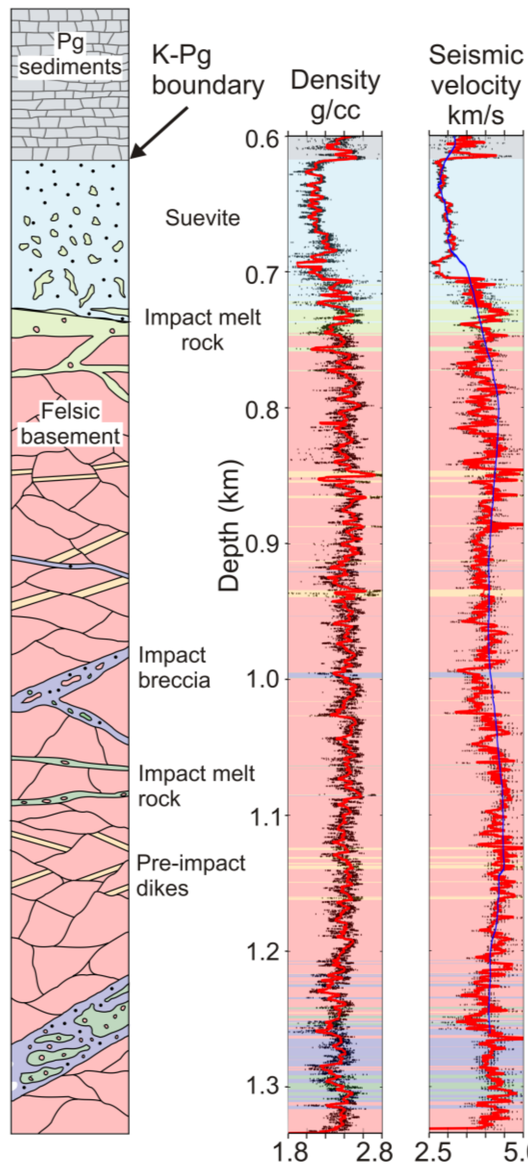

Figure 2. Drill Site M0077A: lithology (lhs), MSCL density measurements (middle) and seismic velocity (rhs) from the downhole sonic (red) and VSP (blue). Redrawn from [1].