PHYSICAL PROPERTIES OF THE CHICXULUB IMPACT BRECCIA DRILLED AT IODP/ICDP EXPEDITION 364 HOLE M0077A. G.L. Christeson[1], C. Gebhardt[2], S.P.S. Gulick[1], E. Le Ber[3], J. Lofi[4], J.V. Morgan[5], C.G. Nixon[6], A. Rae[5], D. Schmitt[6], and the IODP-ICDP Expedition 364 Science Party, [1]Institute for Geophysics, Jackson School of Geosciences, University of Texas at Austin, TX 78758, [2]Alfred Wegener Institute Helmholtz Centre of Polar and Marine Research, Bremerhaven, 27568, Germany, [3]Department of Geology, University of Leicester, Leicester, LE1 7RH, UK, [4]Géosciences Montpellier, Université de Montpellier, 34095 Montpellier Cedex05, France, [5]Department of Earth Science and Engineering, Imperial College London, SW7 2AZ, UK, [6]Department of Physics, University of Alberta, Edmonton, Alberta, T6G 2E1, Canada.

Introduction: IODP/ICDP Expedition 364 Hole M0077A drilled into the peak ring of the Chicxulub impact crater, recovering core between 506 and 1335 m below the seafloor (mbsf) [1]. Physical property measurements include wireline logging data, a vertical seismic profile (VSP), Multi-Sensor Core Logger (MSCL) measurments, and discrete sample measurements. Here we focus on the physical property measurements of the ~130-m-thick impact breccia unit between 617 and 747 mbsf, composed of a polymict breccia with impact melt fragments (suevite) overlying clast-poor impact melt rock [1].

Physical Property Measurements: The boundary between the suevite and overlying post-impact sediment is marked by large changes in many physical property measurements. There is a sharp decrease in sonic P-wave velocity and density, and an increase in porosity (Figure 1). Other observed changes include a decrease in resistivity and an increase in natural gamma radiation.

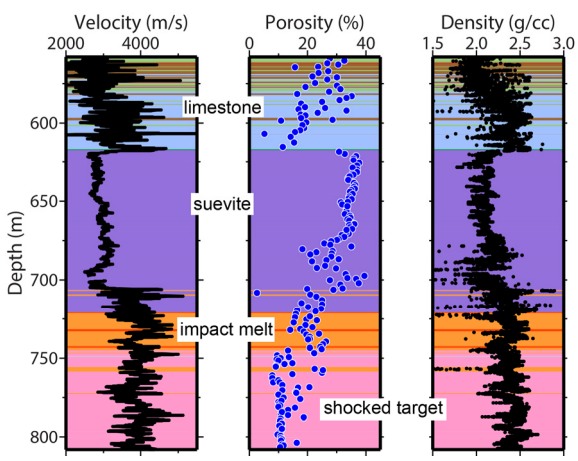

Figure 1. Physical property measurements for Hole M0077A from (left) sonic P-wave velocity from downhole logging; (center) porosity values measured on discrete samples; (right) gamma density measured on the cores using a MSCL.

A large increase in sonic P-wave velocity is observed near the base of the suevite where thin impact melt units are identified (Figure 1). This depth is also associated with porosity and resistivity decreases, and increases in density and natural gamma radiation.

Seismic Imaging: Seismic reflectivity is associated with impedance contrasts, which are affected by vertical changes in velocity and/or density. Hence, because there are sharp changes in velocity and density at the top of the suevite unit, and a sharp change in velocity and modest change in density at the base of the suevite unit, we would expect these boundaries to be associated with seismic reflectors if the suevite unit is laterally continuous. Figure 2 shows an excellent correspondence of low-frequency reflectors with the velocity changes at the top and near the base of the suevite unit.

Future Work: The large change in physical properties across the upper and lower boundaries of the suevite unit, and associated reflectors in the nearby seismic profile, means that we can use our seismic grid to map the suevite unit away from Hole M0077A. We plan to carry out 2 complementary approaches: 1) Map the top and base of the suevite unit using reflectors observed on the seismic images, and convert these values from TWTT to depth using average suevite P-wave velocities at Hole M0077A; and 2) Carry out full-waveform inversions to obtain high-resolution velocity models and images of the breccia unit [2,3]. The first approach can be carried out using existing data, while the second approach requires new computations.

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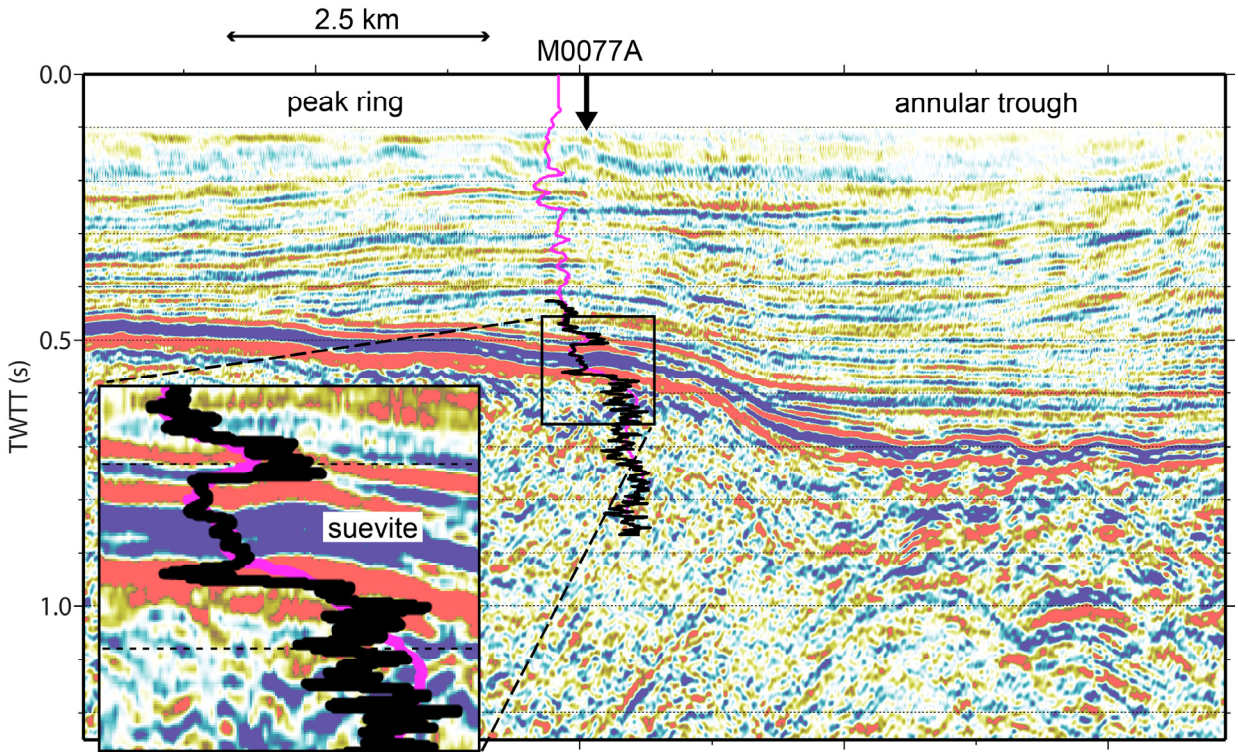

Figure 2. Portion of seismic profile ChicxR3 crossing the peak ring and annular trough. Arrow shows location of Hole M0077A. Vertical axis is two-way travel time (TWTT). Overlain is the seismic P-wave velocity obtained from downhole wireline sonic (black) and VSP (magenta) data. Closeup shows the seismic reflectivity and P-wave velocity data at the M0077A breccia unit.