ABSENCE OF SHOCKED QUARTZ AT CRETACEOUS/PALEOGENE (K/Pg) SITES IN THE NEW JERSEY COASTAL PLAIN, R. J. Aldoroty1 (rachel.aldroty@gmail.com), J. N. Bigolski1,2, 3, D. S. Ebel1, N. H. Landman4, 1Department of Earth and Planetary Sciences, American Museum of Natural History, Central Park West at 79th Street, New York, NY 10024, 2Department of Physical Sciences, Kingsborough College, 2001 Oriental Blvd, Brooklyn, NY 11235, 3The Graduate Center, CUNY, 365 5th Avenue, New York, NY 10016, 4Department of Invertebrate Paleontology, AMNH, New York, NY 10024.

Introduction: The biostratigraphic and geochemical signatures of the Cretaceous/Paleogene (K/Pg) boundary in the New Jersey (NJ) coastal plain are discordant at paleodepths of ~30m [1,2]. A rich ammonite ecology above the Ir (and Ni, Co) anomaly at these localities could result from either 1) local, short-term, post-impact survival of Cretaceous fauna [1,3], or 2) diffusion and reprecipitation of Ir, Ni, and Co to below the ammonite-rich horizon [2]. We report on efforts to locate impact ejecta that could resolve this controversy.

Quartz grains with planar deformation features (PDFs) indicating shock from the K/Pg Chicxulub impact are widespread, possibly on a global scale [4]. We searched for impact quartz in two sections from the New Jersey coastal plain containing K/Pg exposures. Localities in Monmouth County display a well-preserved offshore ecosystem in a series of poorly consolidated glauconitic layers [1,3]. The K/Pg boundary at Agony Creek in the Manasquan River Basin (~30m paleodepth) [5, Fig. 1] consists of the Tinton Formation (uppermost Maastrichtian) unconformably overlain by the Hornerstown Formation (lower Danian) [3]. The uppermost 20cm of the Tinton Fm. is referred to as the Pinna Layer [1]. The Pinna Layer is diverse in shallow marine late Maastrichtian fauna (e.g., ammonites, bivalves) preserved in life position above a sharp ~500pg/g Ir anomaly (above a steady ~100pg/g post impact background [5,6]). The section below is less rich in Cretaceous fauna. Elevated Ni and Co in pyrite framboids coincident with Ir enrichment are reported at Agony Creek [7,8]. Impact derived shocked quartz at the top of the Pinna Layer would suggest migration of impact-derived Ir, Ni and Co to the base of the Pinna Layer [2]. Shocked quartz coincident with the Ir anomaly would confirm the local post-impact survival of the Pinna community [1,5].

At deeper paleodepths in NJ, biostratigraphic and geochemical signatures are coincident. For example, the ammonite-free Crosswicks Creek K/Pg section is continuous with the Meirs Farm section of [2], that contains ~500pg/g Ir in the white clast layer [2]. We showed that this layer coincides with 10-100x enrichments of Co and Ni within boundary layer framoidal pyrites [9], similar to the enrichments at the base of the Pinna Layer at Agony Creek. Crosswicks Creek should contain shocked quartz at this coincident geochemical and biostratigraphic K/Pg boundary, in the white layer.

Core from the K/Pg boundary in Tighe Park in southern NJ, 190m from the Agony Creek locality, shows nearly identical Ir peaks at the base of the Pinna Layer [2]. The Bass River core (uppermost Maastrichtian) near Freehold, at ~60-100m paleodepth contains a spherule bed boasting an Ir anomaly peak of ~2,500pg/g at the base of the spherule bed in addition to a ~700pg/g Ir peak at the top. Shocked minerals are reported throughout the spherule bed [2].

Figure 1: Schematic stratigraphic section [from 1] at Agony Creek in the Manasquan River Basin shows the upper portion of the Tinton Fm. and lower Hornerstown Fm. with the Ir anomaly (blue stars) at the base of the Pinna Layer. Left: down-dip section with erosional features. Right: up-dip section preserving 'burrowed' unit. The difference reflects different degrees of scour at the top of the Pinna Layer.

Methods: Field samples were collected from exposed stream bank outcrops. The Agony Creek (Pinna Layer type locality) section was divided into 1cm-thick segments through the 20 cm vertical extent of two box-core samples. Sediment was collected from every cm increment including three additional vials at the Pinna Layer base and at the upper contact with the Hornerstown Fm. The same method was applied for the 13cm
thick Crosswicks Creek samples (080701-4 and 080701-6), with two additional vials at the white layer. Each sample was disaggregated with 150mL of 30% grade hydrogen peroxide for ten minutes and sonicated for 7 minutes. Samples were wet sieved at 63µm to remove clays, then dry sieved to isolate 75µm to 150µm grains (distal shocked quartz from the K/Pg boundary has an average size of 100µm [10])., and put through a Frantz Isodynamic Magnetic Separator. Quartz grains were sorted from the glauconitic sand at settings of 20° longitudinal slope and a backward tilt at 20° at 0.8amps on a medium/high vibrator setting [10]. Separated quartz grains from Crosswicks Creek were smeared onto 1 inch round petrographic slides (~500 grains per cm²) and were bound using cyanoacrylate based glue and then examined using a petrographic microscope [10, p.284]. Pinna Layer quartz grains were mounted individually onto the heads of sewing needles for observation on a spindle stage and also in epoxy mounts on 1 inch slides for cathodoluminescence (CL) analysis on the HITACHHI S-4700 SEM at the Microscopy and Imaging Facility at the AMNH, to detect PDFs and secondary features in the grains.

Results: The Pinna Layer samples yielded >100 quartz grains per cm². Initial petrographic analyses show a wide range of grain morphology from angular and opaque to spherical and transparent. Many grains show evidence of planar features suggesting deformation by tectonic processes. Quartz from throughout, above, and below the Pinna Layer lacked evidence of impact-generated deformation. Analyses of quartz grains (≥9,000) from the Crosswicks Creek section show a more homogenous population of transparent elongated grains. Only a single grain from the white clay layer in Crosswicks Creek (aliquot 080701-6) exhibited features possibly consistent with PDFs, with closely spaced fractures throughout the entire grain (Fig. 2, left). CL analysis of quartz from the Pinna Layer base contact at 0cm and Hornerstown Fm. contact at 20cm showed no evidence of PDFs or overgrowths.

Conclusions: Maturity of the glauconite, the Ir signature, and truncation of the Pinna Layer (Fig. 1) suggest an extensive time gap at the top of the Agony Creek Pinna Layer [1,13,14], which may have contributed to the absence of quartz with PDFs if the biostratigraphic boundary is coincident with the impact signature [2]. The presence of shocked minerals in the Bass River spherule layer [2] suggests reworking throughout the layer through bioturbation or mass wasting events. It is not clear why shocked mineral grains appear in the Bass River section and not in either of the Agony Creek or Crosswicks Creek sections.


Acknowledgements: We thank S. Wallace (AMNH) for sample preparation assistance; J. Thostenson (AMNH) for SEM CL assistance; D. Kring (LPI), B. French (NMNH), and C. Koeberl (University of Vienna) for their advice. This research is supported by the American Museum of Natural History, and NASA Cosmochemistry grant NNX10AI42G.

Figure 2: left: Quartz grain from Crosswicks Creek (aliquot 080701-6) at the white layer shows only one direction of narrow fractures. right:Confirmed impact-shocked quartz with PDFs usually show more than three sets of thin, narrow (< 3µm), closely spaced (<10µm), parallel lines extending throughout the grain [11, 12]; image [11].