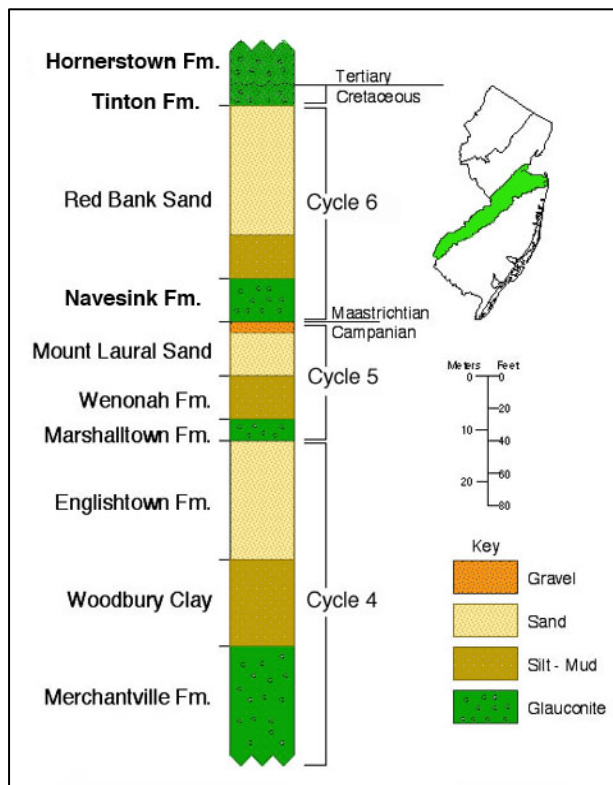


Sediment Analysis of a Stratigraphic Sequence across the K-T Boundary, Manasquan River Basin, NJ

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Overview: Landman et al., 2007 report new outcrop of Upper Cretaceous strata in the Manasquan River Basin, New Jersey coastal plain, exposing the Cretaceous-Tertiary (K-T) boundary at the contact between the Tinton Formation and overlying Hornerstown Formations (fig. 1). What is unique about this new stratigraphic section (fig. 2) is that an iridium anomaly is present 20 cm below an interval containing a rich assemblage of Upper Cretaceous benthic and pelagic invertebrates, including abundant and diverse ammonites, pelecypods, and gastropods (the *Pinna* layer). The *Pinna* layer is in disconformable contact with the overlying Tertiary (Danian) age Hornerstown Formation, which contains a sparse invertebrate fauna. If the iridium anomaly in this section is the stratigraphic marker for the K-T bolide impact widely attributed to be the cause of the terminal Cretaceous mass extinction, the presence of a healthy in-situ Cretaceous marine fauna deposited after the impact event calls into question the global ecological repercussions of the impact event and its timing relative to the K-T boundary. To better interpret the depositional environments of the Tinton Formation, *Pinna* layer, and overlying Hornerstown Formation, we performed a detailed sediment analysis on three samples from these units, characterizing their grain distribution and mineralogical composition. These data were then used to compare the three samples to sediments from a previously analyzed stratigraphic sequence from the slightly older Navesink Formation (fig. 1).

Fig. 1. Stratigraphic formations and cycles in the uppermost Cretaceous of the New Jersey coastal plain (after Owens et al., 1970 and Owens and Gohn, 1985).



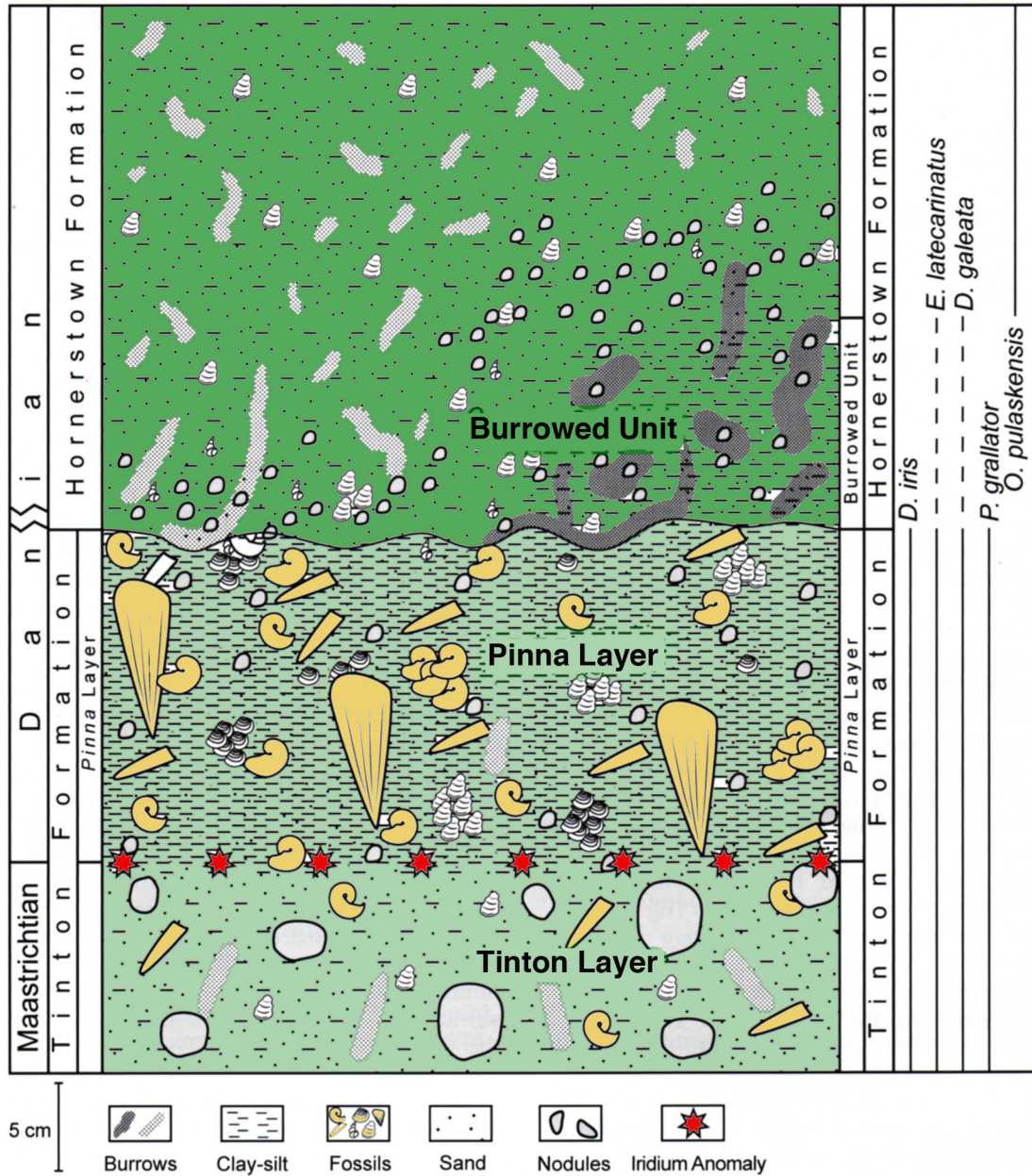


Fig. 2. Stratigraphic sequence across the K-T boundary exposed in the Manasquan River Basin, Monmouth Co., NJ. Fig. from Landman et al., 2007, fig. 3. Sediment samples analyzed in this study are labeled on the diagram (Tinton Layer, Pinna Layer, Burrowed Unit).

Methods: Bulk sediment samples of several hundred grams, obtained from Neil Landman at the American Museum of Natural History (AMNH), were disaggregated by soaking in bleach followed by wet sieving. Silt and mud-sized material was collected for later analysis. All sediment greater than 4 phi in size was dried and dry sieved at half phi increments. Size fractions were weighed to obtain a weight percent grain size distribution for each sample. Visual estimates were made of the percentage of different grain types (undisaggregated matrix, quartz, glauconite, iron oxide, diagenetic calcite,

shell fragments, and mica) in each size fraction using standard percent estimate diagrams (Compton, 1985). For comparison, similar estimates were made for six previously processed sediment samples representing different facies in a stratigraphic sequence previously described from the Navesink Formation (Bennington et al., 1998; Bonelli and Bennington, 2000).

Results: Sediment analyses of the Manasquan River Basin samples show that all three are predominantly glauconite grains in a mud matrix. Iron oxide grains (possibly hematite and / or limonite) are common in all samples (fig. 3). Quartz grains form a minor component of the samples. Direct comparison of the three samples is hindered by the presence of grains of non-disaggregated matrix in the Tinton and Pinna layer samples. The Burrowed Unit sample disaggregated completely, whereas the Tinton and Pinna Layer samples were more indurated and did not completely disaggregate, even after extended treatment with ultrasound to break up the remaining grains of matrix. Nevertheless, comparison of the samples reveals that the Tinton and Pinna Layer samples are very similar in their grain composition and grain size distribution. The Tinton Layer sample appears to have more detrital quartz than the overlying layers and is somewhat skewed toward larger grain sizes (smaller phi values) relative to the Pinna Layer. The Burrowed Unit sample from the Hornerstown Formation has almost no quartz and is predominantly composed of grains of glauconite in the size range of 1 to 3 phi, which are significantly larger than the grains found in the Tinton and Pinna Layer samples.

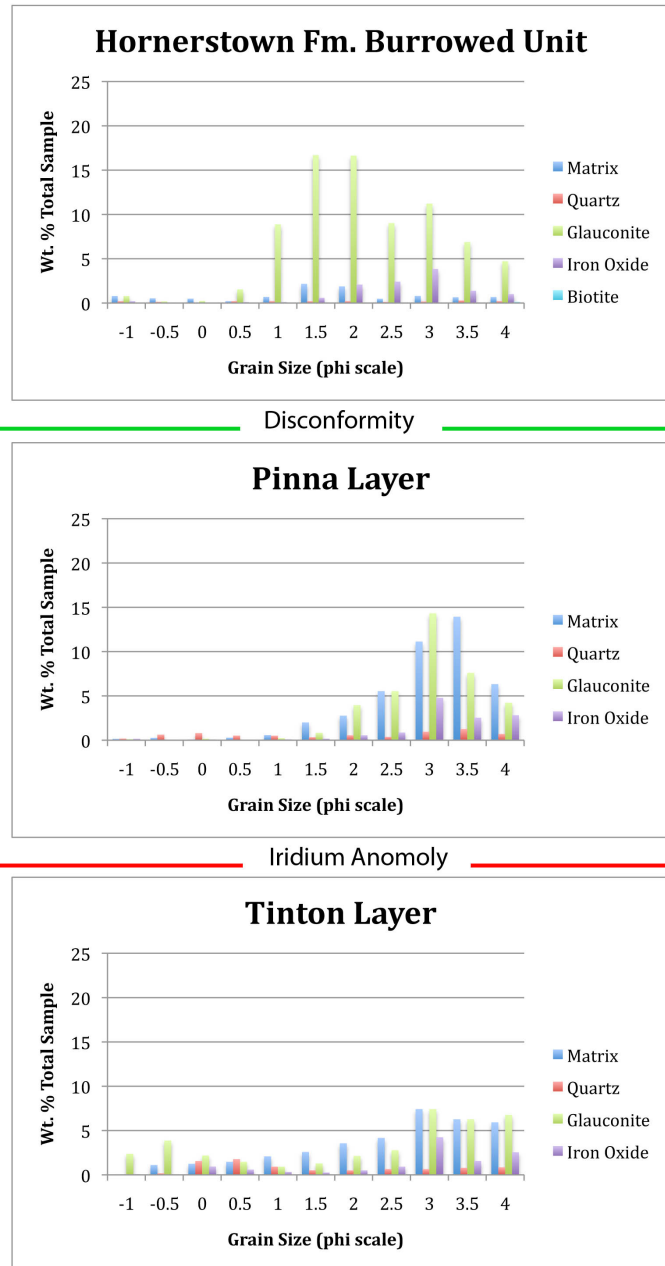


Fig. 3. Grain size distributions showing estimated grain type percentages for the Manasquan River Basin units.

Navesink Formation samples show an upsection trend of increasing predominance of glauconite grains and decreasing quartz. This has been previously interpreted to represent an overall deepening and diminishment of terrestrial detrital influx as the shoreline transgressed westward during sea level rise (Bennington et al., 1998; Bonelli and Bennington, 2000). This trend appears to be punctuated by minor disconformities, across which the grain size distribution and grain composition changes abruptly, possibly in response to pulses of deepening. These minor disconformities form the boundaries between a sequence of increasingly deeper water facies (fig. 4, facies A, B, C, D, and E of Bennington et al., 1998).

Interpretation: Comparison of the Manasquan River Basin samples to the samples from the Navesink Facies sequence (fig. 4) shows that the Tinton Layer, Pinna Layer, and Burrowed Unit are sedimentologically similar to the deeper, more offshore part of the Navesink sequence (facies C and D) where sedimentation is dominated by authigenic glauconite with very little influx of detrital quartz. The Tinton Layer and Pinna Layer samples are most similar to Navesink samples from facies C, which are dominated by glauconite but contain a small amount of detrital quartz. The Burrowed Unit sample is almost identical to the Navesink sample from facies D, interpreted to be the most offshore, deepwater facies of the Navesink. This interpretation is somewhat different from that presented in Landman et al., 2007, which attributes a relatively nearshore, shallow water environment of deposition to the Pinna Layer.

The change in sedimentation from the Tinton Layer to the Pinna Layer, across the iridium anomaly, appears to be related to minor deepening and a reduction in detrital sediment influx. The highly fossiliferous nature of the Pinna Layer, including abundant nektonic belemnites and ammonites, also suggests that this is a moderately condensed interval, accumulated over an ecologically significant interval of time (hundreds to thousands of years?). Again, this interpretation differs from the interpretation argued in Landman et al., 2007, which posits a period of less than 200 years for the deposition of the Pinna Layer. The question of the duration of deposition of the Pinna Layer has important implications for interpreting its significance relative to the iridium anomaly at the base of the Pinna Layer. A rapidly deposited Pinna Layer may simply represent a short, post-disaster, survival interval for the Cretaceous benthic fauna before the ecological repercussions of the bolide impact fully manifested themselves. A more prolonged interval of survival for a normal, open marine, Cretaceous fauna implies a decoupling of the bolide impact associated with the iridium anomaly and the marine extinctions that mark the Cretaceous-Tertiary boundary.

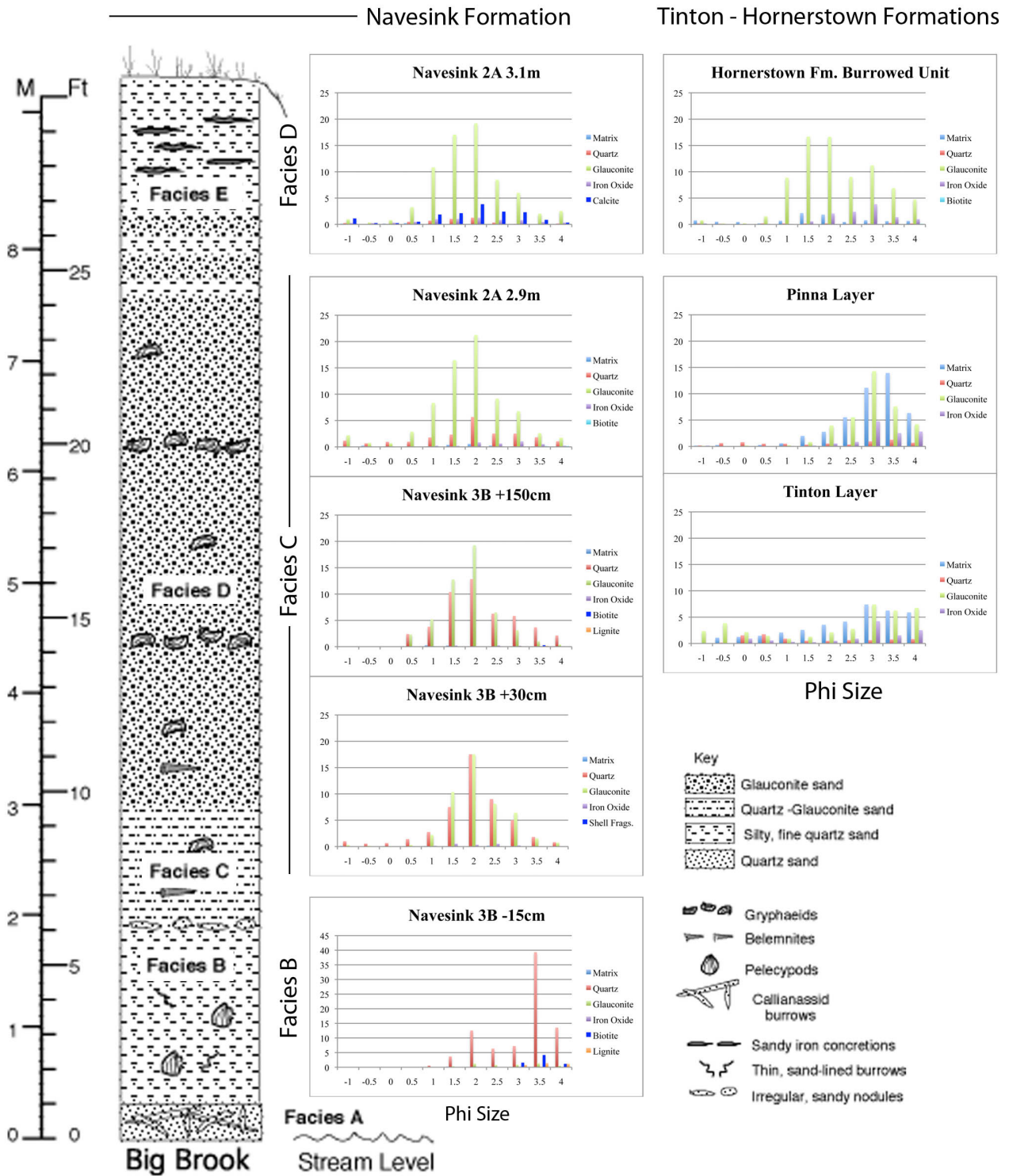


Fig. 4. Comparison of Manasquan River Basin samples, Tinton and Hornerstown Formations, to samples from a stratigraphic sequence in the Navesink Formation.

Bennington et al., 2010, Sediment Analysis of a Stratigraphic Sequence Across the K-T Boundary, Manasquan River Basin, NJ, 17th Annual Long Island Geologists Conference, Stony Brook, New York.

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