Stratigraphic evidence of an Asteroid Impact, Mega-Earthquakes, and Tsunamis in just one bed

The K/Pg boundary in Colombia, Mexico, and the United States

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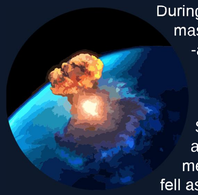
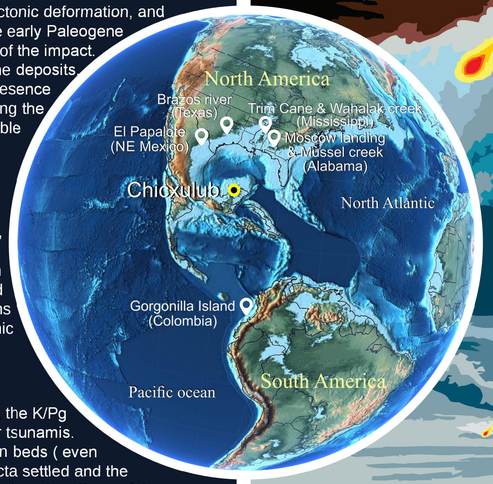
What, Where, and When?



During the Cretaceous - Paleogene boundary (K / Pg, 66 Ma), our planet suffered a mass extinction event that caused the demise of 75% of the species (including non -avian dinosaurs). A colossal asteroid, ~12 -14 km in diameter, collided with our planet in what is now the Yucatan Peninsula. The energy released, equivalent to the explosion of ten billion Hiroshima bombs, was enough to trigger massive earthquakes (Magnitude>11) and generate tsunami waves higher than one km. Simultaneously, millions of tons of molten rock and gases were ejected into the atmosphere during the impact crater's formation (~200 km in diameter) and the meteorite's vaporization. During the hours following the impact, these materials fell as a scorching rain composed of tiny glass spherules.

The evidence

The stratigraphic record of the K/Pg boundary is complex. The near-simultaneous occurrence of several geologic events is overshadowed by poor outcrop exposure, weathering, tectonic deformation, and poor understanding of post-impact events, including local erosion during the early Paleogene In general, the presence of glass spherules was considered clear evidence of the impact. A deformed sequence just below the K/Pg boundary, not affecting Paleogene deposits was related to the Chicxulub Mega - Earthquake and its aftershocks. The presence of coarse-grained, high-energy deposits, even of local expression, interrupting the " normal " sedimentation during the K/Pg transition, was examined as probable evidence of tsunamis triggered by the Chicxulub asteroid impact.



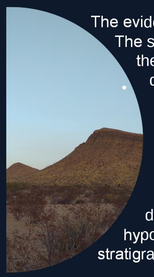
Our research

To study the stratigraphy of the K / Pg boundary and the deposits related to the Chicxulub asteroid impact, we visited K/Pg sections in Gorgonilla Island, Pacific of Colombia; El Papalote, NE of Mexico; and several locations in the southern United States, including several areas close to Starkville, and Trim Cane & Wahalak creek sections (Mississippi); Moscow landing, Braggs, and Mussel creek (Alabama); and Brazos river section, Texas. In all the sections we conducted a thorough lithologic description and a detailed photographic record to carry out a meticulous stratigraphic and sedimentologic analysis.

What did we discover?

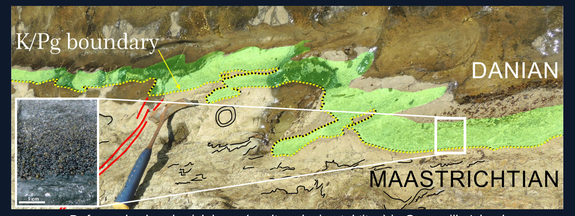
As the Gorgonilla Island section was located in a deep-marine environment, the K/Pg boundary interval was continuously preserved, and unaffected by storms or tsunamis. The effects of the mega-earthquake are evident in the cuspidal Maastrichtian beds (even affecting the spherule-rich layer), proving seismic waves arrived before ejecta settled and the seismicity persisted weeks to months after the impact. In the El Papalote section, the effects of the seismicity are more evident due to its proximity to the crater and lithology. The shallow-marine environment allowed the accumulation of facies prone to preserve liquefaction structures, which persist even in the facies reported as a product of tsunamis. The Brazos River section records massive flows and faulted blocks related to the mega-earthquake. Several spherule-rich layers interbedded with storm deposits reveal reworking and suggest erosion during the early Danian. There is no evidence of the preservation of tsunami deposits. The Mississippi and Alabama localities were deposited in low-energy shallow marine environments preserving very fine-grained monotonous facies, unfavorable for developing soft-sediment deformation and liquefaction structures. Additionally, the record appears incomplete, and the transition between the Maastrichtian and the Danian is almost imperceptible. In most outcrops, no impact spherules are observed, and deformation is restricted to some fractures and almost complete destruction of the sedimentary fabric in the uppermost Maastrichtian. In general, there is no evidence of tsunami-related facies. Intense bioturbation and storm deposits are frequent at the base of the Paleogene, suggesting erosion and reworking of the uppermost Cretaceous. However, it is remarkable the local presence of faulted blocks in sectors of the Trim Cane and Wahalak creek sections (Mississippi) and Moscow landing and Mussel Creek (Alabama) that allowed the preservation of coarse-grained facies and seismically induced cracks proving the presence of the Chicxulub mega-earthquake and the tsunami in this part of the Gulf of Mexico.

What does this mean?



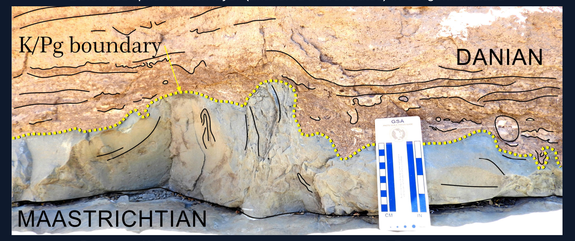
The evidence proves seismic activity and tsunamis resulted from the Chicxulub asteroid impact. The sedimentary record varies with paleodistance, paleogeography, and facies reflecting the paleoenvironment. In some cases, the evidence is barely noticeable or does not exist due to the lithology or subsequent erosion. Natural barriers and faulted blocks (created during the mega - earthquake were critical factors in preserving the tsunami deposits. The detailed stratigraphic and sedimentological analysis allowed us to establish the depositional conditions, identify sedimentary and deformation processes, as well erosion and reworking in a regional and local context. These "basic" tools have been somewhat neglected in many recent studies, sometimes only focusing on collecting samples for sophisticated analysis or modern techniques without considering the deposit's geology. Carefully observing the rocks in the field is essential for raising solid hypotheses following the scientific method, as correctly describing and interpreting the stratigraphic record is a basic but critical element in understanding complex geological events.

COLOMBIA



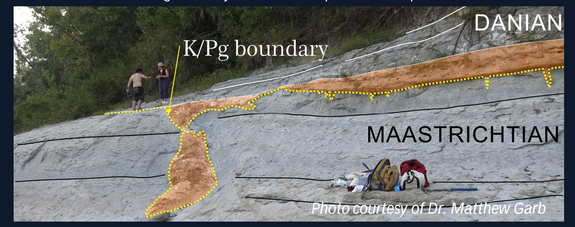
Deformed spherule-rich layer (unaltered microtektites) in Gorgonilla Island

NE MEXICO

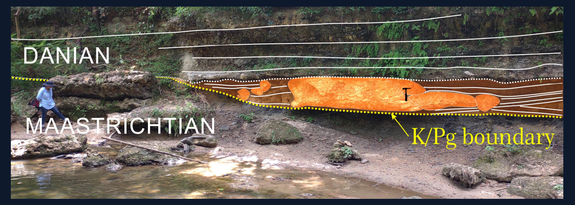


Deformed K/Pg boundary and tsunami deposits at El Papalote section

ALABAMA



Seismically induced cracks overlain by tsunami deposits in Moscow landing sector

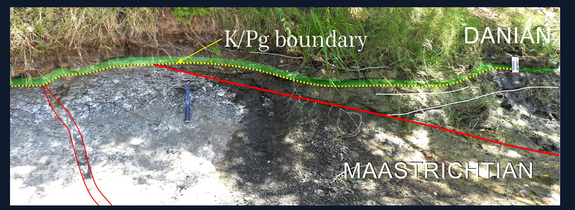


Locally preserved tsunami deposits linked to the K/Pg boundary. Mussel creek section

MISSISSIPPI

Fault-controlled blocks preserving tsunami deposits. K/Pg boundary in Trim Cane creek

TEXAS



Fault-controlled blocks below the K/Pg boundary at Brazos river section

Scan me for more cool information

T22. Sedimentary Geology Division/SEPM Student Research Poster Competition: Dynamics of Stratigraphy and Sedimentation

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