The Cretaceous-Paleogene Boundary Ejecta Layer and its Source Crater at Chicxulub

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Impact cratering is a high-energy event that occurs at more or less irregular intervals. At the Cretaceous-Paleogene (K-Pg) boundary, the discovery of an extraterrestrial signature, together with the presence of shocked minerals, led not only to the identification of an impact event as the cause of the end-Cretaceous mass extinction, but also to the discovery of a large buried impact structure about 200 km in diameter, the Chicxulub structure. The Chicxulub impact crater, Mexico, is unique. It is the only known terrestrial impact structure that has been directly linked to a mass extinction event. It is the only one of the three largest impact structures on Earth that is well-preserved. It is the only terrestrial crater with a global ejecta layer. It is the only known terrestrial impact structure with an unequivocal topographic "peak ring." Chicxulub's role in the K-Pg mass extinction and its exceptional state of preservation make it an important natural laboratory for the study of both large impact crater formations on Earth and other planets, and the effects of large impacts on the Earth's environment and ecology. Effects of the large impact event at Chicxulub range from minutes to millennia and include a variety of short-term and severe environmental perturbations.

An ICDP-financed borehole, Yaxcopoil-1, was drilled from December 2001 through March 2002 in the southern sector of the crater, 62 km from the approximate crater center. The Yaxcopoil-1 (Yax-1) borehole was planned to core continuously into the lower part of the post-impact carbonate sequence, the impact breccias, and the displaced Cretaceous rocks. Drilling extended to a depth of 1,510 m. Approximately 795 m of post-impact Tertiary carbonate rocks, 100 m of impactites, and 615 m of pre-impact Cretaceous rocks (megablock) were intercepted.

A new drilling project at Chicxulub by ICDP and IODP was conducted in 2016. The goal was to address several questions, including: 1) what is the nature of a peak ring, 2) how are rocks weakened during large impacts to allow them to collapse and form relatively wide, flat craters, and 3) what caused the environmental changes that led to a mass extinction? Our understanding of the impact process is far from complete, and the first two questions represent fundamental gaps in our knowledge. Despite over 30 years of intense debate, we are still striving to answer the third question. A principal objective of the proposed drilling is to understand the fundamental impact process of peak ring formation. Drill hole Chicx-03A was intended to sample material that forms a topographic peak ring, and reveal the lithological and physical state of these rocks, including porosity, fracturing and extent of shock effects. IODP expedition 364 took place 5th April to 6th June 2016 and was highly successful. The studies of the rocks contribute to our understanding of such a large-scale impact event.