The Chicxulub Impact: A Cosmic Event that Changed the Course of Life 65 Million Years Ago.

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In 1980, Luis Alvarez and his geologist son, Walter, proposed that a giant asteroid or comet struck the Earth approximately 65 million years ago and directly caused the extinction of the dinosaurs and over 70% of all life on Earth. This bold proposition resulted from their discovery, near the medieval town of Gubbio, Italy, of a centimeter-thick clay layer among limestones at the Cretaceous-Tertiary (KT) boundary. The limestone directly beneath the clay layer abounds with planktonic forams of latest Cretaceous age, whereas the Tertiary limestone unit immediately above the clay layer showed only rare and poorly formed fossils. Thus the clay layer itself, the scientists reasoned, must be the event horizon that could hold clues to the duration and nature of the mysterious KT extinction event, one of the most dramatic calamities to afflict Earth's biosphere since the development of complex life over a billion years ago. They found that the clay contained high concentrations of the element iridium, extremely rare in Earth's crustal rocks but quite abundant in certain meteorites, and proposed that his clay was the altered remains of the dust cloud blasted around the world when a 10-km asteroid or comet struck the Earth. Fifteen years of research has upheld this idea, and now all indications are that the source crater has been found.

The collision occurred in the Yucatan platform and is centered near the port city of Progreso, Mexico. The 200-300 kilometer wide crater lies buried beneath 1,100 meters of limestone laid down in the intervening years, and few clues of its presence remain at the surface. Prominent circular anomalies in geophysical data gained the interest of Petroleos Mexicanos, and in the early 1950s they began an exploration campaign that included deep drilling to recover samples of the subsurface rocks. The buried features became known as the Chicxulub (Cheek-shoo-lub) structure after the name of the first well located near the Mayan village by the same name. Pemex drilling continued throughout the early 1970s and by that time, Mexican scientists realized that the Chicxulub structure was something quite unusual. Three wells near the center had recovered silicate rocks with igneous textures, initially mistaken for volcanic rocks, and others, located between 140km and 210km from the center of the structure recovered breccia deposits hundreds of meters thick, indicating catastrophic or explosive conditions. By 1980 at least one scientist at Pemex felt that the evidence pointed to impact, although a volcanic origin for the Chicxulub structure could not be ruled out.

Beginning in 1990, samples from the Pemex wells were located in Mexico City, and teams of scientists from the United States and Mexico quickly developed an impressive case that the Chicxulub structure was indeed the KT's 'smoking gun'. Diagnostic mineral evidence of shock metamorphism, requiring pressures and strain rates considerably higher than those produced by terrestrial processes, indicated that the crystalline rocks within the basin were melt rocks formed by an impact event and not by volcanism. Biostratigraphic information indicates that the structure was formed in uppermost Cretaceous rocks, consistent with a KT age. Argon and uranium-lead age determinations reveal that the melt rocks and the associated breccias are the same age as the tiny spherules of impact glass found within KT boundary deposits in Haiti and Mexico and the unmelted granitic fragments found in KT boundary exposures throughout western North America. Isotopic analyses demonstrate that the Chicxulub melt rocks and the ejecta spherules originated from the same source rocks. Consequently, there is a clear chemical as well as temporal link between the Chicxulub structure and the KT boundary deposits.

Additional geological and geophysical evidence collected over the last few years now suggest that Chicxulub could be the largest impact basin to form on Earth in the last billion years or so. Over 200 thousand cubic kilometers of the Earth's crust were instantly vaporized, melted, or ejected from the crater. Continuing studies of this structure through additional scientific drill coring and seismic profiling will shed valuable new light on understanding the cratering process and its geological implications.

This presentation will review recent discoveries at the Chicxulub structure that constrain its size and origin. In addition, the potential environmental and economic significance of the event that produced this basin will be explored.

Biographical Sketch

Virgil L. Sharpton is a Staff Scientist at the Lunar and Planetary Institute in Houston, Texas. His research interests include analysis of large impact basins on Earth, with a particular focus on the geological and environmental consequences of meteorite impact. He received his B.S. in 1979 from Grand Valley State, where he recently received the Distinguished Alumni Award. He received both his MS and his PhD (1984) from Brown University.

Prior to joining the LPI, Dr. Sharpton was Natural Sciences and Engineering Research Council Postdoctoral Fellow working with the Geological Survey of Canada for two years and received the Government of Canada Group Achievement Award. He received the National Aeronautics and Space Administration Group Achievement Award in 1992 for his participation in the Magellan radar mission to Venus. He is co-discoverer of the Marquez impact structure in East Texas and is currently involved in research on the Slate Islands impact feature in Canada as well as the Chicxulub basin in Mexico. He has authored over 40 papers on meteorite impact and related topics and holds research grants with NASA and NSF.