Preface: About the Book

The story of Chicxulub describes what was likely the most traumatic astrophysical event visited upon the Earth, during the last 100 million years: that of the giant 10-km asteroid that plummeted into the ancient Gulf of Mexico.[1] Moreover, this singular event imposed a far greater disruption to the Earth's biosphere than the strongest earthquake or most violent volcanic eruption. This asteroid's mass (likely half of that of Mount Everest) blasted through the atmosphere within seconds. Its impact at the sea surface set off an explosion that penetrated through a kilometer or so of seawater and into the Earth's crust, reaching the upper mantle (some 20–25 km beneath the surface). Meanwhile, its original explosion had produced searing global heat ejecting Gigatons of debris and dust into the atmosphere.

In addition, a globe-circling tsunami was then launched into the Gulf and beyond, drowning some 25 % of the world's coasts and leaving a huge water-filled crater. Its crater water boiled into the atmosphere and altered regional oceanographic conditions. The resulting atmospheric contamination fueled a series of long-lasting climate disruptions. The totality of these short- and long-term changes resulted in the mass extinction of 60–80 % of plant and animal life (including the dinosaurs) and likely changed the path of human evolution.

The Prologue describes Chicxulub's apocalyptic early morning fall to Earth 65.5 million years ago. Chapter 1 examines the nature of orbiting asteroids and their kinetic energies, followed by a discussion of historical asteroid impacts and the probability of future Earth–asteroid collisions.

[1] The object hit a much larger and deeper Gulf of Mexico at the location of what is now the coastal fishing village of Puerto Chicxulub—hence its name.

Chapter 2 describes the discovery of Chicxulub, beginning with the 1980 "Alvarez" analysis of the Cretaceous Paleocene (K-Pg) boundary, whose chemistry suggested that it was derived from a massive asteroid's impact on Earth. Years following the Alvarez expedition, the existence of a huge crater deep under the Gulf of Mexico was confirmed later as the asteroid impact site. A summary is given of the latest analyses of the Chicxulub data, also suggesting effects on the Earth's biosphere.

Chapter 3 paints a possible scenario of the Chicxulub impact sequence. Its explosion is described as it blasted through the atmosphere, the Gulf water, and deep into the Earth's crust. These explosive effects are compared to those of an underwater nuclear blast and include a model suggesting sequential formation of the impact crater. Similarities are drawn between the Chicxulub event and those of other asteroid impacts and volcanic eruptions. Finally, the energy of Chicxulub is compared with those of explosive geophysical phenomena and geological and astronomical events.

In Chapter 4, we discuss the tsunami created by Chicxulub and include a general "primer" on these types of waves and properties of refraction and run-up. Additional comments are made about historic earthquake and tsunami-generated floods. Two models of enormous tsunamis generated from different sources are then described. The first traces waves produced from a hypothetical caldera collapse in the Canary Islands. The second illustrates a future impact in the North Atlantic Ocean by an asteroid of 1.1 km diameter (one-tenth that of Chicxulub)—predicted to pass close to the Earth in 2085. Both models describe huge tsunamis hitting the shorelines that border the Atlantic Ocean. Finally, we draw a comparison between a laboratory-produced "Edgerton Effect" impact and the tsunami splash into the Gulf. We then track wave inundations around ancient Gulf coasts, the lowland areas of Central and North America, and then its rampage over the world's oceans.

Chapter 5 discusses long-term effects of the boiling Chicxulub crater water that fed atmospheric cloud as well as subsequently raising sea temperatures and altering oceanographic conditions in the Gulf and western North Atlantic Ocean. Meanwhile, the debris cloud blocking the sunlight shut down photosynthesis and produced frigid global temperatures and gray blizzards over the continents. As the atmosphere cleared, the remaining greenhouse gases dealt a final blow to Earth's biota, which suffered sweltering temperatures, perhaps for centuries.

Finally, a tally is made of the loss of biota from the mass extinction where approximately 60–80 % of all plants and animals were destroyed, ranging from the tiniest ocean foraminifera to land-lumbering dinosaurs. Mysteriously, some small mammals survived.

The Epilogue concludes our tale by an example of how the notable Cambrian Burgess Shale became isolated by pure chance, and subsequently precipitated animal extinctions, altering the tree of life. A question could be posed—how could an improbable single Chicxulub event alter by a similar process the entire future path of human evolution.

A Note from the Author (David Shonting)

The framework for this story was derived from research on tsunamis. As lead author and physical oceanographer, I was drawn to contemplating both the tsunami and the effects of the hot impact crater upon the ocean environment. Whetted by my interest in the study of waves and in the underlying sciences involved, I set about to revisit the Chicxulub story. Our tale touches upon an eclectic interplay of subjects including astronomy, geology, oceanography, chemistry, biosciences, and even world history. We have attempted to present the material not in a text format, but rather as a narrative, based on science for the general reader. Because this book relates to so many disciplines, tedious referencing has been minimized in order to help the reader engage with the flow of the writing. Alternatively, footnotes are used to expand on an idea or to provide added information.

A Note from the Coauthor (Cathy Ezrailson)

This Chicxulub tale starts out in fantasy and supposition and then initiates a journey that takes us through reality with its marvelous unfolding mysteries. Having had a rewarding career teaching young adults, I undertake this collaboration with my coauthor in order to help present a unique piece of Earth's history to the general public and to a new generation of science enthusiasts.

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David Shonting, Sc.D.
Cathy Ezrailson, Ph.D.

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