DECCAN VOLCANISM, ASTEROIDS, AND DINOSAURS:
DECODING THE COMPLEXITIES OF THE K-T EXTINCTION

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An AI generated image showing the hypothetical scenario of an asteroid hitting the Earth while a volcano erupts in the background

Nicolaus Copernicus's idea that the Sun is the centre of the solar system, Charles Darwin's idea of evolution via natural selection, Ignaz Semmelweis's idea of hand sanitation to reduce infections, and Alfred Wegener's idea of continental drift, are common knowledge today. Still, these revolutionary scientific ideas did not gain wide acceptance when they were first proposed. This is true for most ground-breaking scientific ideas. An exception to this would be Luis W. Alvarez's Asteroid impact hypothesis in 1980 which became an instant hit among the masses. However, some in the scientific community have reservations about it to date.

Asteroid impact has been the most widespread explanation among the masses regarding the Dinosaur extinction. The 1996 book 'The Great Dinosaur Extinction Controversy' by Charles Officer and Jake Page discusses how the above idea oversimplifies a complex event. The book narrates the events surrounding the problem at hand - finding the cause of Cretaceous-Tertiary (K-T) extinction, the proposed hypotheses - falling anywhere on a scale of sane to insane, massive media and public interest in favor of one hypothesis over the other, opposing factions within the science world, and remoulding of the original hypotheses to accommodate newer findings.

Through fossil records, it was known that Earth had witnessed five major extinction events (besides several minor extinctions), the most recent being the K-T extinction that occurred around 66 million years ago (mya). Compared to the previous four major extinction events, the K-T extinction garnered the most public and scientific attention as it brought an end to the reign of the majestic Dinosaurs. Several hypotheses were proposed to explain the extinction namely, disease (pandemic), volcanism (volcanic activity releasing massive amounts of carbon dioxide and sulfur dioxide into the atmosphere, causing extreme climate), competition with newly evolving mammals, sea level recession leading to habitat loss, climate change, and spread of angiosperms leading to a famine-like situation for the gymnosperm adapted dinosaurs. Hitherto, most hypotheses proposed a terrestrial cause of the extinction which changed in 1980 when Luis W. Alvarez and co-authors proposed an extra-territorial cause of the extinction - asteroid. This hypothesis was a massive hit in popular culture for its dramatic overtone, a giant fireball gushing toward Earth, a thunderous explosion, Earth-splitting tremors, and debris blanketing the Earth for years. It eventually made it to the cover of Time magazine as such. The impact hypothesis was based on the increased level of iridium, 300 times more than the background level, within a thin layer of clay at the boundary between the Cretaceous and Tertiary ages at a geological site in Italy. Iridium is a rare earth metal but is abundant in asteroids. Thus, Alvarez et al. proposed a giant asteroid (~10 km diameter) smashing onto the earth, releasing a tremendous amount of iridium and wiping Dinosaurs out of existence. Besides iridium, quartz, a silica-based crystal also supports the impact hypothesis. Under normal conditions, quartz would have a smooth crystal structure while under intense pressure, as upon a giant asteroid striking Earth, the crystals would be deformed. Such 'shocked' quartz was reportedly found at multiple K-T layers across the globe.

However, there were several geological findings that the impact hypothesis could not explain.

Fossil records do not point towards an instantaneous extinction, rather, extinction appears to have occurred stepwise over some 400,000 years; dinosaur and other fossils become progressively rarer towards the K-T boundary. To explain the observed extended extinction record, Alvarez et al. replaced the single asteroid with multiple comet impacts over three million years. However, no geological evidence supporting this idea was found. While iridium is indeed found in asteroids, volcanic activities were also shown to release massive amounts of iridium. Similarly, 'shocked' quartz was found associated with Earthquakes and tectonic movements. Impact sites dated to various geological ages were known from across the World; no correlation between the estimated time of impact and the known major five extinctions was found. Thus, there was no precedent of an extraterrestrial object causing mass extinction on Earth.

The opposing faction found the asteroid theory to be based on anecdotal evidence and not conclusive evidence. However, the opposing ideas found little success in convincing the impact enthusiasts. Premier journals such as Science and Nature were more likely to publish papers favouring the impact hypothesis than those opposing it. Media outlets relied on these 'generalist' journals for their source of science news rather than the 'specialist' geological journals which mostly disagreed with the impact hypothesis. The buzz around the impact hypothesis continued and further strengthened when palaeontologists David Raup and Jack Sepkoski in 1984 reported in their analysis in the Proceedings of the National Academy of Sciences, USA that a mass extinction occurred every 26 million years, including the K-T extinction. Soon, researchers started looking for the possible cause of this periodicity - an unseen galactic object (asteroid, planet, or star) in an elliptical orbit that visits Earth every 26 million years, causing asteroid collisions. Within a year the idea was dumped as it was shown that 26-million-year periodicity was a statistical artifact and not real.

The crucial missing part in the asteroid impact hypothesis was the impact site. The proposed 10-km wide asteroid would have caused a 150-200 km wide crater on Earth and the discovery of 'shocked' quartz implied that the impact site should be on land and not the ocean. Among the potential craters, most of which were in North America, the Chicxulub crater was finally agreed upon as the site of the hypothesized impact. The opponents of the impact hypothesis pointed out the discordance between the findings and the expected data. The Chicxulub site had orderly sequences of sediments from pre- and post-collision periods. While the layers corresponding to the post-asteroid period (Paleocene till Pliocene) are expected, layers representing the period before the asteroid impact (late Cretaceous) are anomalous. An asteroid large enough to create a 200 km wide crater would have excavated at least 10 km of the upper crust destroying the uppermost cretaceous layers, thus destroying all the fossil records before the impact event. The opponents of the asteroid impact suggested Chicxulub to be a crater of volcanic origin.

Authors of the book, Charles Officer and Jake Page opine that Alvarez's hypothesis provided a solution to a problem that did not exist. There was no abrupt extinction record, the proposal of a single cataclysmic event to explain the mass extinction was an overreach. They believed that all the geological evidence points toward a period of intensive volcanism. The Deccan traps of India appear prominently in their discourse. Around 66 mya when the Indian plate was drifting away from the African plate, it passed over the reunion hotspot, and the ensuing volcanism lasted 600–800,000 years.

The volatile emissions led to acid rain and ozone depletion. A proposed global cooling led to the formation of ice sheets and a drop in sea level. A sea level drop of 100 m would lead to a total loss of intertidal zone, as the ocean floor falls dramatically beyond 100 m of the continental shelf. Thus, the marine life forms in the intertidal zone were the most affected during the K-T extinction while those in the deep zones were relatively unaffected, consistent with the fossil records. Finally, asteroid impact could have been the final nail in the proverbial Dinosaur coffin.

Were Dinosaurs affected by two tragedies, an asteroid impact and volcanic eruptions simultaneously? Most scientists agree that the two events occurred around the same time. It is not agreed whether the impact of the asteroid initiated Deccan volcanism or made it worse. Whatever the case, the mighty Dinosaurs had an equally mighty end and continue to be discussed and celebrated 66 million years after their extinction.

About the Author:

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