# The Day the Dinosaurs Died

P.M. Magazin, May 2002; http://en.wikipedia.org
and others

Compiled by U. Schreiber

**The Mesozoic - the middles ages of Earth history - lasting from 225 million to 65 million years ago, were the 'Age of the Dinosaur'. Especially during the Jurassic and Cretaceous they proliferated and temporarily became the Kings of Creation, conquering land, water and air. However, at the end of this period they disappeared completely from the face of the Earth... a phenomenon that has led to numerous theories and speculations to be propounded by earth and life scientists alike.**

**After decades of animated debate, the hypothesis claiming a major meteorite hit in the Caribbean region to be responsible for the mass die-off around 65 million years ago has become the most widely accepted. According to it, the fate of the dinosaurs as well as that of many other species was sealed when the impactor (itself generated by a major collision between planetoids some 160 million years ago) was thrown out of its orbit in the asteroid belt between Mars and Jupiter to wander into the inner solar system... long before it was captured by Earth's gravity well and came soaring out of the sky to bring death and destruction!**

Triceratops, despite of its fearsome appearance, was a herbivore that lived in herds

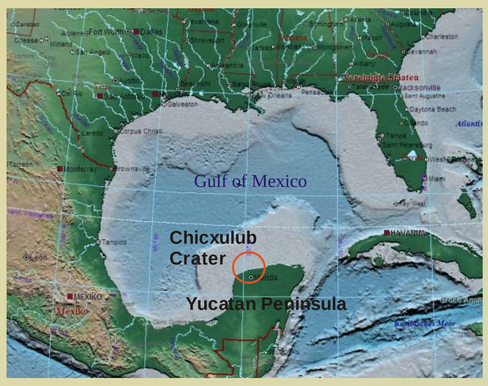
Moments before death: an enormous flood wave races towards a startled Diplodocus

## D-Day

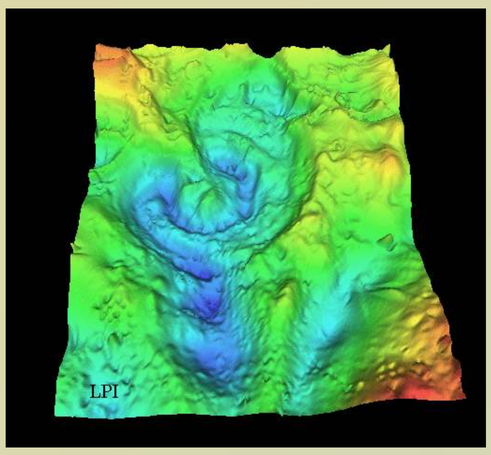
Life had been pleasant on Earth for more than 100 million years before the catastrophe, but death comes swiftly and mercilessly as the monstrous ball of rock from space crashes into the home planet with a travelling speed of some 70 000 km/h. A pall of fire and smoke rises high into the atmosphere as $4\times10^{23}$ joules of energy - equivalent to 100 000 000 megatons of TNT - are released. Innumerable creatures within a radius of more than 1000 km of the impact site die instantaneously, while millions farther away are granted a short reprieve, only to perish before long in giant wildfires, tsunamis and earthquakes racing around the globe.

It has been estimated that within seconds a billion tons of rock are vaporized by the enormous temperatures of around 10 000°C, which also destroy the impactor itself. When the walls of the 40 km deep impact crater collapse, pressures are generated that again cause glowing material and boiling water (about one half of the impact crater lies under the waves of the Atlantic at the time of the catastrophe) to be flung several kilometres high into the atmosphere - some of these ejecta actually are catapulted out of Earth's gravity well! What rains back to the ground in the form of burning debris is scattered within a radius of 7000 km around the impact site.

Then nuclear winter strikes as sunlight is blocked out by the enormous amount of ice (crystallized water vapour), ash and poisonous gases suspended in the atmosphere. Locally the temperature drops 20 °C before rising again as a consequence of heat being trapped underneath the impenetrable clouds. Those creatures who haven't been buried under mountains of debris, burned or drowned during or immediately after the impact, now suffocate, freeze or starve to death, as a chain reaction sets in, which affects the entire biosphere. Life on Earth is at the edge of an abyss.




Location of the Chicxulub Crater




Three-dimensional map of local gravity and magnetic field variations showing Chicxulub to be a multiringed structure

## The Location

Chicxulub is situated near the tip of the Yucatan peninsula on the verge of the Gulf of Mexico, where the shelf slopes down to a depth of some 1200 m. Above the impact feature lies a 1000 m thick succession of marl and limestone dating back as far as 60 million years ago. The sedimentary rocks are underlain by more than 500 m of andesite glass and breccia restricted to the impact feature, which contain minerals typical of impact-melt rocks (e.g. shocked quartz). Also, the K-T boundary inside the feature is depressed to 600 - 1100 m, as compared to ca. 500 m outside.

When the asteroid struck the sediments of the carbonate shelf, which contained sulphur-rich evaporites, reacted with the water vapour created by the impact heat to produce enormous amounts of sulfate aerosols and carbon dioxide, whose concentration in the upper atmosphere caused a "nuclear winter". Thus the particular geology and morphology of the impact site can magnify its destructive power, although a larger asteroid (>100km radius) would certainly sterilize Earth, no matter where it struck, by destroying the oceans and the atmosphere, which form the basis of life on this planet.

Sites of impact craters around the world created between 2 000 million and 50 000 years ago

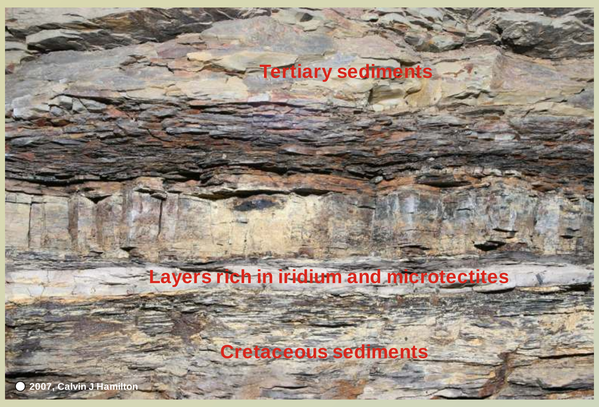
Shocked quartz from Chicxulub exploration well #2

## The Evidence

While the theory of a "killer asteroid" causing the disappearance of the dinosaurs, as well as two thirds of all living species ca. 65 million years ago, is not uncontested, a considerable amount of supporting evidence has come to light during the last decades. Especially impact signs such as tectites (blackish spheres of molten rock), and traces of iridium, a rare metal not commonly found on Earth, in the clay layer that marks the Cretaceous - Tertiary boundary around the world has strengthened the case for a major asteroid hit with global impact at this time. Seismic studies off the coast of Yucatan, in tandem with high-resolution satellite imagery, have moreover revealed the existence of a large impact structure, now hidden under more than a kilometre of sedimentary rock at the bottom of the Gulf of Mexico.

Chicxulub impact melt breccia

Tectite

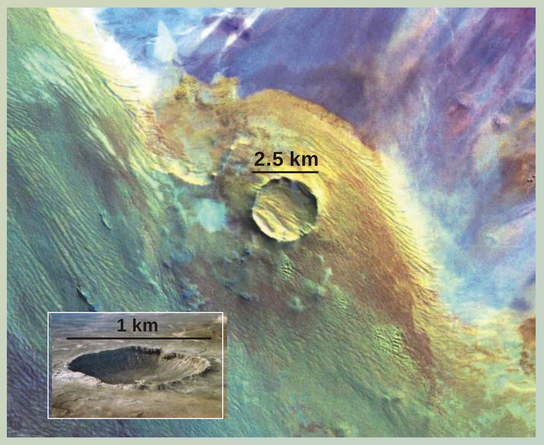



Cross-section through the Cretaceous - Tertiary boundary: The light-coloured clay layer contains impact signs such as spheres of molten rock, grains of shocked quartz and iridium

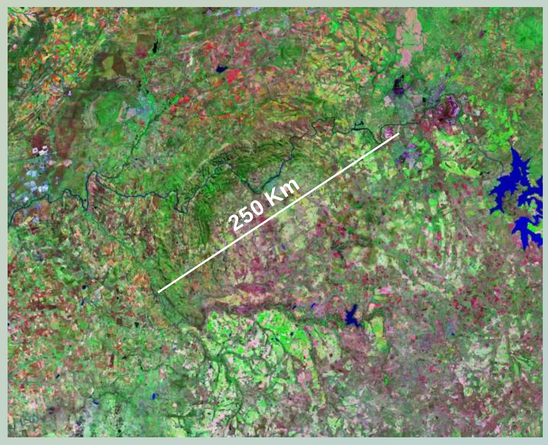
## Outlook

After the initial bombardment by debris left over from the formation of the solar system, Earth's newly formed atmosphere provided some protection, as many of the smaller meteorites burned up upon entry. Still, depending on entry angle, size and composition, a good many continued to reach the ground, although few created big impact craters. Some 50 such events - which must have wreaked havoc upon the local or global environment as it then existed - have left recognizable impact structures with diameters of 0.5 to 250 km, but more have been obliterated by the forces shaping Earth's crust.

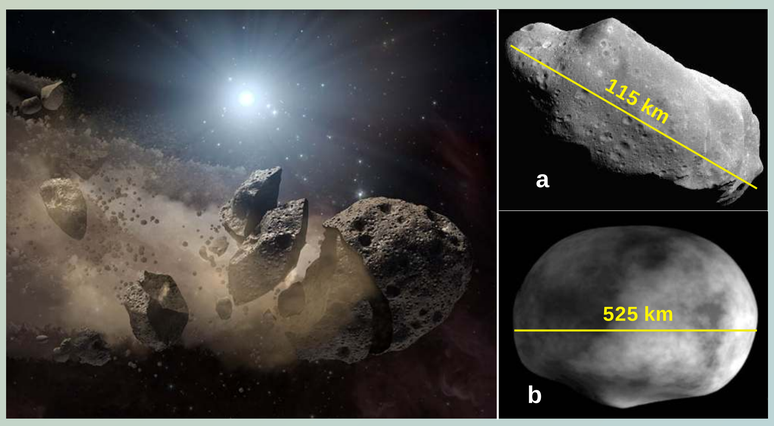
Although asteroids larger than a kilometer that could cause global disasters only are expected to reach Earth's surface every few hundred thousand years on average, it is imperative to keep an eye on near-Earth objects, as one strike may be enough to wipe out Mankind! Therefore the trajectories of potential "candidates" are constantly being tracked, because an attempt at deflection, with current technology, can only succeed, if the threat is recognized in good time (i.e. years ahead of the projected collision).




Roter Kamm in southern Namibia is ca. 5 million years old; inset: the Barringer Crater in Arizona (USA) is the most recent impact structure known (49 000 years)




The Vredefort Dome in South Africa is the largest clearly visible impact structure in the world, which is thought to have formed ca. 2 billion years ago.




Asteroids the size of Ida (a) and Vesta (b) would be capable of wiping out Earth's biosphere; an incoming asteroid could be destroyed by warheads if spotted in time (left; artist's impression)

At least for the next 90 years, however, there's no danger for Earth, as the calculated closest encounter this century took place in 2004, when asteroid *Toutatis* (a 5 km irregular-shaped rock), whizzed by at a distance of 1.5 million km measured from the centre of Earth... a pretty close shave by cosmic standards!

## Alternative History

Although the impact and the catastrophic effect it had upon life on Earth nowadays is widely accepted, it does not mean that we would be sharing our planet with dinosaurs today, if the asteroid had missed Earth. Having ruled supreme for more than a hundred million years, their day was already waning, but without Chicxulub they may have lasted a few million years longer. Aided by the periodic global climate changes that have effected Earth since its beginnings, they would have been replaced by smaller, more efficient "designs" in the course of natural evolution - especially as competitors for food and living space, such as the now ruling mammals, already had begun to appear. Still, Chicxulub undoubtedly played its part in the development of life on Earth, by helping to open ecological niches previously occupied by the dinosaurs and other reptiles, thus marking the dawn of a new era - the Cenozoic.


In the race for survival the Cretaceous-Tertiary (now called Palaeogene) boundary turned out a major barrier especially for the larger species, with a body mass in excess of 20 kilogram