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A Detailed Study of the Drastic Worldwide Climatic Change by the Cretaceous/Paleogene (K/T)-Impact of Chicxulub

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The impact of Chicxulub (Yucatan, Mexico) was a global event exhibiting a short-time (fallout) and a long-time (boundary clay) sedimentation of the K/T-boundary [1]. The fallout is mainly characterized by iridium, Ni-Cr-rich magnesia-ferrite spinels (K/T-spinels), spherules, as well as shocked quartzes. The amount of the sediments and their distribution depend on the distance from the impact crater. The Cretaceous/Paleogene (K/T) boundaries at three different locations namely Caravaca (Spain), Cerbara (Italy), and Bjala (Bulgaria) have been well analyzed. About 65 million years ago, they were located at the distances from the impact crater $\sim$6000 km, $\sim$7500 km, and $\sim$8800 km, respectively. The boundary clay is characterized by transported minerals like quartzes and feldspars, authigenically formed minerals, as well as biominerals like Mg-calcites and greigites (Fe_3S_4). The samples were analyzed by scanning X-ray diffractometry (Bruker Analytical X-ray System), scanning electronic microscopy (XL30, ESEM-Philips), neutron activation analyses, Delta^{13}C and Delta^{18}O analyses, and the determination of nannofossils and foraminifera. Owing to the Earth's rotation, the analyzed samples lie along a great circle (crossing the equator under an angle of $\sim$23°) which covers Chicxulub, Caravaca, Cerbara, and Bjala indicating the existence of only a single impact. The study of this K/T-boundary by means of high resolution scanning X-ray diffractometry in combination with the scanning electron microscopy and neutron activation analyzes revealed the time dependency of the K/T-event in the fallout as well as in the boundary clay. The biomineralization of sulfate-reducing bacteria by greigites provided the duration of the sulfuric acid rain. The reoccurrence of algae is indicated by the appearance of Mg-calcite at the end of the boundary clay. The K/T-spinels were formed on the nucleus of metallic iridium [2]. They were built in the mesosphere (in a height of about 100 km) and grew during the fall to the Earth's surface by forming ferrimagnetic twins, which were etched by the H_2SO_4 content of the atmosphere. We developed an extensive mathematical model incorporating all relevant physical effects (particle growth, pressure dependence of the atmosphere, fluid resistance, centrifugal and coriolis forces, etc.) in order to study the development of the particles during the fall. For Caravaca, the shortest flight time for the Iridium fallout is approximately 6.5 days, while the shortest flight time for the ejecta near Chicxulub last only a few hours.

The K/T-impact took place about 65 million years ago in a sea depth of more than 2000 m. Consequently, the impact heated up the sea water and the water molecules reacted with the $CaCO_3$, $CaSO_4$, and the silicates down to a depth of 28 km. This hydrothermal reaction reduced the melt temperature significantly, especially those of silicates. Therefore, the pyroxenes and plagioclases changed to clay minerals.

The sedimentation rate of Chron 29R$_K$ is about twice than that of Chron 29R$_T$, which equals to Chron 29N in Caravaca, Cerbara, and Bjala. The precession cycles of Chron 29R and Chron 29N are 22.5 kyears. The time span of the K/T-boundaries between Chron 29R$_K$ and Chron 29R$_T$ is worldwide about 1 kyear.

Concluding all our results, only one big impact took place at Chicxulub (Yucatan, Mexico) about 65 million years ago and caused, during the formation of the K/T-boundary, a worldwide climatic change.

References:

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