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A multi-proxy approach to decode the end-Cretaceous mass extinction

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The Cretaceous-Tertiary boundary (KTB) mass extinction may have involved a complex array of interrelated causes that are best evaluated by a multi-proxy approach. This study evaluates the environmental changes during the Plummerita hantkeninoides zone CF1 leading up to the extinction using planktic foraminifera, carbonate dissolution effects, stable isotopes, and magnetic susceptibility for sedimentary sequences in France (Bidart), Austria (Gamsbach) and Tunisia (Elles). Results show higher abundance (20-30%) and diversity ($\sim$15 species) of globotruncanids in planktic foraminiferal assemblages at Bidart and Gamsbach (deep water deposits) than at Elles (abundance <10%, diversity <10%, middle shelf deposits). Oxygen isotopes in zone CF1 of Elles record rapid climate warming followed by cooling and a return to rapid warming during the last 10 kyr prior to the mass extinction.

The onset of the mass extinction crisis is observed in the top 50-60 cm below the KTB at Bidart and Gamsbach, and in the top $\sim$4.5 m at Elles due to much higher sediment accumulation rates. These intervals record low magnetic susceptibility and high foraminiferal test fragmentation index (FI) and increased abundance of species with dissolution-resistant morphologies. The correlative interval in India records significantly stronger carbonate dissolution effects in intertrappean sediments between the longest lava flows, ending with the mass extinction. Based on current evidence, carbonate dissolution follows the first warming event and may be linked to ocean acidification as a result of massive Deccan volcanism. The estimated 12,000–28,000 Gigatons (Gt) of CO_2 and 5200–13,600 Gt of SO_2 introduced into the atmosphere likely triggered the carbonate crisis in the oceans. This could have resulted in severe stress for marine calcifiers and led to the mass extinction.