Global events of the Paleogene: towards a refined and complete record

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Abstract

In order to better understand the evolution of the Earth, the International Commission on Stratigraphy pursues the unambiguous definition of a hierarchy of chronostratigraphic units, which provide the framework for global correlation. Consequently, the primary goals of the International Subcommission on Paleogene Stratigraphy (ISPS; https://www.paleogene.org/) include the formal definition of basal boundary stratotypes (Global Stratotype Section and Point, GSSP) of the Paleogene stages and series, the conservation of geologically and paleontologically important sites, and the facilitation of scientific cooperation in Paleogene Stratigraphy.
The ISPS encourages international collaboration in understanding the evolution of the Earth during the Paleogene, a period of significant and extreme changes in Earth's climate and biota. The Paleogene began with the impact of an asteroid that triggered the fifth largest mass extinction of the Phanerozoic, and it was characterized by a two-fold, long-term warming and cooling trend, punctuated by short-lived warming events of different duration and magnitude. Holistic analysis of these global events, their nature and consequences, their biotic and stratigraphic expression, as well as the trends, rhythms and feedbacks of the Paleogene climate, is essential to understand how our planet works and how the Earth system will respond to the current climate change. These goals can only be achieved through increased precision of the dating of Paleogene events, the unambiguous definition of stages and series that allow global correlation, and through evaluation of the most continuous and complete stratigraphic records.

Within the Paleogene, the Bartonian is the only stage still pending formal definition of its basal GSSP. All the other stages of the Paleogene have official GSSPs, but the stability of some of them is questionable. In particular, the Ypresian GSSP at Dababiya section (Upper Nile Valley, Egypt) presents limitations regarding its continuity, potential for global correlation, and accessibility to the outcrop. The search for continuous sections spanning the Paleocene-Eocene transition continues, and future efforts should focus on selecting a better GSSP and a set of auxiliary stratotype sections and points for the base of the Ypresian.
The completeness and resolution of the stratigraphic record are equally important for the study of the events and the evolution of the Paleogene. Short-lived events such as the Late Lutetian Thermal Maximum are difficult to identify in deep-sea sediments due to their short duration (c.a. 10 kyr or less), and these events are to be identified in a wider range of localities and settings that allow global correlation with astronomically calibrated time scales. Unlike this global warming event, the impact of an asteroid at the Cretaceous/Paleogene (K/Pg) boundary is among the most intensively studied events of the geological history.

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This rapid, geologically instantaneous event has been identified in hundreds of land-based sections and ocean drilling sites, in terrestrial and marine settings, and it has been often studied at high resolution. Analyses of apparently complete K-Pg boundary marine records show strong post-impact variability of marine productivity in space and time, supporting the existence of post-extinction heterogeneous oceans with regional plankton blooms. But this apparent variability might at least in part be due to variable incompleteness of the geological record at high time resolution, i.e., millennial resolution or less. Even incomplete records will document extinction, but detailed patterns of events (e.g., impact winter superimposed on long-term warming, short-term acidification superimposed on long-term CaCO3 oversaturation) can be understood from high-resolution records only. The completeness of the K/Pg record is therefore of vital importance in reconstructing the environmental consequences of the impact on short time scales, and sections traditionally considered to be continuous (such as the Bidart section in SE France, Alegret et al. 2004; or ODP Site 1262 in the SE Atlantic Ocean) due to the presence of all biozones may be incomplete in detail, requiring re-evaluation of the K/Pg records and their paleoenvironmental interpretation.

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