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Organic records for progressive ecosystem collapse leading to the largest biotic crisis in the Phanerozoic - *Alfred Treibs Medal Lecture*

SHUCHENG XIE[1], THOMAS J. ALGEO[1,2,3], PAUL B. WIGNALL[4], GORDON D LOVE[5], JIAQI WU[1] AND GENMING LUO[1]

[1]State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences
[2]University of Cincinnati
[3]State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences
[4]School of Earth and Environment, University of Leeds
[5]University of California - Riverside

Presenting Author: xiecug@163.com

The Earth system experienced the largest mass extinction of the Phanerozoic during the Permian-Triassic transition, thought to have been a rapid event (~60 kyr). High-temporal-resolution lipid biomarker records from South China reveal that the collapse of both marine and terrestrial ecosystems proceeded in a stepwise pattern of increasing intensity during a period of temperature rise recorded by bioapatite oxygen isotopes, inferring their causal relationship.

In marine settings, two episodes of rapid change in microbial communities and associated environmental conditions coincided with the two main phases of faunal extinction. The first episode, in the latest Permian, was characterized by increases in red algae and nitrogen-fixing bacteria, accompanied by enhanced wildfires and elevated soil erosion, whereas the second episode, in the earliest Triassic, was associated with expansions of green sulfur bacteria, nitrogen-fixing bacteria and acritarchs, accompanied by strong climatic hyperwarming and ocean stratification. Marine environmental deterioration was possibly greater during the second extinction episode when major changes in ecosystem structure were documented. Several classes of lipid biomarkers provide evidence of a substantial reduction in salinity of marine surface waters in the eastern equatorial Paleo-Tethys during the earliest Triassic, coincident with hyperwarming and a reduced temperature gradient between the western and eastern equatorial Paleo-Tethys. This change can be attributed to strongly intensified precipitation in the eastern Paleo-Tethys, leading to detrimental perturbations of marine ecosystems.

In terrestrial settings, three episodes of deforestation have been identified. Episode I was marked by a large decline in terrestrial biomass, as recorded by the reduced relative abundance of C_{29} steranes. Episodes II and III were characterized by intense soil erosion revealed by a sharp rise in dibenzofuran content. Episode II was coincident with the disappearance of coal seams and a sharp negative shift in organic carbon isotopes. Episode III was associated with local volcanic activity, as shown by peak values of Hg/TOC. The stepwise and protracted deforestation process was modulated by the global temperature rise.