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Similarities between several major extinctions and preservation of life – biomolecules to geomolecules: an interdisciplinary approach

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Photic zone euxinia in ancient seas has proven signficant for elucidating biogeochemical changes that occurred during three of the five Phanerozoic mass extinctions, viz. the Permian/Triassic [1], Triassic/Jurassic [2] and Late Givetian (Devonian) [3] events, including the conditions associated with exceptional fossil preservation [4,5]. The series of events preceding, during and post the Triassic/Jurassic event, is remarkably similar to that reported for the Permian/Triassic extinction, the largest of the Phanerozoic Era.

For the Late Givetian event, the first forests evolved and reef-building communities and associated fauna in tropical, marine settings were largely affected [6]. Sedimentary rocks on the margins of the Devonian reef slope in the Canning Basin, WA, contain novel biomarker, isotopic and palynological evidence for the existence of a persistently stratified water-column (comprising a freshwater lens overlying a more saline hypolimnion), with prevailing anoxia and PZE [7].

Also from the Canning Basin, the exceptional preservation of a suite of biomarkers in a Devonian invertebrate fossil within a carbonate concretion supports rapid encasement of the crustacean (identified by % of C27 steroids) enhanced by sulfate reducing bacteria under PZE conditions. PZE plays a critical role in fossil (including soft tissue) and biomarker preservation. In the same sample, the oldest occurrence of intact sterols shows that they have been preserved for ca. 380 Ma [5]. The exceptional preservation of this biomass is attributed to microbially induced carbonate encapsulation, preventing full decomposition and transformation, thus extending the record of sterol occurrences in the geosphere by 250 Ma. A suite of ca. 50 diagenetic transformation products of sterols is also reported, showing the unique coexistence of biomolecules and geomolecules in the same sample, previously assumed unfeasible. The coexistence of steroids in a diagenetic continuum, ranging from stenols to triaromatic steroids, is attributed to microbially mediated eogenetic processes. Under exceptional conditions concretions preserve biomolecules at extraordinary levels, providing a new opportunity to study the
distributions of biomolecules in deep time and thereby improving our understanding of the evolution of life where fossils are rarely preserved.

References

[1] Grice K., Cao C., Love G.D., Bottcher M.E., Twitchett R,, Grosjean E., Summons R.E., Turgeon S., Dunning W.J. & Jin Y., 2005. Photic zone euxinia during the Permian-Triassic superanoxic event. Science. 307, 706–709.

[2] Jaraula C.M.B, Grice K., Twitchett R.,J., Böttcher M.E., Le Metayer P., Dastidar A.G. & Opazo L.F., 2013. Elevated pCO_2 leading to Late triassic extinction, persistent photic zone euxinia, and rising sea levels. Geology 41, 955–958.

[3] Tulipani S., Grice K., Greenwood P.F, Haines P., Sauer P., Schimmelmann A., Summons R.E., Foster C.B., Böttcher M.E., Playton, T. & Schwark L., 2014a. Changes in palaeoenvironmental conditions in Late

Devonian Reef systems from the Canning Basin, WA: A biomarker and stable isotope approach. Gondwana Research, in press.

[4] Melendez I., Grice K., Trinajstic K., Ladjavardi M., Thompson K. & Greenwood P.F., 2013a. Biomarkers reveal the role of photic zone euxinia in exceptional fossil preservation: An organic geochemical perspective. Geology 41, 123–126.

[5] Melendez I., Grice K. & Schwark L., 2013b. Exceptional preservation of palaeozoic steroids in a diagenetic continuum. Nature Scientific Reports. 3.

[6] Grice K., Lu H., Atahan P., Hallmann, C., Asif M., Greenwood P.F., Tulipani S., Maslen E., Williford W.H. & Dodson J. 2009. New insights into the origin of perlyene in geological samples Geochimica et Cosmochimica Acta, 73, 6531–6543.

[7] Tulipani S., Grice K., Greenwood P.F., Schwark L., Summons R.E., Böttcher M.E. & Foster C.B., 2014b. Molecular proxies as indicators of freshwater incursion-driven salinity stratification. Geochemistry, Geophysics, Geosystems, accepted.