

Significance of Biomarkers for P/T and F/F Mass Extinctions

K. GRICE¹, B. NABBefeld¹, E. MASLEN¹,
R.E. SUMMONS², L. HAYS², R.J. TWITCHETT³, S.
TURGEON⁴, T. ALGEO⁵ AND M.E. BOETTCHER⁶

¹Curtin University of Technology, Perth WA

(K.Grice@curtin.edu.au;

B.Nabbefeld@exchange.curtin.edu.au;

E.Maslen@curtin.edu.au)

²MIT, USA (rsummons@mit.edu; lhays@mit.edu)

³Plymouth University, UK

(richard.twitchett@plymouth.ac.uk)

⁴University of Alberta, Canada (st23@ualberta.ca)

⁵University of Cincinnati (algeot@email.uc.edu)

⁶Leibniz Institute for Baltic Sea Research

(michael.boettcher@io-warnemuende.de)

The most significant pulses of evolution throughout Earth's history have coincided with abrupt extinction events (e.g. Benton & Twitchett 2003). The most pronounced extinction of the Phanerozoic occurred near to the Permian-Triassic (P/Tr) boundary. Many trigger mechanisms have been proposed for the P/Tr event and include bolide impact, Siberian flood basalt volcanism, ocean anoxia, H₂S emissions and catastrophic release of methane from the collapse of gas hydrates, all leading to the loss of many marine organisms and land plants. Biomarkers derived from pigments of photosynthetic green sulfur bacteria have been reported in sections from W. Australia and S. China, indicating the presence of toxic H₂S in the zone of light penetration (PZE) of the Tethys Ocean during the P/Tr extinction (Grice *et al.*, 2005). Similar observations were made in a section from W. Canada (Hays *et al.*, 2007) suggesting that the Panthalassic Ocean was also prone to periodic euxinia. Any H₂S reaching the atmosphere would have been both toxic and persistent (Kump *et al.*, 2005). The significance and value of biogeochemical markers for identifying changes at the P/Tr and F/F will be presented. In particular, the pervasiveness of PZE conditions and the origin and importance of the biomarker crocetane, generally associated with the anaerobic oxidation of methane, will also be presented.

References

- Benton, M.J., Twitchett, R.J. (2003), *Trends in Ecology and Evolution* **18/7** 358-365.
- Grice, K., Cao, C., Love, G.D., Böttcher, M.E., Twitchett, R.J., Grosjean, E., Summons, R.E., Turgeon, S.C., Dunning, W., Jin, Y. (2005), *Science* **307** 706-709.
- Hays L., Beatty T., Henderson C.M., Love G.D. and Summons R.E., 2007, *Paleoworld* (In Press).
- Kump, L., Pavlov, A., Arthur, M., 2005, *Geology* **33** 397-400.

Amorphous components in the shell material of the brachiopod

Megerlia truncata

E. GRIESSHABER¹, K. KELM², W.W. SCHMAHL¹ AND
A. SEHRBROCK²

¹Department for Earth and Environment, LMU Munich,

Munich, Germany (E.Griesshaber@lrz.uni-muenchen.de,

W.Schmahl@lrz.uni-muenchen.de)

²CAESAR Research Institute, Bonn, Germany,

(K.Kelm@caesar.de, A.Sehrbrock@caesar.de)

Brachiopods have existed throughout the phanerozoic and they developed shell materials employing the two principal mineral groups of hard biologic tissue: calcium carbonate and calcium phosphate, each with distinct hierarchical architecture [1, 2, 3]. We have observed a large domain filled with amorphous calcium carbonate in the shell of the modern brachiopod *Megerlia Truncata* by transmission electron microscopy. The domain has the typical outer shape and size of calcite crystals composing the fibrous secondary layer shell. It is adjacent to a large solid inclusion incorporated into the shell, suggesting that the amorphous material is related to a repair mechanism. The fibres of the secondary shell layer are surrounded by an organic sheath. Along the innermost segment of the secondary layer, in addition to the organic sheaths, thick organic membranes are present. The amorphous domain is located between two thick organic membranes. In the outer nanocrystalline (primary) layer we do not observe any organic material between the crystallites. Under TEM imaging conditions the amorphous carbonate crystallized in situ to vaterite. Our observations indicate that brachiopod shell formation may occur via an amorphous calcium carbonate precursor that is produced in an initial stage prior to the crystallization of calcite.

References

- [1] C.Merkel, E.Griesshaber, K.Kelm, R.Neuser, G. Jordan, A.Logan, W.Schmahl (2007), *J.G.R.- Biogeosci.* in press
- [2] W.W. Schmahl, E. Griesshaber, R. Neuser, A. Lenze, R. Job, U. Brand (2004), *Eur. J. Mineral.* **16** 693-697
- [3] E. Griesshaber, W. W. Schmahl, R. Neuser, T. Pettke, M. Blüm, J. Mutterlose, U. Brand (2007), *Am. Min.* **9** in press