Significance of marcasite across the Permian-Triassic boundary

E. LOUNEJEVA[1], R. LARGE[1], L. DANYUSHEVSKY[1], T.ALGEO[3], K.GRICE[4], T. RODEMANN[2], G. DAVIDSON[1]

[1] ARC Centre of Excellence in Ore Deposits (CODES), School of Physical Sciences, University of Tasmania, Private Bag 79, Hobart, Australia, 7001, Elena.Lounejeva@utas.edu.au

[2] Central Science Laboratory, University of Tasmania, Hobart, Australia

[3] Department of Geology, University of Cincinnati, Cincinnati, USA

[4] Western Australian Organic and Isotope Geochemistry Centre, Curtin University, Perth, Australia

Interaction of climatic and tectono-magmatic drivers has been advanced to explain the Permian-Triassic boundary (PTB) crisis. Modelling has shown that linkage of acid rain and ozone-layer collapse to gas release from Siberian Traps magmatism is an efficient mechanism to account for end-Permian ecosystem failure on land (Black et al. 2013). In marine sediments across the PTB, pyrite was reported worldwide as layers, laminae, and euhedral crystals while framboidal pyrite has received attention as a redox indicator. Independent studies of sulfur isotopes in pyrite in the Meishan and Nhi Tao PTB sections recorded a positive anomaly associated with euhedral pyrite. This anomaly was conservatively interpreted either as due to oxygen fluctuations across the boundary or as a product of sulfidic upwelling.

In this work we study sedimentary pyrite from marine PTB sediments representing the shallow Tethys (Perth Basin, Australia; Meishan, China) and the deeper Panthalassa (Ubara, Japan). We show that the latest Permian extinction interval (LPEI), which is associated with a negative $\delta^{13}C_{carb}$ shift in addition to a positive $\delta^{34}S_{py}$ anomaly, is distinguished by the presence of euhedral crystals that consist of intergrown pyrite and marcasite, as revealed by Raman spectroscopy. Marcasite is commonly considered to be a mineral proxy for oxidative events in carbonaceous muds and, especially, in grey shales, implying a downward diffusive flux of oxygen in the sediment (Schieber, 2011). Alternatively, we propose that planet-wide acid rain associated with intense Siberian Traps volcanism may have caused a large pH drop in the contemporaneous global ocean, after which marcasite formed on pyrite precursors.

Black BA, Lamarque JF, Shields CA, Elkins-Tanton LT, Kiehl JT (2013) Acid rain and ozone depletion from pulsed Siberian Traps magmatism. Geology 42(1):67-70

Schieber J (2011) Marcasite in black shales--a mineral proxy for oxygenated bottom waters and intermittent oxidation of carbonaceous muds. Journal of Sedimentary Research 81(7):447-458

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