Expanding hypoxia challenging marine life: Metazoan adaptations and limitations revisited

HANS-O. PÖRTNER[1]

[1]Integrative Ecophysiology, Alfred-Wegener-Institute, Am Handelshafen 12, 27570 Bremerhaven, (correspondence: Hans.Poertner@awi.de)

Expanding hypoxia in the world's oceans has led to renewed interest in the adaptation of organisms to life in hypoxic waters and to quantifying their sensitivity. The paper will discuss concepts and present understanding of hypoxia effects in the context of other marine drivers, predominantly temperature, and CO_2, which may combine with further anthropogenic stressors such as pollutants. In animals the concept of oxygen and capacity dependent thermal tolerance (OCLTT) has been proposed as a suitable integrator of various effects, from molecular to ecosystem level of biological organisation. Recent studies confirm applicability of the concept to climate related phenomena in the field. It has successfully explained effects of climate-induced temperature changes on species abundance and biogeographical ranges and appears applicable to climate related shifts in species distribution, temperature related phenology and predominance based on differential temperature dependent performance ranges which are sensitive to hypoxia. Focusing on various degrees of hypoxia, the paper will discuss the living conditions in hypoxic zones and which life forms those conditions can or do not support. Furthermore, it will be investigated how interactions of hypoxia with temperature and CO_2 may have played a key role in metazoan evolution during climate oscillations in earth history.

Li and Ca isotope evidence for continental weathering as a driver of End-Ordovician glaciation

PHILIP POGGE VON STRANDMANN[1], ANDRE DESROCHERS[2] AND TONU MEIDLA[3]

[1]Department of Earth Sciences, University of Oxford, UK, (philipvs@earth.ox.ac.uk)
[2]Department of Earth Sciences, Univsity of Ottowa, Canada
[3]Institute of Geology, University of Tartu, Estonia

The end-Ordovician Hirnantian interval (~445Ma) represents one of the largest mass extinctions in Earth history, and coincides with low temperatures, a major glaciation, and a significant drop in sealevel. However, this time period is also characterised by relatively high pCO_2 levels, and therefore the processes that triggered the glaciation, and its consequences for marine chemistry and life, are not well understood. Proposed causes include an increase in marine productivity and burial of organic carbon (causing a positive C isotope excursion), leading to drawdown of CO_2 [1], but also oscillations in silicate weathering (as a major sink of atmospheric CO_2), potentially due to continental movement and later ice-sheet coverage [2].

Lithium isotopes are a relatively novel tracer of continental weathering. Li is almost entirely situated in silicates, rather than carbonates, and its isotopic fractionation in rivers is demonstrably due to the intensity of silicate weathering. In addition, Li isotope fractionation remains constant in marine carbonates, regardless of changes in temperature or type of skeletal calcite. Calcium isotopes yield information on the balance of continental weathering vs. carbonate precipitation in the oceans, and hence the combination of Li and Ca isotopes can be used to examine CO_2 removal and sequestration processes.

We have determined Li and Ca isotope ratios through multiple marine carbonate sections from Anticosti Island in Canada and Inju in Estonia. The sections show an increase in δ^7Li, reaching its peak slightly earlier than the peak in the C isotope excursion caused by the glaciation. This suggests that silicate weathering intensities decreased, while silicate weathering fluxes increased, in the run-up to the glaciation. We further investigate this with a series of dynamic models, using changes in ocean chemistry (Li, Ca, Sr and Os isotopes) to constrain the evolution of continental and marine processes through this period of extreme climate change.

[1] Brenchley *et al* , 1995, Mod. Geol. **20**, 516-519 [2] Kump *et al* , 1999, Palaeo^3 **152**, 173-187

DOI:10.1180/minmag.2013.077.5.16