Increasing metabolic activity of clams and brachiopods over the past 500 million years: A consequence of the changing biological pump?

JONATHAN L. PAYNE[1], NOEL A. HEIM[1], MATTHEW L. KNOPE[1], KATJA MEYER[1] AND CRAIG R. MCCLAIN[2]

[1]Dept. of Geological & Environmental Sciences, Stanford University, Stanford, CA 94304, USA; (jlpayne@stanford.edu)
[2]National Evolutionary Synthesis Center (NESCent), 2024 W. Main St., Suite A200, Box 104403, Durham, NC 27705

Numerous indirect lines of evidence suggest a long-term increase in the metabolic activity of marine animals. However, the timing and magnitude of this increase remain poorly quantified, preventing detailed testing of hypothesized controls. Here we use newly compiled body size data for 6834 genera of brachiopods and bivalves, two of the most abundant and diverse clades of marine animals, to show that mean per taxon, per occurrence, and per capita metabolic rates of primary consumers have increased by approximately two orders of magnitude from the Cambrian to the present day, with most of this increase occurring between Cambrian and Jurassic time (540-140 Mya). Secular trends in the thickness of shellbeds, prevalence of fossils, and intensity of bioturbation indicate that this increase in per capita metabolic activity was not offset by a decrease in the number or total biomass of benthic animals, whether bivalves, brachiopods, or other taxa. Biogeochemical modeling suggests that secular variation in the strength of the biological pump may account for the magnitude and timing of this trend in animal community metabolism.

A forward modelling approach to understanding continental growth

J.L. PAYNE[1], K.M. BAROVICH[1], N.J. PEARSON[2] AND M. HAND[1]

[1]Centre for Tectonics, Resources and eXploration (TRaX), University of Adelaide, S.A., 5005 Australia. (*correspondence: justin.payne@adelaide.edu.au)
[2]ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS), Macquarie University, NSW 2109 Australia.

The rapid expansion of global datasets of U-Pb and Lu-Hf (±O) isotopic data in detrital zircon has provided an avenue to address the questons of the timing and rates of continental growth. Any model suggesting significant growth of the continents in early earth history has dramatic implications for the rate and mechanisms of crustal growth and recycling throughout Earth history. Recent studies using Hf model ages obtained from detrital zircon have suggested 60-65% of the current volume of continental crust existed by the late Archean[1,2].

Studies using Hf model ages for continental growth must deal with the issue of Hf model ages that result from the mixing of melts derived from the mantle and crust and/or multiple crustal sources. Studies commonly assume the consistency of mixing across Earth history will average out any short-term bias or else employ O-isotope data to identify mixed model ages. Each of these approaches has shortcomings that may compromise the robustness of the final continental growth model.

Estimates of the proportion of juvenile crustal addition using the ratio of Hf model ages to model ages plus U-Pb ages in a 100 Myr time slice can be reproduced using synthetic Hf data randomly generated from detrital U-Pb age distributions. The use of O-isotopes to remove mixed Hf model ages also seems to be at odds with studies of granite genesis that suggest a larger proportion of granites contain both mantle and crustal components than interpreted from the use of Hf and O isotope data in detrital zircon datasets.

We propose the use of a forward modelling approach to resolve continental growth. This approach uses a priori geologic information to produce models of continental growth that are testable against the detrital zircon and geological records.

1. **E. A. Belousova *et al*** , (2010). The growth of the continental crust: Constraints from zircon Hf-isotope data. *Lithos* 119, 457.
2. **B. Dhuime *et al*** , (2012). A Change in the Geodynamics of Continental Growth 3 Billion Years Ago. *Science* 335, 1334.

DOI:10.1180/minmag.2013.077.5.16