Carbon isotope clues on the origin of Frere granular iron formation from the Paleoproterozoic Earaheedy Basin

JACQUES L. ERFFMEYER[1*], DOMINIC PAPINEAU[1,2], AND FRANCO PIRAJNO[3]

[1] Department of Earth and Environmental Sciences, Boston College, United States.
[2] Geophysical Laboratory, Carnegie Institution of Washington, United States.
[3] Geological Survey of Western Australia, Perth, Australia.

The rocks of the late Paleoproterozoic Earaheedy Basin in Western Australia were deposited on a continental passive margin between the Pilbara and Yilgarn Craton and preserve a prominent horizon of granular iron formation (GIF). A drill core through the 1.83 to 1.79 Ga Frere Formation intersects the iron-rich horizon and was investigated for possible biological activity using carbon isotopes, which may provide clues on the origin of GIFs. Microbial involvement in the formation of granules is a possibility that remains to be demonstrated. The lowermost part of the studied section of the core consists of stromatolitic dolomite of the Yelma Formation, with mm- to cm-thick layers and veins of pyrite and galena. The lack of weathering and low metamorphic grades experienced by these rocks yield a particularly interesting suite of rock samples to investigate the local carbon cycle.

Granules with sizes between ~100 to ~500 microns were observed to be composed of chert associated with variable assemblages of microplaty hematite, magnetite, greenalite, sulfides, and organic matter. In a few samples, granules are exclusively composed of chert and organic matter, which forms rounded sub-structures, of possible diagenetic origin, a few tens of microns in size inside the granules. Initial results indicate large ranges of $\delta^{13}C_{org}$ values ranging from -14.0 to -33.1‰ for generally low total organic carbon contents between 0.01 to 0.50%wt. However, organic carbon could not be detected in all samples and many also contain carbonate carbon. Current work is focused on expanding the carbon isotope dataset of both organic and carbonate carbon, which will allow for a better characterization of the original depositional environment and of diagenetic and possibly metamorphic alteration.

The tracer-dependence of biodiffusion coefficients

PASCAL LECROART[1*], OLIVIER MAIRE[1], SABINE SCHMIDT[1], ANTOINE GREMARE[1], PIERRE ANSCHUTZ[1], FILIP J.R. MEYSMAN[2]

[1]Universite de Bordeaux, laboratoire EPOC, Talence, France
p.lecroart@epoc.u-bordeaux1.fr (* presenting author)
[2] Netherlands Institute of Ecology (NIOO-KNAW), Department of Ecosystem Studies, Yerseke, The Netherlands

Bioturbation refers to the mixing of sediment particles resulting from benthic faunal activity. It is the dominant particle mixing process in most marine sediments and exerts an important control on biogeochemical processes. In models, bioturbation is usually treated as a diffusive process where the biodiffusion coefficient (Db) characterizes the biological mixing intensity. Biodiffusion coefficients are classically computed by fitting a diffusive model to vertical profiles of particle-bound radioisotopes.

One peculiar observation is tracer-dependence: Db values from short-lived tracers tend to be larger than those obtained from long-lived tracers from the same site. Recent theoretical work, based on random walk theory and Lattice Automaton Bioturbation Simulations (LABS), has suggested that this tracer-dependence is simply a model artifact and has concluded that the biodiffusion model is not applicable to the short observational time scales associated with short-lived radioisotopes.

Here we have compiled a global dataset of Db values obtained from different radiotracers to assess tracer-dependence from a data perspective. Tracer-dependence is significant in low-mixing environments like slope and deep-sea sediments, but is not present in intensely mixed coastal areas. Tracer-dependence is absent when the number of mixing events is larger than 20, or the potential length scale is greater than 0.5 cm. Roughly this comes down to tracer-derived Db values greater than 2 $cm^2\ yr^{-1}$. This condition is met for 68%, 50%, and 8% of published Db values obtained from coastal, continental slope, and abyssal environments, respectively.

These results show that short-lived radioisotopes are suitable to quantify biodiffusion mixing in sedimentary environments featuring intense bioturbation.

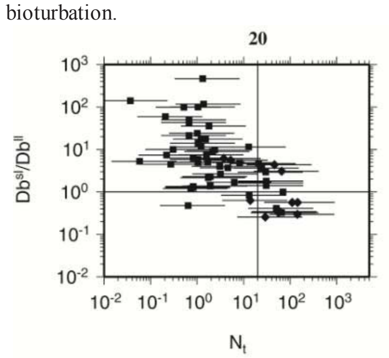

Fig. Evolution of the ratio between Db derived from short-lived tracers (Db^{sl}) and Db derived from long-lived tracers (Db^{ll}) as a function of the number of mixing events (Nt).