A plausible link between the onset of Pangea break-up and the evolution of marine biocalcifiers through changes in atmospheric CO_2 and ocean chemistry

Y. GODDERIS[1], Y. DONNADIEU[2], R. PIERREHUMBERT[3], R. JACOB[3]

[1] LMTG, CNRS, Observatoire Midi-Pyrénées, Toulouse; France, godderis@lmtg.obs-mip.fr
[2] LSCE, CNRS, Gif-sur-Yvette, France; yannick.donnadieu@cea.fr
[3] Dept Geophysical Sciences, University of Chicago, USA; rtp1@geosci.uchicago.edu

After almost 100 Myr of continental assembly, the demise of the supercontinent Pangea begins at the end of the Triassic period (~230-200 Myr) and is concomitant with fundamental changes occurring in the calcification process within the ocean and more generally with a gradual decline of the biotic diversity. While many mechanisms have been suggested to account for the catastrophic mass extinction occurring at the Triassic Jurassic boundary, no clear reasons have been suggested to explain the appearance of coccolithophores and associated calcareous nannoplankton in upper Triassic sediments [1]. These organisms are nevertheless fundamental as they are the most abundant calcifiers inhabiting our planet, being as such the ultimate regulators of the marine carbon cycling and ocean atmosphere CO_2 exchange. Here we asses the effect of the palaeogeographic changes, occurring during the Triassic, on the long term atmospheric carbon dioxide concentrations using a numerical model of the coupled climate (FOAM GCM) and carbon cycle at the geological timescale (GEOCLIM) [2]. In our simulations, the northward drift of Pangea exposes a large continental surface over the equatorial humid belt which increases consumption of carbon dioxide through continental weathering and results in a dramatic decrease in atmospheric carbon concentrations by about 2000 ppmv during the late Triassic, between the Carnian and the Rhetian. This atmospheric CO_2 collapse triggers a calculated increase in pH of the oceanic surface waters by 0.3 units, corresponding to a decrease in H^+ concentration in seawater by a factor of 2. We suggest that this major change is a catalyst of the rise of Ca^{2+} ATPase_based trans-calcification process [3], leading to the coeval diversification of calcareous nannoplankton.

References

[1] Bown P.R. (2005) *Micropaleotonlogy* **51**, 299-308
[2] Donnadieu Y. et al. (2004) *Nature* **428,** 303-306 ; Donnadieu Y. et al. (2006) *G3* **submitted**.
[3] Mc Connaughey T.A. and Whelan J.F. (1997), *Earth-Sci. Rev.* **42**, 95-117