Dwarf coccoliths at the onset of Cretaceous Oceanic Anoxic Events 1a and 2: an example of calcareous nannoplankton sensitivity to excess CO_2?

Elisabetta Erba, Cinzia Bottini

High-resolution sampling of the initial phase of both early Aptian Oceanic Anoxic Event (OAE) 1a and latest Cenomanian OAE 2 was applied to relatively expanded sections from the western Tethys. Quantitative and morphometric investigations of calcareous nannofossil assemblages pointed out the occurrence of dwarf coccoliths. Small specimens of genera *Biscutum*, *Zeugrhabdotus* and *Discorhabdus* become relatively common, and parallel the decrease in abundance of large nannofossils, such as the heavily calcified nannoconids and other nannoliths.

During the mid-Cretaceous, the natural source of atmospheric CO_2 was Earth's degassing, and emplacement of the Ontong Java-Manihiki and Caribbean Plateau large igneous provinces (LIPs) is recognized as responsible for pCO_2 as high as 2000 ppm. Coeval (and synchronous) biocalcification crises have been documented in pelagic and neritic settings, suggesting a causal link between high concentrations of carbon dioxide in the atmosphere-ocean system and drops in benthic and planktonic calcifiers' efficiency.

Coccolith dwarfism is here interpreted as forced by rapidly increasing pCO_2, and might be the counterpart of the major decrease in nannolith abundance. Our data are consistent with works by Riebesell *et al*. (2000), but are apparently contradicted by recent data by Iglesias-Rodriguez *et al*. (2008), documenting enlarged *Emiliania huxleyi* coccoliths under high CO_2.

We stress the fact that: (1) coccolith size alone is not a measure of calcite production (number of coccoliths must be taken into account) and of calcification rate; (2) *E. huxleyi* is not the best taxon for testing biocalcification: this species is super-opportunistic and might take advantage in any environment; (3) during OAEs pCO_2 concentrations were so elevated as to exceed threshold values, and current lab experiments might not be good analogues.

Although dwarf coccoliths might result from enhanced fertility associated with OAE1a and OAE2, regardless of ocean alkalinity, all geological data indicate a rapid, 4 to 10 times increase of pCO_2 associated with both episodes of global anoxia. We believe that the observed tiny specimens derive from difficult/reduced calcification and suspect that in order to reproduce and understand rates of Cretaceous nannoplankton mineralization, future lab experiments should be run under pCO_2 as high as 1500-2000 ppm.

References

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