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Cretaceous tropical carbonate platform changes used as paleoclimatic and paleoceanic indicators: the three lower Cretaceous platform crises

A. Arnaud-Vanneau and B. Vrielynck
Institute Dolomieu, université Grenoble, France, aarnaud@ujf-grenoble.fr

Carbonate platform sediments are of biogenic origin. More commonly the bioclasts are fragments of shells and skeletons. The bioclastic composition of a limestone may reflect the nature of biota inhabiting the area and a carbonate platform can be estimated as a living factory, which reflects the prevailing ecological factors. The rate of carbonate production is highest in the tropics, in oligotrophic environments, and in the photic zone. The rate of carbonate production varies greatly with temperature and nutrient input. Three types of biotic carbonate platform can be distinguished. The highest carbonate production is linked to oligotrophic carbonate platform characterized by the presence of assemblages with hermatypic corals. This type of platform is developed in shallow marine environment, nutrient poor water and warm tropical sea. A less efficient production of carbonate platform is related to mesotrophic environments in cooler and/or deeper water and associated to nutrient flux with, sometime, detrital input. The biota includes red algae, solitary coral and branching ahermatypic corals, common bryozoans, crinoids and echinoids. The less productive carbonate platform is the eutrophic muddy platform where the mud is due to the intense bacterial activity, probably related to strong nutrient flux.
All changes of type of carbonate platform can be related to climatic and oceanic changes.
Three platform crises occurred during lower Cretaceous time. They are followed by important turnover of microfauna (large benthic foraminifers) and microflora (marine algae). They start with the demise of the previous oligotrophic platform, they continue with oceanic perturbations, expression of which was the widespread deposition of organic-rich sediments, well expressed during Late Aptian/Albian and Cenomanian Turonian boundary and the replacement of previous oligotrophic platforms by mesotrophic to eutrophic platforms.
The first crisis occurred during Valanginian and Hauterivian time and is related to the opening of the North Atlantic and the neocimerian tectonic phase. It could be linked to cooling periods. Geographically, the warm oligotrophic tropical carbonate platforms of the northern Tethyan margin migrated towards the equator from more than 500kms. The Upper Valanginian-Hauterivian mesotrophic to eutrophic carbonate platforms are muddier and microbially dominated (algal mats, oolites). 60% of benthic foraminifers living in carbonate platform became extinct.
The second crisis occurred during Late Aptian to Albian time. It is coeval to the increasing plate movement and the opening of the central Atlantic Ocean. It is linked to massive detrital input on both margins of the Tethys. Tropical carbonate platform are mostly mesotrophic to eutrophic with abundance of opportunistic species such as Orbitolina, which took advantage of abundance of clastic grains. 50% of benthic foraminifers living in carbonate platform became extinct.
The last crisis coincides with the Cenomanian-Turonian boundary. This period corresponds to a rapid northward movement of Africa and Spain and the opening of the North-South Atlantic connection. At the boundary we note the disappearance of organisms such as large benthic foraminifers, corals and rudists, which had a symbiotic relationship with green algae. More than 90% of large benthic foraminifers living in carbonate platform became extinct, but this extinction is not available for small size benthic foraminifers, which had not symbiosis.