



Biostratigraphy of Late Cretaceous carbonate platforms based on larger foraminifera: the Late Cretaceous shallow benthic zones (LKSBZ)

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The larger foraminifera are single-celled organisms extremely abundant and diverse in tropical-to-subtropical shallow-water oligotrophic-to- mesotrophic environments, especially in carbonate platforms. They cover all the environments within the platform, from the littoral areas to the lower limit of the photic zone.

In the geological past, starting from the Late Carboniferous, the same ecological niches were inhabited by different assemblages that evolved in subsequent global community maturation cycles (GCMCs). These cycles are bounded by global palaeoenvironmental crises marked by increased extinction rates or even mass extinctions. This work focuses on the Late Cretaceous Global Community Maturation cycle (LKGCMC), which is bracketed between two mass extinction events: the Cenomanian-Turonian boundary event at the base and the Cretaceous-Palaeogene boundary event at the top.

Ten shallow benthic zones (SBZs) are proposed for the time span going from the base of the Turonian up to the Maastrichtian-Danian boundary. A SBZ is a composite zone of parallel phylogenetic lineages that covers at least the most common facies realms of shallow-water deposits. Each zone corresponds to the "total range zone" of some larger foraminifera taxa, and is defined using integrated evidence on multiple first appearances and last occurrences of taxa from all available neritic palaeoenvironments. The new biozonation is based on an extensive regional data set derived from well exposed shallow-water carbonate successions on both sides of the Pyrenees (Northern Spain and Southern France).

The LKSBZ 1 corresponds to the earliest phase of the LKGCM cycle. This biozone is characterized by the presence of few Cenomanian survivors. The LKSBZs 2-4 are characterized by the great development of the structurally complex porcellaneous groups and the first diversification of rotaliids. The LKSBZ 5-10 are dominated by lamellar-perforate foraminifera, with three main groups: Orbitoidids, Lepidorbitoidids and Siderolitids. The porcellaneous and agglutinated foraminifera are restricted to the shallowest environments.

Precise dating of several stratigraphical levels in the South Pyrenees by strontium isotope stratigraphy allowed calibrating the LKSBZ to the geological time scale of Gradstein et al., (2004) and correlating the LKSBZs to the ammonite and planktic foraminifera biozones.