



A Cyclostratigraphic Framework for the Maastrichtian at Zumaia (Basque country, Northern Spain)

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Correlation of rhythmic sedimentary successions to astronomical target curves has led to significant refinement of recent parts of the Geological Time Scale. Astronomical tuning of Late Cretaceous cyclic climate records will greatly reduce current uncertainties in the Geological Time Scale of this interval that are on the order of 0.5 Myr. A cyclostratigraphic framework will be established by analysis of multi-proxy lithological and geochemical datasets collected from land-based marine successions in Europe with a rhythmic alternation of marls and limestones. This will provide further constraints on ages and durations of chemo-, bio- and magnetostratigraphic events, which will facilitate the study of Earth's climate system in the past.

The coastal cliffs of Zumaia in the Basque country (Spain) are famous for their rhythmically bedded Late Cretaceous to Eocene deposits and are key site for high-quality and high-resolution calcareous plankton biostratigraphy, magnetostratigraphy and cyclostratigraphy. The Maastrichtian (Latest Cretaceous) part of the Zumaia section contains an alternation of limestones and marls, deposited in a hemipelagic setting, that span the K/Pg (Cretaceous/Paleogene) boundary (~66 Ma) in a continuous succession. The stacking pattern of the lithologies shows a hierarchy - with limestone/marl couplets grouped in bundles of five and twenty- that reflects the combined influence of the orbital parameters of precession and eccentricity. Identification of the expression of the stable 405 kyr eccentricity cycle in the lithology is used for astronomical tuning to new astronomical target curves, which reconstruct the solar energy received by the earth further back in time. The field-interpretation is tested by comparison with cyclic components extracted from high resolution geochemical and geophysical proxy data using bandpass filtering. The acquired cyclostratigraphic interpretation provides ages for characteristic planktonic foraminifer occurrences, several magnetic reversals and measured carbon isotope excursions, which allows global application of the new age model. Correlation to the nearby Sopelana section provides an exceptional opportunity to extend the magnetobiostratigraphic framework back to the base of the Maastrichtian. The potential occurrence of a long term periodicity of 1.2 Myr may shed more light on Late Cretaceous climate and on the behaviour of our solar system. Additionally, characteristic intervals both above and below the K/Pg boundary have been selected to investigate the ocean-climate response to orbital forcing in the Late Cretaceous in more detail.

This research is part of the GTSnext project (next generation Geological Time Scale), which has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement nr.[215458].