

# ASSESSING PALEOTEMPERATURE AND SEASONALITY DURING THE EARLY EOCENE CLIMATIC OPTIMUM (EECO) IN THE BELGIAN BASIN BY MEANS OF FISH OTOLITH STABLE O AND C ISOTOPES

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During its past, Earth has known long-lasting periods characterized by a significantly warmer climate and higher CO<sub>2</sub> levels compared with today. The nature of these so-called greenhouse periods has become a major research domain within the field of paleoclimatology. Interestingly, according to recent research the early Paleogene greenhouse period appears to be highly variable, challenging paleoclimatologists to modify their current knowledge about the functioning of the climate system. The Belgian Basin, part of the southern North Sea bight, comprises a fairly continuous Paleogene sedimentary record. It is dominated by mid-shelf to coastal fossiliferous sands and clays, which have suffered only minor deformation. This marginal setting presents an opportunity to link deep-sea and continental paleoclimate records, increasing our understanding about the impact of climate changes on local marine ecosystems.

The use of fish otoliths – calcareous ear stones comprising seasonal growth rings – as (paleo)environmental indicators is still increasing. In our study, otolith  $\delta^{18}\text{O}$  signatures are measured to assess their potential as an early Paleogene paleotemperature and paleoseasonality proxy. The  $\delta^{18}\text{O}$  of otolith aragonite precipitates in equilibrium with sea water temperature, although this relationship seems to be taxon-specific. Otoliths of several levels and locations within the early Eocene climatic optimum (EECO) interval have been polished, drilled with a micromilling apparatus for bulk and incremental microsamples, and subsequently analyzed by isotope ratio mass spectrometry. The selected species are non-migratory bottom-dwellers belonging to the families Congridae and Ophidiidae, and hence should reflect bottom water temperatures. To calculate temperatures, the paleotemperature equation of Thorrold *et al.* (1997) was used. The isotopic composition of the ambient sea-water  $\delta^{18}\text{O}_w$  was chosen at -1.0‰, taking into account current knowledge about the isotopic composition of northeastern Atlantic ocean waters during the EECO.

A cross-plot of bulk otolith  $\delta^{18}\text{O}$  vs.  $\delta^{13}\text{C}$  results shows significant offsets between both families used (10°C when expressed in temperature). Ophidiid data probably represent true bottom water temperatures of the Belgian Basin. The more negative Congrid data on the other hand, suggests that this taxon probably thrived in more coastal waters, influenced by freshwater influx. Based on Ophidiids, the mean annual temperature (MAT) of the EECO is calculated at 27.5°C, which is in line with other proxy results. However, variations in MAT up to 6°C suggest a more pronounced expression of climate variability in mid-latitude marginal basins than in tropical areas. Incremental analyses revealed a ~9.5°C mean annual range of temperatures, similar to modern seasonality in the same region. These results suggest that otoliths from early Paleogene mid-latitude marginal marine environments such as the Belgian Basin are well suited to infer paleoclimate variability at seasonal and long-term time scales.

## References

Thorrold S.R., S.E. Campana, C.M. Jones and P.K. Swart. 1997. Factors determining  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  fractionation in aragonitic otoliths of marine fish. *Geochimica et Cosmochimica Acta* 61(14):2909-2919.