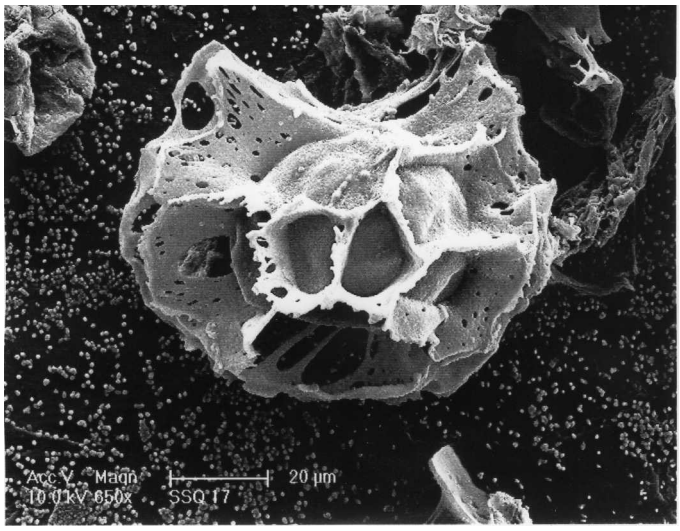
The Eocene-Oligocene transition at St. Stephens Quarry, Alabama, USA: environmental- and sea-level change revealed by dinoflagellate cysts

Quaijtaal W.[1,2], Houben A.J.P.[2], Wade B.S.[3], Schouten, S.[4] , Rosenthal Y.[5], Miller K.G.[6], Brinkhuis H.[2,4]
→ willemijn.quaijtaal@ugent.be

1 Research Unit Palaeontology, Department of Geology and Soil Science, Ghent University, Belgium
2 Marine Palynology, Laboratory of Palaeobotany and Palynology, Department of Earth Sciences, The Netherlands
3 Sellwood Group for Palaeo-Climatology, School of Earth and Environment, University of Leeds, Leeds, United Kingdom,
4 NIOZ Royal Netherlands Institute for Sea Research, Department of Marine Organic Biogeochemistry, Texel, The Netherlands,
5 Marine Biogeochemistry & Paleoceanography, Institute of Marine and Coastal Sciences, Rutgers University, New Jersey, USA,
6 Department of Earth and Planetary Sciences, Rutgers University, New Jersey, United States

The Eocene-Oligocene transition (EOT, 34-33.5 Myr ago) represents the final transition from the early Paleogene "Greenhouse" into the present "Icehouse" through the growth of continental-scale ice caps on Antarctica. Foraminiferal oxygen isotopes ($\delta^{18}O$) record the EOT as two positive steps, ~200 kyr apart. However, the relative contributions of cooling and increasing ice-volume cannot be separated from such $\delta^{18}O$ records. To understand the order of events enveloping the onset of Antarctic glaciation, independent temperature- and sea-level reconstructions are crucial.



Scanning electron microscope photograph of *Pentadinium alabamensis*, a new dinocyst taxon found at St. Stephens Quarry, Alabama, USA.

A classic reference section for the Eocene-Oligocene boundary, St. Stephens Quarry (SSQ) in Alabama, USA, contains a relatively expanded neritic succession. Previous studies at SSQ have already provided magneto- and biostratigraphy, benthic foraminiferal stable isotope- and Mg/Ca based temperature information across the EOT. Sea surface temperatures were reconstructed using TEX_{86} and planktonic Mg/Ca analyses. Altogether, these data show that the first step of the EOT (precursor or EOT-1) primarily reflects cooling, while the second step (the Oi-1) only shows a minor temperature decrease.

Here, we report on biotic change revealed by evaluating assemblages of organic remains of dinoflagellates (dinocysts). Dinoflagellates (see figure) are a group of unicellular surface dwelling algae, sensitive to environmental changes, e.g. temperature, coastal proximity and productivity. We integrate dinocyst assemblage data with lithostratigraphic studies to propose an updated sequence stratigraphy for the SSQ-borehole. We document a sea-level fall associated with the EOT-1 and a distinct sea-level fall at the Oi-1 level, the latter being a feasible result of increasing continental ice volume. Furthermore, we recorded typical cold water taxa at the EOT-1, in line with sea surface temperature reconstructions. In addition, early Oligocene dinocyst assemblages above the Oi-1 are indicative of more productive settings, along with larger amplitude environmental changes in the shelf environments. The latter could be related to the inception of Oligocene glacial-interglacial cycles and the subsequent far-field sea level response. Our records thus show that the EOT was a period of profound environmental change, also in the (sub)tropics.