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Temperature evolution over the Eocene-Oligocene transition in the eastern part of the North Sea Basin

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In the eastern part of the North Sea Basin, including the present Danish land area, the Eocene-Oligocene transition coincides with a major shift in the depositional pattern. Eocene sediments are dominated by hemipelagic clays while Oligocene deposits are characterized by locally distributed, thick, sandy clinoforms, prograding from the north-east.

Four litostratigraphical units span the Eocene-Oligocene transition onshore Denmark: the Søvind Marl, Moesgaard Clay, Kysing Marl and Viborg Formation. The first three units are of Eocene age. The Viborg Formation of NP21 age represents the oldest Oligocene unit on the Danish land area. The Moesgaard Clay has been suggested to represent a late Eocene cooling known as the Vonhof event (Nielsen et al., 2008).

In order to investigate climate changes in the North Sea Basin during the Eocene-Oligocene transition, organic geochemical studies were carried out on a composite section (based on the Kysing-4 and Horn-1 boreholes) from the Danish land area.

Sea surface temperatures (SST) were obtained from the TEX86 index (TetraEther indeX of tetraethers with 86 carbon atoms). The TEX86 method was used only where the Branched and Isoprenoid Tetraether (BIT) index values, a proxy for input of riverine soil organic matter, were lower than 0.4.

During the deposition of the Bartonian-Priabonian part of the Søvind Marl SST oscillated around 25ºC. SST during the deposition of the Moesgaard Clay decreased by ca. 4ºC in relation to the temperatures prevailing before. The beginning of the deposition of the Kysing Marl coincides with an increase of the SST by ca. 4ºC. The SST decreased during the deposition of the Kysing Marl by ca. 6ºC, and decreased by another ca. 4ºC during the deposition of the lowermost part of the Viborg Formation. The general trend of the SST shows a first short period of cooling, coinciding with the Moesgaard Clay (SST ca. 20.5ºC) and a second period of more pronounced cooling (SST ca. 14ºC) during the deposition of the lowermost part of the Viborg Formation.

The trend obtained by the TEX86 study is in agreement with published oxygen isotope data. The cooling coincides with the North Sea Basin shift of depositional pattern and thus points to a cause and effect relationship between the two.

Oligocene deposits above the lowermost part of the Viborg Formation are also being investigated geochemically. They show BIT values varying between 0.4 and 0.96 which can bias the TEX86 values. Therefore, we are currently analyzing the Cyclization of Branched Tetraethers (CBT) and the Methylation of Branched Tetraethers (MBT) proxy for reconstructions of Oligocene mean annual air temperature (MAT) for the Danish drainage basin.