From greenhouse to icehouse -- reconstructing the environment of the Voring Plateau

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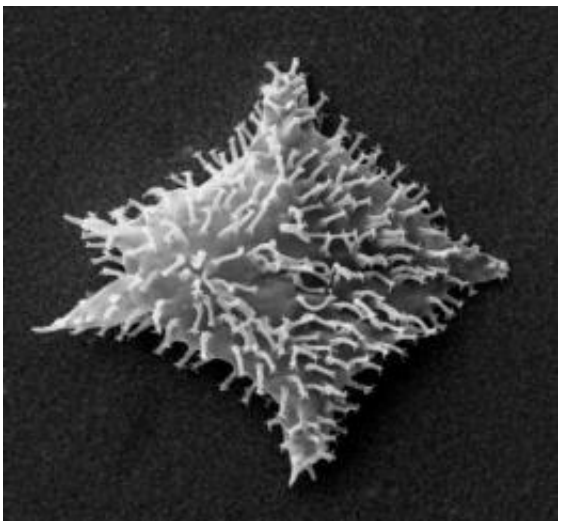

This is a scanning electron micrograph of one of the characteristic brackish water species of the genus *Wezteliella*. Credit: NOCS

The analysis of microfossils found in ocean sediment cores is illuminating the environmental conditions that prevailed at high latitudes during a critical period of Earth history.

Around 55 million years ago at the beginning of the Eocene epoch, the Earth's poles are believed to have been free of ice. But by the early Oligocene around 25 million years later, ice sheets covered Antarctica and continental ice had developed on Greenland.

"This change from greenhouse to icehouse conditions resulted from decreasing greenhouse gas concentrations and changes in Earth's orbit," said Dr Ian Harding of the University of Southampton's School of Ocean and Earth Science (SOES) at the National Oceanography Centre, Southampton (NOCS): "However, the opening or closing of various marine gateways and shifts in ocean currents may also have influenced regional climate in polar high-latitudes."

The separation of Eurasia and Greenland due to shifting tectonic plates led to the partial or complete submergence of former land barriers such as the Vøring Plateau of the Norwegian continental margin. For the first time, waters could exchange between the Norwegian-Greenland Sea, the Arctic Ocean and the North Atlantic.

Dr Harding and his former PhD student Dr James Eldrett have reconstructed the environmental conditions over the Vøring Plateau over this time period by carefully analysing the fossilised remains of organic debris and cysts of tiny aquatic organisms called dinoflagellates from sediment cores.

"Because different dinoflagellate species are adapted to different surface water conditions, their fossilised remains help us reconstruct past environments," said Dr Harding.

The evidence from the sediments cores suggests the development of shallow marine environments across parts of the Vøring Plateau during the early Eocene. However, the presence of fossilised species that lived in fresh or brackish water indicates that northerly parts of the plateau as well as the crest of the Vøring Escarpment were still above water.

In the late Eocene sediments (around 44 million years old) only marine plankton species were found, indicating that the entire Vøring Plateau had by then subsided and become submerged. This demonstrates that

marine connections were established between the various Nordic sea basins much earlier than had previously been thought. These surface water connections may have promoted the increased surface water productivity evidenced by the abundance of planktonic fossils preserved in the sediment cores of this age.

"Increased productivity would have drawn carbon dioxide down from the atmosphere," said Dr Harding: "Because carbon dioxide is a greenhouse gas, this may have contributed to declining global temperatures and led to the early development of continental ice on Greenland in the latest Eocene."

More information: Eldrett, J. S. & Harding, I. C. Palynological analyses of Eocene to Oligocene sediments from DSDP Site 338, Outer Vøring Plateau. *Marine Micropaleontology* 73, 226-240 (2009).

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