

Early to Middle Miocene nannofossils from the Valhall–Hod area, Norwegian North Sea

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The siliceous–diatomite succession of the lower to middle Miocene is currently a focus in the Norwegian sector of the North Sea in the Valhall–Hod area, owing to its potential as a hydrocarbon reservoir. Cored sections from the Valhall and Hod fields together provide a unique, continuous record of the Aquitanian to Langhian succession of the Lark Formation (upper part of the Hordaland Group). The succession is equivalent to the recently established Dany and Nora Formations in the Danish sector of the North Sea, which comprise gray to brown muds with diatom-rich intervals. A high-resolution, multidisciplinary biostratigraphic study, including foraminifera, dinoflagellate cysts, diatoms, silicoflagellates, and calcareous nannofossils, has recently been carried out on the lower to middle Miocene succession in six wells from the Valhall and Hod fields. The biostratigraphic framework resulting from the study of the two new cored wells, 2/11-12S (Hod field) and 2/8-G10A (Valhall field), was tested successfully on ditch cuttings samples from four neighboring, non-cored wells: 2/8-N4, 2/8-V6, 2/8-8, and 2/11-1.

Biostratigraphic subdivision of the North Sea Miocene succession, using dinoflagellate cysts and microfossils (foraminifera, Bolboforma, and pyritized diatoms), has proven to be reliable in clays and marls, and recently siliceous diatoms have been successfully applied to the siliceous intervals for biostratigraphic breakdown. Nannofossil biostratigraphy is not conventionally used in the Miocene of the North Sea due to the success and effectiveness of other fossil groups and comparatively long nannofossil zone ranges. However, a limited number of nannofossil samples, which were collected from calcareous intervals in the six wells, contained nannofossil assemblages with varying abundance, diversity, and preservation. The Valhall and Hod fields lower to middle Miocene sections span nannofossil Zones NN3–6. The nannofossil biostratigraphy supports that of the other microfossil disciplines in this study, supplementing the refined and robust biostratigraphic framework.

Useful nannofossil events, in stratigraphic order, that correlate across the Valhall–Hod area include the first occurrences (FOs) of *Cyclicargolithus floridanus*, *Helicosphaera carteri*, *Helicosphaera ampliapertura*, and *Discoaster emblematicus* and the last occurrences (LOs) of *Discoaster caulifloris*, *D. emblematicus*, *Discoaster exilis*, *Helicosphaera bipuncta*, and *C. floridanus*. Nannofossil assemblages also include *Helicosphaera bipuncta*, *Helicosphaera waltrans*, *Helicosphaera walbersdorfensis*, *Reticulofenestra pseudoumbilicus*, *Sphenolithus apoxis*, and *Sphenolithus puniceus*. Early to middle Miocene sea surface temperature fluctuations are indicated by variations in the relative abundance patterns of *Discoaster* spp. and *Sphenolithus* spp. (warm affinity) and *Reticulofenestra* spp. (cool affinity), complementing the microfossil and dinoflagellate cyst data.