The Upper Miocene-Lower Pliocene Utsira Formation in the northern North Sea

(Extent and thickness, age from fossil and strontium isotope correlations, lithology, paleobathymetry and regional correlation)

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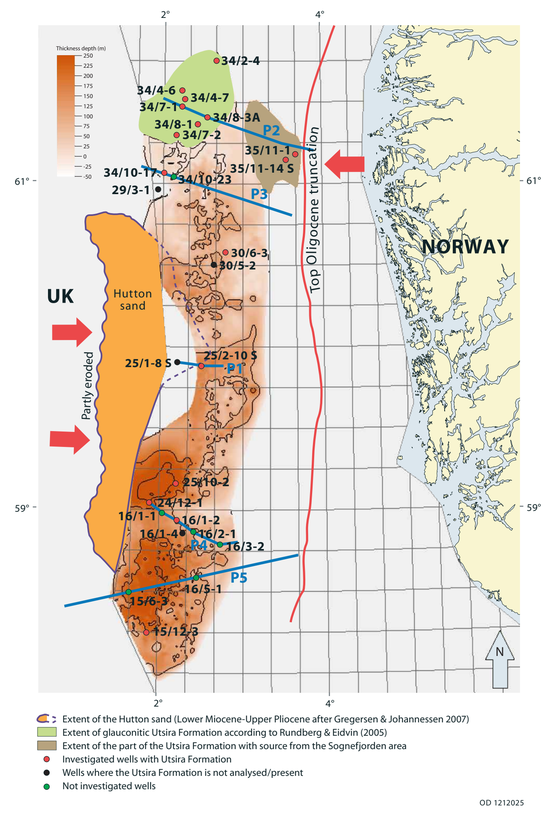
The Utsira Formation represents a huge sedimentary depositional system in the northern North Sea (about 450 km long and 90 km wide) comprising one large sandy depo-center (250-300 m in the southern Viking Graben) and an area with 80-100 m thick sandy deposits in the northern Viking Graben. The western central area comprises a large deltaic system which prograded eastwards in the Early and Middle Miocene, but where Late Miocene - Early Pliocene sediments (Utsira Formation) are thin or absent. Far to the north, in the Tampen area, the Utsira Formation is represented by a thin glauconitic unit overlying Oligocene strata and deposited close to the Miocene-Pliocene transition. This member is thought to cap the main Utsira Formation sands in the north-eastern part of the basin (Profile 2, Rundberg & Eidvin 2005, Eidvin & Rundberg 2007). Within the Tampen area the glauconitic member is locally absent and Upper Pliocene deposits lie unconformably on Paleogene sediments, e.g. in the Tordis Field area (Eidvin 2009 and Eidvin & Øverland 2009). We suggest dividing the Utsira Formation into three members, viz. Southern Utsira Member, Northern Utsira Member and a Glauconitic Utsira Member in the northernmost part (see Fig. 21). In the same way as the Skade Formation, in the western part of the Norwegian sector block 30 and 25, the Utsira Formation merges with parts of Hutton sand (see Profile 1).

Rundberg & Eidvin (2005) pointed out an obvious correlation conflict between the Utsira and Skade formation in the type wells of Isaksen & Tonstad (1989) and showed the need for a revision of the base of the Utsira Formation. Eidvin & Rundberg (2007) suggested an adjustment of the base of the Utsira in the type well 16/1-1 from 1064 to 815 m, and noted also that after such a revision the well 16/1-1 is no longer the appropriate choice as the type well for the sandy system. It penetrates only thin sand and does not represent typical succession of the sandstones of the Utsira Formation. Consequently, we suggest 24/12-1 from 730 to 495 m as the new well type section (also the well reference section for the Southern Utsira Member, Fig. 9, Profile 4). We suggest 30/6-3 from 750 to 680 m as the well reference section for the Northern Utsira Member (Fig. 19) and 34/4-6 from 1250 to 1210 m as the well reference section for the Glauconitic Utsira Member (Fig. 1). According to our investigations the Utsira Formation sands were laid down between approximately 12 to 4.5 Ma.

Thickness of the Upper Miocene - Lower Pliocene Utsira Formation



Extent of the Hutton sand (Lower Miocene-Upper Pliocene after Gregersen & Johannessen 2007)
Extent of glauconitic Utsira Formation according to Rundberg & Eidvin (2005)
Extent of the part of the Utsira Formation with source from the Sognefjorden area
Investigated wells with Utsira Formation
Wells where the Utsira Formation is not analysed/present
Not investigated wells

OD 1212025

Fig. 17: Thickness of the Upper Miocen - Lower Pliocene Utsira Formation in the northern North Sea (modified after NPD, 2011). The outline of the Miocene - Upper Pliocene Hutton sand is after Gregersen & Johannessen (2007). Extent of the area with glauconitic sand is according to Rundberg & Eidvin (2005).

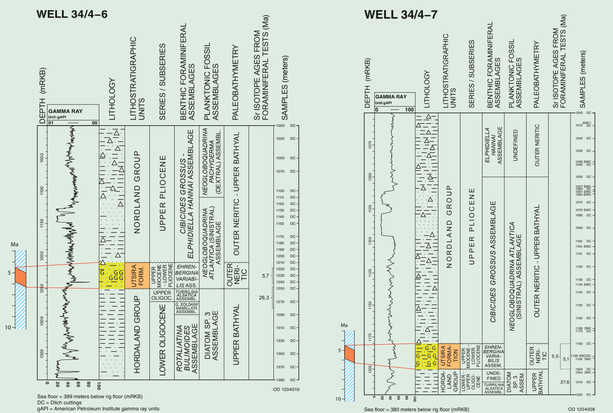


Fig. 1

Fig. 2

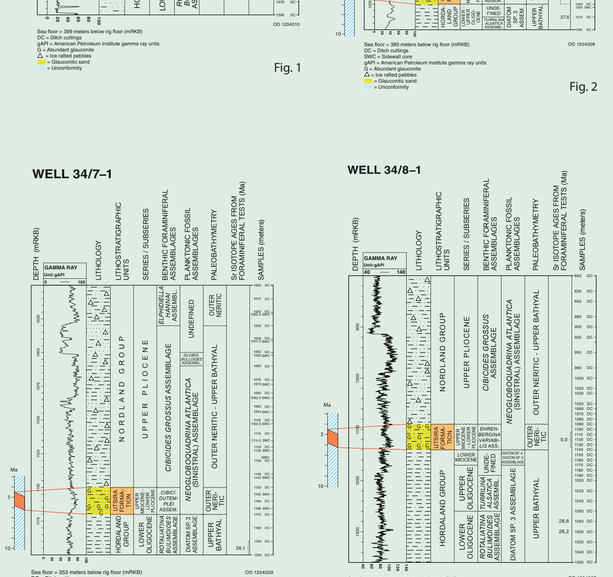


Fig. 3

Fig. 4

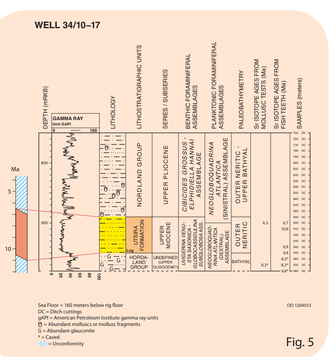
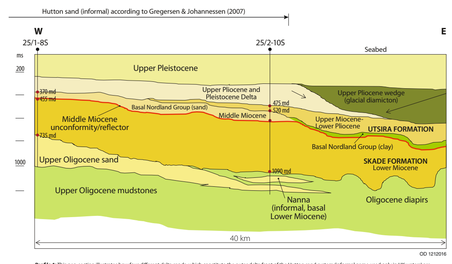


Fig. 5

Fig. 6



Profile 1: This geo-section illustrates how four different delta sands, which constitute the outer delta front of the Hutton sand system (informal name used only in UK waters) are deposited. In Norwegian waters the Lower Miocene Skade Formation is turbitic in origin and overlays Oligocene mudstones. The Utsira Formation overlays a mud prone, distal Middle Miocene unit and thins out west from the delta front towards the 25/1-8S area. An Upper Pliocene delta builds on top of the Utsira Formation in the 25/2-10S area, modified after Gjeldvik et al. (2011).

Reference: Gjeldvik, I. T., Eidvin, T. & Riis, F., 2011: Neogene Delta Systems In The North-Western North Sea. Poster shown at Sustainable Earth Sciences Conference & Exibition, Valencia, Spain, 8-10 November 2011, Available from the internet: http://www.npd.no/Global/Norsk/3-Publikasjoner/Presentasjoner/Plakat.pdf

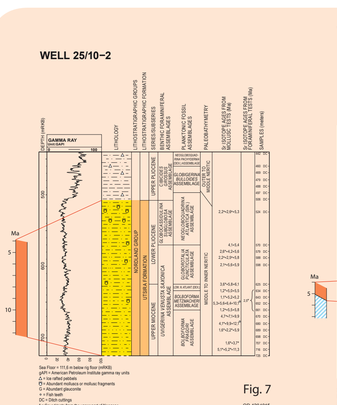


Fig. 7

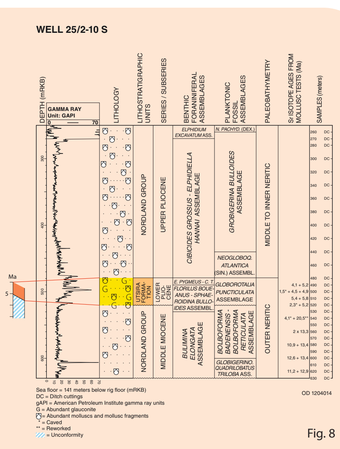


Fig. 8

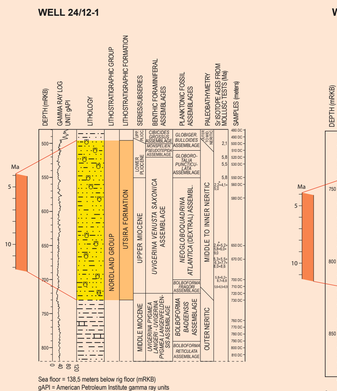


Fig. 9

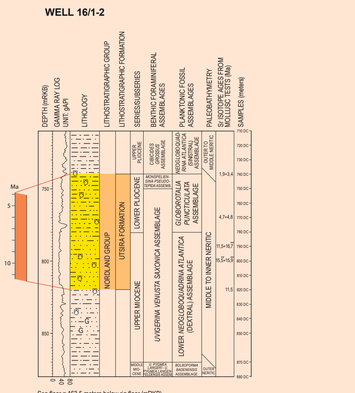


Fig. 10

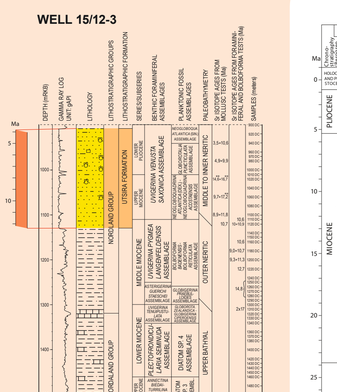


Fig. 11

Fig. 13

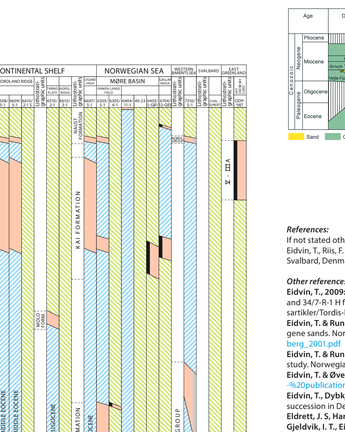


Fig. 14

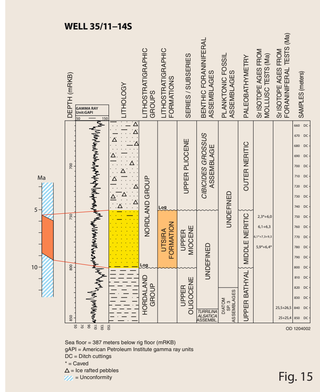


Fig. 15

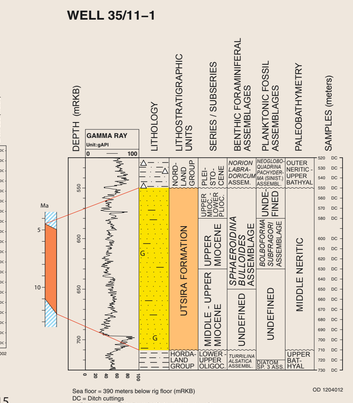


Fig. 18

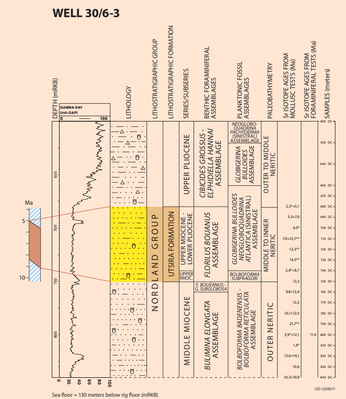
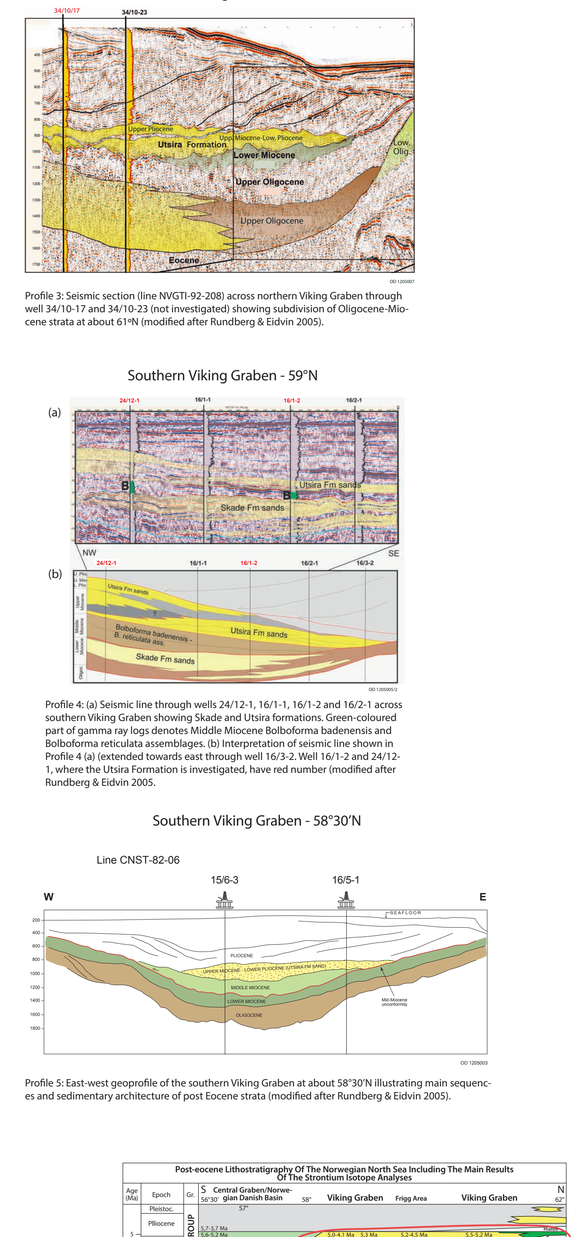


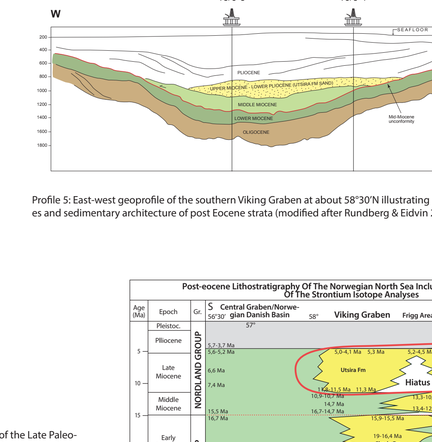
Fig. 19



Northern Viking Graben - 61°N

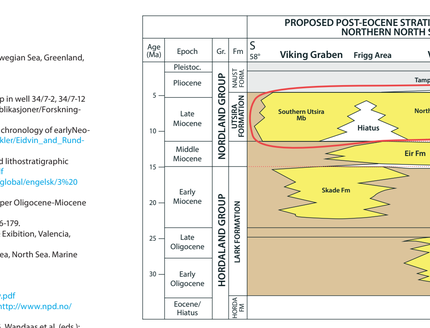
Profile 2: East-West transect of the northern North Sea at about 61°N illustrating main sequences and sedimentary architecture of the post Eocene strata. Note the mid-Miocene unconformity (red line) and the seismic truncation of the Lower Miocene (modified after Eidvin & Rundberg 2001 and Rundberg & Eidvin 2005).

Northern Viking Graben - 61°N



Profile 3: Seismic section (line NVGTI-92-208) across northern Viking Graben through well 34/10-17 and 34/10-23 (not investigated) showing subdivision of Oligocene-Miocene strata at about 61°N (modified after Rundberg & Eidvin 2005).

Southern Viking Graben - 59°N



Profile 4: (a) Seismic line through wells 24/12-1, 16/1-1, 16/1-2 and 16/2-1 across southern Viking Graben showing Skade and Utsira formations. Green-coloured part of gamma ray logs denotes Middle Miocene Bolboforma badenensis and Bolboforma reticulata assemblages. (b) Interpretation of seismic line shown in Profile 4 (a) (extended towards east through well 16/3-2. Well 16/1-2 and 24/12-1, where the Utsira Formation is investigated, have red number (modified after Rundberg & Eidvin 2005.

Southern Viking Graben - 58°30'N

Profile 5: East-west geoprofile of the southern Viking Graben at about 58°30'N illustrating main sequences and sedimentary architecture of post Eocene strata (modified after Rundberg & Eidvin 2005).

Geochronology of studied wells, boreholes and outcrops

(The Utsira Formation in dark red)

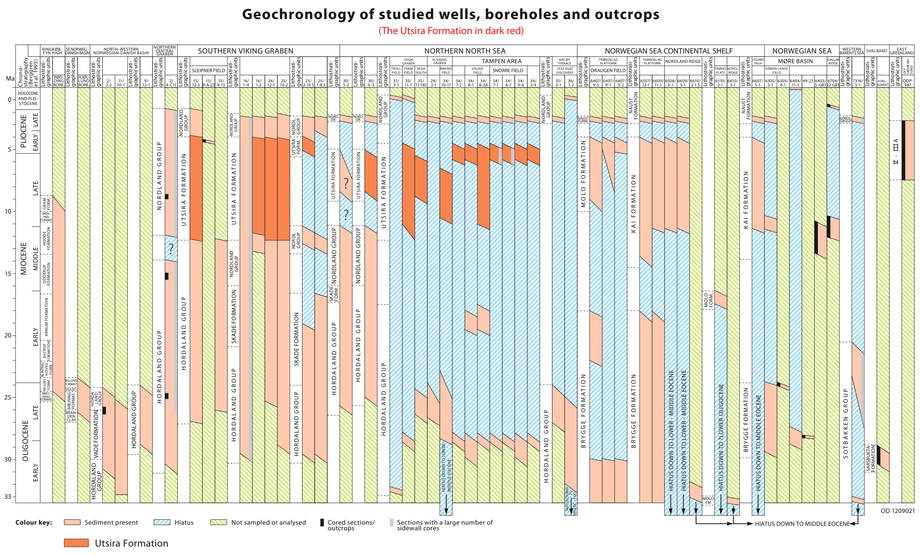


Fig. 12. Geochronology of all studied wells including the 16 wells with the Utsira Formation.

Late Paleogene and Neogene lithostratgraphy

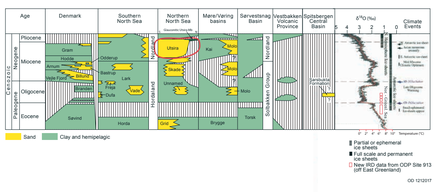


Fig. 16: General view of the Late Paleogene and Neogene lithostratigraphy in the investigated areas modified after Rasmussen et al. (2008) and Rundberg & Eidvin (2005). On the right hand side of the diagram there is added some paleoclimatic data including a global deep-sea oxygen curve, bottom-water paleotemperatures in the world's oceans and periods with ice-sheets in the Antarctica and northern hemisphere (after Zachos et al. 2001). Periods with deposition of IRD at ODP Site 913 (off East Greenland) are also indicated (Eldrett et al. 2007).

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Post-eocene Lithostratigraphy Of The Norwegian North Sea Including The Main Results Of The Strontium Isotope Analyses

Fig. 20: Post Eocene lithostratigraphy of the Norwegian North Sea including main results of the strontium isotope analyses based on fossil tests interpreted to be in situ (after Eidvin et al, work in progress 2).

PROPOSED POST-EOCENE STRATIGRAPHY OF THE NORTHERN NORTH SEA

Fig. 21: Proposed lithostratigraphic subdivision of post-Eocene strata in the northern North Sea. Mb = member, Gr = group, Fm = Formation.