Micropaleontology and Strontium Isotope Stratigraphy (SIS) of well 25/3-1 (Utsira High) in the North Sea including the sandy Ull (informal), Skade, Eir (informal) and Utsira formations

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For the investigation of well 25/3-1 (59° 55' 52.99'' N, 02° 46' 21.34'' E, Fig. 1), micropaleontological and Sr isotope analyses for the interval 1010 to 400 m are obtained. Fifty-nine ditch-cutting samples were analysed (Table 1, Fig. 2).

Micropaleontological analyses
Micropaleontological investigations are based on analyses of planktonic and benthic foraminifera, *Bolboforma* and pyritized diatoms. The fossil assemblages are correlated with the micropaleontological zonation for Cenozoic sediments in the North Sea of King (1989). The zonations of planktonic foraminifera (Spiegler and Jansen, 1989; Weaver and Clement, 1986, 1987; Weaver, 1987) and *Bolboforma* (Spiegler and Müller, 1992; Müller and Spiegler, 1993) from ODP and DSDP drillings in the Norwegian Sea and the North Atlantic are also very important for the dating of the sediments since these zones are calibrated with both nannoplankton and palaeomagnetic data. Note that the micropalaeontological zonation of King (1989) and the the planktonic foraminiferal zonation of Spiegler and Jansen (1989) are based on the time scale of Berggren *et al*. (1985), but we have converted the ages to the time scale of Berggren *et al*. (1995). The *Bolboforma* zonation of Spiegler and Müller (1992) and Müller and Spiegler (1993) is based on the time scale of Berggren *et al*. (1995).

Lithological analyses
The lithological analyses are based on visual examination of the samples prior to treatment, and the dissolved and fractionated material after preparation.

Sr isotope analyses
Strontium isotope stratigraphy is used as an additional control for the biostratigraphic correlations. The method has best resolution for sediments older than 15 Ma (Howard and McArthur, 1997, 2004). For samples with ages younger than 8 Ma, the Sr isotope ages have to be treated with more caution. This is due to less variation in the Sr isotopic composition and a relatively flat curve especially between 4.6 and 2.75 Ma, but also to some extent between 8 and 6 Ma (Howard and McArthur, 1997, 2004).

Forty-seven samples were investigated for their Sr isotopic composition. Since foraminiferal and *Bolboforma* index fossils are few in the sandy formations and mollusc fragment are common in such sediments, the analyses were conducted on mollusc fragments. Except for one sample, all the samples were analysed twice for control purposes (Table 1). The analytical work was carried out at the Mass Spectrometry Laboratory at the University of Bergen, Norway. Sr values were converted to age estimates using the strontium isotope stratigraphy look-up table of Howard and McArthur (1997, 2004). The look-up table of Howard and McArthur (1997) is based on the time scale of Berggren *et al*. (1995), and this time scale is used throughout the report. The look-up table of Howard and McArthur (2004) is based on the time scale of Gradstein *et al*. (2004). There is currently no SIS look-up table that is based on the new time scale of Cohen *et al*. (2013). The time scales compiled by Berggren *et al*., (1995) and Gradstein *et al*. (2004) does not deviate significantly from the new time scale of Cohen *et al.* (2013). The most important difference is that the base of Pleistocene has been moved from 1.85 Ma to 2.588 Ma. Of that follows that according to Berggren *et al*. (1995) and Gradstein *et al*. (2004), the Gelasian is in the uppermost part of Pliocene, and according to Cohen *et al*. (2013) the Gelasian is in the lowermost part of Pleistocene. Some geologists have suggested that one should use the new time scale of Cohen *et al*. (2013) throughout our papers and reports, but it will not be possible when we use Sr look-up tables based on the time scale of Berggren *et al*. (1995) and Gradstein *et al*. (2004). Consequently, one has to wait until Howard and McArthur or somebody else are able to construct a new look-up table based on the time scale of Cohen *et al*. (2013).

Stratigraphy of well 25/3-1

There are recorded 30 m of Upper Oligocene sediments, 230 m with Lower Miocene deposits, 140 m with Middle Miocene deposits, 120 m with Upper Miocene sediments, approximately 10 m with Lower Pliocene deposits and approximately 90 m with mainly Gelasian sediments (Fig. 2). The base of the Upper Oligocene and the top of the Gelasian are not investigated.

Biostratigraphy

Upper Oligocene (1010-980 m, Hordaland Group including the Ull Formation (informal))

Benthic foraminifera of the *Turrilina alsatica-Elphidium subnodosum* assemblage and pyritized diatoms of Diatom sp. 3 assemblage together with five Sr isotope ages give a Late Oligocene age for this unit (Fig. 2, Table 1). In addition to the nominate species, the benthic foraminiferal assemblage also includes *Gyroidina soldanii girardana*. The benthic foraminiferal assemblage is correlated with Zone NSB 8 of

King (1989), and the diatom assemblage is correlated with Zone NSP 9c (upper part) of King (1989) from the North Sea.

Lower Miocene (980-760 m, Hordaland Group including the Skade Formation)

Benthic foraminifera of the *Uvigerina tenuipustulata-Astigerina guerici staeschei* assemblage and planktonic foraminifera of the *Globorotalia zealandica-Globigerina angustiumbilicata-Globigerina praebulloides* assemblage together with 39 Sr isotope ages give an Early Miocene age for this succession (Fig. 2). The benthic foraminiferal fauna also includes *Nonion granosum, Plectofrondicularia seminuda* and *Ehrenbergina serrata*. The *Uvigerina tenuipustulata-Astigerina guerici staeschei* assemblage is correlated with Zone NSB 9 and Zone NSB 10 (lower, main part) and the *Globorotalia zealandica-Globigerina angustiumbilicata-Globigerina praebulloides* assemblage is correlated with Zone NSP 11 of King (1989) from the North Sea.

Middle Miocene (760-620 m, Nordland Group including the Eir Formation (informal))

Bolboforma of the *Bolboforma badenensis-Bolboforma reticulata* assemblage and benthic foraminifera of the *Astigerina guerichi staeschei* assemblage and *Trifarina gracilis-Trifarina gracilis* var. A (Skarbø and Verdenius,1986) assemblage together with 24 Sr isotope ages give a Middle Miocene age for this unit (Fig. 2). In addition to the nominate species the *Bolboforma badenensis-Bolboforma reticulata* assemblage also includes *Bolboforma clodiusi* and *Bolboforma laevis* in the upper part of the unit. The benthic foraminiferal assemblages also include *Bulimina elongata*, *Sphaeroidina bulloides*, *Florilus bouanus* and *Cibicides dutemplei*. Spiegler and Müller (1982) described a *B. badenensis* Zone and a *B. reticulata* Zone from the North Atlantic and Müller and Spiegler (1993) described a *B. badenensis/B. reticulata* Zone from the Vøring Plateau (Norwegian Sea) in deposits with an age slightly older than 14 to 11.7 Ma. The benthic foraminiferal faunas can probably be correlated with the uppermost part of Zone NSB 10, Zone NSB 11 and Zone NSB 12 of King (1989) from the North Sea.

Upper Miocene – Lower Pliocene (620-490 m, Nordland Group including the Utsira Formation (lower, main part))

Bolboforma of the *Bolboforma clodiusi-B. laevis-Bolboforma compressispinosa* assemblage, *Bolboforma metzmacheri* assemblage and planktonic foraminifera of the *Neogloboquadrina atlantica* (sinistral) assemblage (lowermost part), benthic foraminifera of the *Uvigerina venusta saxonica-Globocassidulina subglobosa-Florilus bouanus* assemblage and *Florilus bouanus* assemblage together with four Sr isotope ages give a Late Miocene to Early Pliocene age for this unit (Fig. 2). In addition to the nominate species the benthic foraminiferal assemblages also include *Uvigerina* *pygmea langeri*, *Sphaeroidina bulloides and Globulina gibba myristiformis. Qvale and Spiegler (1989) described B. clodiusi, B*. *laevis* and *B. compressispinosa* from the uppermost Middle and Upper Miocene on the Vøring Plateau (Norwegian Sea). Spiegler and Jansen (1989) described a *N. atlantica* (sinistral) Zone from the Vøring Plateau from the Upper Miocene to Gelasian deposits. The benthic foraminiferal faunas are correlated with Zone NSB 13 of King (1989).

Mainly Gelasian (mainly Upper Pliocene sensu Berggren et al.,1995 and Pleistocene sensu Cohen et al., 2013, 490-400 m, Nordland Group)

Benthic foraminifera of the *Elphidiella hannai-Cibicides grossus* assemblage, *Elphidiella hannai* assemblage and planktonic foraminifera of the *Neogloboquadrina atlantica* (sinistral) assemblage (upper, main part), *Neogloboquadrina atlantica* (dextral) assemblage and *Globigerina bulloides* assemblage give a mainly Gelasian age for this unit (Fig. 2). The *Elphidiella hannai-Cibicides grossus* assemblage correlates with Zone NSB 15 of King (1989, from the North Sea) which is of Gelasian to early Calabrian age. As stated above, Spiegler and Jansen described a *N. atlantica* (sinistral) Zone from the Vøring Plateau from the Upper Miocene to Gelasian deposits. The last occurrence datum (LAD) of *N. atlantica* (sinistral) in that area is approximately at 2.4 Ma. A *G. bulloides* Zone is described from the North Atlantic (DSDP Leg 94) in Pliocene and Gelasian sediments as young as 2.2 Ma (Weaver and Clement, 1986, 1987; Weaver, 1987). On the Vøring Plateau, *G. bulloides* is common in Pliocene and Gelasian deposits older than 2.4 Ma (Spiegler and Jansen, 1989). *G. bulloides* was also common during warm periods in the middle and late Pleistocene (Kellogg, 1977).

Sr isotope stratigraphy

Nearly all the analysed samples in well 25/3-1 were taken from the sandy Ull (informal), Skade, Eir (informal) and Utsira formations. As mentioned above, foraminiferal and *Bolboforma* index fossils are few in sandy sections and a significant number is needed, of these small tests, to obtain satisfactory analyses. The significant larger mollusc fragments are common in the sandy sections, and the analyses were conducted on these fragments. Comparisons with the micropaleontological data indicate that most of the analysed mollusc fragments from the Ull (informal), Skade and Eir (informal) are based on fragments which mainly are *in situ*. A large number of the analysed fragments from the Utsira Formation and the two uppermost depths of the Eir formation (informal) are probably based on fragments which are caved from higher levels in the well. When drilling well 25/3-1, 30” casing was put in place when the drill bit was at 197 m and 20” casing was put in place when the drill bit reached 703 m (Fig. 2). During the drilling between these depths (upper part of the Eir (informal), Utsira and Naust formations) the borehole was open, exposed to the rotating drill string and to circulating drill mud. The unconsolidated sediments were probably continuously dislodged throughout the drilling of these sections. This is reflected in that most of Sr data from these units indicate that the analyses are based on caved mollusc fragments. All the results of the analyses are listed in Table 1. Fig. 2 (well summery figure) has included only Sr data from analyses of mollusc fragments which are interpreted to be *in situ* or close to *in situ*.

Three analyses based on mollusc fragments from two depths have been carried out on the Ull Formation (informal; 1010 and 1000 m). The foraminiferal and diatoms correlations gave a general Late Oligocene age for this unit. The obtained 87Sr/86Sr ratios gave ages from 24.6 to 24.5 Ma (late Chattian (latest Late Oligocene); Table 1, Fig. 2).

Forty analyses from twenty depths have been carried out on the Skade Formation (980-760 m; Table 1). The benthic and planktonic foraminiferal correlations gave a general Early Miocene age for the Skade Formation. The obtained 87Sr/86Sr ratios from the two lowermost depths of the Skade Formation (980-970 m) gave ages of 24.6 to 24.5 Ma (late Chattian (latest Late Oligocene; Table 1, Fig. 2)). The obtained 87Sr/86Sr ratios from the seven depths above these, in the lower half of the formation (960-900 m), gave ages from 24.3 to 21.9 Ma (late Chattian (latest Late Oligocene) to middle Aquitanian (Early Miocene; Table 1, Fig. 2)). In the upper half of the Skade Formation, twenty-two mollusc fragments from the eleven depths (880-760) m were analysed. The analyses from 880-780 m gave ages of 23.2 to 17.6 Ma (Aquitanian to Burdigalian (Early Miocene)). Analyses of four fragments from 770-760 m gave 17.8, 15.9, 14.8 and 9.3 Ma respectively (Early, Middle and Late Miocene). The fragment which gave Middle and Late Miocene ages are probably caved (Table 1).

Twenty-six analyses from thirteen depths have been carried out on the Eir formation (informal; 750-620 m; Table 1). The benthic and planktonic foraminiferal correlations and the *Bolboforma* correlation gave a general Middle Miocene age for the Eir formation (informal). The analyses of the mollusc fragments from 750-640 m gave ages from 18.8 and 17.0 at 750 m (latest Early Miocene) to 11.0 at 650 m (earliest Late Miocene). All the other analyses from 740-640 m gave Middle Miocene ages (Table 1; Fig. 2). The mollusc fragments from 750 m may have been reworked, indicating a small break in the sedimentation between the Skade Formation and the Eir formation (informal). The analyses from the two uppermost depths in the Eir formation (informal) gave ages of 2.8 to 2.0 Ma (Table 1; Gelasian to Pleistocene) and are probably caved from the Naust Formation.

Twenty-two analyses from eleven depths have been carried out on the Utsira Formation (610-510 m). The *Bolboforma*, benthic and planktonic foraminiferal correlations gave a general Late Miocene age for the main part of the unit (610-500 m). The uppermost sample at 490 m was given an Early Pliocene age. The Sr-analyses of the mollusc fragments gave ages from 9.5 to 2.0 Ma (Late Miocene to Pleistocene). However, most of the analysed fragments gave Gelasian and

Pleistocene ages (Table 1) and are probably caved from the Naust Formation. Four analyses gave Late Miocene and Early Pliocene ages and are probably based on mollusc fragments which are *in situ* or close to *in situ* (se Fig. 2).

Well 25/3-1

Litho. Unit	Sample (DC)	Corrected $^{87/86}Sr$	2S error	Age (Ma; H&M, 1997; mean values)	Age (Ma; H&M, 2004; mean values)	Comments	Analysed fossils
Utsira Fm	510 m	0.709068	0.000009	2.62	2.58	Caved	One mollusc fragment
Utsira Fm	510 m	0.709084	0.000009	2.06	2.05	Caved	One mollusc fragment
Utsira Fm	520 m	0.709076	0.000008	2.30	2.30	Caved	One mollusc fragment
Utsira Fm	520 m	0.709077	0.000007	2.27	2.27	Caved	One mollusc fragment
Utsira Fm	530 m	0.709070	0.000009	2.52	2.50	Caved	One mollusc fragment
Utsira Fm	530 m	0.709068	0.000009	2.62	2.58	Caved	One mollusc fragment
Utsira Fm	540 m	0.709065	0.000009	3.23	2.72	Caved	One mollusc fragment
Utsira Fm	540 m	0.709056	0.000009	3.98	3.65		One mollusc fragment
Utsira Fm	550 m	0.709058	0.000009	3.79	3.40		One mollusc fragment
Utsira Fm	550 m	0.709052	0.000009	4.21	4.11		One mollusc fragment
Utsira Fm	560 m	0.709086	0.000009	1.98	1.97	Caved	One mollusc fragment
Utsira Fm	560 m	0.709086	0.000009	1.98	1.97	Caved	One mollusc fragment
Utsira Fm	570 m	0.709064	0.000009	3.31	2.78	Caved	One mollusc fragment
Utsira Fm	570 m	0.709069	0.000006	2.57	2.54	Caved	One mollusc fragment
Utsira Fm	580 m	0.708903	0.000009	9.42	9.52		One mollusc fragment
Utsira Fm	580 m	0.709053	0.000008	4.14	4.01	Caved	One mollusc fragment
Utsira Fm	590 m	0.709055	0.000007	4.09	3.76	Caved	One mollusc fragment
Utsira Fm	590 m	0.709084	0.000009	2.06	2.05	Caved	One mollusc fragment
Utsira Fm	600 m	0.709069	0.000008	2.57	2.54	Caved	One mollusc fragment
Utsira Fm	600 m	0.709062	0.000009	3.45	2.78	Caved	One mollusc fragment
Utsira Fm	610 m	0.709075	0.000009	2.34	2.33	Caved	One mollusc fragment
Utsira Fm	610 m	0.709070	0.000010	2.52	2.50	Caved	One mollusc fragment
Eir Fm	620 m	0.709054	0.000009	4.10	3.88	Caved	One mollusc fragment
Eir Fm	620 m	0.709087	0.000008	1.94	1.93	Caved	One mollusc fragment
Eir Fm	630 m	0.709070	0.000009	2.52	2.50	Caved	One mollusc fragment
Eir Fm	630 m	0.709033	0.000009	5.11	5.09	Caved	One mollusc fragment
Eir Fm	640 m	0.708823	0.000009	12.71	12.63		One mollusc fragment
Eir Fm	640 m	0.708815	0.000009	13.08	12.98		One mollusc fragment
Eir Fm	650 m	0.708860	0.000009	11.01	10.84		One mollusc fragment

Eir Fm	650 m	0.708858	0.000009	11.06	10.91		One mollusc fragment
Eir Fm	660 m	0.708848	0.000007	11.41	11.30		One mollusc fragment
Eir Fm	660 m	0.708824	0.000013	12.67	12.58		One mollusc fragment
Eir Fm	670 m	0.708842	0.000009	11.66	11.67		One mollusc fragment
Eir Fm	670 m	0.708850	0.000008	11.34	11.22		One mollusc fragment
Eir Fm	680 m	0.708778	0.000008	15.12	15.06		One mollusc fragment
Eir Fm	680 m	0.708843	0.000009	11.61	11.59		One mollusc fragment
Eir Fm	690 m	0.708816	0.000008	13.03	12.93		One mollusc fragment
Eir Fm	690 m	0.708819	0.000009	12.89	12.80		One mollusc fragment
Eir Fm	700 m	0.708806	0.000008	13.52	13.51		One mollusc fragment
Eir Fm	700 m	0.708782	0.000009	14.98	14.97		One mollusc fragment
Eir Fm	710 m	0.708807	0.000009	13.45	13.43		One mollusc fragment
Eir Fm	710 m	0.708802	0.000008	13.88	13.94		One mollusc fragment
Eir Fm	720 m	0.708818	0.000009	12.93	12.84		One mollusc fragment
Eir Fm	720 m	0.708804	0.000008	13.70	13.69		One mollusc fragment
Eir Fm	730 m	0.708842	0.000008	11.66	11.67		One mollusc fragment
Eir Fm	730 m	0.708820	0.000009	12.85	12.76		One mollusc fragment
Eir Fm	740 m	0.708827	0.000008	12.49	12.45		One mollusc fragment
Eir Fm	740 m	0.708736	0.000008	16.19	15.75		One mollusc fragment
Eir Fm	750 m	0.708536	0.000008	18.76	18.68	Reworked?	One mollusc fragment
Eir Fm	750 m	0.708695	0.000007	16.97	16.41	Reworked?	One mollusc fragment
Skade Fm	760 m	0.708907	0.000008	9.25	9.39	Caved	One mollusc fragment
Skade Fm	760 m	0.708619	0.000008	17.74	17.64		Two mollusc fragments
Skade Fm	770 m	0.708747	0.000009	15.94	15.57	Caved?	One mollusc fragment
Skade Fm	770 m	0.708787	0.000009	14.79	14.85	Caved?	Three small mollusc fragments
Skade Fm	780 m	0.708637	0.000009	17.55	17.39		One mollusc fragment
Skade Fm	780 m	0.708477	0.000009	19.70	19.46		One mollusc fragment
Skade Fm	790 m	0.708479	0.000009	19.66	19.43		One mollusc fragment
Skade Fm	790 m	0.708462	0.000007	19.96	19.66		Three small mollusc fragments
Skade Fm	800 m	0.708439	0.000009	20.31	20.00		One mollusc fragment
Skade Fm	800 m	0.708430	0.000009	20.44	20.14		Two small mollusc fragments
Skade Fm	810 m	0.708395	0.000009	21.0	20.81		One mollusc fragment
Skade Fm	810 m	0.708467	0.000009	19.89	19.59		One mollusc fragment
Skade Fm	820 m	0.708445	0.000007	20.22	19.90		One mollusc fragment
Skade Fm	820 m	0.708429	0.000009	20.45	20.15		Three small mollusc fragments
Skade Fm	830 m	0.708312	0.000009	22.91	22.08		One mollusc fragment
Skade Fm	830 m	0.708332	0.000008	22.36	21.79		One mollusc fragment

Skade Fm	860 m	0.708340	0.000008	22.14	21.68		One mollusc fragment
Skade Fm	860 m	0.708382	0.000009	21.22	21.06		One mollusc fragment
Skade Fm	870 m	0.708301	0.000009	23.16	22.23		One mollusc fragment
Skade Fm	870 m	0.708334	0.000009	22.30	21.76		One mollusc fragment
Skade Fm	880 m	0.708345	0.000009	22.03	21.61		Two mollusc fragments
Skade Fm	880 m	0.708299	0.000008	23.21	22.26		Two mollusc fragments
Skade Fm	900 m	0.708350	0.000009	21.91	21.53		One mollusc fragment
Skade Fm	900 m	0.708347	0.000009	21.98	21.58		Two mollusc fragments
Skade Fm	910 m	0.708240	0.000010	24.28	23.25		One mollusc fragment
Skade Fm	910 m	0.708342	0.000009	22.09	21.65		One mollusc fragment
Skade Fm	920 m	0.708329	0.000009	22.45	21.83		One mollusc fragment
Skade Fm	920 m	0.708318	0.000009	22.76	21.98		Two mollusc fragments
Skade Fm	930 m	0.708310	0.000008	22.95	22.11		One mollusc fragment
Skade Fm	930 m	0.708315	0.000008	22.84	22.04		One mollusc fragment
Skade Fm	940 m	0.708333	0.000008	22.33	21.78		Two mollusc fragments
Skade Fm	940 m	0.708300	0.000009	23.18	22.24		One mollusc fragment
Skade Fm	950 m	0.708282	0.000008	23.56	22.52		One mollusc fragment
Skade Fm	950 m	0.708258	0.000009	23.99	22.93		One mollusc fragment
Skade Fm	960 m	0.708274	0.000009	23.70	22.65		Two mollusc fragments
Skade Fm	960 m	0.708263	0.000009	23.90	22.84		One mollusc fragment
Skade Fm	970 m	0.708229	0.000009	24.45	23.47		One mollusc fragment
Skade Fm	970 m	0.708216	0.000009	24.64	23.73		One mollusc fragment
Skade Fm	980 m	0.708229	0.000007	24.45	23.47		Two mollusc fragments
Skade Fm	980 m	0.708227	0.000009	24,48	23.51		Two mollusc fragments
Ull Fm	1000 m	0.708228	0.000009	24.47	23.49		Three small mollusc fragments
Ull Fm	1010 m	0.708223	0.000009	24.54	23.59		Two mollusc fragments
Ull Fm	1010 m	0.708218	0.000008	24.61	23.69		Three mollusc fragments

Table 1: Strontium isotope data from well 25/3-1. The samples were analysed at the University of Bergen. Sr ratios were corrected to NIST 987 = 0.710248. Numerical ages are derived from the SIS Look-up Tables of Howarth and McArthur (1997, 2004). NIST = National Institute for Standard and Technology. DC means ditch-cuttings.

Lithology

Ull formation (informal; Upper Oligocene; 1010 to 990 m (log))

Coarse- to fine grained sand dominates the samples from the Ull formation (informal). Clay and silt are also common in some parts. Quartz dominates the sand fraction, but glauconite and minor mica and mollusc fragments are recorded throughout (Fig. 2).

Skade Formation (Lower Miocene; 990 m (log) to 760 m)

Coarse- to fine grained, mainly quartzose sand, dominate throughout this succession. Glauconitic sand is also common in the lower and the upper part of the unit, and minor mica is recorded in the sand fraction throughout. Clay and silt are also common in some parts. Proportions of lignite coal and mollusc fragments vary from common to sparse throughout the succession. However, the lignite coal is mainly concentrated in the middle part (Fig. 2).

Eir formation (informal; Middle Miocene; 760 to 620 m)

The lower part of the unit is dominated by clay and silt. The upper, main part is dominated by coarse- to fine grained sand. Quartz dominates the sand fraction with minor glauconite and mica. Lignite coal and mollusc fragments are quite common throughout the upper, main part of the Eir formation (informal; Fig. 2).

Utsira Formation (Upper Miocene and Lower Pliocene; 620 to 490 m)

The Utsira Formation by dominated by sand with minor clay and silt. Quarts dominates the sand fraction, but glauconite is also common in parts of the section. Lignite coal is quite common in the lower part and mollusc fragments are common throughout (Fig. 2).

Naust formation (still informal in the North Sea area; mainly Gelasian; 490 to 400 m)

The ditch cutting samples in this unit contain a clay-rich diamicton with sand, pebbles of crystalline rocks and common mollusc fragments. The sand fraction is dominated by quartz (Fig. 2).

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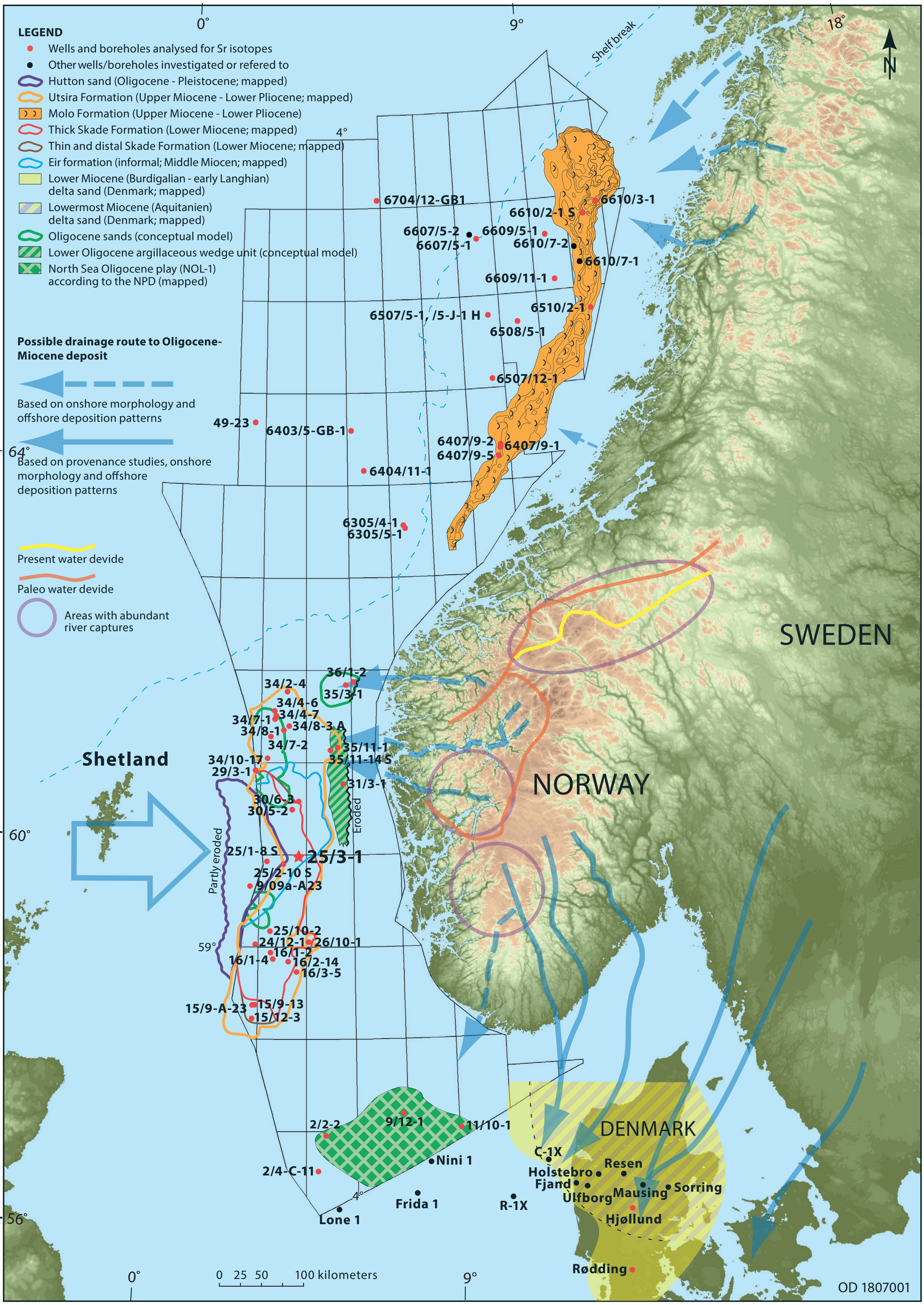
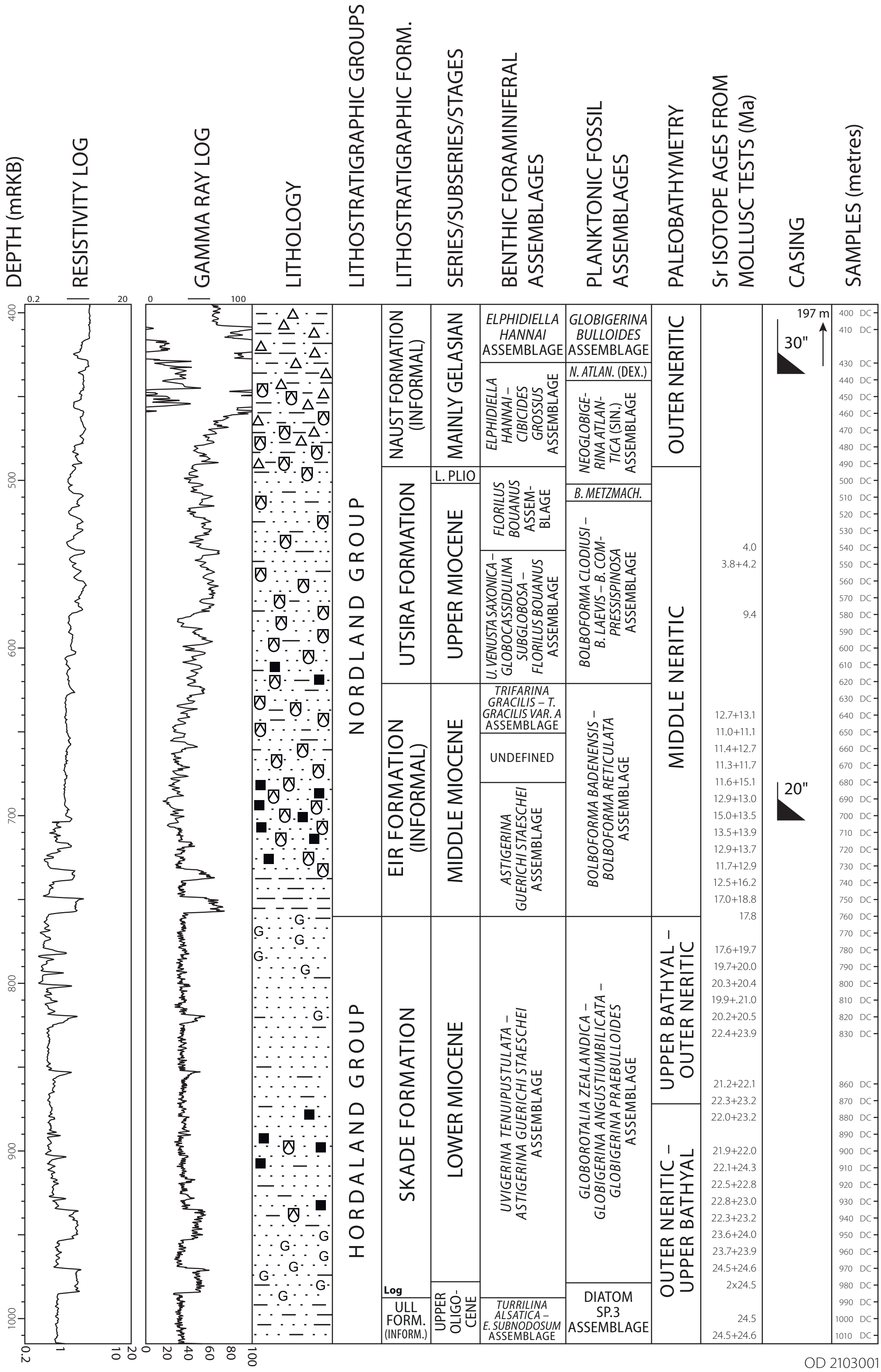


Fig. 1: The location of well 25/3-1 shown on a map showing wells and boreholes containing Oligocene to Upper Pliocene - Pleistocene deposits (modified after Eidvin et al., 2013, 2014). The extent of the Utsira, Eir and Skade formations in the North Sea is according to NPD factpages. The extent of the Molo Formation is after Bullimore et al. (2005) and the extent of the Hutton sand (informal) is after Gregersen and Johannessen (2007). The extent of the North Sea Oligocene play (NOL-1) is according to the Norwegian Petroleum Directorate web page (www.npd.no). Provenance study is after Olivarius et al. (2014) and topographic map is after Olesen et al. (2010).

WELL 25/3–1



Sea floor = 136 metres below rig floor (mRKB)
DC = Ditch cuttings
gAPI = American Petroleum Institute gamma ray units

△ = Ice rafted pebbles
G = Abundant glauconite
■ = Common lignite coal
Ö = Common molluscs and mollusc fragments

Fig. 2: Well summary figure including resistivity and gamma ray logs, lithostratigraphic units, series/subseries/stage, benthic foraminiferal assemblages, planktonic fossil assemblages, paleobathymetry, strontium isotope ages and analysed samples for the investigated sequence in well 25/3-1 (Upper Oligocene to Upper Pliocene-Pleistocene (mainly Gelasian).