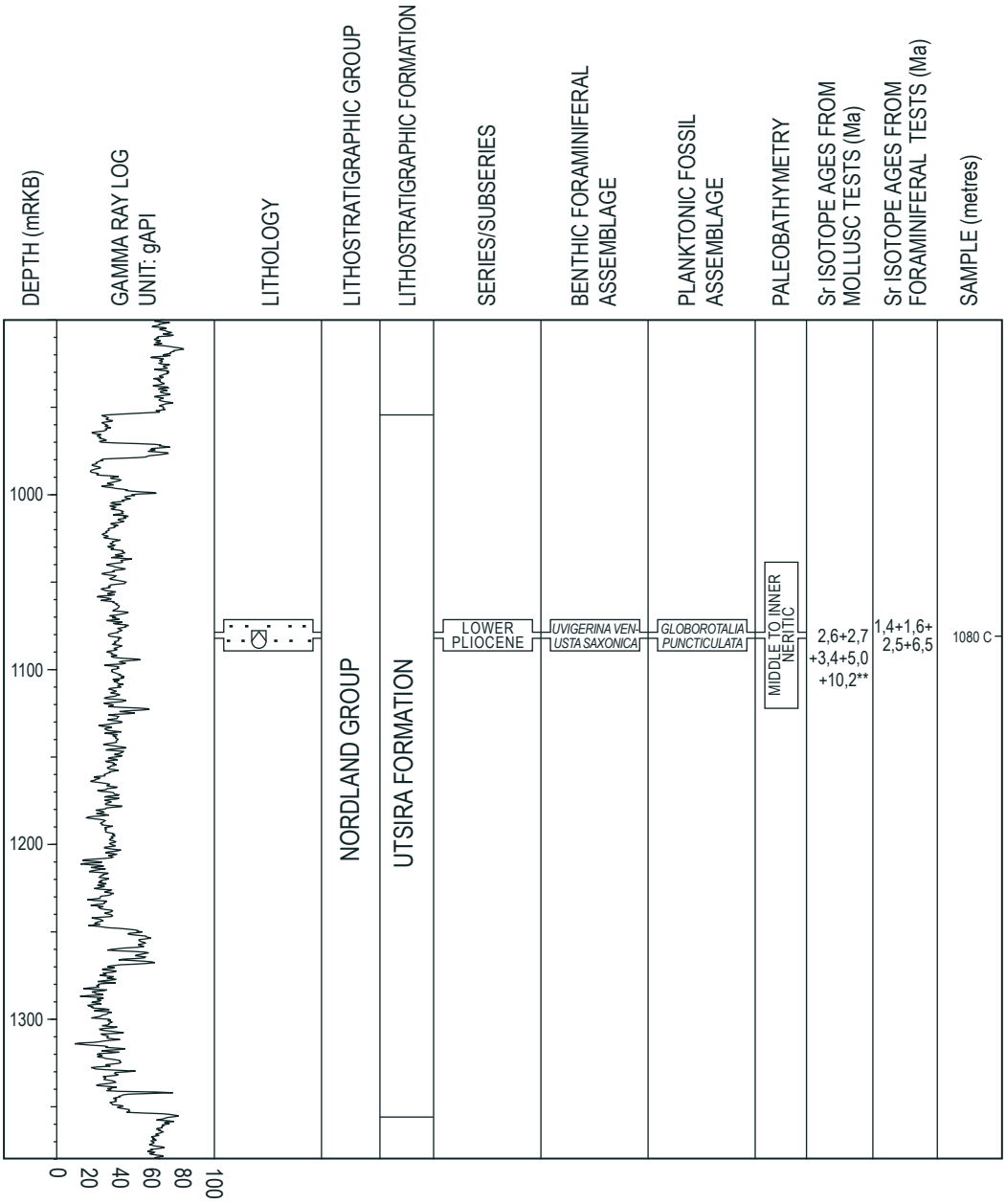
WELL 15/9-A-23



Sea floor = 160 metres below rig floor (mRKB)
C = Core
gAPI = American petroleum Institute gamma ray units
⌓ = Abundant molluscs or mollusc fragments
** = Reworked

OD 1206037

Fig. 1: Well summary figure including gamma ray log, lithology, lithostratigraphic units, series/subseries, benthic foraminiferal assemblages, planktonic fossil assemblage, paleobathymetry, strontium isotope ages and analysed samples for the investigated core in well 15/9-A-23 (Lower Pliocene, modified after Eidvin & Rundberg 2007).

Lower Pliocene in well 15/9-A-23

Modified after Eidvin & Rundberg (2007).

In well 15/9-A-23 (58º22'02.05"N, 01º54'32.06"E, Map 1), the upper part of the Utsira Formation was sampled with a short conventional core (1088.5-1079 m). We analysed the core with one sample (1080 m) which we gave an Early Pliocene age based on analyses of benthic and planktonic foraminifera and Sr isotopes (Fig. 1). A detailed description of this sample (including fossil chart) was presented in Eidvin & Rundberg (2007), but we have carried out additional Sr analyses (Table 1).

Biostratigraphy

Benthic foraminifera of the *Uvigerina venusta saxonica* assemblage and planktonic foraminifera of the *Globorotalia puncticulata* assemblage show that the core sample at 1080 m is of Early Pliocene age. In addition to the nominate species, the benthic foraminiferal fauna includes *M. pseudotepida* and *F. bouanus*. The planktonic foraminiferal fauna also includes *G. bulloides* and *N. atlantica* (sinistral). The benthic foraminiferal assemblage is correlated with the upper part of Subzone NSB 13a or the lower part of Subzone NSB 14a of King (1989, North Sea). An Early Pliocene *G. puncticulata* Zone is described by Weaver & Clement (1986) from the North Atlantic. FAD of *G. puncticulata* occurs at ca. 4.6 Ma and its LAD occurs at ca. 2.5 Ma. This indicates an Early Pliocene age for the sample since the benthic foraminifera can rule out a Late Pliocene age.

Sr isotope stratigraphy

Five samples based on mollusc fragments and four samples based on foraminifera were taken from the core. The obtained $^{87}Sr/^{86}Sr$ ratios displayed surprisingly large scatter which resulted in two of the samples giving Pleistocene ages (1.6-1.5 Ma), and the seven other samples yielding Late Miocene to Early Pliocene ages of 10.2, 6.5, 5.0, 3.4, 2.7, 2.6 and 2.5 Ma (Table 1a and b, Fig. 1). The variation could be explained from a combination of the fact that the most of the values fall within the flat part of the $^{87}Sr/^{86}Sr$ curve where the corresponding ages are less precise, analytical error or reworking of tests. However, the mean age is of approximately 4 Ma (Early Pliocene), and that fits very well with the biostratigraphical correlations.

Well 15/9-A-23

Litho. Unit	Sample (core)	Corrected $^{87/86}Sr$	2S error	Age (Ma)	Comments	Analysed fossils
Utsira Fm	1080 m	0.708884	0.000009	10.19	Reworked	Two mollusc fragments
Utsira Fm	1080 m	0.709068	0.000009	2.62		Three mollusc fragments
Utsira Fm	1080 m	0.709113	0.000009	1.35		23 tests of *Elphidium haagensis*
Utsira Fm	1080 m	0.708964	0.000008	6.46		19 tests of *F. bouanus*
Utsira Fm	1080 m	0.709098	0.000009	1.6		34 tests of *E. haagensis, C. pliocarinata, C. teretis, U. venusta saxonica, G. bulloides, N. atlantica* (sinistral)
Utsira Fm	1080 m	0.709071	0.000009	2.48		32 tests of *E. haagensis, C. pliocarinata, C. teretis, U. venusta saxonica, G. bulloides, F. boueanus*

Table 1a: Strontium isotope data from well 15/9-A-23. The samples were analysed at the University of Bergen. Sr ratios were corrected to NIST 987 = 0.710248. The numerical ages were derived from the SIS Look-up Table Version 3:10/99 of Howard & McArthur (1997). NIST = National Institute for Standard and Technology. Modified after Eidvin & Rundberg (2007).

Well 15/9-A-23 (new analyses)

Litho. Unit	Sample (core)	Corrected $^{87/86}$Sr	2S error	Age (Ma)	Analysed fossils
Utsira Fm	1080 m	0.709067	0.000009	2.73	One mollusc fragments
Utsira Fm	1080 m	0.709041	0.000008	4.86	One mollusc fragments
Utsira Fm	1080 m	0.709063	0.000008	3.38	One mollusc fragments

Table 1b: New strontium isotope data from well 15/9-A-23 for the current investigation. The samples were analysed at the University of Bergen.

Lithology

The sample contains a medium to fine sand dominated by quartz grains. Minor glauconite and mica are also present. Mollusc fragments are common.

References

Howarth, R. J. & McArthur, J. M., 1997: Statistics for Strontium Isotope Stratigraphy: A Robust LOWESS Fit to Marine Sr-Isotope Curve for 0 to 206 Ma, with Look-up table for Derivation of Numeric Age. *Journal of Geology 105*, 441-456.

Eidvin, T. & Rundberg, Y., 2007: Post-Eocene strata of the southern Viking Graben, northern North Sea; intergrated biostratigraphic, strontium isotopic and lithostratigraphic study. *Norwegian Journal of Geology 87*, 391-450. Available from the internet: http://www.npd.no/Global/Norsk/3-Publikasjoner/Forskningsartikler/Eidvin_and_Rundberg_2007.pdf

King, C., 1989: Cenozoic of the North Sea. *In* Jenkins, D. G. and Murray, J. W. (eds.), *Stratigraphical Atlas of Fossils Foraminifera*, 418-489. Ellis Horwood Ltd., Chichester.

Weaver, P. P. E. & Clement, B. M., 1986: Synchronicity of Pliocene planktonic foraminiferid datums in the North Atlantic. *Marine Micropalaeontology 10*, 295-307.