Data report: Pleistocene diatoms from Sites U1302 and U1303, Orphan Knoll, northwestern Atlantic Ocean[1]

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Chapter contents

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Abstract

Downcore variations of total diatom concentration and diatom assemblages have been studied along the upper 48 meters composite depth (mcd) of the corrected spliced composite section at Integrated Ocean Drilling Program Expedition 303 Sites U1302 and U1303. Diatom concentration varies between 1.0×10^3 and 2.1×10^6 valves/g. The highest diatom values are seen in the lower part, mostly between 35 and 48 mcd. The highly diversified diatom community is composed of ~110 species. The fossil diatom assemblage reflects the complex oceanographic setting in surface waters overlying Sites U1302 and U1303. Arctic/Subarctic components dominate the diatom assemblage, such as *Actinocyclus curvatulus*, *Rhizosolenia hebetata* var. *hiemalis* Bailey, *Thalassiosira antiqua* (Grunow) Cleve-Euler, *Thalassiosira angulata*, the vegetative cell of *Thalassiosira gravida* Cleve, and *Thalassiosira trifulta* G. Fryxell. Moderate influence of coastal waters is reflected by the occurrence of several species of resting spores of *Chaetoceros*, *Actinocyclus octonarius* Ehrenberg, *Coscinodiscus radiatus* Ehrenberg, and *Thalassionema nitzschioides* var. *nitzschioides* (Grunow) Van Heurck. Transport from shallow waters into the hemipelagic realm is mirrored by the presence of *Delphineis karstenii* (Boden) G. Fryxell and *Paralia sulcata* (Ehrenberg) Cleve, whereas *Alveus marinus* (Grunow) Kaczmarska and G. Fryxell and *Fragilariopsis doliolus* (Wallich) Medlin and Sims mainly represent a low-latitude Atlantic signal.

Introduction

The Neogene–Quaternary diatom community of the north central and eastern Atlantic Ocean and the Nordic Seas is well known. Coring during Ocean Drilling Program Legs 151, 161, and 162 provided excellent recovery, allowing a detailed and reliable diatom biostratigraphy to be constructed for the Nordic Seas (Koç and Scherer, 1996; Koç and Flower, 1998; Koç et al., 1999) and the north central Atlantic (Baldauf, 1984, 1987). Less is known, however, about the preserved diatom communities from the high-latitude northwestern Atlantic Ocean. Because of its pelagic character, high rates of Pleistocene sedimentation, and the presence of a highly diversified diatom community (Shipboard Scientific Party, 2005) Sites U1302 and U1303 were chosen for a high-resolution study of the paleoclimatic and paleoceanographic changes that

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occurred in the high-latitude northwestern Atlantic during the last 1.5 m.y. This report presents the diatom concentration and lists the diatom species preserved in the upper 48 meters composite depth (mcd) of the corrected spliced composite section at Sites U1302 and U1303 near Orphan Knoll in the northwestern Atlantic, off Newfoundland.

Methods

For diatom study, we used 2 cm^3 samples taken every 10 cm. For light microscope study, samples were prepared following the method proposed by Schrader and Gersonde (1978). Qualitative and quantitative diatom analyses were done at 1000× magnification using a Zeiss-Axioscope with phase-contrast illumination. Counts were carried out on permanent slides of acid-cleaned material (Mountex mounting medium). Several traverses across the coverslip were examined, depending on valve abundance. At least two coverslips per sample were scanned in this way. Diatom counting of two replicate slides indicated that the analytical error of concentration estimates is ≤15%. The counting procedure and definition of counting units for diatoms to the lowest possible taxonomic level followed those proposed by Schrader and Gersonde (1978).

Sites U1302 and U1303

Sites U1302 and U1303, separated by 5.68 km (50°10′N, 48°38.3′W; water depth = ~3560 m), are located close to Orphan Knoll in the northwestern Atlantic, off Newfoundland. Drilling revealed a very similar stratigraphic sequence at both sites. An almost complete composite section was constructed at Site U1302 spanning the interval 0–107 mcd. The density and magnetic susceptibility records from Sites U1302 and U1303 are remarkably similar and can be easily correlated (Shipboard Scientific Party, 2005).

Sediments at Sites U1302 and U1303 are dominated by varying mixtures of terrigenous components and biogenic debris, primarily quartz, detrital carbonate, and nannofossils; therefore, the most common lithologies are clay, silty clay, silty clay with nannofossils, nannofossil silty clay, silty clay nannofossil ooze, and nannofossil ooze with silty clay (Shipboard Scientific Party, 2005). Dropstones are present throughout the cores. Samples from Sites U1302 and U1303 reveal rich assemblages of calcareous, siliceous, and organic-walled microfossils.

Results and discussion

Approximately 320 samples from the upper 48 mcd of the corrected splice composite section at Sites U1302 and U1303 were studied. Following the North Atlantic diatom zonation proposed by Baldauf (1987), the event indicative of the change from the *Fragilariopsis doliolus* Zone (0–0.69 Ma) to the *Fragilariopsis reinholdii* Zone (0.69–1.88 Ma), which is the last occurrence of *F. reinholdii,* was not observed. *F. reinholdii* is present in a few samples, but because of the rarity of the specimens and sparsity of their occurrence biostratigraphically, these are thought to be reworked, which places the interval examined here entirely within the *F. doliolus* Zone (Baldauf, 1987) (Fig. **F1**).

Diatom concentration varies widely and ranges from 1.0×10^3 to 2.1×10^6 valves/g (average = 1.33×10^5 valves/g) (Table **T1**). The highest diatom concentration is recorded in the lower part, mostly between 35 and 48 mcd (Fig. **F1**). The moderate diatom concentration corresponds well with moderate to low biogenic silica (opal) content at Sites U1302 and U1303 (O. Romero, unpubl. data) and responds to the dominant mixture of terrigenous components (primarily quartz and detrital carbonate) and calcareous debris (Shipboard Scientific Party, 2005)

The diatom community is highly diversified (see the **"Appendix"**). We identified ~110 species of diatoms in the upper 48 mcd of the corrected spliced composite section of Sites U1302 and U1303. On average, the most abundant diatoms are *Thalassiosira angulata* (Gregory) Hasle, *Actinocyclus curvatulus* Janisch and resting spores (RS) of *Chaetoceros* spp. (average relative contribution = 13.4%, 10.5%, and 9.6%, respectively).

The highly diversified diatom assemblage reflects the complex oceanographic setting of surface waters overlying Sites U1302 and U1303. The most abundant diatom group is the Arctic/Subarctic group, composed of *A. curvatulus*, *Rhizosolenia hebetata* var. *hiemalis* Bailey, *Thalassiosira antiqua* (Grunow) Cleve-Euler, *T. angulata*, the vegetative cell of *Thalassiosira gravida* Cleve, and *Thalassiosira trifulta* G. Fryxell (Andersen et al., 2004). The influence of coastal waters is reflected by the occurrence of several species of *Chaetoceros* RS, *Actinocyclus octonarius* Ehrenberg, *Coscinodiscus radiatus* Ehrenberg, and *Thalassionema nitzschioides* var. *nitzschioides* (Grunow) Van Heurck (Romero et al., 2003). Transport from coastal shallow waters into the hemipelagic realm is mirrored by *Delphineis karstenii* (Boden) G. Fryxell and *Paralia sulcata* (Ehrenberg) Cleve (Romero et al., 2003, 2008), whereas *Alveus marinus* (Grunow) Kaczmarska and G.

Fryxell and *F. doliolus* (Wallich) Medlin and Sims mainly represent a tropical/subtropical signal (Romero et al., 2005). The qualitative and quantitative variations of the fossil diatom assemblage at Sites U1302 and U1303 will provide insight into paleoclimatologic and paleoceanographic Pleistocene variability in the high-latitude northwestern Atlantic.

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Figure F1. Total diatom concentration, Sites U1302 and U1303. Biostratigraphy mainly from Baldauf (1987). For comparison, the diatom zonation proposed by Koç and Flower (1998) for the North Atlantic north of 60°N is shown.

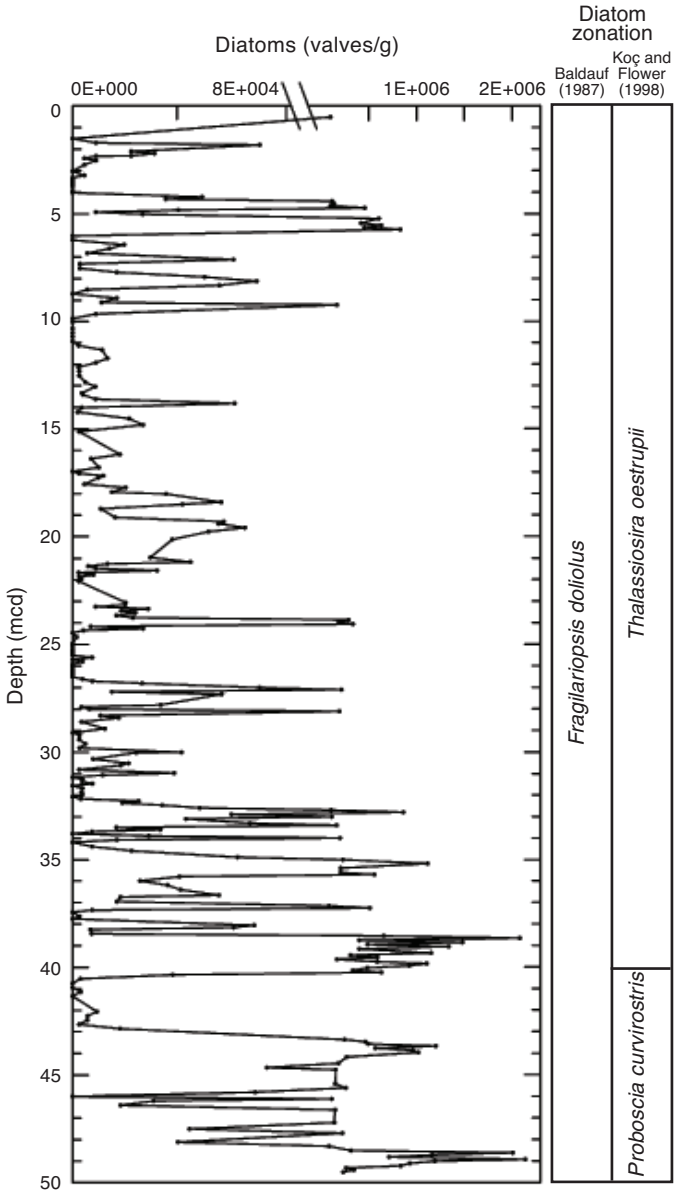

Table T1. Relative contribution of diatoms, Sites U1302 and U1303. This table is available in an **oversized format.**

Appendix

Species list

The following list presents all the species and varieties of diatoms (Bacillariophyta) identified in the upper 48 mcd of the corrected spliced composite section of Sites U1302 and U1303 at the Orphan Knoll in the northwestern Atlantic Ocean. Almost all of species were identified to the lowest possible taxonomic level. For each taxon identified at species level, the author's name, date of the original publication, and published figures are quoted, followed by the work used for its identification in this report.

Actinocyclus curvatulus Janisch
Janisch (in Schmidt et al., 1874–1959), pl. 57, fig. 31
Hustedt (1927–1966), p. 538, fig. 307

Actinocyclus elongatus Grunow
Grunow (1881), pl. 3, fig. 14
Simonsen (1974), p. 21, pl. 20, figs. 1–3

Actinocyclus octonarius Ehrenberg
Ehrenberg (1838), pl. 3, fig. 14
Hustedt (1927–1966), p. 524, fig. 298

Actinoptychus senarius (Ehrenberg) Ehrenberg
Ehrenberg (1838), p. 172, pl. 21, fig. 6
Hasle and Syvertsen (1996), p. 141, pl. 22

Adoneis pacifica G.W. Andrews and P. Rivera
Andrews and Rivera (1987), pp. 1–14

Alveus marinus (Grunow) Kaczmarska and G. Fryxell
Cleve and Grunow (1880), p. 70
Kaczmarska and Fryxell (1996), p. 2, figs. 1–35

Aulacoseira granulata (Ehrenberg) Ralfs in Pritchard
Ehrenberg (1839b), p. 415
Hustedt (1927–1966), p. 248, fig. 104

Aulacoseira islandica (O. Müller) Simonsen
O. Müller (1906), p. 56, pl. 1/(3-), fig. 6
Le Cohu (1996), p. 333, figs. 1–19

Azpeitia neocrenulata (VanLandingham) G. Fryxell and T.P. Watkins
VanLandingham (1968), p. 930
Fryxell et al. (1986), p. 18, figs. 16, 30–2

Azpeitia tabularis (Grunow) G. Fryxell and T.P. Watkins
Schmidt et al. (1874–1959), pl. 59, figs. 20, 22, 23
Fryxell et al. (1986), p. 19, figs. 17, 18–1, 18–5, 30–3, 30–4

Chaetoceros bacteriastroides Karsten
Karsten (1907), p. 390, pl. 44, figs. 2a–2c

Resting spores of *Chaetoceros (Chaetoceros affinis, Chaetoceros compresus, Chaetoceros diadema, Chaetoceros debilis,* and *Chaetoceros* sp. (unidentified)
Rines and Hargraves (1988), pp. 1–196

Cocconeis costata var. *costata* Gregory
Gregory (1855), p. 39, pl. 4, fig. 10
Romero and Rivera (1996), p. 321, figs. 2–16

Coscinodiscus argus Ehrenberg
Ehrenberg (1839a), p. 129
Hasle and Sims (1986), p. 308, figs. 1–7, 33, 34

Coscinodiscus decrescens Grunow
Grunow (in Schmidt et al., 1874–1959), pl. 61, figs. 7–9
Hendey (1964), p. 77

Coscinodiscus marginatus Ehrenberg
Ehrenberg (1844), p. 78
Hasle and Syvertsen (1996), p. 107, pl. 18

Coscinodiscus oculus-iridis Ehrenberg
Ehrenberg (1854), pl. 19, fig. 2
Sancetta (1987), p. 235, pl. 2, figs. 11–14; pl. 3

Coscinodiscus radiatus Ehrenberg
Ehrenberg (1839b), pl. 3, fig. 1
Hasle and Sims (1986), p. 310, figs. 8–32, 35–39

Cymatosira sp.

Cymbella sp.

Delphineis karstenii (Boden) G. Fryxell
Boden (1950), p. 406, fig. 87
Fryxell and Miller (1978), p. 116, figs. 1–10

Diploneis sp.

Eunotia sp.

Fallacia nyella (Hustedt ex Simonsen) D.G. Mann
Hustedt (1927–1966), p. 535, fig. 1571

Fragilariopsis doliolus (Wallich) Medlin and Sims
Wallich (1860), p. 48, pl. 2, fig. 19
Hasle and Syvertsen (1996), p. 303, pl. 69

Fragilariopsis fossilis (Frenguelli) Medlin and P.A. Sims
Frenguelli (1949), p. 118, pl. 1, fig. 7
Medlin and Sims (1993), p. 332

Fragilariopsis oceanica (Cleve) Hasle
Cleve (1873), p. 22, pl. 4
Hasle (1965), p. 11, pl. 1, figs. 15–19; pl. 2, figs. 6, 7

Fragilariforma sp.

Gomphonema sp.

Grammatophora sp.

Hemidiscus cuneiformis Wallich
Wallich (1860), p. 42, pl. 2, figs. 3, 4
Fryxell et al. (1986), p. 25, fig. XXVI

Lioloma sp.

Navicula distans (Wm. Smith) Ralfs in Pritchard
Smith (1853), p. 56, pl. 18, fig. 169
Hendey (1964), p. 203, pl. 17, fig. 13

Nitzschia interruptestriata (Heiden) Simonsen
Heiden and Kolbe (1928), p. 665, pl. 7, fig. 150
Simonsen (1974), p. 52, pl. 36, figs. 9–11; pl. 37; pl. 38, figs. 1–7

Nitzschia sp.

Odontella aurita (Lyngbye) C.A. Agardh
Lyngbye, 1819, p. 182, pl. 62
Hasle and Syvertsen (1996), p. 236, pl. 49

Paralia sulcata (Ehrenberg) Cleve
Ehrenberg (1838), p. 170, pl. 21, fig. 5
Crawford (1979), p. 201, figs. 1–33

Pinnularia sp.

Planktoniella sol (Wallich) Schütt
Wallich (1860), p. 38, pl. 2, fig. 1
Hargraves and Schmid (1992), p. 222, pl. 1, figs. 1–6; pl. 2, figs. 7–18

Porosira glacialis (Grunow) Jørgensen
Grunow (1884), p. 108, pl. 5, fig. 32
Hasle and Syvertsen (1996), p. 236, pl. 49

Proboscia alata (Brightwell) Sundström
Brightwell (1858), p. 95, pl. 5, fig. 8
Sundström (1986), p. 99, figs. 258–266

Proboscia curvirostris Jousé
Jousé, 1959, p. 48, pl. 2, fig. 17;
Akiba and Yanagisawa (1986), p. 497, pl. 42, figs. 1, 2; pl. 45, figs. 1–6

Psammodyction panduriforme (Gregory) D.G. Mann
Gregory (1857), p. 80, pl. 1, fig. 45
Mann (in Round et al., 1990), p. 612, figs. a–i

Rhizosolenia acuminata (H. Peragallo) H. Peragallo in H. and M. Peragallo
Peragallo (1892), p. 110, pl. 2, fig. 4
Sundström (1986), p. 69, figs. 31, 165–176

Rhizosolenia bergonii H. Peragallo
Peragallo (1892), p. 110, pl. 2, fig. 5
Sundström (1986), p. 72, figs. 32, 33, 177–189

Rhizosolenia borealis Sundström
Sundström (1986), p. 30, figs. 10, 11, 80–87

Rhizosolenia hebetata f. *hiemalis* Bailey
Bailey (1856), p. 5, pl. 1, figs. 18, 19
Hasle and Syvertsen (1996), p. 149, pl. 27

Roperia tesselata (Roper) Grunow
Roper (1858), p. 19, pl. 3, fig. 1
Fryxell et al. (1986), p. 24, figs. XXV, XXXII–3, 4

Stephanodiscus astraea (Ehrenberg) Grunow
Ehrenberg (1845), p. 267
Gasse (1986), p. 167, pl. V, figs. 1, 2

Stephanopyxis grunowii Grove and Stuart
Grove and Stuart (in Schmidt et al., 1874–1959), pl. 130, figs. 1–5
Harwood (1989), p. 81, pl. 2, figs. 1–4

Thalassionema nitzschioides var. *nitzschioides* (Grunow) Van Heurck
Grunow (1862), p. 403, pl. 5, fig. 18
Hallegraeff (1986), p. 58, figs. 1–4

Thalassiosira angulata (Gregory) Hasle
Gregory (1857), p. 498, pl. 10, fig. 43
Hasle and Syvertsen (1996), p. 51, pl. 4

Thalassiosira antiqua (Grunow) Cleve-Euler
Cleve-Euler (1952), p. 72, fig. 119
Akiba (1986), p. 445, pl. 12, figs. 1, 3, 4

Thalassiosira bipora Shiono 2000
Shiono (2000), p. 139, figs. 25–44

Thalassiosira eccentrica (Ehrenberg) Cleve
Ehrenberg (1839b), p. 146
Fryxell and Hasle (1972), p. 300, figs. 1–18

Thalassiosira ferelineata Hasle and G. Fryxell
Hasle and Fryxell (1977), p. 26, figs. 46–53

Thalassiosira gravida Cleve (vegetative cell)
Cleve (1886), p. 12, pl. 2, figs. 14–16
Syvertsen (1977), p. 102, pl. 1, figs. 3, 4; pl. 3, fig. 13

Thalassiosira gravida (spore)
Syvertsen (1977), p. 102, pl. 4

Thalassiosira grunowii (Grunow in Schmidt et al.) F. Akiba and Y. Yanagisawa
Grunow (in Schmidt et al., 1874–1959), p. 59, fig. 1
Akiba and Yanagisawa (1986), p. 493, pl. 27, fig. 5; pl. 29, figs. 1–8b; pl. 30, figs. 1–10

Thalassiosira jouseae F. Akiba
Akiba (1986), p. 457, pl. 6, figs. 8–10

Thalassiosira leptopus (Grunow) Hasle and G. Fryxell
Grunow (in Van Heurck, 1883), pl. 131, figs. 5, 6
Hasle and Fryxell (1977), p. 20, figs. 1–14

Thalassiosira lineata Josué
Josué (1968), p. 13, pl. 1, figs. 1, 2
Hasle and Fryxell (1977), p. 22, figs. 15–25

Thalassiosira nodulolineata (Hendey) Hasle and G. Fryxell
Hendey (1958) p. 39, pl. 5, figs. 4, 5
Hasle and Fryxell (1977), p. 35, figs. 86–93

Thalassiosira oestrupii var. *oestrupii* (Ostenfeld) Hasle
Ostenfeld (1900), p. 52
Hasle (1972), p. 544, figs. 1–10

Thalassiosira oestrupii var. *venrickae* G. Fryxell and Hasle
Fryxell and Hasle (1980), p. 810, figs. 11–19

Thalassiosira nordenskioeldii Cleve 1873
Cleve (1873), p. 7, pl. 1, fig. 1
Hasle and Syvertsen (1996), p. 56, pl. 5

Thalassiosira symmetrica G. Fryxell and Hasle
Fryxell and Hasle (1972), p. 312, figs. 37–46

Thalassiosira trifulta G. Fryxell
Fryxell and Hasle (1979), p. 16, figs. 1–24