

IODP EXPEDITION 306: NORTH ATLANTIC CLIMATE II

SITE U1314 SUMMARY

Hole U1314A Latitude: 56°21.883'N, Longitude: 27°53.309'W

Hole U1314B Latitude: 56°21.896'N, Longitude: 27°53.311'W

Hole U1314C Latitude: 56°21.896'N, Longitude: 27°53.287'W

Water depth: 2799.6 m

IODP Site U1314 (Scientific Prospectus Site GAR1B) is located on the southern Gardar Drift in a water depth of 2800 m. Close to the location of Site U1314, a 33 m *Marion Dufresne* core (MD99-2253) was collected on the crest of the Gardar Drift in 1999. The MD99-2253 piston core has a high sedimentation rate of ~9 cm/ky for the last glacial cycle and well-defined planktonic $\delta^{18}\text{O}$ and geomagnetic paleointensity records. During ODP Leg 162, Site 983 and Site 984 were drilled off Iceland on the northern part of the Gardar and Bjorn Drifts, respectively. These sites have mean Pleistocene sedimentation rates in the 10-15 cm/ky range and have produced high resolution climatic and geomagnetic records. ODP Sites 983 and 984, however, are located outside the main IRD belt and do not contain a robust detrital carbonate (Heinrich layer) signal. Furthermore, both sites are at shallower water depths (<2000 m) than Site U1314 and therefore monitor intermediate water but not NADW. Site U1314, on the other hand, is located (1) close enough to the IRD belt to record the Heinrich-type detrital layers that monitor ice sheet instability, and (2) in water depth of 2800 m allowing a high-resolution monitoring of NADW and its short-term (sub-) millennial variability.

Three holes (Holes U1314A, U1314B, and U1314C) were cored with the Advanced Piston Coring (APC) system and nonmagnetic core barrels to a maximum depth of 258.4 mbsf, 279.5 mbsf, and 207.7 mbsf, respectively. The average recovery was 102.7%. “Drill over” technique was not required for the three holes.

The sedimentary sequence at Site U1314 mainly consists of nannofossil- and clay-rich sediments with minor and varying proportions of diatoms and foraminifers. Only one lithostratigraphic unit has been defined at Site U1314, which spans the late Pliocene to Holocene time interval. In particular, two sets of lithologies can be identified: (1) predominantly

nannofossil oozes enriched in biogenic (mainly diatoms and foraminifers) and terrigenous (principally clay minerals, quartz, opaque minerals, and calcite) components, and (2) terrigenous silty clay with a varying proportion of calcareous and siliceous organisms. The sediment varies in color mainly from very dark gray to light gray to hues of greenish gray. Slight to moderate bioturbation is typical for most of the section. Horizontal and parallel bedding planes and color contacts without erosional relief suggest that there is not visible evidence of significant sediment disturbance by natural processes. Sand- and gravel-sized sediment, common at Site U1314 from 0 to 240 mbsf, provides direct evidence of ice-rafting and documents the influence of Pliocene-Pleistocene glaciations in this region. Based on the occurrence of mafic igneous and felsic igneous dropstones as well as sand-sized, hematite-stained quartz, Iceland and Greenland are probable source areas of the IRD material.

Site U1314 yields abundant assemblages of calcareous and siliceous microfossils spanning the late Pliocene to Holocene. Sedimentation rates based on microfossil datums and paleomagnetism indicate decreasing rates from approximately 11-11.5 cm/ky during the late Pliocene to ~7.0-7.5 cm/ky during the Pleistocene. Polar and subpolar species dominate the assemblages, with a subordinate amount of transitional species present as well.

Calcareous nannofossils are abundant and generally well-preserved throughout the section. Minor amounts of Cretaceous and Paleogene reworked nannofossils occur in all holes. Samples with increased amounts of reworked material typically contain coarser sediment and reduced abundances of in-situ nannofossils. Late Pliocene discoasters are rare, but present, and can be used biostratigraphically, even though they are considered warm-water species. Generally well-preserved planktonic foraminifers are the dominant component in the sand fraction of most core catcher (CC) samples, with lower proportions of benthic foraminifers, ostracods, siliceous microfossils, and IRD. The fauna consists of species typical for transitional to subpolar provinces in the Pleistocene and Pliocene. *N. pachyderma* (sin) is dominant in several of the glacial samples.

Radiolarians show a great variation in species and abundances among the three holes. The state of preservation is generally good in all holes. *Cycladophora davisiana* is found in most samples, and with a first common occurrence in Samples U1314A-25H-CC and U1314B-24H-

CC. This species has a first common abundance in the North Atlantic at about 2.6 Ma. *Cycladophora sakaii* is commonly found in Samples 25H-CC in Holes U1314A and U1314B. In the North Pacific, *C. sakaii* evolves into *C. davisiana* at about 2.6 Ma. This is the first documented occurrence of *C. sakaii* in the North Atlantic. The last occurrence of *Spongaster ?tetras*, 2.6 Ma, is found in Samples U1314A-28H-CC and U1314B-27H-CC.

Abundant and diverse boreal to sub-arctic diatom flora, with a minor input of warm-water species, are present in all holes. The exception is the interval around U1314A-13H-CC to 15H-CC, where few or rare diatoms coincide with high content of siliciclastic material. The preservation is generally moderate to good, with a deteriorating trend downhole, as well as poor preservation coinciding with lithics-rich intervals. The flora is dominated by long pennate specimens, as well as resting spores of *Chaetoceros* and fragments of big *Coscinodiscus* species.

The magnetostratigraphy at Site U1314 was constructed on the basis of continuous measurements of the natural remanent magnetization (NRM) after alternating field (AF) demagnetization at a peak field of 20 mT. NRM intensities after 20 mT AF demagnetization are in the range of 10^{-1} to 10^{-2} A/m. These values are considerably greater than at Sites U1312 and U1313, owing to a higher magnetic mineral content. Site U1314 provides a very good record of the Brunhes, Matuyama, and the upper part of the Gauss. The Brunhes/Matuyama reversal occurs at 57.3 ± 0.1 mbsf in Hole U1314A, 56.6 ± 0.1 mbsf in Hole U1314B, and 57.7 ± 0.1 mbsf in Hole U1314C. The deepest magnetic polarity interval recorded at Site U1314 corresponds to the top normal interval of the Gauss (subchron 2An.1n; 2.58 Ma). Several short geomagnetic intervals are present in the paleomagnetic record, such as the Cobb Mountain and the Reunion event. The magnetostratigraphy is consistent with the biostratigraphy throughout the section.

Stratigraphic correlation was straightforward at Site U1314 because most of the sediment physical properties show prominent short-wavelength amplitude variations related to changes in lithology. For depth-shifting the cores, we relied mainly on between-hole correlation of distinctive magnetic susceptibility and natural gamma ray variations. These correlations were confirmed to be consistent with geomagnetic polarity reversals recorded in the paleomagnetic inclination. The resulting mcd scale is well resolved, and the spliced section is complete down to 281 mcd. Because of core disturbance in the upper part of Hole U1314A, the splice in the

interval 0-188.30 mcd was built from Holes U1314B and U1314C, with the exception of a short interval (65.80-69.50 mcd) where an undisturbed section of Core U1314A-8H was incorporated into the composite section. From 188.30 to 300 mcd the splice was constructed from Holes U1314A and U1314B, because Hole U1314C was drilled only to 222 mcd. The two deepest cores U1314B-29H and 30H, which span an interval not cored in Holes U1314A or U1314C, were appended to the splice. A growth factor of 1.08 is calculated by linear regression for the three holes at Site U1314, indicating an 8% increase in mcd relative to mbsf.

The ionic composition of the pore waters at Site U1314 was measured between Cores U1314A-1H and 12H. Pore water alkalinity increases downhole from 5.34 to 7.46 mM. Ca^{2+} and Mg^{2+} concentrations decrease downhole from 8.4 to 5.2 mM and 48.7 to 37.4 mM, respectively. Fe^{2+} concentrations are variable with the lowest value (6.5 μM) measured at 36.4 mbsf, which coincides with more abundant darker lithologies. Ba^{2+} concentration is higher at Site U1314 than at the other IRD sites, ranging from 17 to 18.3 μM . Mn^{2+} concentration ranges from 46.8 to 15.9 μM and shows a rapid decrease downhole between 17.4 and 36 mbsf. H_4SiO_4 concentration increases with depth from 487.6 to 571.9 μM .

Calcium carbonate concentrations in the sediments of Hole U1314A range from 3.7 to 70.5 wt%. The average carbonate value linearly shifts from 20 wt% at 250 mbsf towards 40 wt% near the top. CaCO_3 values show a good correlation to Lightness (L^*) data throughout the section. Total organic carbon (TOC) varies between <0.1 and 0.5 wt% with an average of 0.2 wt%. The downhole TOC variation is similar to the variability in magnetic susceptibility, suggesting that organic carbon at Site U1314 is primarily of terrigenous origin. Based on initial results from eight samples, solvent extractable organic matter at Site U1314 consists mainly of long-chain, odd-numbered $\text{C}_{25}\text{-C}_{35}$ *n*-alkanes and long-chain $\text{C}_{37}\text{-C}_{40}$ alkenones. Except for one sample from the upper Pliocene, all Pleistocene samples show a distinct prevalence of *n*-alkanes relative to alkenones, confirming the assumption of a mainly terrigenous origin of the organic matter at Site U1314. Alkenone derived sea-surface temperatures vary between ~10 and 13°C.

Physical property measurements at Site U1314 included non-destructive measurements of magnetic susceptibility, density, p-wave velocity, and natural gamma radiation. Working sections were used to measure moisture and density (MAD) and compressional P-wave velocity.

These properties are positively correlated consistent with the terrigenous nature of the sediment. The magnetic susceptibility records, for example, show a highly variable record attributed to lithologic and/or mineralogic changes; multiple excursions towards high values are generally associated with IRD layers.

At Site U1314, a complete upper Pliocene to Holocene sequence, characterized by high sedimentation rates of 7 to >11 cm/ky has been recovered. Due to its location close to the IRD belt and within the North Atlantic Deep Water, as well as its high potential for paleomagnetic and isotopic age control, this section will be used to establish a high-resolution (millennial to submillennial) environmental record of sea-surface and bottom-water characteristics and a detrital (Heinrich-type) stratigraphy for the past ~ 2.7 Ma.