2. EXPLANATORY NOTES[1]

Shipboard Scientific Party[2]

Leg 163 used observational and analytical techniques similar to those used on Leg 152. Therefore, we report here only the techniques that differ from those employed on Leg 152. This information should help the reader understand the observations on which our preliminary conclusions have been based and also help the interested investigator select samples for further analysis. The reader should refer to the Leg 152 *Initial Reports of the Ocean Drilling Program* (Larsen, Saunders, Clift, et al., 1994) for details of drilling operations and core curation procedures.

AUTHORSHIP OF SITE CHAPTERS

The separate sections of the site chapters were written by the following shipboard scientists (authors are listed in alphabetical order):

Site Summary: Duncan, H.C. Larsen
Background and Objectives: Duncan, H.C. Larsen
Operations: Grout, Allan
Lithostratigraphy: Clift, Krissek, Kudless
Biostratigraphy: Aita
Paleomagnetism: Hooper, Nakasa, Rehacek
Structural Geology: Clift, Hurst, Le Gall
Igneous Petrology: Allan, Arndt, Cashman, Fitton, L. Larsen, Lesher, Niu, Philipp, Saunders, Teagle, Tegner
Physical Properties: Bücker, Cerney, Planke

The summary core descriptions ("barrel sheets") and photographs of each core are in the volume section following the site chapters.

SHIPBOARD SCIENTIFIC PROCEDURES

Leg 163 shipboard scientific procedures of labeling and archiving core and samples followed that of Leg 152 (Larsen, Saunders, Clift, et al., 1994). As on Leg 152, the following coring abbreviations were used: R = rotary core barrel (RCB), H = hydraulic piston core (APC, or advanced hydraulic piston core), and X = extended core barrel (XCB). As on Leg 152, we recorded sample recovery types as follows: B = drill-bit recovery, C = center-bit recovery, I = in situ water sample, S = sidewall sample, W = washed-core recovery, and M = miscellaneous material.

CORE HANDLING

Sediments

Leg 163 followed procedures similar to those of Leg 152 (Larsen, Saunders, Clift, et al., 1994) in handling and archiving sedimentary cores. Physical properties samples were denoted as "PP." After the end of the cruise, the Leg 163 cores were transferred from the ship in refrigerated air-freight containers to cold storage at the Bremen Repository of the Ocean Drilling Program, at Bremen, Germany.

Igneous and Metamorphic Rocks

Leg 163 followed procedures similar to those of Leg 152 (Larsen, Saunders, Clift, et al., 1994) in handling and archiving igneous and metamorphic rock cores. As with the other Leg 163 cores, these are housed at the Bremen Repository.

LITHOSTRATIGRAPHY

Because Leg 163 operated in the same geographic area as Leg 152 and we anticipated the recovery of similar sediment lithologies, the visual core description forms (VCDs), barrel sheets, and sediment classifications were prepared using the guidelines presented in the Leg 152 *Initial Reports* (Larsen, Saunders, Clift, et al., 1994).

BIOSTRATIGRAPHY

Preliminary age assignments determined during Leg 163 were based on the biostratigraphic analysis of siliceous microfossils. A single group of radiolarians was examined on core-catcher samples. Additional shipboard samples were also observed when more refined age determination was necessary. Other siliceous microfossils (e.g., diatoms and silicoflagellates) and other major microfossil groups (e.g., calcareous nannofossils, planktonic foraminifers, dinoflagellates) were not studied on Leg 163. They will be analyzed and reported by shore-based studies. Sample position and the abundance, preservation, and chronostratigraphic age or biozone for radiolarians were recorded on the barrel sheets for each core. The radiolarian biostratigraphy of Leg 163 was correlated to the chronostratigraphic time scale of Cande and Kent (1992), except for the Paleocene, where the Berggren et al. (1995) time scale was used.

The radiolarian zonation for the Norwegian Sea proposed by Bjørklund (1976) and Goll and Bjørklund (1989) and North Pacific zonations for diatoms (Akiba, 1986; Koizumi, 1992), radiolarians (Foreman, 1975; Sakai, 1980), and nannofossils (Martini, 1971) were used (Fig. 1) for time scale correlations to Cande and Kent's (1992) scale. Correlation of the low- and mid-latitude biostratigraphic zonations for the Paleogene and uppermost Cretaceous with the Cande and Kent and Berggren et al. (1995) time scales is shown in Figures 2 and 3. The zonation used for planktonic foraminifers is that of Berggren and Miller (1988) and of Blow (1969, 1979). Low-latitude radiolarian zones used for the Paleogene are those of Sanfilippo et al. (1985). The radiolarian zonation used for the Paleocene is that of Nishimura (1987, 1992) and of Hollis (1993).

Radiolarians

Radiolarian biostratigraphy in the Irminger Basin offshore Southeast Greenland is based largely on the high-latitude zonations estab-

[1]Duncan, R.A., Larsen, H.C., Allan, J.F., et al., 1996. *Proc. ODP, Init. Repts.,* 163: College Station, TX (Ocean Drilling Program).
[2]Shipboard Scientific Party is given in the list preceding the Table of Contents.

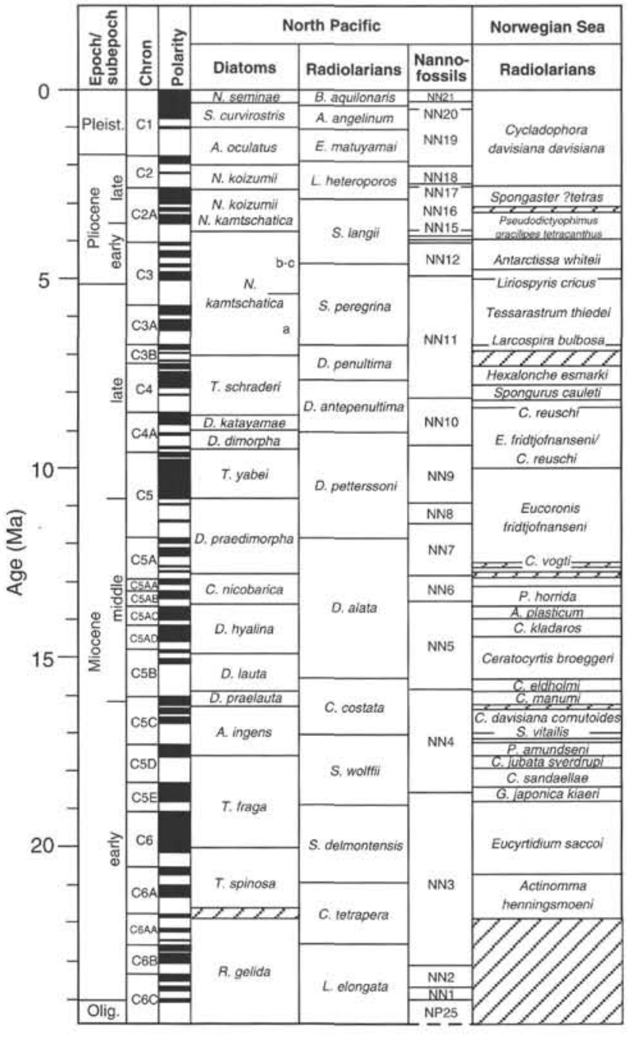

Figure 1. Correlation of diatom, radiolarian, and calcareous nannofossil zones for the North Pacific with radiolarian zones for the Norwegian Sea used during Leg 163. The chronostratigraphic calibration is based on the geomagnetic polarity time scale of Cande and Kent (1992). The compared North Pacific zonations are those of Akiba (1986) and Koizumi (1992) for diatoms, Foreman (1975) and Sakai (1980) for radiolarians, and Martini (1971) for nannofossils. The Norwegian radiolarian zones used are those of Goll and Bjørklund (1989).

lished by Bjørklund (1976) and Goll and Bjørklund (1989) from the Norwegian and Greenland Seas. Because of a lack of low- and mid-latitude marker species, age and taxonomic assignments on Leg 163 were based partly on comparison with faunas from surface sediments in the Arctic Sea (Kruglikova, 1989), from Leg 151 in the North Atlantic–Arctic Sea (Shipboard Scientific Party, 1995), from Leg 105 in the Labrador Sea (Lazarus and Pallant, 1989), from Leg 81 in the Rockall Plateau (Westberg-Smith and Riedel, 1984), and from Leg 38 in the Norwegian Sea (Dzinoridze et al., 1978).

Samples were prepared from 10–20 cm^3 of sediment, with 20% hydrogen peroxide, 10% hydrochloric acid, and 10% sodium pyrophosphate solutions to remove organic matter, calcium carbonate, and clay minerals. After this treatment, aggregated sediments were sieved at 63 µm. Strewn slides were made from dried residues using Entellan Neu mounting medium, with a mounted 22 × 40 mm cover glass.

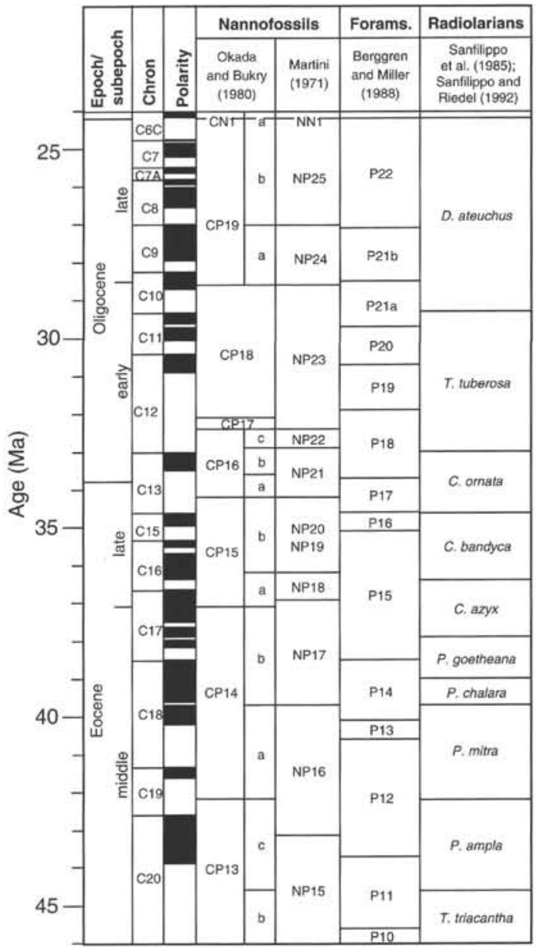

Figure 2. Correlation of Eocene and Oligocene nannofossil, foraminifer, and radiolarian zones with the geomagnetic polarity time scale of Cande and Kent (1992).

Radiolarian abundances for each sample were recorded as follows:

A (abundant) = >100 specimens per slide traverse;
C (common) = 50–100 specimens per slide traverse;
F (few) = 10–50 specimens per slide traverse;
R (rare) = <10 specimens per slide traverse.

The abundance of individual species was recorded relative to the fraction of the total assemblages as follows:

A (abundant) = >5%;
C (common) = 1%–5%;
F (few) = 0.2%–1%;
R (rare) = two or more specimens per slide;
VR (very rare) = a single specimen per slide.

The preservation of radiolarians was estimated as follows:

G (good) = nearly complete skeletons with little or no indication of dissolution, breakage, or recrystallization;
M (moderate) = most specimens show moderate dissolution, minor fragmentation, and/or recrystallization but are identifiable;
P (poor) = specimens exhibit severe dissolution and extensive fragmentation, and some are unidentifiable.

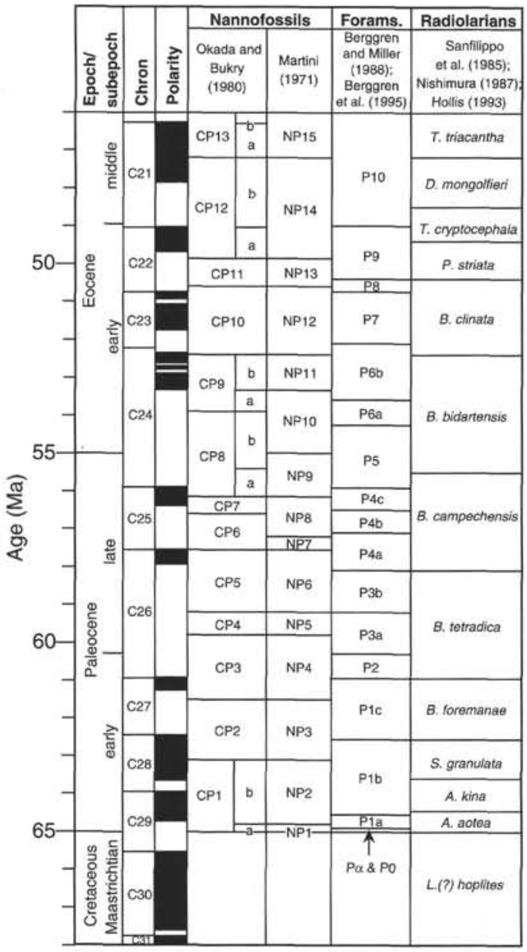

Figure 3. Correlation of Paleocene and Eocene nannofossil, foraminifer, and radiolarian zones with the geomagnetic polarity time scale of Berggren et al. (1995).

PALEOMAGNETISM

Magnetic studies performed on board *JOIDES Resolution* during Leg 163 included the analysis of the natural remanent magnetization (NRM) and magnetic susceptibility. Most of the NRM measurements were made on the archive half of the core sections, and the magnetic susceptibility data were measured from the whole cores. To complement the whole-core analyses, anisotropy of magnetic susceptibility (AMS) and thermal demagnetization were done on discrete samples obtained from the working half of the core sections.

Laboratory Instruments

The remanence of all archive core sections was measured using a 2G Enterprises whole-core cryogenic (WCC) magnetometer, which has an in-line three-axis alternating field (AF) demagnetization system capable of generating fields of 30 mT. For details, see the "Explanatory Notes" chapter in the Leg 152 *Initial Reports* (Larsen, Saunders, Clift, et al., 1994). The magnetic susceptibility of whole cores was measured with a Bartington Instruments magnetic susceptibility meter (Model MS1) with an 8-cm-diameter loop.

Discrete samples (12.87-cm^3 minicores) were drilled from the working half of the core. Field directions for these samples were measured on a WCC magnetometer or a Molspin Spinner magnetometer after demagnetization on a Schonstedt GSD-1 stationary-sample AF demagnetizer. The blocking temperature spectra analysis was done on a Schonstedt TSD-1 thermal demagnetizer. A Kappabridge KLY-2 magnetic susceptibility meter was used for AMS measurements.

Measurements

When the archive core sections were measured on the cryogenic magnetometer, several AF demagnetization steps (up to 30 mT) were applied to each core section to isolate the characteristic remanent magnetization (ChRM). On discrete specimens, more extensive demagnetization (up to 100 mT) was done to confirm polarity changes identified from the whole-core measurements and to evaluate the effectiveness of the limited demagnetization in the cryogenic magnetometer. Both Zijderveld plots and equal-area stereographic projections were used to determine the stability of the magnetic directions, and the ChRM directions of the discrete samples were calculated from principal component analysis (PCA). The thermal demagnetization provided information on magnetic minerals. Finally, magnetic anisotropy data were collected to be used in conjunction with other physical properties to estimate the flow direction in some individual lavas.

Magnetostratigraphy

For each site the entire sequence was divided into magnetozones based on at least two successive samples having the same polarity as determined by ChRM. The ChRM directions were plotted against the depth to show the presence of reversals and short-time magnetic excursions. Where possible, the reversals and excursions were combined with the chemical stratigraphy and biostratigraphy to establish larger scale correlations between sites and/or to the geomagnetic polarity time scale (Berggren et al., 1995).

STRUCTURAL GEOLOGY

Description of the structural geology of cores during Leg 163 was made using the classification system and protocols detailed in the "Explanatory Notes" chapter of the Leg 159 *Initial Reports* (Mascle, Lohmann, Clift, et al., 1996). In addition to the structural identifier codes defined and used by that scientific party on the structural VCDs, we employed the code "Z" to mark core in which no identifiable structures were noted. The structural VCDs are included on the CD-ROM in the back pocket of this volume.

IGNEOUS PETROLOGY

We followed the Leg 152 conventions for rock and thin-section description and analysis (Larsen, Saunders, Clift, et al., 1994) except that we modified the description of the extent of alteration and the nomenclature of the rocks according to phenocryst content.

Porphyritic rocks were named according to (1) the percentage of total phenocrysts present and (2) the types of phenocryst phase in the rock. The term "phenocryst" was used for a crystal that is significantly larger (typically at least 5 times larger) than the average size of the crystals of the groundmass. Many porphyritic basalts recovered during Leg 163 exhibit a range of crystal sizes (seriate texture), however, size distributions were not determined. Descriptors were defined as follows:

Aphyric: phenocrysts constitute less than 1% by volume of the rock;
Sparsely phyric: phenocryst content ranges between 1% and 2%;
Moderately phyric: phenocryst content ranges between 2% and 10%;
Highly phyric: phenocryst content exceeds 10%.

These descriptors were further modified by including the names of the phenocryst phases, in order of decreasing abundance. Thus, a "highly olivine-plagioclase phyric basalt" contains more than 10% (by volume) phenocrysts and the dominant phenocryst is olivine, with lesser amounts of plagioclase. The prefix includes all of the phenocryst phases that occur in the rock, as long as the total content exceeds 1%.

Many of the rocks recovered during Legs 152 and 163 contain olivine in the groundmass and as phenocryst phases. The name "aphyric olivine basalt" was applied where olivine or its alteration products were considered present in the groundmass, whereas "aphyric basalt" was applied where there is little or no olivine in the groundmass. A "moderately olivine phyric basalt" contains between 2% and 10% olivine phenocrysts. "Picrite" was defined as a rock with at least 15% olivine phenocrysts.

The rock names were initially assigned on the basis of hand-specimen observation and later checked by thin-section examination, especially concerning the occurrence of olivine in the groundmass.

All rocks recovered during Leg 163 have undergone secondary alteration. The rocks were graded according to whether they are fresh (<2% by volume alteration products) or have slight (2%–10%), moderate (10%–40%), high (40%–80%), very high (80%–95%), or complete (95%–100%) alteration. The type, form, and distribution of the alteration were noted. Any changes of alteration through a section or a unit were also recorded.

Alteration and vein visual core description logs were used to provide consistent and complete characterization of the core, and a subset of the data was entered into the HARVI database. To ensure accurate core description, thin-section petrography was integrated with the VCDs where possible. Alteration and vein logs for each hole are presented on the CD-ROM in the back pocket of this volume.

The following information was recorded in the databases:

1. The alteration log was used to record the bulk-rock alteration. Each entry records the igneous unit; identifiers for the core, section, piece, and subpiece; the length of that piece; and the depth below seafloor of the top of that piece. Visual estimates of the percentage of altered groundmass, color, abundance of vesicles (%), vesicle size (mm) and mineral fillings, and the proportion of altered phenocrysts with the precursor and secondary minerals are documented for each piece. A column for comments is included.
2. The vein log was used to record the presence, location, and mineral content of veins observed on the cut surface of the Leg 163 cores. Each entry records the igneous unit and identifiers for the core, section, piece, and subpiece. For each vein the location of the top and bottom of the feature is recorded, and the mineral fillings, vein width (mm), apparent orientation (0°–90°, horizontal to vertical), presence or absence of a related alteration halo, and the half width (mm) of the halo are described. A column for comments is included.

PHYSICAL PROPERTIES

Standard shipboard measurements of physical properties included nondestructive, whole-core, multisensor track (MST) measurements as well as index properties, thermal conductivity, and compressional wave (*P*-wave) velocity at atmospheric pressure. *P*-wave velocity was also measured in several discrete time intervals on three seawater-saturated basaltic samples. This data set will allow calculation of the seismic effects of thermal and stress-release cracking present in the samples after they have been recovered from the oceanic crust.

Sampling Strategy

To meet the general objectives, the physical properties sampling program was formulated to fulfill several requirements:

1. To provide a detailed record of the properties of recovered material, sections generally were scanned using the MST prior to along-axis splitting and sampling of the cores. *P*-wave velocities were also measured on split core sections.
2. Samples from the range of cored materials were selected in conjunction with the igneous petrologists and paleomagnetists to identify features of interest, so that cross-correlation with shipboard physical properties analyses would be achieved. Many physical properties measurements were made on samples common to or adjacent to those used for analyses in other disciplines (e.g., igneous petrology and paleomagnetism).
3. Magnetic susceptibility measurements were made on all split core sections from Site 989 to complement the paleomagnetic studies. These measurements were made only on whole cores from Site 990.

Laboratory Measurements

Index Properties

Index properties (bulk density, grain density, percent water content, porosity, and dry density) were measured using the techniques outlined in the "Explanatory Notes" chapter of the Leg 152 *Initial Reports* (Larsen, Saunders, Clift, et al., 1994).

Multisensor Track

The MST incorporates the gamma-ray attenuation porosity evaluator (GRAPE) and magnetic susceptibility and natural gamma-ray devices in scans of either whole or split core sections. MST measurements were made during Leg 163 following the guidelines presented in the Leg 152 "Explanatory Notes" chapter (Larsen, Saunders, Clift, et al., 1994), with the following differences:

1. GRAPE measurements of bulk density were made at 2-cm intervals.
2. Magnetic susceptibility measurements were made at 2-cm intervals using the Bartington magnetic susceptibility meter with an 8-cm-diameter loop.
3. Natural gamma-ray intensity was measured at 2-cm intervals.

Velocimetry

P-wave velocity measurements were obtained using two different systems during Leg 163, following the general guidelines for velocimetry presented in the Leg 152 "Explanatory Notes" chapter (Larsen, Saunders, Clift, et al., 1994). Immediately after the core was split, measurements were performed at 5-cm intervals on the split core sections using the Hamilton Frame velocimeter. *P*-wave velocity was also measured on discrete seawater-saturated minicore samples.

Thermal Conductivity

The thermal conductivity of cored material was measured using the needle probe method in half-space configuration for basaltic samples (Vacquier, 1985) and following the techniques, equipment, and corrections described in the Leg 152 "Explanatory Notes" chapter (Larsen, Saunders, Clift, et al., 1994). The basaltic samples for half-space measurement were obtained from the archive half of the split core. The measurements were performed on the polished core pieces in a water bath under slight overburden pressure.

In all cases, one has to keep in mind that the physical parameters describing magnetic susceptibility, acoustic velocity, and thermal conductivity have anisotropic properties and may vary in different directions.

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