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39. *DATA REPORT:* MAGNETOSTRATIGRAPHY OF THE PLEISTOCENE–LATE PLIOCENE SEDIMENTS OF ODP SITES 994, 995, AND 997, BLAKE RIDGE[1]

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INTRODUCTION

The Blake Ridge, offshore South Carolina, was drilled at three sites, Sites 994, 995, and 997, during Ocean Drilling Program Leg 164. During the cruise, shipboard paleomagnetic measurements were performed to establish a magnetostratigraphy to refine age dates of the sediments. Shipboard measurements yielded a preliminary reversal stratigraphy (Shipboard Scientific Party, 1996a, 1996b, and 1996c). The routine paleomagnetic measurements of continuous core sections with the pass-through cryogenic magnetometer after alternating field (AF) demagnetization at 20 mT showed downhole inclination profiles with negative and positive intervals in the sections recovered with the advanced hydraulic piston corer (APC). The cryogenic results agreed with the results from analysis of discrete samples. The reversal stratigraphy was constructed based on the cryogenic and discrete sample results.

Although the primary reversal stratigraphy was constructed for each site during the cruise, the boundaries of magnetic polarity zones were poorly constrained because there were insufficient polarity measurements obtained from the discrete sample analysis (Only one or two samples per core were made in the intervals recovered with the APC; fewer were made in the intervals cored with the extended core barrel [XCB]. Each core is 9.5 m). Therefore, I conducted shore-based paleomagnetic analyses to determine more precise locations of the magnetic polarity zones and reversals for the APC-cored intervals at Sites 994, 995, and 997.

In this report, I describe progressive AF demagnetization behavior of the samples and present paleomagnetic declination, inclination, and intensity data before and after AF demagnetization. Magnetic polarity zones are defined for the APC-cored intervals of Sites 994, 995, and 997, and these are presented with nannofossil data and interpreted nannofossil zonations (Okada, Chap. 33, this volume).

METHODS

Sampling and Experimental Procedures

Discrete samples were collected using standard ODP plastic boxes (volume = 7 cm^3) from at least two horizons of each 1.5-m-long section in the upper part of the APC-cored intervals (Cores 164-994C-1H to 15H, 164-995A-1H to 15H, and 164-997A-1H to 13H) and from one horizon of each section in the lower part of the APC-cored intervals (Cores 164-994C-16H to 19H, 164-995A-16H to 20H, and 164-997A-14H to 20H). Magnetic cleaning was performed for the samples by means of progressive AF demagnetization to a limit of 100 mT. Remanent magnetization of the samples was measured on a 2G Enterprises cryogenic magnetometer 750 at the University of Tokyo.

Paleomagnetic Analyses

Magnetic stability of the samples was examined by the Zijderveld diagram (Zijderveld, 1967), using the results of progressive AF demagnetization. Figure 1 shows typical examples of the demagnetization diagram. Based on the type of response to progressively higher AF demagnetization, samples were classified into one of three groups. Type X samples were those whose trajectory of the magnetization vector of the AF demagnetization steps is nearly linear toward the origin (Fig.1A, B). Some Type X samples are composed of two magnetic components of low and high coercivity, indicated by changes in vector direction during the progressive demagnetization, usually at 10–15 mT and, rarely, at 40–50 mT. The low-coercivity components usually have normal polarity, probably indicating soft secondary viscous remanent magnetization acquired during the recent Brunhes normal polarity chron, whereas the high-coercivity components are directed toward the origin. Type Y samples were those in which the trajectory of the magnetization vector followed a zigzag pattern but progressed toward the origin (Fig. 1C). In these samples, the trajectory of the early steps of AF demagnetization between 0 and 5 mT sometimes shows a steep downward inclination, which probably indicates a core-barrel overprint acquired during coring (Shipboard Scientific Party, 1992). Type Z samples showed unstable and erratic changes in remanent direction during progressive demagnetization (Fig. 1D). The demagnetization trajectories of Type X and Type Y samples indicate removal of the overprints of drilling-induced magnetization and viscous remanent magnetization during the early steps of AF demagnetization, and, thus, the high-coercivity components can be interpreted as the primary remanence.

The paleomagnetic directions were identified by fitting the least-squares best-fit line (Kirschvink, 1980) to the segments of the stable high-coercivity components on the Zijderveld plots. Type Z samples were omitted from the extraction of primary magnetic remanence. The identified paleomagnetic directions were interpreted as either normal polarity for the downward directions (e.g., Fig. 1A, C) or reversed polarity for the upward (Fig. 1B), although their declination results showed.

DATA PRESENTATION

The NRM declinations, inclinations, and intensities of Sites 994, 995, and 997 are plotted against the sub-bottom depth in Figure 2. The declinations are plotted using the data before and after Tensor tool orientation, respectively. Before the orientation, the declinations are referred to core coordinates relative to the x-axis (positive-x) direction defined by the double-line fiducial mark in the center of the core liner on the working half of the cores (same as the standard ODP convention). After the orientation, the declinations are referred to geographic north.

The declinations (core coordinates and geographic coordinates) and inclinations obtained from the stable high-coercivity components of Type X and Y samples are plotted against the sub-bottom depth in Figure 3. The intensities of Type X and Y samples after the removal

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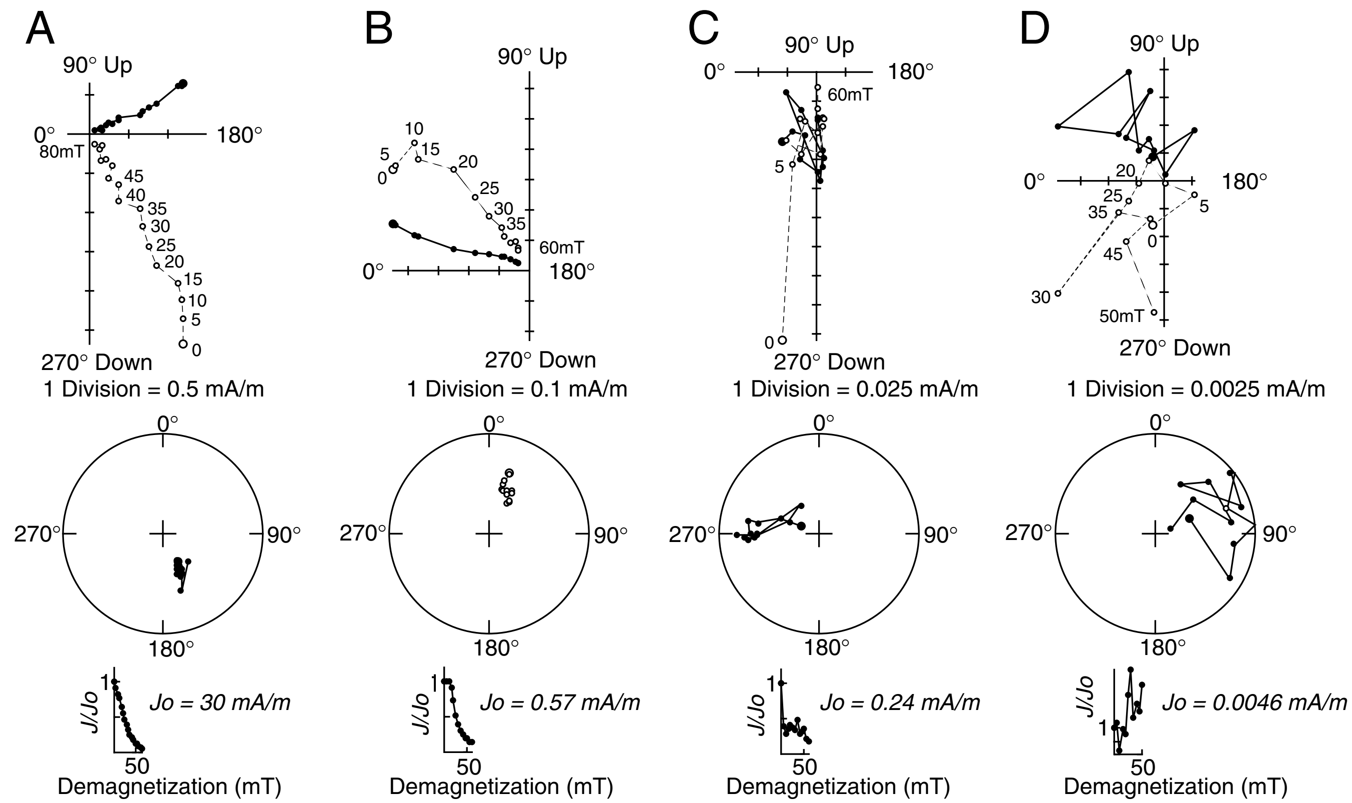

Figure 1. Representative Zijderveld, stereo, and intensity demagnetization plots for (**A**) Sample 164-994C-1H-2, 79–81 cm (2.29–2.31 mbsf), (**B**) Sample 164-994C-8H-3, 19–21 cm (64.59–64.61 mbsf), (**C**) Sample 164-994C-2H-2, 59–61 cm (6.49–6.51 mbsf), and (**D**) Sample 164-994C-3H-1, 79–81 cm (14.69–14.71 mbsf). Based on the type of response to progressive AF demagnetization, samples were classified into one of three types: X (samples A and B), Y (sample C), and Z (sample D). Samples of Types X and Y were usable for magnetostratigraphic purposes. Zijderveld plot: solid circles = projection on the horizontal plane, open circles = projection on the vertical plane. Stereo plot: solid circles = the lower hemisphere. Declination is with respect to core coordinates.

of the unstable low-coercivity components are also plotted in Figure 3.

The determined magnetic polarities of three sites are plotted against the sub-bottom depth in Figures 4–6. There are several zones characterized by continuous normal or reversed polarities in each site. Normal and reversed polarity zones were identified where there are more than two successive samples of normal or reversed polarity. Undetermined polarity zones were defined where only a single sample of normal or reversed polarity was present. The figures also include nannofossil zones and datums obtained by Okada (Chap. 33, this volume).

Table 1 shows a list of the paleomagnetic data obtained by shore-based and on board measurements.

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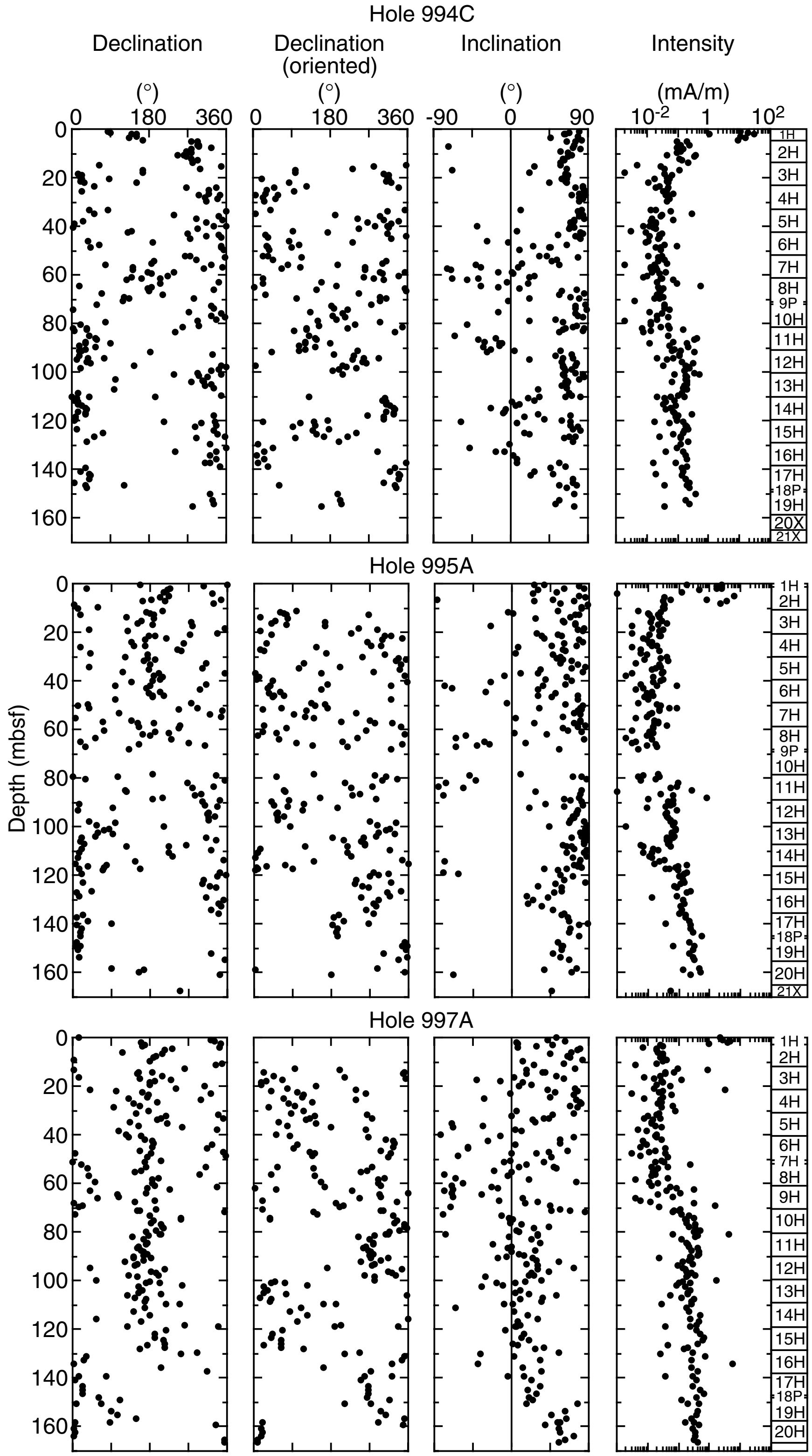

Figure 2. Downhole plots of NRM declination (referred to arbitrary core coordinates and oriented to geographic coordinates), inclination, and intensity at Sites 994, 995, and 997.

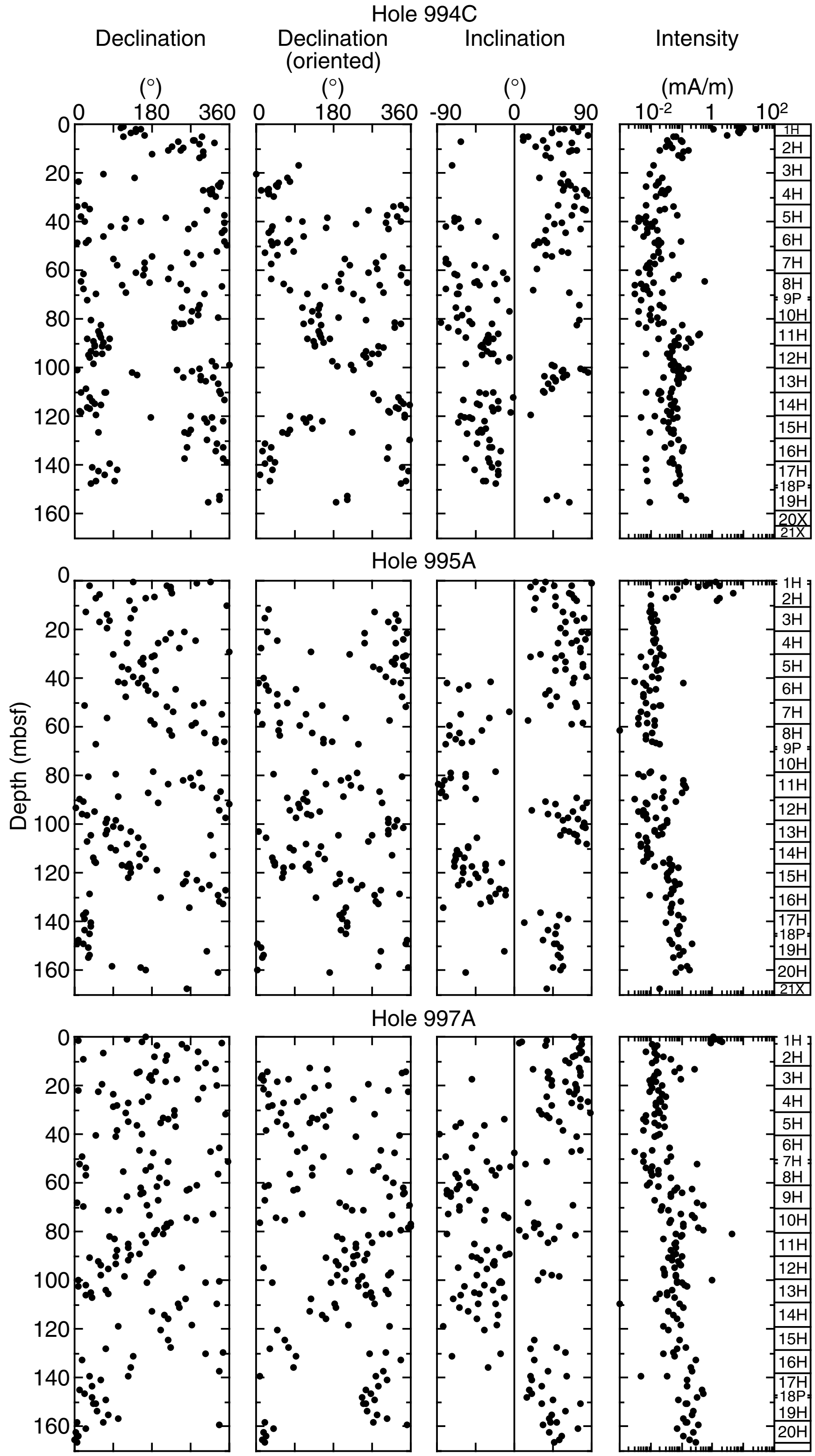

Figure 3. Downhole plots of declination (core coordinates and geographic coordinates) and inclination determined by stable high-coercivity components and of intensity after removal of low-coercivity components for Type X and Y samples at Sites 994, 995, and 997.

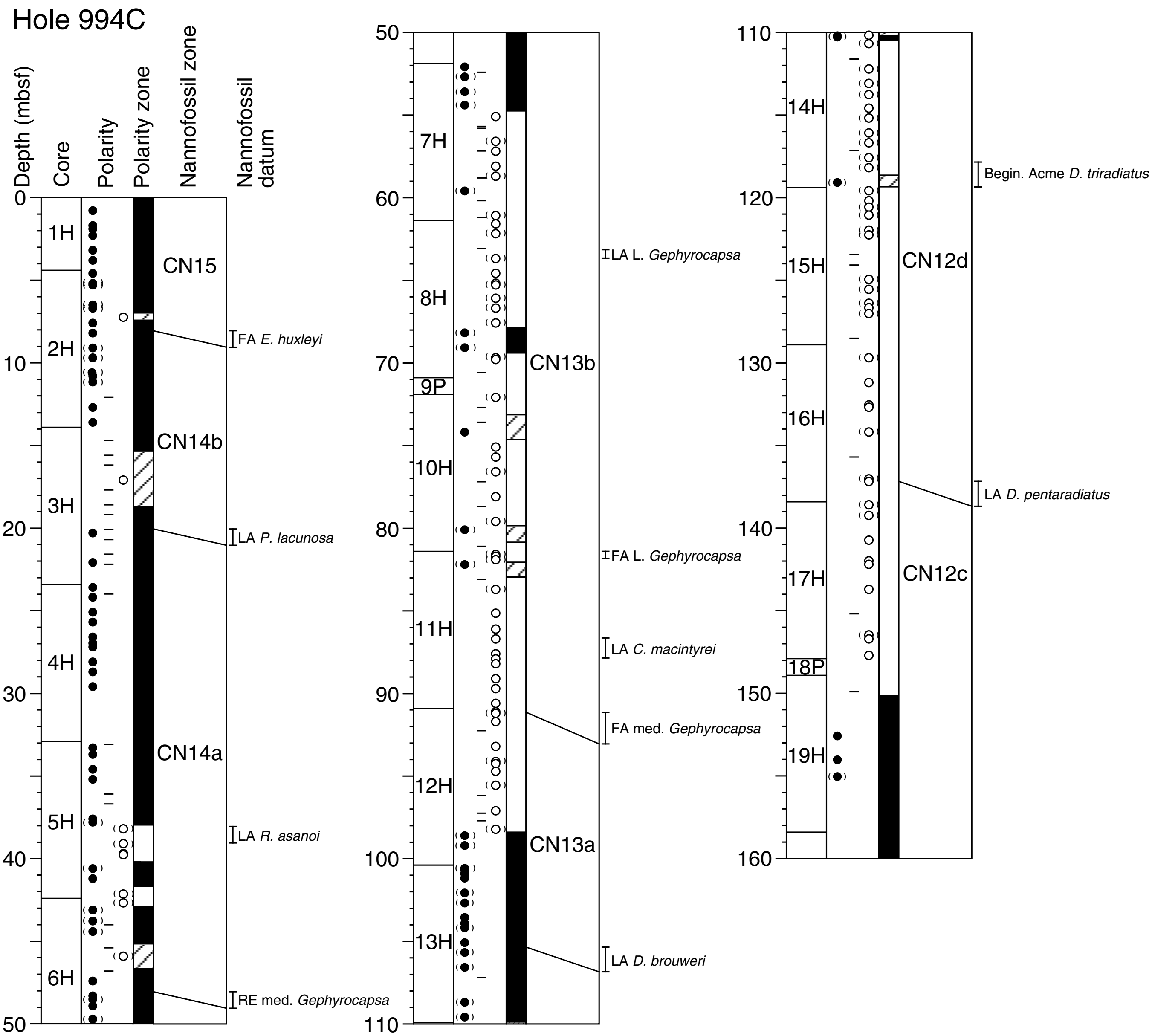

Figure 4. Columns showing magnetic polarities determined from Zijderveld diagram analysis of samples, magnetic polarity zones, nannofossil zones, and nannofossil datums at Site 994. Solid circles and zones = normal polarity, open circles and zones = reversed polarity, parenthesis = less certain polarity interpreted from Type Y samples, bars = unsuccessful analyses of Type Z samples, and diagonal zones = undetermined. The nannofossil data are from Okada (Chap. 33, this volume).

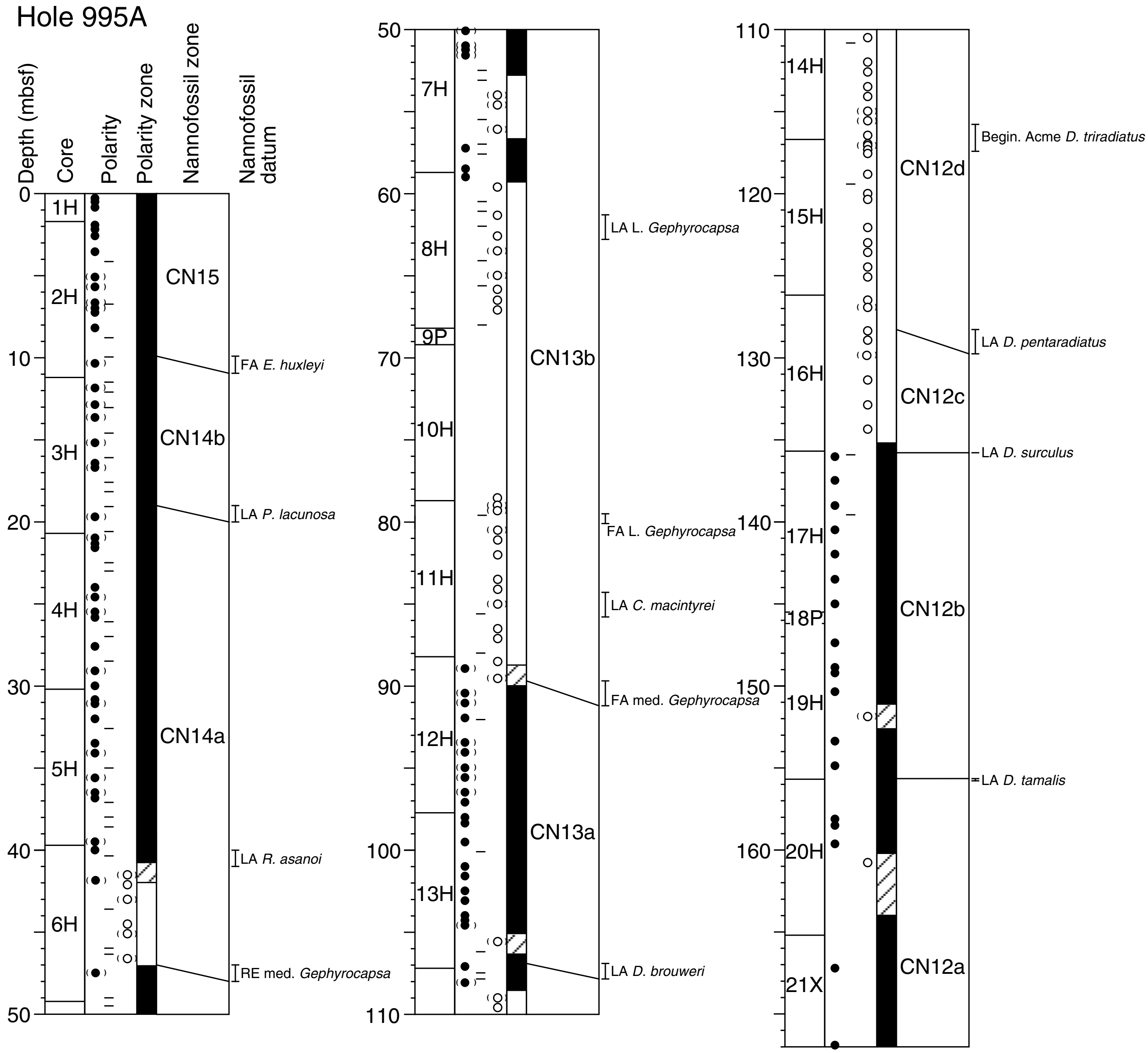

Figure 5. Columns showing magnetic polarities determined from Zijderveld diagram analysis of samples from Site 995. Symbols are the same in Figure 4. The nannofossil data are from Okada (Chap. 33, this volume).

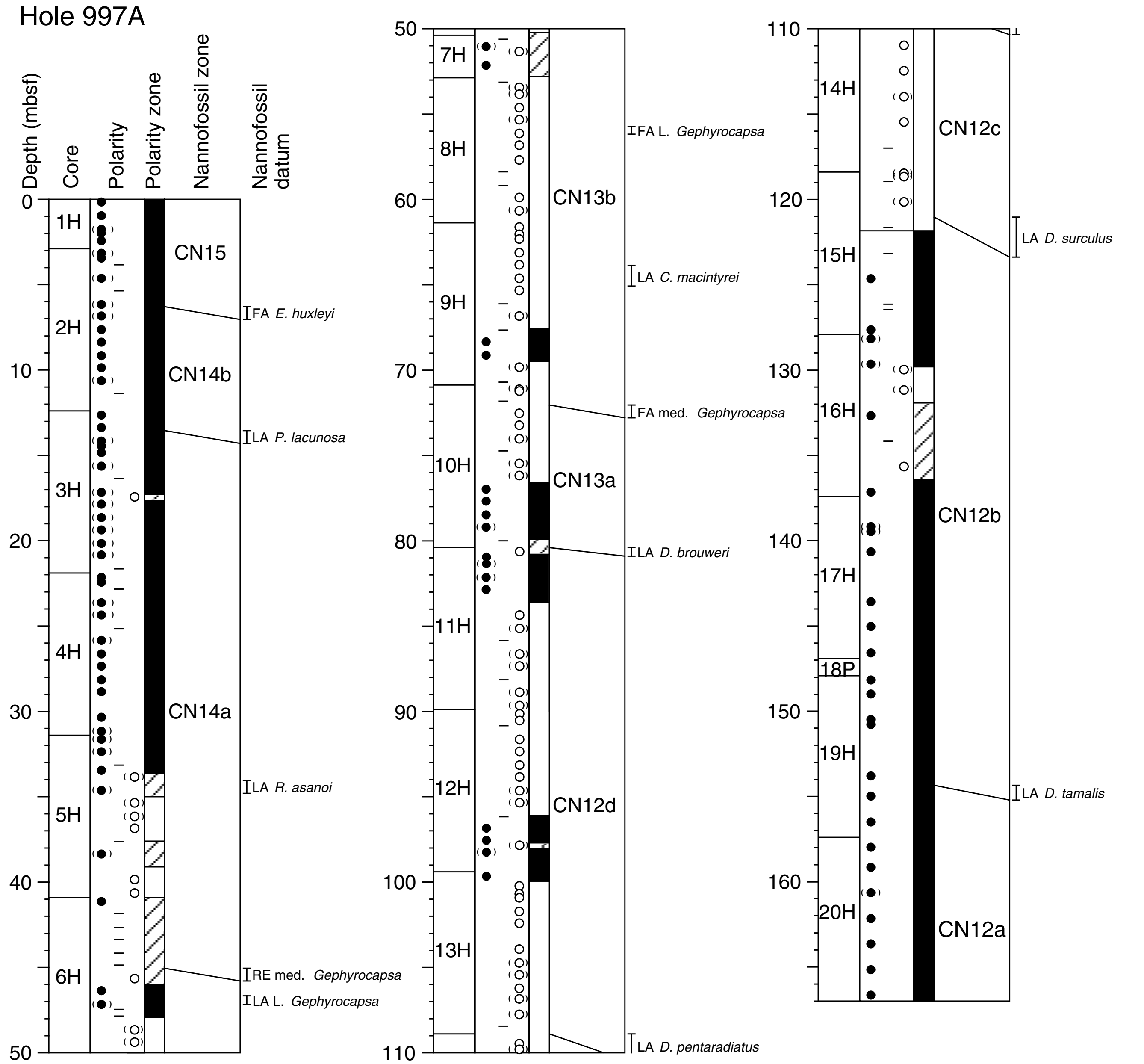

Figure 6. Columns showing magnetic polarities determined from Zijderveld diagram analysis of samples from Site 997. Symbols are the same in Figure 4. The nannofossil data are from Okada (Chap. 33, this volume).

Table 1. Paleomagnetic data of samples from Sites 994, 995, and 997.

Core, section, interval (cm)	Depth (mbsf)	NRM Inclination (degrees)	NRM Declination (core) (degrees)	NRM Declination (oriented) (degrees)	NRM Intensity (mA/m)	AFD Inclination (degrees)	AFD Declination (core) (degrees)	AFD Declination (oriented) (degrees)	AFD Intensity** (mA/m)	AFD type	Magnetic polarity	Onboad data
164-994C-												
1H-1, 79-81	0.79	80.4	83.0		10.970	78.6	114.4		6.700	X	N	
1H-2, 19-21	1.69	67.6	89.1		18.400	67.5	108.4		10.050	X	N	
1H-2, 39-41	1.89	62.9	138.8		1.074	52.1	142.9		1.074	X	N	*
1H-2, 79-81	2.29	63.2	151.3		30.320	58.4	153.3		25.250	X	N	
1H-3, 19-21	3.19	78.4	149.9		11.270	74.1	143.1		7.033	X	N	
1H-3, 79-81	3.79	47.1	132.3		15.140	43.5	131.1		7.770	X	N	
2H-1, 19-21	4.59	82.5	164.2		9.015	85.1	161.9		2.845	X	N	
2H-1, 79-81	5.19	75.7	278.2		0.197	9.9	111.9		0.065	Y	N?	
2H-1, 90-92	5.30	65.2	292.9		0.091	16.6	295.4		0.056	Y	N?	
2H-2, 59-61	6.49	73.8	296.1		0.243	9.8	276.5		0.097	Y	N?	
2H-2, 79-81	6.69	73.7	293.2		0.127	33.5	278.0		0.035	Y	N?	
2H-2, 135-137	7.25	-72.4	295.1		0.101	—	240.2		0.100	X	R	

Notes: NRM = natural remanent magnetization, AFD = alternating field demagnetization. Declination (core) = declination referred to arbitrary core coordinates, (relative to the x-axis direction defined by the double-line fiducial mark in the center of the core liner on the working half of the cores), declination (oriented) = declination oriented to geographic coordinates (relative to geographic north) with the Tensor tool. ** = intensity after the unstable low-coercivity component is removed, AFD type = type of response to progressive AF demagnetization (see text for explanation). N = normal polarity, R = reversed polarity, ? = less certain, — = uncertain.

This is a sample of the table that appears on the volume CD-ROM.