27. MAGNETOSTRATIGRAPHY OF THE CRETACEOUS/TERTIARY GEOLOGICAL BOUNDARY[1]

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INTRODUCTION

The Cretaceous/Tertiary (C/T) geological boundary is usually sharply defined. In deep sea sediments, where its location can be determined within a few millimeters, studies have shown that it is characterized by the large-scale mortality of the biomass in the oceans (Luterbacher and Premoli-Silva, 1964; Perch-Nielsen, 1979; Hsü et al., 1982). It is also characterized by a distinct enrichment of noble elements, in particular Ir and Os, which has led a number of scientists to postulate that the faunal extinctions were caused by an extraterrestrial event, such as the impact of a comet or a meteorite (Alvarez et al., 1980; Hsü, 1980; Kyte et al., 1980; Smit and Hertogen, 1980).

The magnetostratigraphy of the Cretaceous/Tertiary boundary has been studied at several different locations. The boundary has been located within Chron C-29-R as a result of magnetostratigraphic research on marine pelagic limestones in Italian sections near Gubbio (Roggenthen and Napoleone, 1977; Lowrie and Alvarez, 1977) and near Moria (Alvarez and Lowrie, 1978).

However, measurements on different mammalian fossil-bearing continental sections lead in part to contradictory results: Lerbekmo et al. (1979), who studied sediments of the Red Deer Valley, Alberta, placed the C/T boundary within a reversed polarity zone in accord with the Gubbio correlation. On the other hand, Butler et al. (1977), who studied a section in the San Juan Basin of New Mexico and defined the Cretaceous/Tertiary boundary within a normal polarity zone. This result was contested by Alvarez and Vann (1979) on the grounds of possible unconformities. However, Butler's result was essentially confirmed by Lindsay et al. (1981), who studied the sections of the San Juan Basin in greater detail. They reconciled the apparent discrepancy with the Gubbio correlation by making the assumption that the dinosaurs in the San Juan Basin became extinct slightly later than the faunal change recognized as the Cretaceous/Tertiary boundary in the Italian marine deposits. In other words, they postulated that the C/T boundary recognized by vertebrate fossils is younger than the C/T boundary recognized by the marine invertebrate fossils at Gubbio.

The Cretaceous/Tertiary boundary is particularly well preserved and undisturbed in sediments acquired in the Cape Basin of the South Atlantic Ocean. The sediments were acquired by drilling at Site 524 (Leg 73 of the Deep Sea Drilling Project), which was located at 29°29.05′S and 3°30.74′E. The boundary was recognized at a depth of 203.54 m below the ocean floor on the basis of the first occurrences of the Tertiary nannofossils *Markalius astroporus, M. reinhardtii, Zygodiscus sigmoides*, and *Thoracosphaera* species (Hsü et al., 1982; Poore et al., this vol.). The boundary is also characterized by a minimum in the $CaCO_3$ content, which decreased from an average of 40% to about 2% in a 2-cm-thick clay layer at the boundary. The material in the vicinity of the C/T boundary is nannofossil marl that is frequently intercalated by turbidites. The nannofossil marl below the boundary shows abundant signs of bioturbation, which makes it likely that the type of remanent magnetization carried by the sediment is a postdepositional remanence (PDRM). Immediately above the C/T boundary, however, no bioturbation is observed.

The magnetostratigraphy of the C/T boundary was investigated in this core in order to complement earlier studies and to document further its relationship to the geomagnetic reversal sequence.

SAMPLING AND MEASUREMENTS

The overall magnetostratigraphy of the Site 524 core has been determined by Tauxe et al. (this vol.). For their magnetic measurements they used 7-cc specimens taken at intervals ranging from every 10 cm to every 40 cm, depending on the sediment type. In order to enhance the resolution of the magnetostratigraphy in the present investigation more intensive sampling was carried out. Cylindrical samples with a volume of 2 cc were taken at an average spacing of 5 cm. To minimize the disturbance of the residual core material by the sampling procedure, a special tool was developed that takes oriented cylinders without affecting the rest of the sediment core.

The magnetization of the 2-cc samples was then measured with a cryogenic magnetometer at the Institut für Geophysik of the Eidgenössische Technische Hochschule Zürich. Evenly distributed pilot samples were subjected to progressive alternating field demagnetization in order to investigate the composition of the natural remanent magnetization (NRM). Secondary magnetization were of minor importance in most samples and

[1] Hsü, K. J., LaBrecque, J. L., et al., *Init. Repts. DSDP*, 73: Washington (U.S. Govt. Printing Office).

could easily be removed by partial alternating field demagnetization in peak magnetic fields less than 160 × 10^2 A/m (200 Oe). The nannofossil marl and the intercalated turbidites were equally good media for the magnetostratigraphy. Little difference in magnetic behavior was observed between the two types of sediments, although the magnetic stability was slightly lower in the turbidites than in the marls.

Since the drill location is in the midlatitudes, the inclination of the natural remanent magnetization of a sample can be used to identify the polarity. The magnetic inclination to be expected at the latitude of the drill site is 48°. In the Southern Hemisphere, negative inclinations result from a normal field, positive inclinations from a reversed field. Comparison of the polarity pattern in Cores 12 through 29 to the polarity time scale of LaBrecque et al. (1977), aided by paleontological data obtained by Poore et al. (this vol.), leads to confident identification of Chrons C-27 through C-31. By using the LaBrecque et al. (1977) anomaly ages, the sedimentation rate in the vicinity of the C/T boundary was determined to be about 30 mm/10^3 yr. (Fig. 1). This sedimentation rate appears high by comparison with normal deep sea cores, a result of the frequent intercalation of turbidites in the nannofossil marl.

Our measurements show that the Cretaceous/Tertiary boundary at Site 524 lies well within a zone of positive inclination, or negative polarity, which can be identified from the overall magnetostratigraphy of Tauxe et al. (this vol.) as the negative polarity interval within Chron C-29. This result is in accord with the Gubbio and Moria correlations obtained by Lowrie and his coworkers (Fig. 2). No anomalous behavior of the magnetization inclination, intensity, or susceptibility is observed at the C/T boundary itself (Figs. 2 and 3).

DISCUSSION

The location of the Cretaceous/Tertiary boundary at Site 524 agrees with the magnetostratigraphic studies on the Gubbio and Moria sections (Lowrie and Alvarez, 1977; Alvarez and Lowrie, 1978). The relatively long time span between the C/T boundary and the next geomagnetic reversal, deduced in Figure 3 from the sedimentation rate, makes it unrealistic to assume any causal link between the two events.

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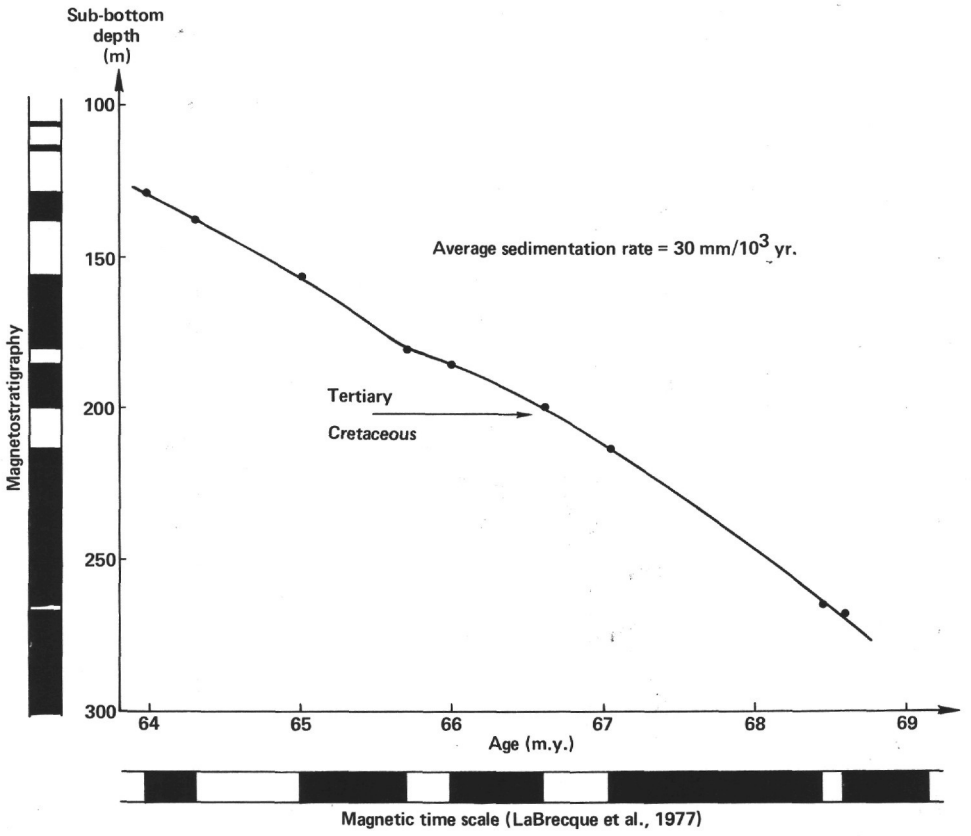

Figure 1. Sediment accumulation in the vicinity of the Cretaceous/Tertiary boundary versus age for Site 524. Determination of sedimentation rate is based on the correlation of the magnetic polarity zones in the core (taken from the overall magnetostratigraphy of Tauxe et al., this vol.) to the geomagnetic reversal time scale of LaBrecque et al. (1977).

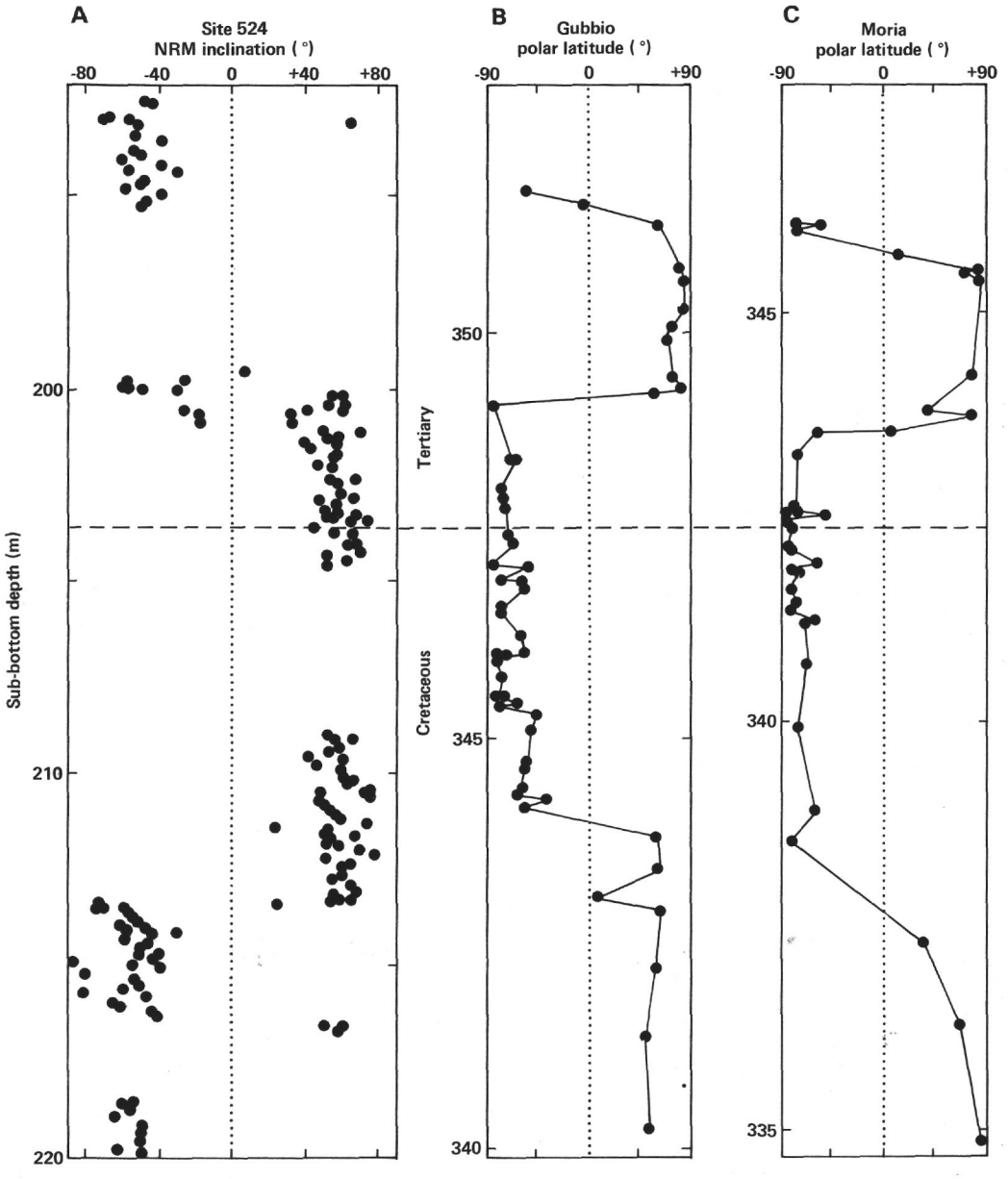

Figure 2. Magnetostratigraphy of the Cretaceous/Tertiary boundary of three marine pelagic sediment sections. A. Site 524, South Atlantic. In the Southern Hemisphere, negative inclinations result from a normal field, positive inclinations from a reversed field. B. Pelagic limestone section at Gubbio, Italy. Data are from Lowrie and Alvarez (1977) and Lowrie (unpublished data). C. Pelagic limestone section at Moria, Italy. Data are from Alvarez and Lowrie (1978) and Lowrie (unpublished data).

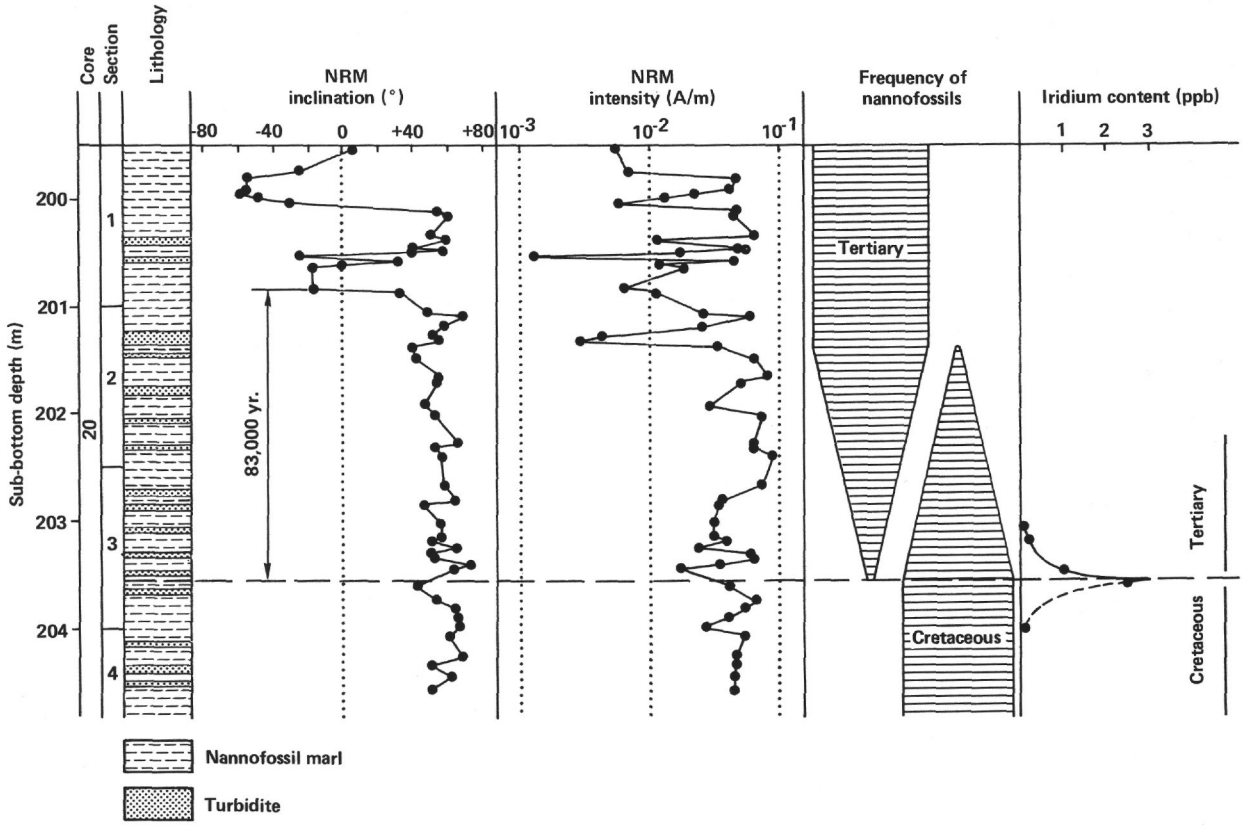

Figure 3. Detail of the magnetostratigraphy of Site 524 in the immediate vicinity of the Cretaceous/Tertiary boundary. NRM data after alternating field demagnetization in 140 × 10^2 A/m peak field. Biostratigraphy and iridium data from Hsü et al. (1982). The time interval of 83,000 yr. between the C/T boundary and the next geomagnetic reversal has been determined by assuming a constant sedimentation rate of 30 mm/10^3 yr. across the boundary (compare Fig. 1).