Quaternary high latitude magnetostratigraphy

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Magnetostratigraphic dating of Quaternary sediments is in general exclusively based on the identification of the Brunhes/Matuyama boundary and the Jaramillo and Olduvai Subchrons within the Matuyama Chron. Mounting evidence suggests, however, that short excursions or reversal events of the earth's field have also occurred during the Brunhes Chron (Verosub 1982). Although absolute age, duration and global synchronism of these features remain a matter of controversy, they are potentially very useful in establishing high resolution Quaternary stratigraphies. This should be particularly true for the high latitudes where biostratigraphic and oxygen-isotope studies typically face considerable problems in this period. In a recent paper Løvlie et al. (1986) for the first time presented paleomagnetic data for short gravity cores from the Arctic Ocean which they interpret as a recording of two geomagnetic excursions within oxygen isotope stage 2–3.

This contribution reports results of paleomagnetic analyses of sedimentary series recovered in five gravity cores by RV 'Polarstern' along a transect about 4°W to 17°W through the Norwegian-Greenland Sea at 69.5°N. Details of this study will shortly be published elsewhere (Bleil & Gard in prep.). The deposits mainly consist of brownish to greyish clays occasionally interlayered with sandy horizons and ash beds. Standard sample spacing was 10 cm and reduced to 5 cm or less at critical intervals. Magnetization intensities and directions were measured on a cryogenic magnetometer. The characteristic stable remanent components of all samples were isolated by systematic stepwise alternating field demagnetization treatment and evaluated from different graphical representations of the demagnetization data (Bleil et al. 1984).

The large majority of the samples was found to have normal stable polarities and quite simple uniform remanent magnetization structures. Minor unstable components, most likely acquired by a spurious overprinting, are totally discriminated by alternating fields of 10 mT or less. In contrast, many samples with apparent primary reversed remanence directions revealed a much more complex demagnetization behavior. In addition to small spurious components there is typically a normal polarity fraction observed which is thought to represent an in situ viscous magnetization due to the prevailing Brunhes field. The magnitude and stability of this normal component are extremely variable. Usually an almost single-component reversed direction is isolated in alternating fields of about 30 mT. On the other hand, for a relatively large number of samples, progressive demagnetization up to the highest field applied, 100 mT, only yields more or less continuous directional changes from steep normal to shallow normal or shallow reversed inclinations without ever attaining a unique stable direction. A reversed polarity was assigned to these samples, in cases where an unequivocal reversed direction was encountered in the adjacent sample.

Fig. 1 shows the derived paleomagnetic polarity logs for the different sections cored. Up to five intervals of reversed or mixed polarities are encountered in each core. They are interpreted to represent 'geomagnetic events' of short duration. Their mostly complex internal directional structure seems to indicate rapidly changing geomagnetic field configurations. At present, however, the data base is inadequate to discriminate between true reversals and excursions of the earth's magnetic paleofield. As the Brunhes/Matuyama boundary was not reached in any of the cores, the main problem in evaluating these records in terms of a quantitative magnetostratigraphy are the rather dramatic inconsistencies which exist in the literature regarding number, ages and duration of postulated reversal events within the Brunhes Chron. For the present study, nomenclature and ages of events have been adopted from the compilation of Jacobs (1984). The tentative correlation of this time scheme to the polarity logs obtained is further based on 1) the assumption that a prominent ash layer provides a synchronous horizon through the entire transect, 2) the yet preliminary identification of oxygen-isotope stages based on nannofossil data (Gard pers. comm., for details of the method see Gard 1986).

This admittedly simple first approach yields average apparent sedimentation rates of 1–2 cm per 1,000 years. This tallies reasonably well with previous results from the Norwegian-Greenland Sea (Kellogg et al. 1978; Thiede et al. 1986). In detail the accumulation records appear to be extremely variable, however. The main features of the magnetochronologic summary given in Fig. 1 is briefly discussed in the following.

At all but one site two events, termed Lake Mungo and Laschamp, are observed between oxygen isotope stages 1 and 5 (12,000 to 71,000 years, Imbrie et al. 1982) in remarkable good agreement with recently published data of Løvlie et al. (1986). At the easternmost Site 23243 in the central Norwegian-Greenland Sea only a single reversed zone was recorded in this interval. This seems to reflect a regional tendency in that the paleomagnetic data appear to become less clear from west to east, just the opposite trend to the one observed for the biostratigraphy. The Blake Subchron near the base of oxygen isotope stage 5, probably the best documented event in the literature, was identified only at Site 23243. At least at the adjacent Site 23244 the position of the prominent ash layer suggests a hiatus as a possible explanation for the absence of the Blake Subchron.

In the lower halves of the cores age considerations depend almost exclusively on the biostratigraphic framework. With the

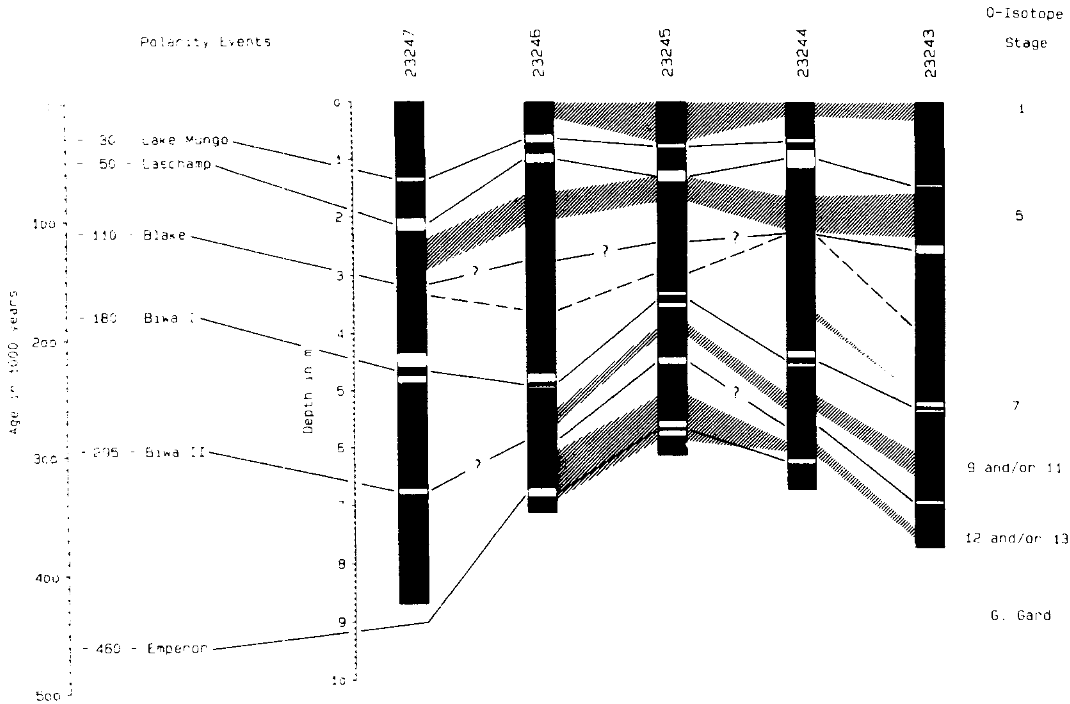

Fig. 1. Magnetostratigraphic polarity logs for five sediment cores recovered along an EW transect at 69.5°N in the Norwegian-Greenland Sea, black denoting normal, white reversed polarity. Oxygen isotope stages (shaded) are from Gard (pers. comm.). The broken line marks the position of a prominent ash horizon. The proposed correlation of reversed polarity zones with the geomagnetic event stratigraphy as compiled by Jacobs (1984) is indicated by straight lines.

possible exception of the mid stage 12 oxygen isotope level defined by the LAD of *Pseudoemiliana lacunosa* (458,000 years, Thierstein et al. 1977), the quality of these data is presently rather poor. The proposed correlation of the polarity records encountered in these parts of the cores with the available event chronology given in Fig. 1, has to await confirmation by further independent evidence. The two reversed zones correlated with the Biwa I Subchron are separated by a short normal interval in all cores. Their stratigraphic positions are confined within oxygen isotope stages 7 and 9/11. The Biwa II Subchron occurs within oxygen isotope stages 9/11 and 12/13 and was identified only at Sites 23243, 23245 and 23247, whereas the Emperor Subchron appears only in the records of the middle three Sites 23244, 23245 and 23246. The latter observation may be caused by slightly higher average sedimentation rates both towards the western and eastern ends of the transect. The radiometrically calibrated age of the Emperor Subchron (460,000 years, Champion et al. 1981) coincides remarkably well with its apparent position relative to the oxygen isotope stages in the present study. For the Biwa I and II Subchrons at least a general age consistency is indicated in this respect. In view of the highly variable and perhaps not entirely continuous sedimentary records and without an independent precise time control available, no attempt has yet been made to infer age and duration of the polarity events from the present magnetostratigraphic data.

In summary, the results of the present study strongly support previous evidence for the existence of at least five polarity events within the last 0.73 my of the geomagnetic Brunhes Chron. Minimum requirements for their successful identification in marine sedimentary sequences are a dense sampling scheme and a detailed demagnetization analysis of all samples.

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