Magnetic Investigations of Sediment Cores from the Mediterranean

by

DIETRICH HEYE
Bundesanstalt für Bodenforschung, Hannover (Federal Republic of Germany)

Abstract

A method for a non-destructive measurement of the declination of sediment cores enclosed in plastic tubes was used. Investigations were carried out of 12 deep-sea cores which originated from the Ionian Sea. In two shorter cores it was succeeded in determining paleomagnetic reversals, which means that the age in the lower part of these cores exceeds 7 10^5 years (date of the last reversal). Very low sedimentation rates of $S = 0.54$ mm/10^3a and $S = 2.5$ mm/10^3a have been derived by this means. The first result was obtained by evaluating six magnetic time marks and thus proved it to a sufficient degree.

As regards the course of magnetization versus depth, it was found that a similarity exists only among few cores. Even cores from the same station have only slight similarity and from these results the conclusion may be drawn that within the survey area the conditions of sedimentation even vary on a rather small scale.

Additionally, some layers of volcanic material can be determined by magnetic investigations.

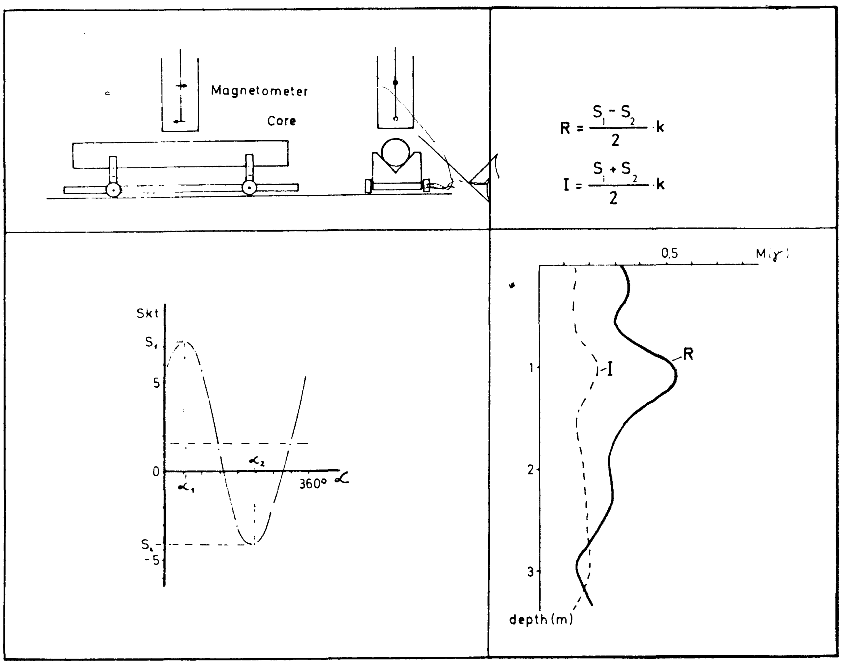

FIG. 1.

Rapp. Comm. int. Mer Médit., **21**, 11, pp. 861-864, 10 fig. (1973).

Introduction

During the last few years paleomagnetic measurements on deep-sea sediments have been carried out with particular intensity. They are aimed at finding geomagnetic reversals in order to derive a correlation or age-determination of the sediments. [Glass *et al.* 1967; Ninkovich *et al.* 1966; Keen 1963; Opdyke *et al.* 1966; Phillips *et al.* 1968] [1], [2], [3], [4], [5]. But even in cores in which no reversal can be discovered, the possibility exists theoretically to find a correlation with the help of typical intensity of their magnetization.

Generally, the inclination and declination of single samples are measured, taken from the cores, but in the investigation reported here the declination of core parts was measured. A paleomagnetic reversal is possible to be found by a change of sign, too.

Method and evaluation

The cores were taken with a piston corer in a plastic tube of 5.9 cm inside diameter and cut into pieces of 1 m length. For determining the radial component of magnetization in the core (magnetic declination), each core part is rotated beneath an astatic magnetometer in various positions corresponding to various core depths. Thus, the angles of maximum and minimum deflection of the instrument are determined (Fig. 1). In general, the maxima and minima, each, lie on one generatrix of the cylinder. After these two angles or generatrixes have been determined, measurements at intervals of 2.5 cm are carried out on both of these surface lines along the core parts.

The advantage of this method is that a non-destructive measurement is possible without preparation or handling of single samples. The magnetization is averaged over a length of core of about 5 cm. Therefore, an irregular change of the magnetization appears as a rise or decrease of this length. The evaluation was done on the assumption of an infinitive cylinder, homogeneously magnetized in cross direction. From the measured maxima S_1 and minima S_2, the remanence R and the induced magnetization I, are obtained by equations given in Fig. 1. In these equations k is the factor of both geometry of the cylinder and the calibration of the magnetometer. If there is a paleomagnetic reversal in the core, maxima and minima change their places in the core and remanence changes sign.

This method restricts the measurements to the radial magnetic component of the core (declination). This restriction, however, does not play an essential rôle in these cores owing to the fact that they originate from latitudes, and the amount of the inclination is expected to be small.

In figure 2 there are given the results near a geomagnetic reversal. The minima and maxima exchange their places and the remanence changes its sign.

In figure 3 results of a disturbance are given, which can intere with the regular measurements. The shifting of the minima and maxima versus depth in the upper part of this core does not indicate a geoma-

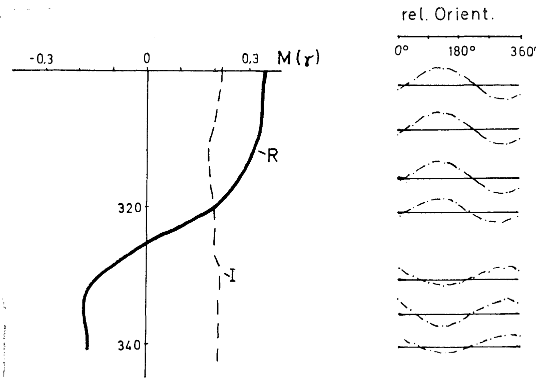

Fig. 2.

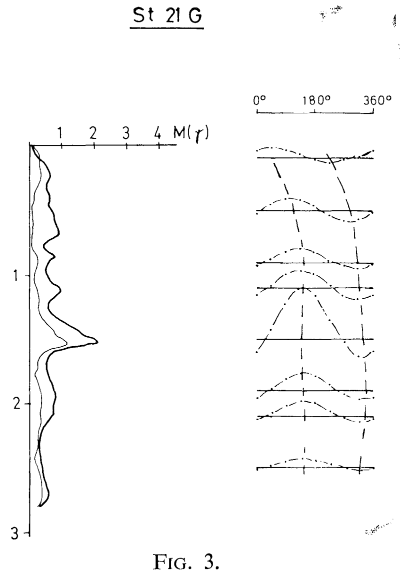

Fig. 3.

gnetic reversal. This effect is generated only, because the piston corer did not work correctly, it rotated slowly in the « coring moment ». This motion was retarted by the sediment in a short time and then the deeper part of core was taken without rotation. Therefore, it is necessary to distinguish between the « rotation effect » (indicated by a slow shifting of the extreme) and the geomagnetic reversals (indicated by a sudden exchange of minima and maxima).

In figure 4 the geographic distributions of the cores are given. The cores are generated from a line between Malta and the southern part of the Peloponnesus.

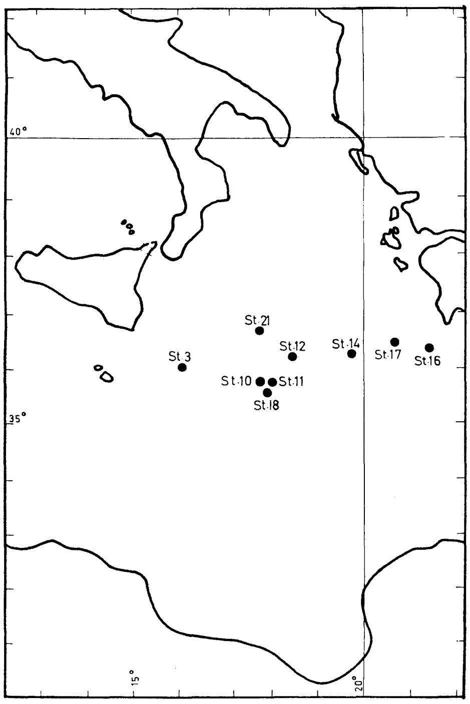

FIG. 4.

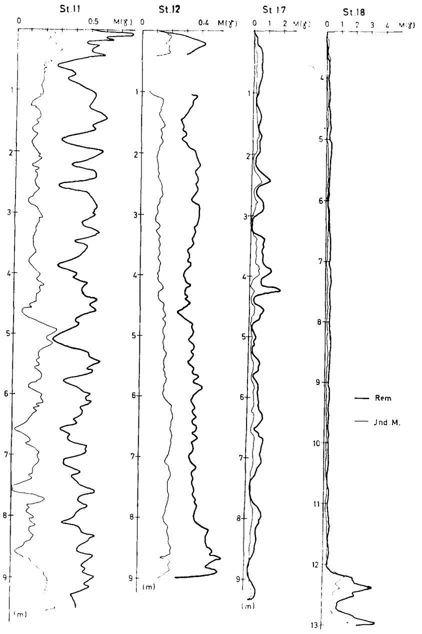

FIG. 5.

Results of the measurements

In figure 5 the magnetic results — remanence and induced magnetization — of 4 deep-sea cores from this region are given. The cores from Station 17 and 18 have a much higher magnetization and, therefore, the scale is changed by a factor 10. No geomagnetic reversals are to be seen as changes of the remanence within these cores. Remarkable are the periodical changes of alternations of the remanence in the core St 11 and in a lower degree in the core St 12, too. The reason of these alternations are unknown.

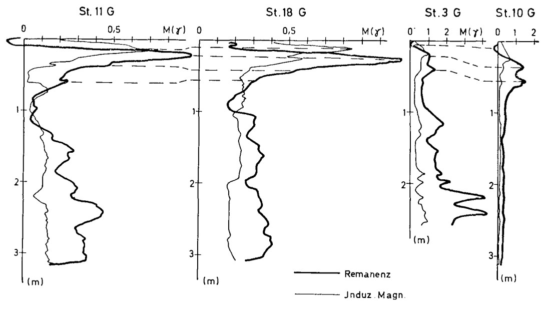

FIG. 6.

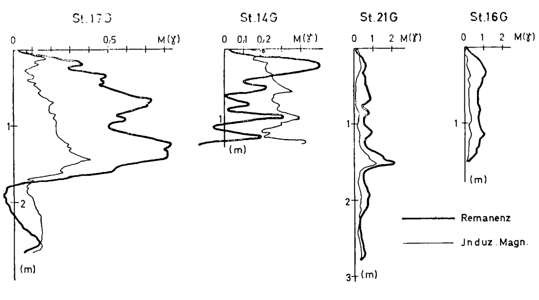

FIG. 7.

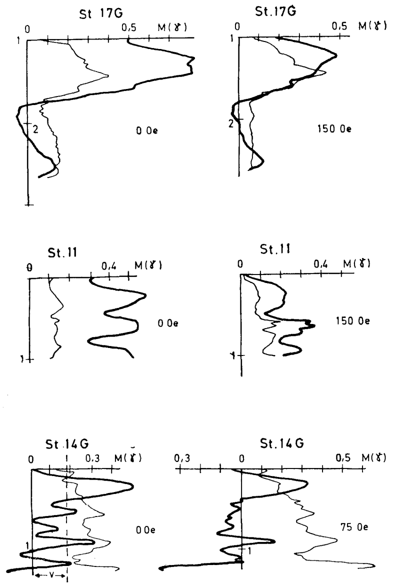

FIG. 8.

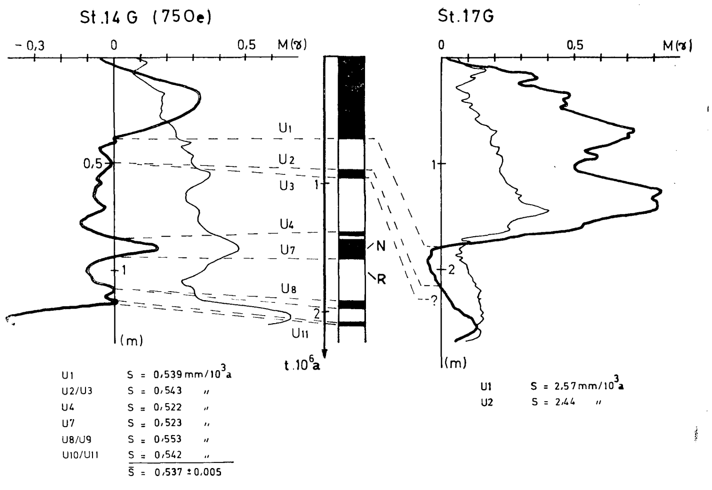

FIG. 9.

In some cases intensity correlations between cores are possible. In such cases the supply of magnetic minerals into the sediment seems to be controlled by the same process. The similarities in the cores St 11 G and St 18 G are generated by volcanic material. (Figure 6).

The cores St 17 G and St 14 G in figure 7 seem to have geomagnetic reversals, but it is necessary to prove the stability or hardness of the magnetization in such cases.

It has not been possible to heat the sediment material for determining the Curie point, because during this process the plastic tube would have been destroyed. For this reason, this question could only be solved by the means of alternating-field demagnetization. In the figure 8 the final results are given for a comparison with the original measurements. In the core St 17 G the remanence decreases by about 40 % only, yet the course of the curve is maintained. But in the case of the core St 14 G, the final curve is quite different from the original one. The material is now « cleaned » from the viscous magnetization and the real paleomagnetic events are to be seen.

In figure 9 an interpretation is given that means a correlation between the paleomagnetic reversals and the paleomagnetic time scale. Based on this time scale it is possible to date the cores. This method is of particular value because thus periods exceeding 7.10^5 years are opened to being detected. The single results of the two cores are in good agreement and averaged sedimentation rates of 0.54 mm/10^3a and 2.5 mm/10^e a are derivable. (Figure 10).

It is not possible to generalize these results because these two cores are taken from the top or the flanks of sea-mounts. Finally, the conclusion may be drawn that the sedimentation conditions are very different in this area. Cores from the same station have only very low similarities in their magnetic results.

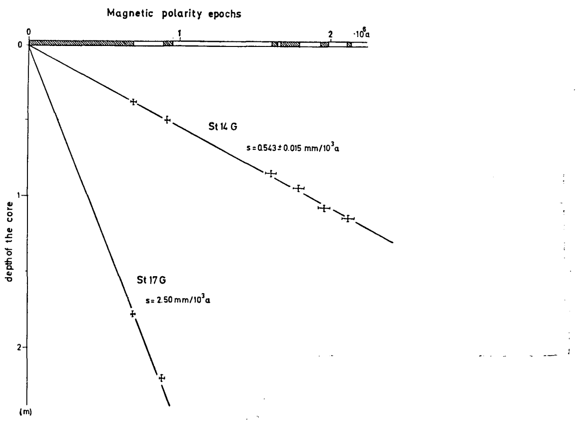

FIG. 10.