136. The Oscillation of Field in the Matuyama Geomagnetic Epoch

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From a spot in the north Pacific basin with the longitude 170°05'W and latitude 38°26'N we have obtained a boring core of sediments of the Quaternary and Tertiary periods incessantly piled up presumably at the ocean bottom.

In our laboratory a sensitive micro-astatic magnetometer as shown in Fig. 1 was set up to detect the weak magnetic vector preserved in the sediments. Permanent magnets we used are so small (0.5 and 5.0 mm in diameter and length respectively) that leaking flux out of the free poles can hardly disturb the remanence of the specimens placed close to the magnetometer during measurement. No effect of remagnetization was observed even when the core surface was brought within 3 mm from the poles.

Underneath the magnetometer the core column is rotated about its longitudinal axis while it is kept standing upright. The horizontal component of the fossil magnetism stored in the upper part of the column is determinable then from the deflection of the magnetometer.

Next a slice 1 mm thick is cut off from the head of the column by using non-magnetic knife of beryllium copper. The slice is measured and removed. The remaining column is then shifted upwards exactly 1 mm onto the magnetometer and is rotated again about the same longitudinal axis and deflection measured.

This simple procedure is repeated more than 1000 times till the height of the column is reduced approximately 2 m from top.

The uppermost slice has the strongest magnetic torque which brings about deflection to be measured on the magnetometer. The torque decreases from top downwards, the rate being 1/r^3, where r is the distance from top.

From the rate of sedimentation we may estimate that each slice of the core represents about 500 years of sedimentation in this part of the basin. The change of magnetic field as the depth increases

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from 25 to 197 cm (Fig. 2) will disclose the geomagnetic state from the recent age back to nearly 1.50 million years ago, at 500 year intervals, covering both the Brunhes and Matuyama epochs.

In the upper parts of the column from top down to a depth 52 cm declination is mostly normal, being in the same direction as that of the presently existing field. An antiparallel declination then appears more than 5 times and seems to persist for a relatively short time (since inclination during the polarity change has not been examined as yet, the change is not to be ascribed to such a frequently recurring excursion of the Brunhes poles as we have confirmed recently in Lake Biwa\textsuperscript{3,4}). At the depth 52 cm a reverse declination suddenly appears and continues to exist till to the depth 74 cm. The curve showing the change with depth is here so steep that the boundary that separates the normal and reverse declination covers only a 1 mm slice of the core, suggesting that the transition in rather short and swift than has been considered so far. Cox et al.\textsuperscript{5} and Niitsuma,\textsuperscript{4} namely, supposed more than 4,000 years for the change to take place.

Fig. 1. Micro-astatic magnetometer.
Fig. 2. Change of declination with depth of sediments.
The first depth above is, as assumed by Kobayashi,\textsuperscript{1,2}) the boundary of the Matuyama and Brunhes epochs. The second and the third show where the Jaramillo event ends and begins in the long Matuyama epoch. A radiometric dating\textsuperscript{7}) has revealed that the three have 0.69, 0.89 and 0.95 m.y. each.

From the depth 52 to 87 cm and also from the depth 124 to 142 cm declination does not fluctuate greatly except the two swift shifts that occur at the upper and lower Jaramillo event.

The term “tranquillness” has been in use to characterise the steady Matuyama epoch as a whole. Actually, however, in the later stages of the Matuyama epoch the geomagnetic field is oscillating conspicuously, a normal field being always followed by a reverse one and vice versa, although the duration of the field with reverse polarity is much longer than that of normal polarity. The Matuyama epoch, it may now be maintained, consists of the tranquil as well as oscillating stages that follow one another consequently.

Doell and Cox\textsuperscript{8}) have propounded the view that the Pacific ocean is a place where no remarkable secular anomaly exists. They considered that any actual anomaly is due to the non-dipole geomagnetic fields which move continuously westward (relative to the mantle) causing the secular variation. In order to explain the absence of anomaly in the Pacific they took into account the physical property of the mantle deep beneath the ocean that is especially conductive, absorbs easily the moving magnetic flux and dissipates it into heat. However, the secular field of the Matuyama epoch is, as has been shown, rather noisy suggesting that their arguments might not be tenable here. Even in the tranquil Matuyama stage declination frequently fluctuates in one thousand years with the amplitude over 30°, the value too large to be looked for experimental errors. The so-called Pacific quietness or “dipole window” is indeed missing in the entire Matuyama epoch.

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