

Reconstruction of the mean past geomagnetic field by use of paleomagnetic data

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Mapping relations of Gauss coefficients have been studied, especially for instantaneous data. They include virtual geomagnetic pole (VGP) (Kono and Tanaka, 1995), field intensity (Kono and Hiroi, 1996), inclination and declination (Kono, 1997), and the form of distribution of field directions and VGPs (Kono, 1997).

Kono, Tanaka, and Tsunakawa (1999) tried the inversion of paleointensity data of the last 10 Ma. Now we extend the inversion to the nonlinear data. This is an extension of the method of Gubbins and Bloxham (1985), who obtained the maximum likelihood estimate (mle) from the data containing errors. In addition to the errors, we also consider the fluctuation of Gauss coefficients, and seek mle of them. The method and its application to synthetic data will be described.

We have been studying the mapping relation between Gauss coefficients and various field components, especially when the data are not of instantaneous nature such as paleomagnetic data. In this case, not only the averages but also variances (and other higher moments) affect the observed means of the data, if the mapping relation is nonlinear. The studied field elements and their derivatives include virtual geomagnetic pole (VGP) (Kono and Tanaka, JGG, 47, 115--130, 1995), field intensity (Kono Hiroi, EPSL, 139, 251--262, 1996), inclination and declination (Kono, JGG, 49, 615--631, 1997), and the form of distribution of field directions and VGPs (Kono, PEPI, 103, 313--327, 1997). We feel that the forward problem of paleomagnetic mapping has well been covered by these studies.

Accordingly, Kono, Tanaka, and Tsunakawa (JGR, in press, 1999) tried to apply the developed method to the inverse problem. Since they found difficulties in the case of nonlinear data (inclination, declination, etc.), they restricted themselves to the case of linear data, namely the paleointensity data of the last 10 Ma, which are also accompanied by the direction information.

In the present study, we extend the inversion to the nonlinear data. The method is a natural extension of the stochastic inversion of Gubbins and Bloxham (GJ, 80, 695-713, 1985). These authors showed the inversion method based on the maximum likelihood estimate of data which contain errors which can be assumed Gaussian with zero mean. In addition to the errors, we consider the effect of the fluctuating Gauss coefficients, linearized at the starting model, and seek a maximum likelihood estimate of these coefficients. The method and its application to synthetic data will be described.