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Improved method of the correction for the magnetic field produced by vehicle body

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The vehicle magnetization correction (Isezaki, 1986) is the most essential but the most puzzling process in the magnetic vector field analysis. It often happens that a part of variation in magnetic field apparently correlates to the vehicle attitude, or that correction coefficients and the resulting magnetic field variation significantly depend on which data set we use to calculate the correction coefficients.

We would fail to obtain good correction coefficients when (a) there exists a time lag between the magnetic field and the vehicle attitude data (even a 0.5 second lag can affect the result), or (b) the data set to calculate the coefficients are not enough to obtain numerically stable solution. As for (a) we can find and correct the time lag by trial calculations with shifted data. We can also stave off the case (b) by taking care to collect data in as variable vehicle attitudes as possible.

But even if it is neither the case, results are often far from satisfactory. It has been attributed to some viscous behavior of the vehicle magnetization which cannot be represented in the linear observation equation. However, we rather consider that we have missed out the most appropriate correction coefficients and that errors are mainly caused by the assumption of the geomagnetic reference field as the ambient field in the calculation of correction coefficient. We present an improved method of the correction and its application to deep-sea magnetic field data obtained with AUVs.

1. Correction method considering magnetic anomalies at the place of calibration

In the current method the geomagnetic reference field is assumed as the ambient field. But if the anomaly field has a component perpendicular to the main field, that considerably affects the coefficients and resulting magnetic profiles.

This problem can be well settled by solving the anomaly field together with the correction coefficients as follows:

(1) the observation equation becomes linear by neglecting a small term considering that the induced magnetization coefficients are expected much smaller than 1 and that the anomaly field is much smaller than the main field.

(2) the number of variables are apparently 15 (12 correction coefficients + 3 components of the anomaly field), but the component of the anomaly field parallel to the main field cannot be determined because it is complementary to the diagonal elements of the induced magnetization coefficient matrix. Therefore, adding the two components of the anomaly field perpendicular to the main field as independent variables the number of variables becomes 14.

The solution is obtained by using the least squares method, but the method using normal equation results in an unrealistic solution, which does not satisfy the conditions for the linearization. Iterative methods such as the Gauss-Siedel method work good: the coefficients calculated by using the current method (i.e., assuming the reference field as the ambient field) and zero anomaly field are appropriate as the initial solution. If some anomalies exist a slightly different coefficients would be obtained accordingly. As long as we applied to our deep-sea data these revised coefficients significantly improve the resulting magnetic profiles, suppressing false variations correlating to vehicle attitude changes.

2. Level shifts in anomalies among parallel survey lines

If we have several EW survey lines for example, it often happens that there is an apparent level shift between the east-going and west-going lines. This kind of false variations can be mostly removed by changing slightly a part of the coefficients (specifically, the horizontal components of the permanent magnetization Hp1 and Hp2 and the two elements in the induced magnetization matrix a31 and a32). We present some simple formulations to give the correction value.

Isezaki, N. (1986), A new shipboard three-component magnetometer, Geophysics, 51, 1992?1998.

Keywords: three-component magnetic field measurement, vehicle magnetization correction