

A representation of the geomagnetic total force variation around Japan and its application to tectonomagnetic studies

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The geomagnetic field contains changes due to the piezomagnetic effect or volcanomagnetic effects, which reflect the physical status within the Earth's crust. Hence, observation of the geomagnetic field can be a tool to monitor tectonic activities. However, it is not an easy matter to detect these changes. They are generally far smaller than global geomagnetic variations due to the Earth's external field and the internal core. Therefore, techniques to eliminate global changes from the observed field variation should be developed.

Most commonly used way to eliminate global changes is to make simple differences between data at a field station and data observed simultaneously at a reference station. This method is valid when the variation at the reference station is coincident with that of the field station. However, global changes are not uniform between two stations. And data at reference station may contain non-global component. Therefore, the reliability of the result depends on the selection of the reference station. Our strategy is to construct a reference field model based on data from many reference stations to express only the global geomagnetic variation. Once such a model is obtained as a function of time and position, we can extract tectonomagnetic changes from each geomagnetic data only by subtracting value predicted by the model.

In the present study, a spatial-temporal model of the monthly mean values of geomagnetic total forces has been constructed for the time interval from 1997 to 2005. Data from six geomagnetic observatories and ten continuous geomagnetic stations in Japan are used for the model. Characteristics of temporal changes of the model is expressed by a numerical functions which are derived from the Principal Component Analysis, while spatial dependency of the variations are expressed as a analytical functions determined by a regression method. The accuracy of the model is within approximately a few nT.

Using this model, we have reexamined the total force variation observed in the Tokai Area, central Japan. It was reported that characteristic changes had been observed in the geomagnetic field in association with the Tokai Slow Slip Event. However, the model constructed in the present study shows some of observed changes are not actual signals but apparent ones.

Although simple difference method is effective and has been used for many studies, the result of the present study shows that small changes derived from the simple difference method should be seen with some suspicions.