A new investigation on drift of base-line value in geomagnetic observation

DONG-MEI YANG (扬冬梅) YU-FEN GAO (高玉芬) YONG-FEN ZHAO (赵永芬)
WEI-BEI HUANG (黄蔚北)
Institute of Geophysics, State Seismological Bureau, Beijing 100081, China

Abstract

A new explanation on drift of base-line (BL) value in geomagnetic observation was presented by means of detailed analysis on BL value of H-variometer at Tianshui Observatory from 1991 to 1995, in association with some numerical simulation. It was confirmed that drift does not always exist. For variometers running normally for many years, drift appears to be zero. The temperature-dependence of BL value is reversible below a certain temperature but irreversible above it. This irreversibility is the main reason that causes the BL value to show a monotonous declination with time, which has been mistaken for the drift in the past. As to the H-variometer at Tianshui Observatory, no drift exists in BL value in these years. A new method was introduced to study the BL value variation with temperature by separating it into three parts.

Key words: base-line (BL) value drift temperature coefficient

Introduction

A typical system of geomagnetic routine observation consists of two parts. One is the relative observation which is the continuous measurement of the geomagnetic field variation by using the variometers. The other is the absolute observation which is to determine the BL value of the variometers. Studying BL value variation can help people to understand the working status of the instruments at the observatories, to find and resolve the problems that might exist, and to provide the most reliable data for researches on geomagnetic field and geomagnetic effects in earthquake prediction.

Generally the known factors influencing on the BL value change are temperature dependence and drift. As the magnet steel making the magnet needle in variometer is essentially temperature-dependent, variometer observation is inevitably affected by temperature even though the needle has been heat-treated, stability-treated and compensated by temperature. For recently installed variometer, its observation declined monotonously since the parts need to fit in with each other for a certain time and because of other effects. This kind of monotonous declination is called drift. It is believed that the BL value drift will slow down with time and finally disappear when the instrument working status comes to a relative stability. But in practice, the BL value of most variometers shows an annual variation with a monotonous declination even if they have worked for many years. The annual variation is commonly taken as the effect of temperature and the monotonous declination as the effect of drift. From studies on BL value for many variometers of different kind, Kuboki (1963) concluded that the BL value of H-variometer decreases exponentially during about one year from the initial installation, and then it reaches a constant negative

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drift with a velocity of several nT per year. Starting from this point, Yanagihara (1975) analyzed the BL value changes of KM-type H-variometers at three observatories i.e., Kakioka, Memambetsu and Kanoya and concluded that the temperature coefficient and drift coefficient all changed with temperature for each variometer. The BL value were treated in the similar way in China. Gao et al. (1990) processed the BL value by using the regression method and considered the temperature and drift to be two independent variables, and then got the temperature coefficient and drift coefficient for each observatory. But their fitting errors were large and regular for some observatories. To make it better, Gao et al. (1991) added the mixed component of temperature and drift in their regression. Although errors were reduced without essential improvement, meanwhile a mathematically wrong idea was brought in.

As processing the BL value was carried out for each year separately, some phenomena and regular pattern are not easy to be observed. In this paper, the BL value data of several successive years were made up a long time series. Therefore the detailed analysis on the regular pattern and characteristics of BL value variation can be conducted. And in association with the numerical stimulation, a new explanation on BL value variation was presented and was quite different from the traditional ones. It was confirmed that the drift does not always exist and the irreversibility of the temperature-dependent change of BL value at high temperature is the actual reason that causes the BL value to show a monotonously decreasing with time which has been mistaken as the influence of drift.

1 Data, method and viewpoint

The BL value of H-variometer at Tianshui Observatory (34.5°N, 105.9°E) from 1991 to 1995 were used to illustrate the data analyzing and processing method and the achieved results.

The time-dependent variations of BL value and temperature in recording room during 1991 ~1995 were shown in Figure 1a. Time was initiated from January 1st, 1991. A basic value of 32 200 nT was eliminated from all the observed BL value. From Figure 1 we can see that both the BL value and temperature varied annually with a similar pattern, only there remained a linear decreasing with time in BL value which had always been interpreted as drift. However this was not the case if we analyzed in the following way.

![Figure 1](image-url)  
Figure 1: The BL value variation of H-variometer at Tianshui Observatory from 1991~1995. (a) Variation of BL value and temperature with time. (b) Variation of BL value with temperature in each year.

The same BL value were used in Figure 1b as in Figure 1a, but the temperature was shown in the horizontal axis in Figure 1b. The corresponding years were marked in the curves. It was shown obviously in Figure 1b: ① The BL value decreased as temperature ascended. When temperature descended after reaching its peak value, the BL value did not come back to the same one as its original one in the temperature ascending period, even if they were at the same temperature point. So the temperature-dependent change of BL value in a year appears to be irreversible. ② The BL value varied in a quite similar way in different years. ③ The BL value decreased from year to year.