b-value analysis for low-frequency earthquakes beneath Mt. Fuji

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Two important problems about low-frequency earthquakes beneath volcanoes remain still not elucidated. One of them is location of the occurrence area relative to magma reservoir or magma supplying system. The other is if occurrence rate increase could be regarded as a signal indicating an eruption in near future. Here, we take up the first problem, that is, we examine if the *b*-value analysis of low-frequency earthquakes is an effective method to infer location of the magma reservoir.

There have been a lot of studies in which depth of magma reservoir was successfully estimated by the *b* -value analysis using ordinary earthquakes around volcanos (e.g., Wiemer & McNutt, 1997; Wyss et al., 1997; Wiemer et al., 1998). The estimated locations were found to be consistent with velocity structure and other observational data. Also, there have been such studies that existence of thermal fluids is inferred based on the spatial distribution of the *b* values (Yoshida et al., 2001; Nanjo et al., 2017). The *b* value represents the ratio of the number of large earthquakes relative to that of small ones. It is known that the *b* value takes a large value when temperature of the seismogenic area is high. So far, there has been no study that the *b* value of low-frequency earthquakes was used to estimate location of magma reservoir. In that meaning, this is the first attempt.

Figure 1 is an example of our investigation into low-frequency earthquakes beneath Mt. Fuji. We used the Japan Meteorological Agency (JMA) catalog. Figure 1 shows the north-south cross-sectional view of the *b* values for the low-frequency earthquakes in western (Figs. 1a,c) and eastern (Figs. 1b,d) sides of the earthquake swarm, projected onto a north-south longitudinal plane. Our *b*-value analysis was conducted for the two time periods, 2000-2008 (Fig. 1a,b) and 2009-2017 (Fig. 1c,d). It is seen from Fig. 1 that an area of large *b* value exists in the shallow part for both periods. However, the position is apparently different, that is, the large *b* value area is recognized in the western half section in and before 2008, while the area is seen in the eastern half section in and after 2009.

We consider, from Fig. 1, that the spatial distribution of the *b* value did not show a stationary pattern. The results that a high-*b*-value area was seen in the western side during the former period (2000-2008) and in the eastern side during the latter period (2009-2017) indicate that the spatial pattern of the *b* value does not reflect location of the magma reservoir. Because it is difficult to suppose that magma reservoir changed its location from the west to the east in 10 years or so and it seems improbable that magma reservoir exists over the area of the occurrence of low-frequency earthquakes. Then, what change in the seismogenic area produced the difference in the *b* value distribution between the two periods? We do not have an answer to the question at present. Yet, we could show that the *b*-value analysis might be an effective method to investigate physical state of the occurrence area of low-frequency earthquakes.

It might be meaningful to note that activity of low-frequency earthquakes was remarkably high in the fall of 2000 and the occurrence rate of low-frequency earthquakes seems to have been increasing since 2014.

Figure 1. Cross-sectional view of *b* values for low-frequency earthquakes beneath Mt. Fuji. Results in the left column (a,c) are based on low-frequency earthquakes during the time periods 2000-2008 (a) and 2009-2017 (c) in a western side (138.73-138.745˚E, 35.31˚-35.41˚N) of the earthquake swarm, which are

projected onto a north-south longitudinal plane from 35.31˚N to 35.41˚N. Similarly, in creating cross-section maps in the right column (b,d), low-frequency earthquakes in an eastern side (138.75-138.765˚E, 35.31˚-35.41˚N) were used. To map *b*-values in a-d, we created a dense spatial grid (0.1 x 0.1 km), each grid point at which a *b* value was computed by the EMR technique (Woessner & Wiemer, 2005).

Keywords: Mt. Fuji, b value, low-frequency earthquake, volcano seismology, magma migration, seismicity and tectonics

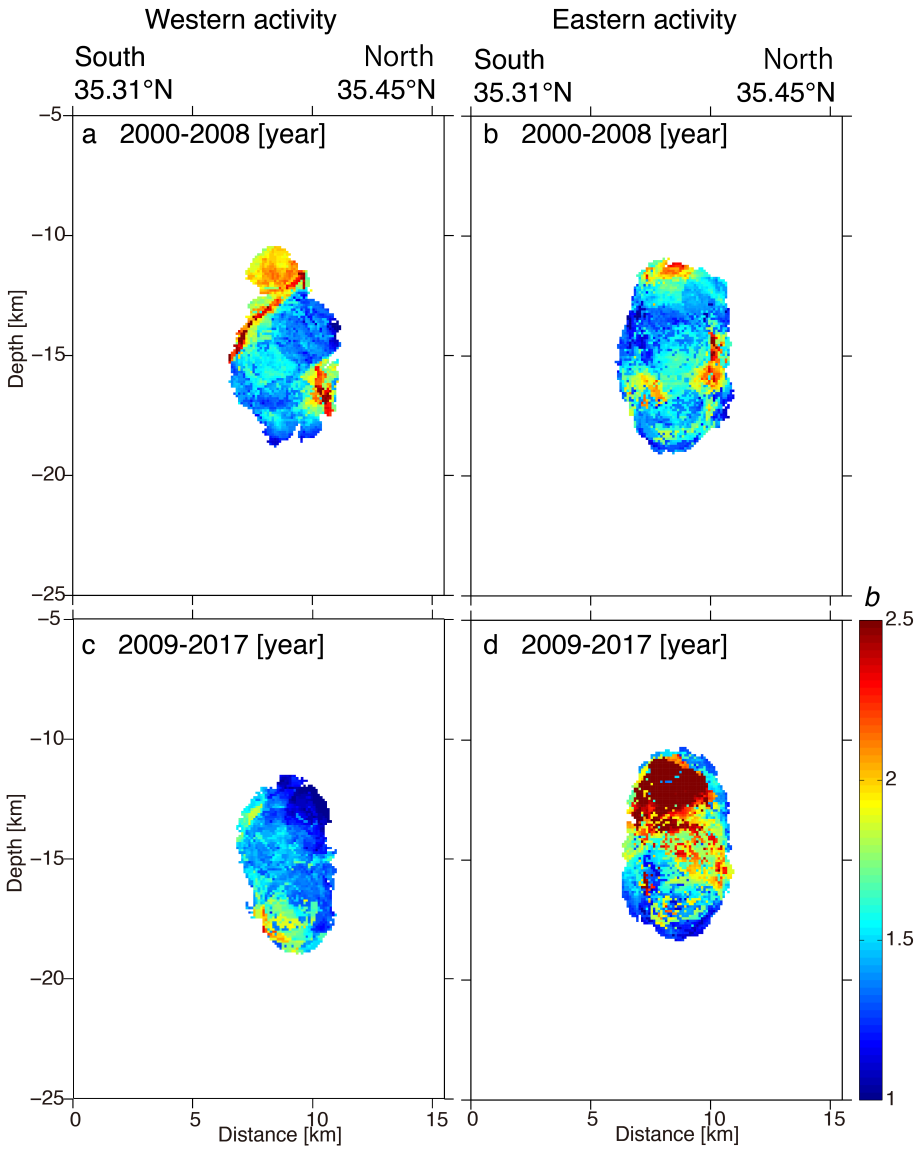

図1. 富士山近傍で発生した低周波地震に基づく*b*値の南北断面。
Figure 1. Cross-sectional view of *b* values for low-frequency earthquakes beneath Mt. Fuji.

