Time Series Analyses of EM-ACROSS Data (2)

*Sohei Serita[1], Yasuo Ogawa[1], Kuo Hsuan Tseng[1], Keiichi Ishizu[1], Takahiro Kunitomo[2], Takuto Minami[3], Hiroshi Ichihara[2], Grant Caldwell[4]

1. Tokyo Institute of Technology, 2. Nagoya University, 3. Kobe University, 4. GNS Science

In volcanic eruption prediction research, it is important to image magma and hydrothermal systems and monitor and observe their temporal variations. Resistivity is a geophysical quantity sensitive to magma, hydrothermal fluids, and clay minerals. It is possible to detect resistivity distribution and its temporal variation in the subsurface by electromagnetic exploration. In the Kusatsu-Shirane volcano, the past MT surveys revealed the resistivity structure (Nurhasan et al., 2006; Matsunaga et al., 2020; Tseng et al., 2020a). Time-lapse MT observation is one way to detect the time variation of the resistivity structure (Aizawa et al., 2011; Peacock, 2012), but for signal stability and noise suppression, the method using artificial electromagnetic signals is advantageous (Utada et al., 2007; Hino Ho, 2014; Minami et al. 2018). We installed an EM-ACROSS (ElectoMagnetic-Accurately-Controlled-Routinely-Operated-Signal-System) transmitter system Kusatsu-Shirane volcano (Tseng et al., 2020b). It has two grounded dipoles in two directions, and two signal series consisting of line spectra with slightly different frequency sets are transmitted simultaneously from independent transmitters. We can measure the two series of signals from the received signals at all times. So far, we have been analyzing the EM-ACROSS data as follows (Tseng et al., 2020b). First, a data window of 1,000 seconds, consisting of 10 sets of 100 seconds, which is the repetition period of the signal, was used as the unit of analysis. The data in each 1,000-second data is detrended and cosine-tapered, and then Fourier transformed. This Fourier component is obtained for each data window and stacked, but of course, this includes noises. If we focus on the frequency of a signal and plot the Fourier components obtained for each data window of 1,000 seconds on the complex plane, we can recognize clusters and outliers. Here, we use the median absolute deviation to discriminate and remove the outliers from the stack. As a result, only good data can be selectively stacked (Tseng et al., 2020b). On the other hand, there is a problem of decreasing the number of stacks by excluding data. In this new study, we work in the time domain. The data is represented as a sum of a sine wave consisting of signal components to extract a weak stationary signal. In the lecture, as a prelude to the analysis of the actual data acquired, test data with the noise of about ten times the known signal's amplitude was prepared for one-day length and analyzed. Then, we apply the method to the field data obtained in 2020.

