Subsurface exploration using longwave radio-clock time-signal

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VLF method has been used for subsurface exploration survey that ties records at single points. Since VLF electromagnetic wave is not stable due to various effects, subsurface exploration using VLF method has limitations in resolution and in the applicability depending on the place of surveys. To overcome some of the limitations, we propose to use standard-time longwave electromagnetic transmissions ,which is called JJY(C) in Japan, JJY is more stable than VLF, so that it will be available for the exploration of underground structure. By using radio time-signal receivers , we can quickly record continuous time signals in wide area to estimate resistivity distribution of subsurface ground. In our study, we applied numerical experiments to reveal the characteristic of subsurface exploration using JJY. We used electromagnetic wave of 20 kHz as an existing VLF wave and 40 and 60 kHz as JJY standard electromagnetic waves and evaluated the resolution of the methods derived from the influence of the geometry for various combination of the orientation of an anomalous structure, the propagation direction of radio wave, and the orientation of two-dimentionally aligned receivers.

Our results show the following confirmation: (1) we can evaluate attenuation of JJY wave using FDTD method , (2) higher the frequency becomes, the better sensitivity it has in shallow area,(3) the smaller difference angle becomes, better the sensitivity of survey becomes. Therefore, we conclude that the structural anomaly runs in the direction of radio wave propagation, the most ideal survey would be conducted as known well for electromagnetic surveys. Our study suggests that JJY signal or any other continuous time signal could be used for the estimation of subsurface resistivity distribution.

The prototype of the measuring instrument has been developed. And we are trying to extend the method to VLF-MT for subsurface structure and to apply it for field data.