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Article / Book Information

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種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
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論 文 要 旨

THESIS SUMMARY

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学生氏名： Student's Name	TSENG, Kuo-Hsuan	指導教員（主）： Academic Supervisor(main)	小川　康雄
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要旨（英文 800 語程度）Thesis Summary (approx.800 English Words)

In the assessment of predicting the geological disaster or resource exploration, the changes of the subsurface are regularly major indicators. The electromagnetic sounding methods are developed to measure the electrical conductivity of the subsurface structure. Both the passive and active electromagnetic sounding methods have their advantages and disadvantages. The study in this article utilized both passive and active electromagnetic sounding methods for the volcanic hydrothermal system at Kusatsu-Shirane volcano, Japan, due to their advantages. Meanwhile, solved the common problems, including the uncertainty in the operation owing to environmental conditions and noise, and the Galvanic distortion effect in the observed electric field, by developing an alternative methodology to reduce the uncertainty issues in the operation.

An accurately controlled routinely operated signal system for electromagnetic signal (EM-ACROSS) was introduced in this article to achieving the motivations. The purpose of the EM-ACROSS is consistently transmitting a specially designed signal with high accuracy and precision to obtain a robust signal in the data processing. With an assumption that the environmental noise is dominated by Gaussian white noise, a robust signal can remain in the data stacking and then a noise-free response function can be obtained. The signal and the instrument from the prototype were redesigned with considering more features of the environmental noise. In this article, an improved design is explained in detail from signal and instrument design to operation and a specifically created data processing flow.

An initial experiment was located at Kusatsu-Shirane volcano, Japan, and verified the necessity of improved design. For the purpose of solving the Galvanic distortion effect in the local electric field, a concurrently transmitted EM-ACROSS was firstly introduced in this article. The data from the full operation was processed with a specially designated processing flow to attain the efficiency in noise reduction. The processed result represented a strong performance in the noise elimination by competing with geomagnetic noise and efficiently removing the aperiodic noise. The error of the observed result was small enough to be utilized in the modeling computation.

Besides the active electromagnetic sounding method, CSEM, another observation with the passive method, MT was also operated in the same area. Although the previous research of the underlying hydrothermal system beneath Kusatsu-Shirane volcano provided a preliminary comprehension of the conductive anomaly, the comprehension can be further enhanced by applying the topography information into the 3-D inversed modeling. Therefore, the past data was revisited with a new 3-D inversion algorithm. The new model with revisited data represented the undiscovered feature in the result. A sub-vertical conductor connects the upper and the lower conductors that has not been found in the previous studies. The new feature provides an enhanced comprehension to interpret the hydrothermal fluid path and the two-phase reservoir. The modeling result of revisited data was utilized for the newly observed MT data as its initial model. The computed inversed model with newly observed data represents some different features from the one with revisited data. The mismatch between two data was examined by an alternative method with CSEM forward modeling.

A forward modeling algorithm was regenerated in this article by referencing the previous researches. The forward model applied the edge-based frequency-domain FEM with unstructured tetrahedral meshes. A local-to-global numbering system was additionally defined in this article to solve the technical issues. To connecting the advantages between the passive and active electromagnetic sounding methods, both the computed inversed models with MT data were utilized as the based model in the forward modeling. The algorithm generated a sparse linear equations system and

solve the solution by a sparse linear direct solver in python language. The calculated electric field in the forward modeling result is assumed to be distortionless. Because the resistivity information from the inversed models has been treated for the distortion effect. The distortion contained observed data and the distortionless calculated data had an obvious mismatch as in the expectation. That the direct comparison between two data could not be interpreted. Therefore, this article introduced a distortionless response tensor to solve the Galvanic distortion issue.

The distortionless electric field response tensor utilized the features from the concurrent transmission with specially designed signals. The EM-ACROSS signal in the operation provided the independent electric field set for solving the distortionless response tensor. The plot of the real part and imaginary part of the response tensor error (i.e. the difference between the observed response tensor and calculated response tensor) clearly indicated the reliability in the inversed model with newly observed data and provide the feasibility of interpretation. Thus, the utilization of concurrently transmitted EM-ACROSS was verified. The research in this article solved the environmental noise issue and distortion effect by connecting the passive method and active method of electromagnetic sounding as a joint utilization that provided a new conception in future exploration.