学 位 論 文 内 容 の 要 旨

Abstract of Doctoral Dissertation

博士の専攻分野の名称 博士(理 学) 氏名: アブド アラー サブリ アブリマーソン モハメド

Degree requested: **Doctor of Science** Applicant's name: Abdallah Sabry Abdelmohsen Mohammed

学 位 論 文 題 名

Title of Doctoral Dissertation

<Title of Doctoral Dissertation submitted for the degree>

A three-dimensional Resistivity Structure Study Using Airborne Electromagnetics: Application to GREATEM Field Survey Data

(<Doctoral Dissertation title in Japanese>)

(空中電磁法による 3 次元比抵抗構造の研究：GREATEM 探査データへの応用)

ABSTRACT

Recently, it has been indicated that the coast and its adjacent onshore and offshore areas are vulnerable to natural disasters such as earthquakes, tsunamis, and hurricanes. New applications of airborne electromagnetic survey techniques have been introduced for environmental protection and natural disaster prevention to this area. The objective of this study was to establish a method of constructing a three dimensional (3D) subsurface model for a complicated structure. Numerical forward modeling was performed using a modified staggered-grid finite-difference (SFD) method, and adding a finite-length electrical-dipole (FED) source routine to generate 3D resistivity structure models of grounded electrical-source airborne transient electromagnetic (GREATEM) field survey data.

The GREATEM system was introduced by Mogi et al. (1998, 2009) and uses a grounded electrical dipole source of 2–3-km length as a transmitter and a three-component magnetometer in the towed bird as a detector. With a grounded source, a large-moment source can be applied and a long transmitter-receiver distance can be used to yield a greater depth of investigation, although the survey area becomes more limited. Other advantages include a smaller effect of flight altitude and the possibility of higher-altitude measurements. Data are recorded in the time domain, providing a raw time series of the magnetic fields induced by eddy currents in the ground after cutting off the transmitting current, with the result that a noise filter can be easily introduced.

I have verified our 3D electromagnetic (EM) modeling computing scheme, which is based on the SFD method (Fomenko and Mogi, 2002) by comparing the results of a quarter space and trapezoid hill models with the results of the 2.5-D finite-element method by Mitsuhata (2000), and the 3D finite-difference program with the spectral Lanczos decomposition method developed by Druskin and Knizhnerman (1994). This was then used to study the effects of sea and topographic features.

A GREATEM survey was performed at Kujukuri beach in central Japan, where an alluvial plain is dominated by sedimentary rocks and shallow water. A reliable resistivity structure was obtained at a depth range of 300–350 m both on land and offshore, in areas where low-resistivity structures are dominant. Another GREATEM survey was performed at a location in northwestern Awaji Island, where granitic rocks crop out onshore. Resistivity structures at depths of 1 km onshore and 500 m offshore were revealed by this survey. I performed numerical forward modeling using a modified SFD method by adding a FED source routine to generate a 3D resistivity structure model from GREATEM field survey data at both Kujukuri beach and the Nojima fault. In addition, I have developed a consistent three-dimensional electromagnetic inversion algorithm to calculate the EM response over an arbitrary 3D conductivity structure using the GREATEM system. This algorithm is based on approximating the sensitivities (Han et al., 2008) that can reduce the computation time, without a significant loss of

accuracy when constructing a full sensitivity matrix for 3-D inversion. This algorithm was used to produce a 3D resistivity model of the GREATEM survey data at Kujukuri beach area.

Finally, I have confirmed the accuracy of our 3D forward modeling computing scheme and the effects of complicated structures, such as sea or topography, on GREATEM data were evaluated. I have used this method to generate a 3D resistivity model from GREATEM field survey data acquired at the Kujukuri beach and the Nojima fault. In addition, I have developed a consistent three-dimensional electromagnetic inversion algorithm to calculate the EM response over an arbitrary 3D conductivity structure using the GREATEM data. As results, I have obtained information regarding seawater invasion mechanisms in sedimentary rocks and a resistivity structure along an active fault. This study indicates that the GREATEM system can be used for the assessment of natural disaster areas such as earthquakes, volcanoes, and active faults.