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Determining the three-dimensional position of the anomalous resistivity body in upper oceanic crust using MMR method

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Magnetometric resistivity method (MMR) is one of the controlled source methods, which is useful tool to estimate the electrical resistivity structure in upper oceanic crust. This method consists of a vertical bipole electric current source and OBM (ocean bottom magnetometer) as a receiver. One-dimensional resistivity structures estimated easily from the relation between the source-receiver distance and value of magnetic field induced by the vertical bipole electrical current source, but three-dimensional resistivity structure is hardly estemated. Therefore, we introduce magnetic field anomaly map in order to determine the three-dimensional position of an anomalous resistivity body in the oceanic crust. The magnetic field anomaly is difference between magnetic field induced in the reference resistivity structure (without the anomalous resistivity body) and that with the anomalous resistivity body. A magnetic field anomaly is obtained for a pair of a source and a receiver, and the value of the magnetic field anomaly can be plotted at the source position for the receiver. Magnetic field anomaly map for the receiver can be made by magnetic field anomalies at many different source positions. We calculated the magnetic field anomaly for 10 different models with various parameters (horizontal distance between receiver and the anomalous resistivity body, depth of anomalous resistivity body, and so on) by using 3-D forward modeling. Magnetic field anomaly maps for 10 different models are used to derive two relationships in positions between the magnetic field anomaly and the anomalous resistivity body: 1) The anomalous resistivity body exists under straight line between the peak of magnetic field anomaly and receiver position. 2) The other one is the depth of the anomalous resistivity body can be determined by indicating the depth of anomalous resistivity body has proportional relationship with the horizontal distance between anomalous resistivity body and the peak of magnetic field anomaly. These relationships allow us to determine the three-dimensional position of each anomalous resistivity body through magnetic field anomaly maps for more than two receivers.Our results indicate that magnetic field anomaly map is useful tool to determine the three-dimensional position of the anomalous resistivity body , suggesting that a MMR survey requires many vertical bipole electrical current source transmissions with a few OBM to reveal distribution of anomalous resistivity bodies in upper oceanic crust.

Keywords: resistivity structure, Magnetometric Resistivity method, controlled source method, oceanic crust