Geophysical Research Abstracts
Vol. 13, EGU2011-5435, 2011
EGU General Assembly 2011

Negative apparent resistivity based on physical modeling

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In the dipole-dipole electrical resistivity survey, the sign of apparent resistivity is determined by the pattern of electric potential. When the electric potential decreases with distances from current electrodes, apparent resistivity is defined to be positive. Negative apparent resistivity recorded when the electric potential increases with the distance from current electrodes, had been regarded as noises or measurement errors. In recent years, there are several studies addressing that negative apparent resistivity can be caused by geological structures. Some numerical evidences showing that negative apparent resistivity can be caused by a U-shaped and a crescent-shaped model with high resistivity-contrast were presented. However, some geophysicists presented the possibility that negative apparent resistivity can be due to numerical errors, presenting that their pattern is dependent on numerical modeling algorithms. In order to support numerical modeling results, we carry out physical modeling for the U-shaped conductor model. For the physical modeling, we used a large water tank to alleviate boundary effect arising from finite-size water tank and use a graphite board (called 'grafoil') to simulate high resistivity-contrast model. To examine if the state of the U-shaped conductor is related to the negative apparent resistivity, we first perform a modeling for the U-shaped model by changing its depth and size. Physical modeling results obtained for various depths of the conductor show that negative apparent resistivity appears in a pants-leg shape when the conductor is placed near the surface. The results for various sizes of the U-shaped conductor show that the pattern of negative apparent resistivity appearing in pseudo-sections is closely related to the state of the anomalous body. We also carry out a modeling for elongated and split U-shaped models to verify the secondary source mechanism. As the conductor is elongated along the strike, the negative apparent resistivity values become smaller and closer to zero. The results for the split U-shaped model show that negative apparent resistivity values do not appear when the model is not connected. All the results of physical modeling are in good agreements with numerical modeling. Nevertheless, further study is still needed to provide theoretical evidence for negative apparent resistivity.