EGU21-340
https://doi.org/10.5194/egusphere-egu21-340
EGU General Assembly 2021

Uncertainties Analysis of Electrical Resistivity Tomography

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We examined the uncertainty of the resistivity method in cavity studies using a synthetic cavity model set at six-different depths. Conceptual models were simulated to generate synthetic resistivity data for dipole-dipole, pole-dipole, Wenner-Schlumberger, and pole-pole arrays. The 2D geoelectric models were recovered from the inversion of the synthetically measured resistivity data. The highest anomaly effect (1.46) and variance (24400) in resistivity data were recovered by dipole-dipole array, while the pole-pole array obtained the lowest anomaly effect (0.60) and variance (2401) for the target cavity T_1. The anomaly effect and variance were linearly associated with the quality of the inverted models. The steeper anomaly gradient of resistivity indicated more distinct cavity boundaries, while the gentler gradient prevents the inference of the cavity boundaries. The recovered model zone above the depth of investigation index of 0.1 has shown relatively higher sensitivity. Modeling for dipole-dipole array provided the highest model resolution and anomaly gradient that shows a relatively distinct geometry of the cavity anomalies. On the contrary, the pole-dipole and Wenner-Schlumberger arrays recovered good model resolutions and moderate anomaly gradient but determining the anomaly geometries is relatively challenging. Whereas, the pole-pole array depicted the lowest model resolution and anomaly gradient with less clear geometry of the cavity anomalies. At deeper depths, the inverted models showed a reduction in model resolutions, overestimation in anomaly sizes, and deviation in anomaly positions, which can create ambiguity in resistivity model interpretations. Despite these uncertainties, our modeling specified that the 2D resistivity imaging is a potential technique to study subsurface cavities.