Practical Guidance For electrical resistivity surveying in thE presence of metallic infrastructure

*Benjamin Petersen, S.S. Papadopulos & Associates, Penobscot, ME, USA*

Metallic infrastructure, e.g. metal pipes or well casings, can act as low resistance pathways for electrical flow in the subsurface. These conduits can have large, and usually unwanted, impacts on electrical resistivity measurements. Modeling and field studies within the last two decades have provided insight into the effects of metallic infrastructure on measured apparent resistivities and have led to the development of methods that incorporate metallic infrastructure into inversions. These methods, however, can be difficult to implement and may be impractical for small-scale studies. The aim of this work is to help practitioners limit measurement errors due to the presence of metallic infrastructure and therefore avoid the need to compensate for their presence.

In this study, homogeneous 3D resistivity models with and without the presence of a buried metallic conduit were used to simulate 2D electrical resistivity measurements. Parameters such as array type, conduit resistivity, subsurface resistivity, conduit angle, and distance between the array and conduit were varied. Differences between simulated resistivities of a homogeneous background with and without the presence of a metallic conduit were used to calculate measurement error or the “pipe effect”.

“Pipe effects” (error) are shown to be highly dependent on array type, distance between array and conduit, geometric factor, and the contrast of the subsurface resistivity to conduit resistivity. Wenner, Schlumberger, Gradient, and Dipole-Dipole arrays are generally least affected by a buried conduit while Pole-Dipole and Pole-Pole arrays are significantly more affected. Mean error of simulated Wenner, Schlumberger, Gradient, and Dipole-Dipole apparent resistivities are less than 1% when measurements are collected at least 1/3 of the total array length away from a buried conduit. Pole-Dipole and Pole-Pole mean errors achieve less than 1% error at approximately 2/3 and 1 full array length away, respectively. Larger geometric factors generally correspond to larger errors, suggesting a simple method to reduce inversion errors could be to remove data with relatively large geometric factors. Varying the conduit and subsurface resistivities suggests error caused by buried conduits varies significantly when the resistivity contrast is between 10^3 to 10^8 Ohm-m., but error plateaus towards a maximum when the resistivity contrast reaches 10^8 Ohm-m. Resistivity contrasts in natural conditions depend on several factors, including subsurface resistivity, metal composition, contact resistance, pipe connection resistance, metal degradation, and surface coatings. Any of these factors may cause a non-uniform current distribution along the conduit, which leads to variations in current flow and potential distributions in the subsurface. The dependence of measured apparent resistivities on resistivity contrasts has implications for methods designed to correct for the presence of metallic infrastructure during inversions.