

DC Resistivity Tomography and Radar Full-wave Inversion of Cylindrical Targets

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Abstract: New applications into cylindrical targets other than half-spaces, such as tree trunk imaging, clinic organ tomography, architecture engineering imaging, etc., are rising fast in recent decades. The electrical resistivity tomography (ERT) is both cost-effective and time-saving, and the radar full-wave inversion (FWI) has the advantage of high accuracy. As the important branches of the shallow surface exploration methods, ERT and radar FWI have great potential for imaging cylindrical targets. In this article, we investigate the well-posedness of ERT and radar FWI on detecting cylindrical targets. The 2.5-dimensional direct current (DC) ERT of various cylindrical targets is carried out and the numerical results show that the commonly used optimization wave-number selection is not precise enough to be used in the modeling of cylindrical targets. We proposed a new optimization wave-number selection strategy and use the time-lapse inversion to image the cylindrical targets. Laboratory experiments are conducted and the results show that the newly proposed optimization wave-number selection can improve the accuracy of numerical simulations. For the radar FWI of cylindrical targets, the simulation process mainly includes, firstly, calculating the radar response of a cylindrically-layered media using scattering Green's function, secondly, adapting the far-field model proposed by Lambot et al., (2004) to free the signal from antenna effects, multiple reflections, etc., thirdly, carrying out the inversion using a look-up table (LUT) approach followed by local optimization. Our numerical experiments highlight the complexity of the inverse problem, mainly originating from the multiple propagation modes within cylindrical targets. The laboratory measurements are also conducted and results demonstrated the accuracy of the forward modeling and reconstructions for far-field conditions.

Key words: ERT for cylindrical targets; adapted optimization wavenumber selection; radar FWI for cylindrical targets