COMSOL Multiphysics® Software: Time-Lapse Electrical Resistivity Inversion

T. K. Chou[1], M. Chouteau[2], M. J. Yi[3]

[1]Department of Civil, Geological & Mining Engineering, École Polytechnique de Montréal, Montreal, QC, Canada

[2]Department of Civil, Geological & Mining Engineering, École Polytechnique de Montréal, Montreal, QC, Canada

[3]Korea Institute of Geoscience and Mineral Resources, Daejeon, South Korea

Abstract

Electrical resistivity tomography (ERT) is a non-invasive method for mapping the subsurface resistivity distribution. Time-lapse ERT provides a way to monitor subtle sub-surface changes caused by water flow such as in an infiltration test. Several methods were proposed for inverting a time-lapse ERT data set. One of the basic approaches in interpreting monitoring data is to invert data at each time independently, and the change in ground condition is determined by the difference between the inversion models at time T and T+1. Another approach is to invert the data at a later time while being constrained by the inversion model at the previous time (Loke, 1999). This has being incorporated in the wildly used res2dinv and res3dinv programs. Problems arise when the inversion models contain artifacts due to measurement errors, rapid change in soil electrical property during measurement time, etc. A new approach was developed by Kim et al. (2004 and 2009) that incorporates the time constraint in the standard ERT inversion scheme that simultaneously invert the entire monitoring data set. It was shown that such inversion reduces inversion artifacts and provides adequate reconstruction of the true model. The aim of this project is to determine if COMSOL Multiphysics® software can help inverting monitoring ERT data using the latest inversion scheme proposed. The AC/DC Module has been used for solving forward electrical resistivity problems and in calculating the Jacobian matrix. Numerical models and analytical responses were being used to validate the forward modeling error and inversion error. Tests have shown that COMSOL Multiphysics® with the AC/DC Module provides the necessary tools for creating an ERT time-lapse inversion scheme. Synthetic models have shown a better reconstruction of the true monitoring model when the simultaneous time-lapse inversion scheme was used versus the independent inversion scheme. Recovered models from the method developed using COMSOL, agree very well with the results obtained using the code of Kim et al.

Reference

1. Loke, M.H., Time-lapse resistivity imaging inversion. Proceedings of the 5th Meeting of the Environmental and Engineering Geophysical Society European Section. Budapest, Hungary, (1999).

2. Kim, J.-H., Park, S.-G., Yi, M.-J., and Kim, J.-G., 4-D inversion of geophysical monitoring data acquired over dynamically changing 4-D earth model, Proceedings of 8th SEGJ International Symposium, Kyoto Univ., Kyoto, Japan, 89-94, (2006).

3. Kim, J.-H., Yi, M.-J., Park, S.-G., and Kim, J.-G., 4-D inversion of DC resistivity monitoring data acquired over a dynamically changing earth model, Journal of Applied Geophysics, 68, 522-535, (2009).

Figures used in the abstract

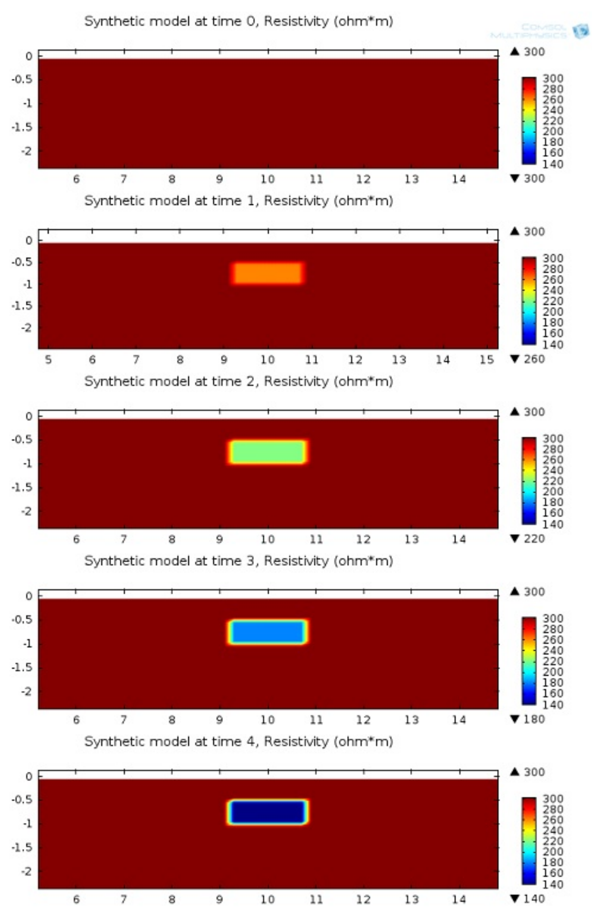

Figure 1: Synthetic time-lapse models of a varying resistive body.

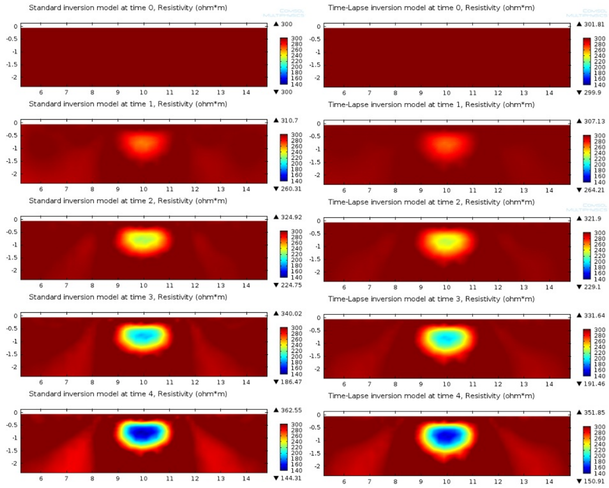

Figure 2: Inversion resistivity models obtained from standard independent inversion (left) and time-lapse inversion (right).

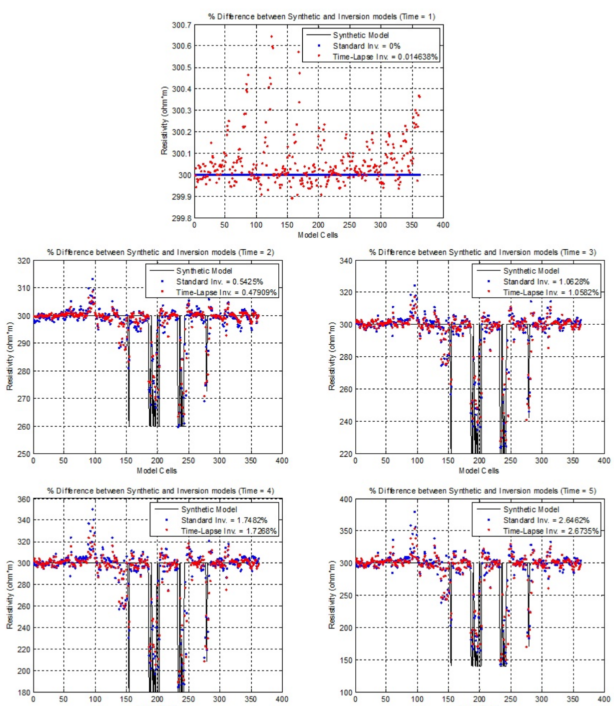

Figure 3: Model comparison between the synthetic true model and the inversion models.

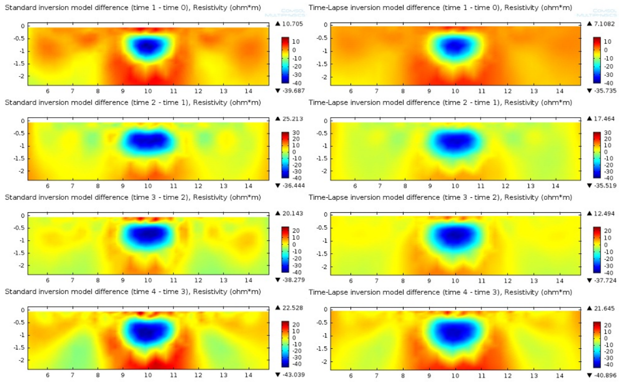

Figure 4: Difference between inversion models at successive time obtained using standard independent inversion (left) and time-lapse inversion (right).