

Why different: an attempt to compare the northwestern U.S. electrical structures obtained by two well-established 3D codes: femtic and ModEM, with potential reason analysis through a technical point of view

H. Song^{1,2}, M. Uyeshima³, Y. Usui⁴, P. Yu⁵, B. Yang^{6,7}, D. Diba⁸, T. Koyama⁹, K. Baba¹⁰,

¹State Key Laboratory of Marine Geology, Tongji University, 1831736@tongji.edu.cn

²Earthquake Research Institute, the University of Tokyo, songhan@g.ecc.u-tokyo.ac.jp

³Earthquake Research Institute, the University of Tokyo, uyeshima@eri.u-tokyo.ac.jp

⁴Earthquake Research Institute, the University of Tokyo, yusui@eri.u-tokyo.ac.jp

⁵State Key Laboratory of Marine Geology, Tongji University, yupeng@tongji.edu.cn

⁶Key Laboratory of Ocean and Marginal Sea Geology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, China, yangb@scsio.ac.cn

⁷Earthquake Research Institute, the University of Tokyo, yangb@scsio.ac.cn

⁸Earthquake Research Institute, the University of Tokyo, dieno@eri.u-tokyo.ac.jp

⁹Earthquake Research Institute, the University of Tokyo, tkoyama@eri.u-tokyo.ac.jp

¹⁰Earthquake Research Institute, the University of Tokyo, kbaba@eri.u-tokyo.ac.jp

SUMMARY

We applied femtic, a well-established 3D MT inversion code, to invert the observed MT impedances and vertical transfer function data from the northwestern USArray. However, the resulting electrical structure, particularly below approximately 60 km depth, notably deviates from previous results obtained using another well-established code, ModEM. This discrepancy warrants further investigation as it could shed light on model uncertainties associated with algorithm-specific choices. These include regularization techniques (pure smoothing-based regularization in femtic vs. combined regularization in ModEM), model discretization strategies (deformed hexahedral mesh in femtic vs. nested mesh in ModEM), forward modeling methodologies (finite element in femtic vs. finite difference in ModEM), optimization schemes (data-space Gauss-Newton in femtic vs. model-space Nonlinear Conjugate Gradient in ModEM), and criteria used to select the optimal model (L-curve method in femtic vs. cooling approach in ModEM). A comprehensive comparison and analysis, both theoretically and practically, would enhance our understanding of the strengths and limitations of each approach. In this work, we try to provide valuable insights into the factors contributing to differences in geological interpretations derived from different inversion methodologies.

Keywords: femtic, ModEM, USArray MT data
