New 2.5D/3D AGILD Geophysical EM Multiple Cross Holes' Imaging

J. Li[1], **M. Oristaglio**[2], **F. Xie**[1], **and G. Xie**[1]

[1]GL Geophysical Laboratory, USA
[2]Schlumberger-Doll Research, USA

Seismic wave, acoustic wave and electromagnetic (EM) field inversion are used for geophysical subsurface imaging. Because there is electric conductivity in the Earth underground, the diffusion EM field with infinite velocity causes the EM inversion more ill posed than seismic and acoustic inversion. The optimizing data configuration, suitable frequency band, and vanishing boundary error, translating coordinate singularity in forward modeling, and combining strong regularizing and weak regularizing etc. approaches will be benefit for EM inversion. In this paper, we propose a "new 2.5D/3D AGILD geophysical EM multiple cross holes' imaging" algorithm. We choose the three, four, and five cross holes data configuration. Based on the AGILD EM modeling and inversion in Piers 2005 in Hangzhou [1] and 3D and 2.5D AGILD EMS modeling in the cylindrical system in Piers 2006 in Cambridge [2], we present the 3D EM modeling and multiple 2D conductivity inversion using the multiple cross holes data. In existing 2.5D algorithm, the conductivity and EM parameters are supposed to be independent on the variable θ and only 2D inversion is processed. Therefore, the existing 2.5 D algorithm can only make rough imaging for whole cylinder subsurface. By using a variable weight average strategy, our new 2.5D inversion can be used to do multiple 2D conductivity inversions using the multiple cross holes data. In the other hand, there is strong coordinate singularity $1/\rho^2$ at $\rho = 0$ in exiting FD and FEM EM modeling in the cylindrical coordinate that is a historical difficulty. Our 2.5D AGILD geophysical EM multiple cross holes' imaging algorithms overcome this difficulty because the strip magnetic field differential integral equation has no coordinate singularity at $\rho = 0$. We use 3D strip magnetic field differential integral equation in the boundary pole strip domain with pole $\rho = 0$ and use magnetic field Garlekin equation in the remainder domain to construct 3D AGILD magnetic and EM field modeling to obtain the model data. Using statistics geology average strategy, we make the 2, 3, 4, or 5 multiple cross holes' 2D AGILD EM inversions. Our new AGILD multiple cross holes' imaging will be useful for geophysical exploration, oil exploration, Earthquake exploration, geophysical engineering, environment characteristic monitoring, nondestructive testing, medical imaging, and material and nano sciences etc sciences and engineering.

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