Three Dimensional Electromagnetic Modeling and Inverison of Seabottom Electromagnetic Data

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Modeling and inversion of low frequency (10 to 0.1 Hz) seafloor electromagnetic data present significant technical challenges because of the enormous quantity of data that is acquired during a field experiment. The problem is further compounded because transmitter-receiver offsets easily exceed ten's of kilometers and the large subsurface volumes that are sensed beneath the sea floor are inherently three-dimensional (3D) in the context of hydrocarbon exploration. Thus modeling and inverting such data is no simple task. There are several methodologies available to treat the problem and here we focus on finite-difference FD methods. Because FD solutions to the 3D time harmonic Maxwell's equations in the quasi-static limit can be solved relatively rapidly on distributive computing platforms, these methods have the flexibility to treat the large scale nature of the problem. Nevertheless much work remains in accelerating 3D FD solutions to the forward and inverse modeling problems. Here we are investigating a variety of approaches. For the forward problem we present some preliminary results of solution acceleration using multigrid (MG) as a preconditioner for Krylov subspace iteration methods that are used to solve sparse, large-scale, linear systems that arise from the finite difference approximation of 3D Maxwell equations. With the inverse problem we present some results for preconditioning the inverse iteration based on approximate adjoint methods for nonlinear conjugate gradient and Gauss-Newton optimization strategies. Because 100's to 1000's of solutions to the forward modeling problem are required with either optimization strategy, MG methods also offer the potential for significant speedup in the context of inverse modeling.