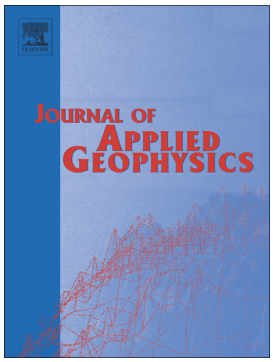

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A compressed sensing based 3D resistivity inversion algorithm for hydrogeological applications

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Abstract

Image reconstruction from discrete electrical responses pose a number of computational and mathematical challenges. Application of smoothness constrained regularized inversion from limited measurements may fail to detect resistivity anomalies and sharp interfaces separated by hydro stratigraphic units. Under favorable conditions, compressed sensing (CS) can be thought of an alternative to reconstruct the image features by finding sparse solutions to highly underdetermined linear systems. This paper deals with the development of a CS assisted, 3-D resistivity inversion tool for use with hydrogeologists and groundwater scientists. CS based l_1-regularized least square algorithm was applied to solve the resistivity inversion problem. Sparseness in the model update vector is introduced through block oriented discrete cosine transformation, with recovery of the signal achieved through convex optimization. The equivalent quadratic program was solved using primal-dual interior point method. Applicability of the proposed algorithm was demonstrated using synthetic and field examples drawn from hydrogeology. The proposed algorithm has outperformed the conventional (smoothness constrained) least square method in recovering the model parameters with much fewer data, yet preserving the sharp resistivity fronts separated by