JOINT INVERSION OF BOISE HYDROGEOPHYSICAL RESEARCH SITE BOREHOLE SEISMIC AND GPR DATASETS

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Abstract

In this work, we propose to use two joint inversion algorithms to invert Boise hydrogeological research site borehole seismic and GPR datasets.

The first algorithm combine a zonal cooperative inversion (ZCI) scheme with a hierarchical Bayesian approach (Bouchedda et al., 2010). The basic idea of ZCI is to use cooperatively cluster analysis and separate inversion algorithm. For each iteration cluster analysis of separate inversion results is used to construct models that contain the parameter characteristics of dominant subsurface structures. These constructed models are then used as starting model in the next iteration of separate inversion. The resulting models are then biased to starting models which are a function of the number of clusters. To overcome this problem, we formulate the inverse problem within a hierarchical Bayesian framework where the hierarchical prior distribution is based on the a priori models constructed from cluster analysis. The advantage of such a formulation is to avoid undesirable bias towards the starting model and leads to significantly improved spatial resolution for consistent prior information.

The second algorithm proceeds by combining the exchange of structural information and a regularization method that consists of imposing an L_1-norm penalty in the wavelet domain (Bouchedda et al., 2012). The minimization of the L_1-norm penalty is carried out using an iterative soft-thresholding algorithm. The thresholds are estimated by maximizing a structural similarity criterion, which is a function of the two (seismic and RTT) inverted models. The regularization in the wavelet domain allows for the possibility of sharp discontinuities superimposed on a smoothly varying background. A Canny edge detector is implemented to extract the structural information. The detected edges serve to build a weighting matrix that is used to alter the smoothness matrix constraint.