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Cooperative Structural Inversion of Cross-hole Electrical Resistance and Ground Penetrating Radar Data

Abderrezak BOUCHEDDA (1), Michel CHOUTEAU (2), and Bernard GIROUX (3)

(1) École polytechnique de Montreal, Montréal, Québec (bouchedda@geo.polymtl.ca/+514-340-3970), (2) École polytechnique de Montreal, Montréal, Québec (chouteau@geo.polymtl.ca/+514-340-3970), (3) Institut national de la recherche scientifique, Québec, Québec (bernard.giroux@ete.inrs.ca/+418-654-2600)

In this work, we propose to combine a zonal cooperative inversion (ZCI) scheme with a hierarchical Bayesian approach, in order to invert cooperatively cross-hole ERT data and cross-hole radar travel time data. 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. To validate our methodology and its implementation, a few experiments using simple synthetic models are performed using different number of clusters. The results show that our cooperative inversion approach provides effective means to constrain resistivity and radar velocity models without biasing the solution.