Accurate characterization of mineral and fluid heterogeneity in subsurface materials and its influence on fluid flow or storage in subterranean reservoirs is of crucial importance in a wide range of contemporary issues including the use of mineral and ground water resources, volcano monitoring, carbon dioxide sequestration and efficient extraction of fossil fuels. A current key strategy to characterize subsurface materials is the integrative analysis of tomograms of several physical properties provided by different geophysical data. Among these physical properties, electrical resistivity plays a central role for its unique sensitivity to fluids and key conductive minerals.

An increasingly popular philosophy to produce these integrative tomograms is the cross-gradient joint inversion, which is underpinned by the hypothesis of structural resemblance and permits the coexistence of natural property correlations. In this framework, electromagnetic methods are advantageous due to their high resolution to heterogeneity on electrical conductivity; however, they also pose special challenges for:

a) the formulation of multi-physics consistent models that permit an accurate prediction of their electromagnetic response and
b) the design of search strategies that simultaneous accommodate electrical and other property variations in convergent processes.

This work presents the theoretical framework of the generalized cross-gradient joint inversion approach and specific strategies adopted for the assimilation of several electromagnetic data in joint inversion. It also discusses the implications of the integration of these data with seismic and potential field data illustrated on field examples. The results demonstrate the advantages of the integration of EM data in structurally consistent multi-property models.