MODELING TARGETS EMI RESPONSES IN AN UNDERWATER ENVIRONMENT

Fridon Shubitidze, Dartmouth College

By estimation, there are approximately ten million acres of underwater (UW) areas potentially contaminated with unexploded ordnance (UXO). Detection and remediation of underwater UXO targets are more expensive than excavating the same targets on land. Over last twenty years advanced electromagnetic induction (EMI) sensors, which utilize multi-angle illumination of targets with 3- axis vector sensing (e.g., MetalMapper), and multi-static array sensors produce multi-sight-angle excitation (e.g., TEMTADS, BUD), have developed and tested. These sensors together with advanced EMI models have provided excellent classification performance for detecting and discriminating subsurface metallic targets on land. However, deploying current land-based EMI instruments for UW UXO targets detection and classification without considering whether to modify the associated EMI models, transmitter currents wave forms, and the associated inversions schemes can lead to incorrect interpretations of UW EMI data. Overall the UXO discrimination problem can be divided into three parts: 1) detection (geophysical mapping), 2) data inversion (mathematical), and 3) classification (decision). The geophysical mapping step involves detecting an object and measuring its EMI response. The mathematical step inverts the EMI data provided by the geophysical step and gives an estimate of the object's intrinsic features, such as its electromagnetic and geometric parameters. Finally, the classification step uses the inverted target's intrinsic parameters and sorts anomalies into either targets of interest or non-hazardous items. The key element to achieve high detection and classification probabilities and to minimize false negatives lies in the understanding underline physics of EMI diffusion in UW and to use these understandings to development enhanced EMI systems and models and signal processing algorithms. Our preliminary experimental and theoretical studies show that when objects are immersed in saline solutions both primary and secondary fields (from sensors and targets, respectively) are disported in the environment. In this talk numerical and experimental investigations are provided to illustrate.