Generating Underwater Synthetic EMI Data Using Physically Complete EMI Models

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Recently, the Department of Defense (DoD) has established the DoD’d Advanced Geophysical Classification Accreditation Program (DAGCAP) to improve and assess the efficiency and accuracy of UXO clean-up on land. One of the critical components of the DAGCAP is the seeding step to validate the Advanced Geophysical Classification (AGC) data collection and processing. The seeding involves emplacing a set of industry standard objects (ISO) or inert target of interest at a recorded location, orientation, and depth. The identity, location, and depth, declination, and orientation of the seed item are blind to the geophysical system operators and data analysts and used for AGC quality assurance and quality check. Although the seeding is an effective component of the AGC process on land, it is time consuming and expensive process. As the AGC process are being considered to extend for underwater (UW) UXO cleanup, one must anticipate dramatic cost increase of the UW seeding process in comparison to the emplacing seed targets on land. To reduce the cost of the UW AGC process, this paper introduces a data driven approach for generating UW synthetic dynamic EMI data sets using the physically complete EMI models. Most, if not all, advanced land based UXO detection and classification geophysical electromagnetic systems operate in time domain. The systems consist of a set of multiple transmitters and 3d receivers. Throughout target sensing, the currents are turned on and off abruptly in the transmitter coils periodically. During the turned-on period, the transmitter currents are raised abruptly and kept constant for a short time interval. The currents produce primary electromagnetic fields, which penetrates inside conducting environment. After the short time interval, the currents are turned-off abruptly and as a result, according to Lentz’s law, transient eddy currents (magnetic dipoles) are induced in the conducting medium, which in return produce the secondary electromagnetic fields. The marine environments and water-air and water-sediment boundaries distort both the primary and secondary magnetic fields. To capture the distortions and generate a sensor and UW -site specific data sets, we solve detailed magneto-static, electromagnetic induction and scattering problems for a high permeable and conducting metallic targets embedded in a multi-layer earth via the volume integral equations and cylindrical plane wave expansion techniques. This paper will present data driven UW synthetic data sets for set of targets of interest. The comparisons between the modeled and actual data will be demonstrated and discussed.