**Data-Driven Decomposition Techniques for Electromagnetic Induction Sensing of Underwater Munitions**

*Lin-Ping Song and Stephen D. Billings*

*Black Tusk Geophysics, Vancouver, Canada*

**Abstract**

Marine electromagnetic induction (EMI) sensing shows promise as an advanced geophysical classification tool for the detection and characterization of underwater metallic items. In highly dynamic environments, marine EMI measurements often contain responses induced by various sources of noise, including system electronics, nearby electromagnetic (EM) activity, motion induced by ocean currents, and geological and cultural interference. The success of marine EMI depends on effectively separating obscured target signals of interest from these unwanted responses.

In this work, we explore two data-driven decomposition techniques: singular spectrum analysis (SSA) and dynamic mode decomposition (DMD), to analyze and characterize EMI responses in underwater environments. Unlike transform-based methods, both SSA and DMD decompose a series into the sum of independent and interpretable components—such as trends, oscillations, and noise—without relying on predefined mathematical models or functions.

Experimental results show that these two methods, with their distinct decomposition mechanisms, complement each other and consistently reveal inherent, hidden dynamics in the observations. Our analyses indicate that these data-driven methods have strong potential to effectively identify and extract background responses, periodic interference, and random noise in EMI response profiles, thereby isolating the desired components.