First results from a new surface-towed controlled source electromagnetic experiment to detect offshore extensions of freshwater aquifers in the Adriatic Sea

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Abstract

Offshore freshened groundwater (OFG) and fresh submarine groundwater discharge (SGD) play significant roles in coastal hydrologic systems. Despite the importance of these offshore groundwater systems and their interactions with onshore systems along global coastlines, a lack of understanding persists due to limitations in geophysical methodologies. Controlled-source electromagnetic (CSEM) techniques are one promising noninvasive avenue for identifying and characterizing OFG and SGD. However, the current availability of CSEM systems in academic research is limited, and applications are still restricted to specific regions. Existing CSEM systems are commonly associated with high deployment costs, logistical complexity, limited modification options and in case of seafloor-towed applications, slow data acquisition rates. To address these limitations, we introduce SWAN - a low-cost, modular, surface-towed hybrid time-frequency domain CSEM system capable of detecting OFG and SGD up to water depths of 100 m. A field test conducted in the central Adriatic Sea showcased the system's capabilities at water depths ranging from several tens to approximately 160 m. SWAN's ability to provide continuous measurements has proven effective in acquiring high-quality data while operating at towing speeds of 2.5 to 3 knots. The system's data coverage allows for the detection of subsurface resistivity variations to depths of approximately 150–200 m below the seafloor. With its user-friendly, modular design, SWAN offers a cost-efficient solution for investigating the hydrogeology of shallow offshore environments. The presentation shows the technological developments of SWAN, including illustrations of measured time series, processed data and first 2D inversion results from the Adriatic Sea.

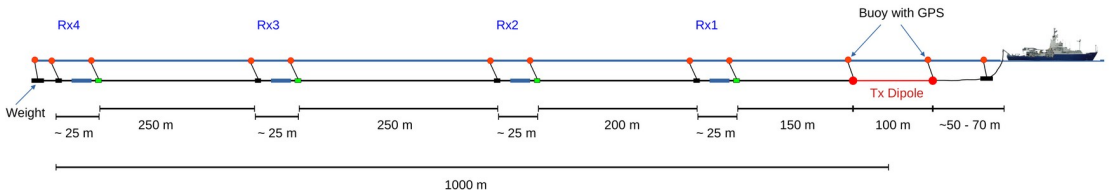

Figure 1: Schematic of the surface-towed SWAN CSEM system.

Reference / more information
Pastoressa, A.E., Haroon, A., Everett, M.E., Rohde, L., Bartels, T., Wollatz-Vogt, M., Faghih, Z., Franz, G.K., Micallef, A. (2023). SWAN: A surface-towed modular controlled-source electromagnetic system for mapping submarine groundwater discharge and offshore groundwater resources. The Leading Edge, 42 (9): 590–597. https://doi.org/10.1190/tle42090590.1