Hydro-geophysical surveys using controlled-source electromagnetic methods in near-coastal environments

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Examples of seawater intrusion into coastal aquifers, groundwater dominated coastal ecosystems, and the use of offshore freshened groundwater as a potential resource for coastal communities highlight the intimate relationship between groundwater, oceans, and society. Hence, understanding the mechanisms controlling salinity distributions along coastal zones, and particularly across the coastline to the offshore domain is not only important from a resource perspective, but also invaluable for protecting terrestrial groundwater reserves and coastal ecosystems from induced seawater intrusion and land subsidence. In terrestrial groundwater studies, the use of electromagnetic methods has proven effective on various spatial scales. As electromagnetic signals are sensitive to variations in pore fluid salinity patterns, several ground-based and airborne methods have been applied to understand the onshore component of coastal aquifer systems. However, due to a loss of sensitivity in the offshore domain caused in part by the masking effect of the conductive seawater, these inductively-coupled methodologies are rather ineffective in mapping groundwater pathways across the shoreline into the marine domain. Here, galvanically-coupled controlled-source electromagnetic applications, in both time- and frequency domain, have demonstrated a high degree of sensitivity for delineating sub-seafloor pore fluid freshening in various geological settings, including siliciclastic Continental shelves (USA, New Zealand), carbonate margins (Israel, Malta), or volcanic Islands (Hawaii). This talk will present an overview of recent controlled-source electromagnetic applications and discuss future developments needed for detecting, investigating, and monitoring groundwater dynamics in coastal regions to assess the resource potential of offshore groundwater and to help safe-guard terrestrial groundwater reserves in coastal regions.