Characterizing Offshore Freshened Groundwater in a Carbonate Shelf Using Integrated Geophysical and Geochemical Analysis: A Case Study from the Maltese Islands

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SUMMARY

Coastal carbonate lithologies host considerable quantities of potable freshwater worldwide. However, the continuation of the terrestrial aquifers across the coastline into the marine realm, or the existence of carbonate-hosted offshore freshened groundwater (OFG) in general, are poorly constrained. Distribution, geometry, volume as well as the controlling factors of freshened groundwater beneath the present-day seafloor remain uncertain in many places across the world. To investigate whether freshened groundwater can exist offshore a semi-arid carbonate coastline like Malta and assess if such resource has the potential to serve as an alternative unconventional source of drinking water is addressed within a joint project between University of Malta and GEOMAR Helmholtz Centre for Ocean Research Kiel. Presently, OFG has been documented in coastal embayments and continental shelves worldwide. Geophysical studies carried out in Israel, New Zealand, Malta and the United States of America provide good examples of how integrating geophysical approaches and borehole data constrain the spatial extent of OFG systems, as well as provide estimates on the salinity of the pore-water. Here, we present an integration of marine controlled source electromagnetic (CSEM) data with 2-D seismic reflection profiles, core samples, geochemical data and borehole measurements targeting OFG along a carbonate shelf offshore the Maltese Islands. Electrical resistivity models derived from 2-D inversion of CSEM data identify a resistive anomaly (> 10 Ωm) offshore the northeastern coast of Gozo. If this resistivity anomaly is associated with a groundwater body at a depth of ~ 300 m below sea level or, alternatively, caused by lithological variability is discussed through an integrated geophysical model using 2-D resistivity models, multi-channel seismic reflection data and in-situ geochemical measurements. Preliminary results show that the resistivity anomalies indicate an OFG body located within the seafloor east of Gozo which extends northeastward. Furthermore, hydrogeological modeling is planned to quantitatively characterize the potential OFG system offshore Maltese Islands.

Keywords: Offshore Groundwater, Controlled Source Electromagnetics, Carbonate Margin, Integrated Geophysics