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Mapping offshore freshwater aquifers using marine controlled-source electromagnetics: Canterbury Basin, New Zealand

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Offshore freshwater aquifers represent significant pathways for material transport across the coastal zone and have been proposed as an important agent in the geomorphic evolution of continental margins. However, the methods used to map the extent, volume, controls, and connectivity of offshore/onshore freshwater aquifers are still in the experimental phase. In this study, we present results from a series of marine controlled-source electromagnetic (CSEM) surveys performed in the Canterbury Basin, offshore the South Island of New Zealand. Nearly 300 km of marine CSEM data was collected using a newly developed seafloor-towed CSEM system that measures contrasts in the bulk electrical conductivity structure beneath the seafloor. Four surveys were collected across and/or in close proximity to IODP Expedition 317 Site U1353 in an area that contains a known shallow ($\sim$ 50 m) freshwater anomaly. Three additional survey lines were conducted outside this region to determine if there are other locations of unknown freshwater aquifers. Processing of selected way points along two survey lines - one crossing U1353, and one $\sim$ 50 km NE of the IODP site - were chosen to assess whether the CSEM data produce realistic resistivity models that might be explained by the presence of groundwater. Results of 1D and 2D inversion models compared with logging data and physical property measurements at Site U1353 suggest that resistivity values below 100 m depth are the same order of magnitude as observed in the IODP borehole. Comparisons between IODP borehole data and selected CSEM surveys suggest that the shallow resistive anomalies along may correspond to the presence of groundwater within the upper 100 m of the seafloor. Further work is planned to jointly invert the CSEM data with seismic data, which will inform 2D and 3D hydrogeological models of the groundwater system in the Canterbury Basin. Our results corroborate previous studies, suggesting that marine CSEM methods are capable of mapping the occurrence of freshwater aquifers offshore.