Reducing ocean wave and swell noise in continental shelf MT sites using remote magnetometers

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SUMMARY

Eleven marine MT stations have been acquired on the seafloor of the Spencer Gulf in water depth 17-40 m, extending a land MT profile that crosses Eyre Peninsula in South Australia. The primary goal was to determine feasibility of collecting broadband to long-period MT (100 Hz to >1000 s) responses in water depths < 200 m across the continental shelf. As a secondary geological objective, the Spencer Gulf transect was acquired to address continuity of resistivity anomalies imaged in various land MT surveys across the Eyre Peninsula.

Water motion associated with ocean waves and swell corrupts MT data collected in depths < 200 m, both by the conductive seawater moving in Earth's magnetic field, and by motion of the instrument itself. Instrument movement appears to be the bigger effect, since noise is larger in magnetic than electric fields. Unless the instrument motion is severe, noise is concentrated in a decade around typical wave and swell periods of 5–15 seconds.

To provide a robust estimate of the seafloor MT response in the wave-noise bandwidth, a hybrid MT response was obtained using seafloor electric fields with a nearby land magnetometer. At high-frequencies apparent resistivities are depressed due to the attenuation of the electric field in the water column, but at longer periods the hybrid MT asymptotes to an effective sea-surface MT response. As the water depth and seawater resistivity are known and reasonably 1D, the sea-surface hybrid impedances can be corrected to a seafloor response that is smoother and lower noise over the entire bandwidth.

New 2D and 3D inversions of land and corrected marine MT responses defines location of major lithopsheric-scale faults and regions of graphitic Palaeoproterozic metasediments. The Eyre Peninsula is a focus for both critical mineral and natural hydrogen exploration, and the addtional continental shelf responses provides important contraints to the land observations.

Keywords: Marine MT; continental shelf; wave noise; ocean swell; South Australia.