

## Improving Sea Bed Logging with Magnetic Field Measurements

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### ABSTRACT

The primary CSEM data are in-line electric field from end-fire electric dipole source and broadside electric field from broadside electric field source. There are other electric field responses that may be sensitive to a deep resistivity anomaly. The magnetic field is also induced from the electric dipole source and may be sensitive to an anomaly as much as the electric field. The magnetic field data are generally not considered as primary data. In the borehole logging, it has been known that the cross-component measurement, i.e., the transverse field from an axial transmitter, is useful for a detection of an adjacent bed. Is there similar advantage of the cross-component electric field measurement in CSEM? It has been recently recognized that the transverse magnetic field from the axial electric dipole source is more sensitive to the adjacent bed around the borehole than the co-axial electric field at very low frequency. Isn't the magnetic field measurement similarly sensitive to a deep anomaly in CSEM and helpful to detect the anomaly? To examine such possibilities I calculated all the electric and magnetic field responses using a simple 3D CSEM model and compared how these responses are sensitive to a resistivity anomaly. I found that one cross-component measurement of the vertical electric field is as sensitive to the anomaly as the in-line electric field. I also found that the transverse magnetic field from the end-fire electric dipole source is more sensitive than the in-line electric field. The transverse magnetic field measurement has deeper depth of detection than the in-line electric field. Analyzing the data with the constant transmitter-receiver offsets, like in the streamer-CSEM survey, I will show that sensitivity of the transverse magnetic field exceeds that of the in-line electric field. Adding the transverse magnetic field data will help CSEM interpretation and inversion. Likewise, in-line magnetic field from a broadside electric dipole source is more sensitive than the broadside electric field. It is not surprising that joint inversion of both magnetic and electric field data is more robust than inversion using the electric field data alone. The result also suggests that adding the magnetic field data may be helpful in some other geophysical imaging surveys using the electric dipole source.