How could the CSEM experiment be improved?

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In conventional marine CSEM for hydrocarbon exploration, the source is towed behind a vessel without active steering, and a set of receivers are positioned on the seafloor. Traditionally, the receivers have been positioned along the towline which leads to the so-called inline source-receiver geometry. In the last few years, the industry has moved towards using 3D receiver grids. A major advantage with 3D is that the subsurface is explored with the inline source-receiver geometry in several directions. Another added value is that one also gets additional broadside data in some of the directions (directions where the source can be decomposed into two components).

However, collecting 3D grids is expensive, and the flexibility of the source-receiver configuration is still limited even in 3D surveys. The improved ability to interpret CSEM data by using 3D grids indicates that the ability to interpret data from 2D line experiments could improve by using both inline and broadside data. One way to achieve this would be to use a two-component steerable source behind the vessel. This could also reduce the inaccuracies in the positioning of the conventional source.

For both the 2D line and 3D grid experiments, data from several receivers are used in the interpretation. This requires that the inter-receiver calibration is very accurate. Although this issue has improved the last few years, there are still improvements to be made in order to enable interpretation of CSEM data in areas with small variations in the subsurface response.

Having a two-component source as well as accurate measurements would open up new possibilities in the data interpretation. A two-component source and a receiver layout that enables horizontal gradient calculations, give the opportunity to calculate the vertical electric and magnetic field components. This provides possibilities for separate analysis of TE and TM responses from the subsurface. The two different polarization modes of the electromagnetic field, TE and TM, respond in a different manner to subsurface structures. Using both TE and TM data in the interpretation means that we may better distinguish thin resistive layer responses from background responses.

In conventional CSEM data in shallow water, the airwave will dominate the TE response and also the total field response. However, the airwave can be removed in conventional data by using weighted differences along the towline. The weights are related to the geometrical spreading of the airwave component in the data. Specifically, the horizontal electric and magnetic field components in the common source or receiver domain can be weighted with the horizontal offset to the power of three before the differences along the towline direction of the weighted field components are calculated (Expanded abstract submitted to EAGE 2009).

We believe that the concept of using a two-component source, better calibrated receiver measurements, and the simultaneous analysis of TE and TM data where the airwave is removed from the TE data, could improve our ability to interpret the subsurface. In order to enable us to use this data analysis concept, we are dependent on the contractors' ability to develop the appropriate equipment.