A Critical View about Marine Controlled Source EM Data Interpretation

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The Sea Bed Logging (SBL) or Marine Controlled Source Electromagnetic (MCSEM) method is aimed at detecting and characterising resistive layers, possibly corresponding with hydrocarbon bearing reservoirs.

The basic principle driving the interpretation of the Marine CSEM data is that electric field magnitude and phase vs. offsets (recorded by a series of receivers deployed at sea floor) will show different trends as a function of the resistivity distribution and depending on water depth.

An interpretation approach that is commonly used in the hydrocarbon industry is based on the assumption that, if a proper reference receiver is selected (for instance in correspondence of an area where hydrocarbon absence has been proven), the normalised magnitudes and phases vs. offset (i. e., the observed data vs. the reference data) can represent an indication of resistive layers, possibly associated with presence of hydrocarbons.

In that framework normalized magnitudes significantly higher than 1 at intermediate to far offsets can be interpreted in terms of subsurface resistivity anomalies. Using a similar approach, also the normalised phases are assumed to be indicators of resistivity anomalies.

It is not difficult to show that, especially in shallow water environment (300–400 m), the above assumptions can be misleading.

If a "perfect" up-down wave separation is performed many of the ambiguities can be avoided. The problem is that a perfect elimination of the airwave effect cannot be guaranteed in any case. The risk is the production of artefacts and misleading interpretation.

An additional open question is about the choice of the reference receiver. Other misunderstandings can be originated by effects due to the presence of resistive layers above and below the target, by the variations of water depth along the acquisition profiles, by the presence of noise and so on.

In this work we clarify better the above concepts using simple synthetic tests and real data. Our goal is to show how the interpretation techniques based on normalised plots should be integrated with a an approach massively based on inversion of MCSEM data.

This is fundamental for an appropriate interpretation, especially if constrained by seismic data, in order to limit the ill-conditioned and ill-posed nature of the inverse electromagnetic problem.