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Use of CSEM as derisking tool in exploratory frontiers – A case study

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Introduction

CSEM is an already established tool, both scientifically and commercially, in the set of geophysical technologies used in exploration for hydrocarbons. It consists in the use of electromagnetic fields generated by a horizontal dipole, measured by receivers spread in a grid on the seafloor. To maximize the coupling of the fields to the subsurface, the source is towed near the sea bottom. The data so acquired are submitted to a non linear inverse problem aiming to obtain a distribution of resistivities in depth.

Hydrocarbon bearing rocks are, in general, more resistive than the surrounding background. In that sense, the presence of resistive anomalies in the inversion of a CSEM dataset might indicate an accumulation of oil or gas. But other factors may cause an increase in the resistivity of rocks (igneous, lesser salinity in formation water, cementation, salt bodies to name a few). Therefore, the sole presence of a resistive anomaly is not by itself a strong indication of prospective success and must be interpreted with other information, such as seismics. On the contrary, the absence of resistive anomalies is a factor that increases the risk of any prospect. That is where the information provided by CSEM excels, be it in the decision of drilling or not as well as in later stages of an exploratory project, for example, in delimiting proven accumulations.

This work presents a case study where the acquisition of a CSEM dataset in an area of new exploratory frontier, and its timely interpretation, could have led to the reduction of the exploratory risk.

Method and/or Theory

Data has been acquired and inverted in 3D volumes of resistivities by an algorithm that accounted for TTI anisotropy. The initial model was a vertical gradient with salt bodies superimposed. Overall data misfit was acceptable. Timely constraints on the result did not allow a denser inversion grid to be used, which might have had negative impacts on the data fitting process and on the resolution of the resulting models.

Results and Conclusions

The result of the inversion presents many new anomalies, which, when correlated with seismics could be interpreted as igneous rocks, mostly. No significant anomaly was identified at the level of the target, in the position of the well that was already being drilled. This result was later confirmed when that well reached its projected depth. Some anomalies in the same level could not be totally interpreted. The fact that the dataset was only acquired and made available when the well was ready to start drilling points to a recurrent difficulty related to the timing of the CSEM acquisition/interpretation workflow that needs to be addressed by contractors and clients.