

## **CSEM in Today's Market Conditions: How it Can Help Spend Less and Extract More**

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### **Abstract**

Integration has several meanings depending on the context. However, when integration is used in conjunction with “Controlled Source Electro-Magnetism”, or CSEM, it becomes a very powerful word. CSEM integrated with Seismic (and/or well data, AVO, Attribute etc.) can help in defining some of the elements of a petroleum system where seismic alone struggles, e.g., source, seal. CSEM integrated with Seismic can help unravel all the elements of the petroleum system. The result is a refined geological model, better-constrained volume estimates and probability of success, which eventually leads to improved economic evaluation and significant reduction in offshore finding cost.

Various tools are used to extract subsurface information and each tool has its own properties. Seismic is the most popular one and rightly so because it is good in defining the trap and reservoir but it is risky for extracting fluid information. In structurally disturbed, the data itself and velocity information deduced from it is ambiguous. On the other hand, well logs only provide 1D information and may not be valid more than a few meters away. The limitations of these data can be overcome, eventually reducing the risk of dry holes. This can be done by integrating the positive attributes of these sub-surface data with the resistivity distribution as found from CSEM processing.

CSEM is sensitive to the resistivity of the subsurface. Resistivity is a very different earth property. It is independent because the physics behind propagation of EM fields it is quite different. Unlike Seismic and Gravity which share a common property (density), seismic and CSEM do not have anything in common and any resulting integration with seismic is not straightforward. However, there is a huge unity within this diversity. If seismic and CSEM are carefully integrated, they complement each other and help in getting a complete picture.

Integration of the data has already shown its mettle in the entire value chain, from frontier exploration to development fields. In frontier exploration, it can help in choosing the well location. Integration achieves its maximum value in the exploration phase by establishing new ‘leads’, confirming ‘leads’ to moving them through, from ‘prospect’ stage to mature ‘prospect’ to ‘drillable prospect’ and upgrading ‘drillable prospects’ to ‘ready to drill’ stage. CSEM is very good in constraining areal extent, hence it is used in appraisal and development to define the reservoir extent and accordingly, an informed choice can be made about appraisal and development well placement.

Various case studies over the last decade are testimony to the power of integration and a recent example from Southeast Asia adds to that list. 2,500 km<sup>2</sup> of multi-client 3D CSEM survey was acquired in Makassar Strait in early 2015. The 3D anisotropic inversion of the CSEM data revealed some interesting anomalies. The full value however was not realised until it was married with seismic. Once integrated, most of the anomalies started making sense and the red blobs on the CSEM resistivity maps were no longer just blobs, but indicators of those deep-water turbidite deposits, which have high chances of hydrocarbon accumulations.