

## **Advances in Electromagnetics for Hydrocarbon Applications**

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Over the past 10 years electromagnetic methods have been successful in finding hydrocarbon and the technology grew its own industry. Electrical methods have been part of applied geophysics since its beginning in the early 1920s. In the 1940s they spawned what is now known as the logging industry.

While seismic has been the workhorse of the industry for structural and stratigraphic targets, its fluid typing capabilities are mostly based on dense spatial sampling as seismic wave travel primarily through the solid part of the rock matrix. Electrical signals respond primarily to the fluid properties and are thus an ideal complement to seismic. The classical use of electrical methods in the oil industry is in logging to distinguish between oil-bearing and water-bearing zones and to determine the hydrocarbon reserves in place.

Marine electromagnetics developed from infancy into a sizable geophysical industry. After initial rapid growth, a downturn occurred and presently the use of marine EM is stabilizing while everyone is trying to integrate it into seismic workflow. 3D acquisition is common practice and the results are displayed in terms of 3-dimensional models.

Land electromagnetics has seen increased use in the oil industry in the 1950s, 1980 and presently a revival is ongoing. The limitations were always lack of integration and often wrong use of the method, which is mostly due to the more complex application environment compared to its offshore counterpart.

The most promising future application is in the reservoir monitoring arena, because most reservoirs exhibit strong resistivity contrasts between the oil-bearing and brine-bearing zone. Because of the specialization of the industry this will require the bridging of two technical areas: logging and surface geophysics.

With the present advancement in electronics and sensors the use of EM will increase in all areas and more very large measurement systems are coming to the market for marine, land and borehole applications.