Detection of Hydrocarbon Reservoirs Using Controlled Source Electromagnetic Imaging

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The Controlled Source EM imaging (CSEMI) method is rapidly gaining acceptance as an exploration tool. Originally developed in the late 1970s, the CSEMI method uses a high powered horizontal electric dipole to transmit a low frequency electromagnetic signal through the seafloor to an array of multicomponent electromagnetic receivers. By studying the received signal as the source is towed through the array of receivers, the bulk electrical resistivity of the seafloor can be determined at scales of a few tens of meters to depths of several kilometres. Transmission frequencies are typically between 0.01 Hz and 10Hz. At such low frequency, the behaviour of electromagnetic fields in the earth is governed by the diffusion equation.

Typical water saturated sediments have a resistivity in the range 1-5 Ωm. Replacing the sea water with resistive hydrocarbon can result in an increase in the bulk resistivity of the formation by 1-2 orders of magnitude. CSEMI sounding exploits this dramatic change in physical properties to distinguish water bearing formations from those containing hydrocarbons. The presence of resistive structures in the background section (for example salt, tight carbonate or shallow gas and hydrates) increases the complexity of CSEMI surveys. Despite this, with careful survey design, data acquisition and data analysis positive results have been obtained in a variety of settings.

While there is a requirement of fossil fuels there is a need to reduce both the cost and environmental impact of exploration and extraction. CSEMI is a non-invasive technology able to minimise the risk of drilling unsuccessful exploration wells by confirming (or otherwise) the presence of hydrocarbons prior to drilling. It can also provide a cost effective way of proving many more prospects within a portfolio, preventing economic reserves of hydrocarbon from being missed.