USC Viterbi
School of Engineering

MORK FAMILY DEPARTMENT OF CHEMICAL ENGINEERING AND MATERIALS SCIENCE

Lyman Handy Colloquium

Thursday, Mar. 28, 2013
ZHS 159 @ 12:45 PM

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Electromagnetics: an ideal tool for shale reservoirs

Abstract: In an unconventional resource play (shale gas as well as shale oil) some of the key questions are: defining the reservoir boundaries, mapping of the fracture network and monitoring reservoir depletion. Shale formation has an inherent string electrical anisotropy and as the hydrocarbons in shale gas or shale oil reservoirs are mostly resistive and the reservoir is relative thin, they give an anomalous electromagnetic (EM) response. Direct Hydrocarbon Indicator or DHI effect gave rise to the entire marine EM industry and is known as In geophysical terms this is also known as the ' thin resistive layer effect' Using modern logging tools that measure electrical anisotropy, surface tensor EM measurements can be calibrated and then become more meaningful. In the absence of anisotropy logs, the anisotropy can be estimated using well known equivalence principle. The response can be measured from the surface in a time lapse sense as the anomalous response is in the order of several percent. Combining borehole and surface electromagnetic measurements gives calibration points in addition to more sensitivity to fluid variations in the pore space. At the same time linking the electromagnetic (EM) information to 3D surface and borehole seismic data as well as the micro-earthquakes data, allows prediction away from the well bore. I will focus on a unique implementation that includes marine and land sources and receivers (CSEM system), surface-to-borehole arrays and a single well system that can detect anomalies as much as 100 m around the wellbore and ahead of the drill bit. For tight shale reservoirs, two key technical elements that were not possible before are the inclusion of electrical anisotropy and directional/tensor measurements, which lead to better estimates of fracture directions and hydrocarbon. On land, for resistive targets such as unconventional hydrocarbon reservoirs, we use Controlled Source ElectroMagnetics (CSEM) with a dipole transmitter. In this case it is preferred over natural source magnetotellurics because of the increased coupling and its enhance sensitivity to the hydrocarbon bearing strata. For ease of operation, it is best to measure all EM components. In the marine environment, the receiver is included in seismic spreads with electromagnetic sensors. CSEM is only needed when the resistive strata are thin. Multicomponent acquisition and dense station spacing are essential to measure anisotropy and lateral structural changes, and to extend the application from exploration to production. One of the major outcomes of the various feasibility projects was that surface electromagnetic methods alone are ambiguous if they are not calibrated or used in combination with surface-to-borehole measurements. The reason lies in the up-scaling associated with the inherent averaging nature of electromagnetic (EM) methods.

The scientific community is cordially invited.
Refreshments will be served in HED lobby at 2 PM.