Direct Method for Determining Organic Shale Potential from Porosity and Resistivity Logs to Identify Possible Shale Plays: An Example from Cretaceous Shale Plays of Sinjhoro Field, Lower Indus Basin, Pakistan

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Abstract

The source rocks are usually shales, marls and limestones, which contain considerable amounts of organic matter. The organic Potential and its maturity are the most important parameters that must be estimated for source rock evaluation. These parameters are determined by Rock Eval Pyrolysis. This method measures TOC% in cutting or core, obtained from samples retrieved at intervals down a well. The sample spacing is usually 18 m, and it can be difficult to obtain an appropriate average value from this data. So, a number of researchers tried to make a correlation between well log responses and organic richness of rocks because well logs provide continuous measurement of vertical sections with a resolution of about 0.15 m. Schmoker (1979), Schmoker and Hester (1983 and 1989) used both gamma ray and density logs for calculation of the wt% TOC. Passey et al. (1990) introduced a technique known as 'ΔlogR' Method. This research focuses on the identification and evaluation of the Cretaceous Shale Plays in Sinjhoro Field of Lower Indus Basin, Sindh, Pakistan. In order to evaluate organic Potential of some localized Source Rock bodies of Lower Goru, the well logs information of three wells; Chak 66-1, Chak 63-1 and Chak 7A was utilized.

The Delta LogR (ΔLogR) technique applied here makes use of basic openhole wireline logs. It is principally based on the curve separation exhibited by the Porosity Log (Sonic 'DT'*) and Resistivity Log (LLD**) in mature organic-rich shale intervals. This separation results from two effects: increased values of "DT" in low-density kerogen portions indicating organic richness, and increased values of resistivity due to presence of generated hydrocarbons indicating higher maturity level. Thus, the two logs were overlaid and the source rock portions were evaluated based on curve separation. The reservoir intervals can be identified and eliminated from analysis using the GR curve. Moreover, the cross plots of 'DT' and 'LLD' curves were also generated for zones of interests, which showed intervals of higher transit time and higher resistivity values, thus further confirming the results quantitatively.

By using this technique, the magnitude of the curve separation in non-reservoir portions can be further calibrated to TOC and its maturity, in order to compensate the unavailability of geochemical data. Furthermore, the depth profiling of organic richness of Cretaceous Shales of Sinjhoro Field is also achieved where the sample data (cores and cuttings) was not available. The results conclude that the Lower Goru of Cretaceous age has Shale packages that are rich in organic content and are mature in terms of hydrocarbon generation. These organically rich packages are locally acting as source rocks for reservoir portions of Lower Goru and are quite favorable for exploration of "Shale Gas" in the area.

*Other porosity logs, like Neutron or Density can also be used in replacement of sonic log after appropriate scaling. **ILM can also be used since it is preferable to use deep reading resistivity tool.