Recent advances in borehole resistivity logging

A.G. Mezzatesta, O. N. Fanini, L. A. Tabarovsky, K. -M. Strack*
Western Atlas Logging Services

In locating hydrocarbons in a borehole, electrical logging techniques play a key role since they can distinguish between oil and water saturated rocks. During the past 5 years, numerous new electrical logging technologies were developed based on integrating state-of-the art geophysical technology into borehole logging. The technologies selected for this presentation include shallow imaging devices as well as deep array resistivity tools and a through casing resistivity device. Geophysical hardware design, acquisition principles, data processing and interpretation, result in better measurements and better signal-to-noise ratio which translate directly into more hydrocarbon reserves. Three-dimensional numerical modeling, that has only recently become available, supports all phases of tool design and interpretation. Here, using case histories, we illustrate how geophysical concepts go hand in hand with the advances in electronics and information technology to get better hydrocarbon reserve estimates.

Two major hardware changes are the major contributing factors: small signal measuring devices such as sigma delta converter and resulting multi-sensor arrays providing multiple depths of investigation. The electronic advances lead to a hybridization of the receiver amplifier and A/D circuitry. As a result, the STAR resistivity imager now measures calibrated values, which allow to successfully compare image button measurement with a micro resistivity log.

Data processing starts with the acquisition of the complete waveform, which is then stacked for signal-to-noise ratio improvement and inverted to obtain the best possible match between the measurements and synthetic curves. In addition, the inversion gives numerous quality indicators, which allow the comparison between different inversion runs. Two-dimensional inversion delivers not only a two-dimensional distribution of the formation parameters but also statistics that are essential for estimating the reliability of the results. In a complex environment, such as that of dipping beds, deep invasion and thin beds, more complex models are used on a selective basis.

Array resistivities from array induction and array laterolog tools can be interpreted with higher vertical resolution, resulting in most cases, in an increase of hydrocarbon reserves. Case histories for differenttools and applications clearly show the benefits of the new concept of integrating multiple resistivity logs.

(1998) Geo-triad '98: Abstracts: Plenary, Oral, Posters, Core Workshop