Simplified Dielectric Log Interpretation In Variable Salinities Using Resistivity Versus Phase Angle Crossplots

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ABSTRACT

Dielectric resistivity values provide additional information when combined with the dielectric phase angles measured between two receivers. Crossplotting the dielectric resistivity versus the phase angle yields the necessary information to determine both water saturation and water salinity by augmenting currently used dielectric formation evaluation techniques. The hydrocarbon, fresh-water, and salt-water fluid values of dielectric resistivity and phase angle occupy unique positions on a resistivity versus phase crossplot, which provides the basic concept for the interpretation model. By porosity-correcting the dielectric resistivity and phase angle to determine the fluid values, both graphic and mathematical solutions can be obtained.

Starting with a system of equations which include new curve fit data equating water resistivity to phase angle water values yields the solution to water saturation and salinity through variable elimination. Combining the known dielectric salinity response with currently used interpretation methods makes the solutions possible in variable water salinity areas. The method being presented allows the user flexibility in choosing locally preferred interpretation techniques while helping to eliminate the common water salinity variables.

Empirical versus theoretical solutions offer assistance in lower resistivity areas subject to increased dielectric spreading losses. Shale corrections to both dielectric resistivity and phase angle can be applied simultaneously if necessary for effective water saturation determination. These methods can be adapted to different transmitter frequencies and transmitter-receiver spacings.

Including the dielectric resistivity with the measured phase angle as part of the interpretation expands the dielectric applications for determining water saturation and salinity.

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INTRODUCTION

For approximately a decade, dielectric logs have been used to help locate hydrocarbons in areas difficult to evaluate using conventional open hole devices due to changing or unknown formation water salinities (Meador and Cox, 1975). Although salinity affects dielectric logs less than some other open hole devices, compensation for salinity changes helps maximize the accuracy of dielectric information used in locating hydrocarbons.

An ideal dielectric device should measure deep into the formation and show little response to salinity. Lower frequency or longer wave length devices provide deeper depths of investigation yet experience more salinity effects. Higher frequency or shorter wave length instruments, however, respond less to salinity changes, but suffer more from borehole and mudcake effects due to the shallow investigation depths. Salinity compensation techniques help to fully utilize the benefits of the moderate and deeper reading dielectric instruments.

INSTRUMENTATION

Table I summarizes the 47 MHz and 200 MHz instruments used in demonstrating the salinity compensation technique. Figures 1 and 2 illustrate the physical configuration of the two instruments. The dielec-