

Geostatistical Simulation of Electrical Double-Layer Properties of Clay Minerals in Shaly Sand Reservoirs (Cliff Heads Oil Field, Perth Basin, Western Australia)

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Characterizing the conductivity of shaly sands below critical formation water salinity can be a challenge in well log evaluation particularly when clays with large surface areas demonstrate significant volume of clay bound water compared to the total pore volume of the reservoir rock.

Via computations of the electrical double layer properties of clay minerals that relates to their expansion and parallel conductance with pore fluids, an improved understanding of their behaviour can be obtained. This paper introduces geo-statistical methods of simulating values for double layer conduction and diffusion layer expansion, based on knowledge of formation water salinity as well as the minimum & maximum range between clay particle surface and the outer Helmholtz plane.

It is an integration of: (1) Rietveld based Siroquant assay for quantitative X-ray diffraction used in determining mineral percentages and clay lattice expansion; (2) Cation Exchange Capacity used to determine the quantity of exchangeable cations at the shale-water interface and (3) Normal and Uniform-Continuous Random number generation techniques. Measured laboratory data include CEC, XRD and formation water salinity on 63 core plugs from the Cliff Heads 3, 4 and 6.

Overall, the approach is useful and time saving in assessing the effect of the double layer properties of clay minerals on conductivity measurements of well logs and plots obtained depict patterns from which excess or double layer conductance of clay minerals can be distinguished from the true conductivity of pore fluids.