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Sensitive Quantification and Reservoir Rock Typing for Improved Reservoir Characterisation

A. Ivakhnenko* (Kazakh-British Technical University)

SUMMARY

Magnetic hysteresis method can provide rapid, improved, non-destructive characterisation of multiple mineral and fluid components for reservoir characterisation. The advantage of the new hysteresis method is identification of multiple mineral components in the reservoir sample, by acquiring data at a range of low and high applied magnetic fields. Plots of applied magnetic field versus magnetisation, where the slope represents the magnetic susceptibility, provide a universal template upon which any reservoir rock or fluid can be typed and characterised. Pure diamagnetic components, rock matrix minerals such as quartz and calcite, or reservoir fluids such as crude oils and formation waters are characterised by straight lines with negative slope.
Magnetic hysteresis method can provide rapid, improved, non-destructive characterisation of multiple mineral and fluid components for reservoir characterisation. The advantage of the new hysteresis method is identification of multiple mineral components in the reservoir sample, by acquiring data at a range of low and high applied magnetic fields. Plots of applied magnetic field versus magnetisation, where the slope represents the magnetic susceptibility, provide a universal template upon which any reservoir rock or fluid can be typed and characterised. Pure diamagnetic components, rock matrix minerals such as quartz and calcite, or reservoir fluids such as crude oils and formation waters are characterised by straight lines with negative slope. In contrast, the pure paramagnetic components, permeability controlling clays such as illite and chlorite display straight lines with positive slope. Mixtures of diamagnetic and paramagnetic minerals can be theoretically modelled and compared with experimental results on the plots. The presence of characteristic hysteresis loops at relatively low fields enable very small concentrations of ferri- or ferromagnetic minerals, such as magnetite or hematite to be also rapidly identified. The presence of multiple components, such as diamagnetic, paramagnetic and ferromagnetic types in the same reservoir core can be recognised by distinctive changes in the slope of the hysteresis curves as a function of applied field. Furthermore, magnetic remanence measurements can independently identify the magnetic remanence carrying ferro- or ferrimagnetic particles without any influence from the diamagnetic or paramagnetic components, which do not acquire a remnant magnetisation. As a result the hysteresis and remanence measurements have allowed very sensitive characterisation of different reservoir rock and fluid types to be made. The techniques allow to distinguish subtle variations in the clastic reservoirs, different carbonate types and different reservoir fluids.