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A New Method for Estimating the Clay Content of Tight Oil Reservoirs from NMR Logs

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Due to the differences in physical properties between clay mineral and sand matrix, clay content has always been an important part of reservoir evaluation. Clay content can be used to calculate effective porosity, saturation and permeability in conventional reservoirs and provide available information for brittleness evaluation and hydraulic fracturing design in tight oil reservoirs or shale gas reservoirs. However, anomaly high value of gamma-ray logs and low resolution of spontaneous potential logs in source-reservoirs make it difficult to calculate clay content. What's more, the calculation of clay content is lack of precision even through optimization method because of the extremely complex lithology of source-reservoirs.
This paper proposed a new method for determining the clay content of tight oil reservoirs of Lucaogou formation in Jimusaer Sag, Junggar Basin using the NMR logs. Four kinds of sandstone samples with different types of clay minerals and the target tight oil rock samples have been analyzed by X-ray diffraction and NMR measurement. The results indicate that the T2 peaks of centrifuged samples with illite and/or montmorillonite are below 10ms, and that the T2 peaks of centrifuged samples with kaolinite and/or chlorite are greater than 10ms, or even 20ms. This is accord with the experimental results about T2 relaxation time of different clay minerals presented by previous research. Different types of clay have different specific surface areas and relaxivities. Thus, the T2 cutoffs for clay bound water vary with the clay types. Based on the results, T2 cutoff of specific clay minerals determined by NMR method can be used to calculate clay water saturation. The relationship between clay content, clay water saturation, and density logs in the study area is established through the equation for cation exchange capacity and clay water saturation. Then we use least square method to set up a statistical model of clay content according to this relationship. The clay mineral contents of Lucaogou formation calculated by this model yield a good agreement with those obtained by experimental measurement, thus verifying the effectiveness and reliability of the proposed method.

References

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