Quantifying Mineralogy, Total Organic Carbon , and Thermal Maturity in Unconventional Reservoirs with DRIFTS

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Hydrocarbon production from unconventional reservoirs is influenced by the mineralogical and organic composition of the shale. In vertical exploration wells, high-resolution log data are used for reservoir characterization and for optimizing the placement of laterals. Similar technologies can be used to characterize highly deviated wells in unconventional plays; however, the well depth and well conditions make logging challenging and often not economically viable. As a result, most lateral wells are not logged, or logged only with a gamma ray tool during drilling.

To fill this data void in highly deviated wells, we present a practical and economic method using diffuse reflectance infrared Fourier-transform spectroscopy (DRIFTS) of drill cuttings to simultaneously measure mineralogy, total organic carbon (TOC) content, and thermal maturity. The infrared inversion solves for the concentrations of nine common mineral constituents (smectite, illite, kaolinite, chlorite, quartz-plus-feldspar, muscovite, calcite, dolomite, and anhydrite) and for kerogen. The quantification and speciation of the clay minerals are important because high concentrations of clay, especially swelling clays, can negatively impact completions and production. Also, the DRIFTS method measures the organic functional groups that relate to kerogen, specifically aliphatic CH_2, aliphatic CH_3, and aromatic CH. Examining the relative intensities of these peaks provides an estimate of type II kerogen properties, such as thermal maturity and kerogen density. Thermal maturity indicates the anticipated hydrocarbon type (oil, condensate, dry gas). By estimating accurate mineralogy, TOC, and kerogen density, the DRIFTS method can be used to estimate an accurate matrix density, which can be integrated with a bulk density log (logging while drilling or through the drill bit) to determine matrix-adjusted shale porosity.