Use of vis-NIR Spectroscopy in Clay Mineral Identification in Shale

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Abstract

Despite the increasing importance of clay mineralogy in scientific geological research and petroleum industry, they have proven difficult to characterize. Identification of clay minerals through X-ray diffraction (XRD) has been the most widely used method. However, there are some disadvantages to application of this technique. Beside high cost of analysis and required sample pre-treatments, XRD fails to detect minerals that are present in lower quantities and those with poor crystalline structures.

In this study, vis-NIR Spectroscopy has been utilized as a complementary technique along with XRD and ED-XRF to examine whole rock and clay mineralogy in about 600 rock and powder samples from multiple wells covering mainly the Second White Specks shale in Saskatchewan. NIR spectroscopy provides fast and inexpensive data and does not require sample pre-treatment. This allows for higher resolution sampling with minimal analysis time. The non-destructive reflection spectroscopy operates in the visible-near infrared spectra (covering the spectral range between 350 and 2500 nm) and can detect all common clay minerals as well as sulfates, hydroxides and carbonates (Viscarra et al. 2008). Clay minerals have distinct spectral characteristics, which make them relatively easy to identify with this method (Stefano et al. 2003). The wave radiation penetrates the sample and the radiation that is not absorbed by the sample reflects back to the instrument. The spectrum, which varies for different minerals because of bonding reaction, can be used to identify different minerals (Bowtiz and Ehling, 2008). In this study TerraSpec 4 spectrometer was used to produce the spectra. The generated spectra were then interpreted using TSG Pro 7.1 software, with digital mineral libraries, to predict different mineral components. With proper data calibration, spectroscopy provides quantitative estimates of clay mineral concentrations.

The objectives of this research includes: (i) to estimate mineralogical composition specifically clay mineralogy from the spectra, (ii) to compare clay mineral concentrations calculated from XRF and XRD analyses with the this technique, (iii) to compare collected spectra using rock samples to spectra collected using powder samples, and finally (iv) to integrate different mineralogy data as well as microscopic and SEM petrography to create a model which is able to predict mineralogical and petrophysical rock/reservoir properties with the aid of well logs.

References Cited

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