Mineralogy on the move

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For many decades now X-ray diffraction (XRD) has been the tool of choice for the mineralogists, producing good quality, reliable bulk and clay fraction data. While this is unlikely to change for laboratory-based analysis, the oil and gas industry is forever on the lookout for smaller, faster and portable solutions. Fourier Transform infrared (FTiR) analyses may just be that solution.

FTiR Theory

FTiR is a spectroscopy technique that collects data from a broad spectral range in the infrared. It can be used to obtain absorption or emission spectra of solids, liquids and gases. As the FTiR collects data simultaneously from a wide range of frequencies the data must undergo a Fourier transform (a mathematical operation) to convert the raw data into the spectrum used (Figure 1). Due to this data collection technique measurements on the FTiR are rapid, in the order of one second. However, multiple measurements are usually added together to improve signal to noise ratio. The basic principles of FTiR have remained the same for decades; however, recent advances in technology have allowed the development of portable devices.

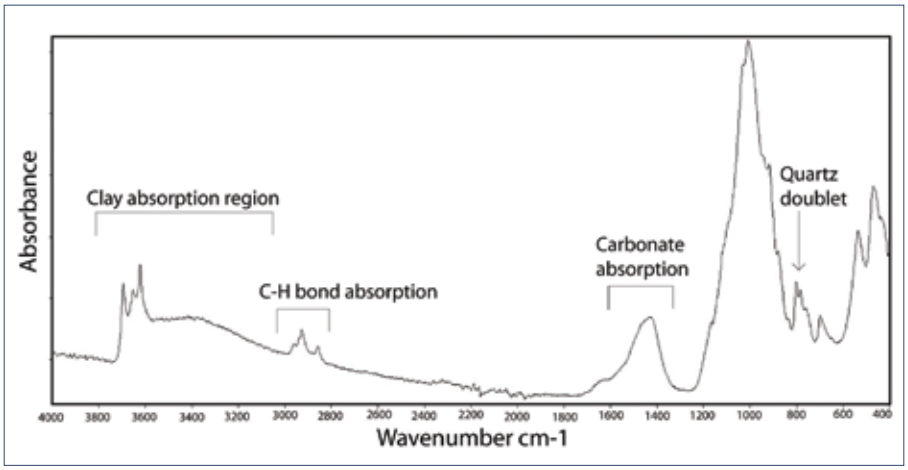

Fig. 1. FTiR absorbance spectrum showing the main peak associations with their mineralogical component. A range of clay minerals can be detected by the FTiR, this example shows predominantly kaolinite. A larger peak signifies a greater concentration of a component; however each peak has a different sensitivity to the component it shows.

Fig. 2. The FTIR instrument is compact, lightweight and easy to use, pictured above is a powdered sample which is prepared in the pictured mortar and pestle.

FTiR Instrumentation

The extremely compact FT-IR spectrometer ALPHA interferometer (Figure 2) has a footprint of an A4 sheet of paper and weights c.7kg. The ALPHA is insensitive to vibration, so it can be placed almost anywhere, can be moved, and be immediately operational without any need for alignment. ALPHA delivers excellent sensitivity as well as x-axis reproducibility and stability. The ergonomic one-finger clamp mechanism simplifies the sample positioning. It is easy to clean, as the pressure applicator can be rotated 360° to provide the user with unobstructed access to the sampling area. This allows quick and easy analysis of small powder (Figure 3) with an average analysis time of less than two minutes. Rock sample preparation could not be simpler, a small quantity of material (<1g) is ground and then analysed (Figure 3).

FTiR Applications

As stated above XRD will undoubtedly remain the mineralogist beast of burden when time or sample location is no issue. However, as Figure 4 shows, once calibrated, the FTiR can supply data comparable to an XRD for many minerals. Its advantage is that it can readily be transported to a core warehouse and hundreds of samples can be analysed is a short timeframe without having to ship or transport samples to the lab. Because <1g of material is required, it is practically non-destructive (although obviously c. 1g of material is powdered). By enabling this amount of mineralogical data to be acquired quickly, there are obvious applications to reservoir quality and petrophysics.

As shown in Figure 4, the FTiR can also provide an indication of TOC, again unlikely to replace LECO-type instruments for laboratory analysis, but data on shale resource cores can be gained rapidly at the same time as mineralogical data, perhaps providing a screening mechanism for more elaborate laboratory based organic analyses.

FTiR has also been used in the coal industry to provide indications of coal rank. Chemostrat have recognised, however, that FTiR is sensitive to both coal maturity and maceral content / type. We are currently working with coal samples of known maceral content and

maturity to build a model that will provide quick and cost effective ways to analyse CSG intervals.

Finally, because of its robust, small footprint, lack of moving parts and simple user interface our FTiR mineralogy on the move services are ideally suited for well-site applications. ■

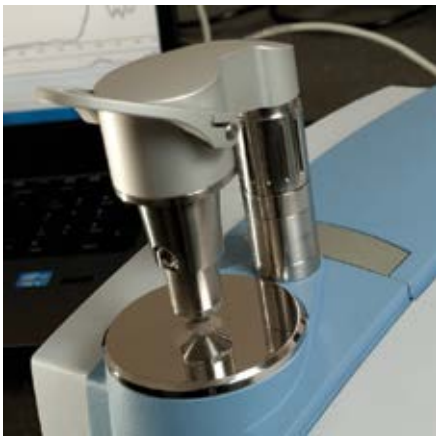

Fig. 4. Close up of instrument stage, with analysis underway. Note simple sample presentation protocol and small amount of sample required.

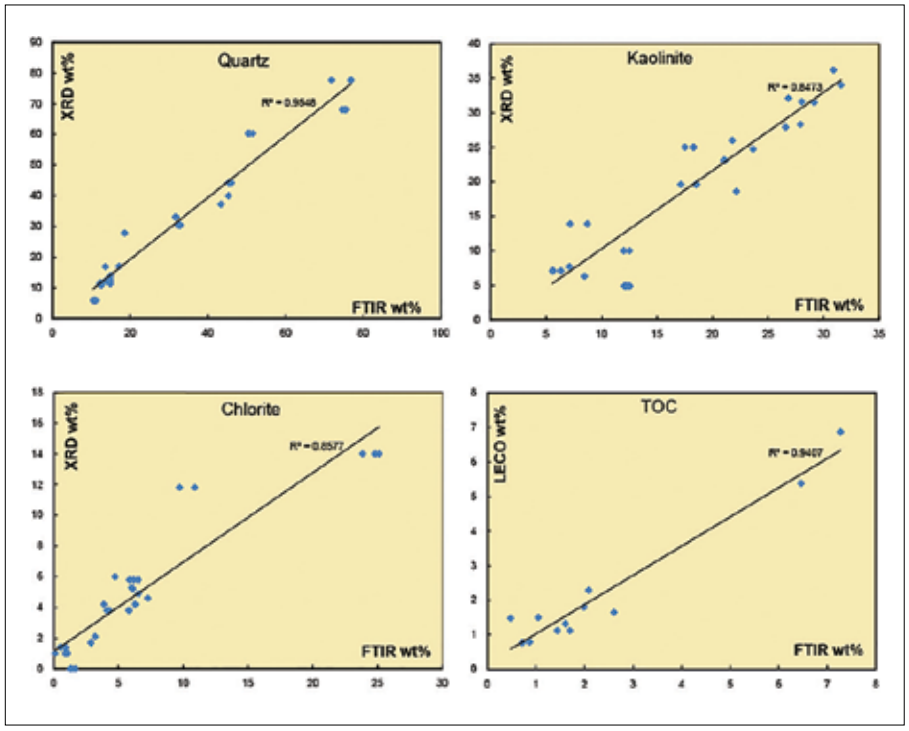

Fig. 3. Cross plots of selected variables obtained by XRD analysis (quartz, kaolinite, chlorite) and LECO analysis (TOC) compared against same variables obtained by FTR analysis.