



D4 ENDEAVOR  
X-ray diffractometer



MATRIX-I  
FT-NIR spectrometer

## Combined NIR and XRD solves clay problem in mining

**Bruker Fourier-Transform Near-Infrared (FT-NIR) spectroscopy and X-ray powder diffraction (XRD) allow fast, semi-automated measurement of quantitative mineralogy thereby leading to improved ore recovery and cost savings in the mining industry. The combination of these complimentary methods provides the total mineralogy, including swelling clays. The extent to which each method is used depends on the requirements of the mine.**

Knowing the quantitative mineralogy of rock is of fundamental importance for the efficient recovery of valuable metal from the ore. The minerals determine, for instance, the hardness of the rock which affects the drilling time of blast holes, the amount of explosives needed, the type of crusher and mill used for comminution, the grinding time, and the energy consumed by the mill. Minerals show different separation behavior and reactivity during recovery of the metal in leaching or flotation. Gangue minerals may consume leach acid or make froth flotation bubbles to collapse, all this resulting in less recovery of the metal.

X-ray powder diffraction (XRD) combined with quantitative TOPAS Rietveld analysis is used for quantitative minerals analysis in mining. XRD is easy to perform, fast, and yields accurate quantitative results without using standards. The preparation can be automated to ensure a reproducible quality of samples. However, without making special efforts, XRD is restricted to the investigation of crystalline matter. This makes it an excellent probe for hard (typically well crystallized) minerals such as quartz, feldspar, plagioclase, etc. Furthermore, XRD uniquely distinguishes minerals of very similar chemistry such as e.g. the various metal sulfides.

Clays are soft minerals, which are often not well crystallized. Their structure may vary by swelling, according to humidity or cation exchange. This complicates the quantification by XRD. Larger concentrations of swelling clay are typically critical for operation. They may stop the flow of acid in the leach pad or influence the concentrator process by affecting the stability of froth bubbles. This reduces recovery. On the other hand swelling clays have volitional properties as well. They are used for impermeable liners below stock piles. Soft minerals in general simplify drilling, blasting and comminution.

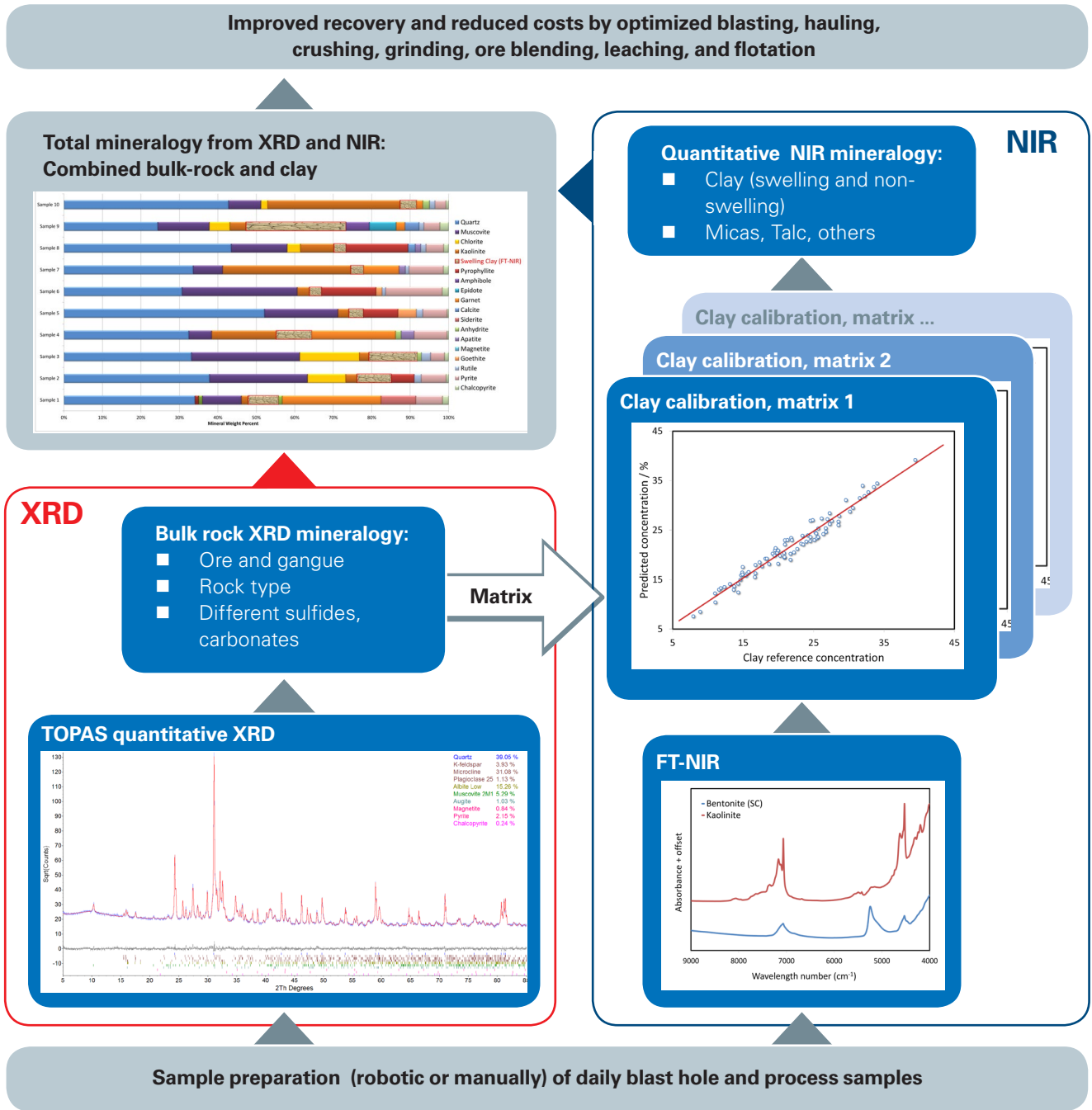
Near-infrared (NIR) spectroscopy measures the change of absorption or transmission by molecular vibrations of e.g. water, hydroxyl or carbonate groups. These molecules are found in many soft minerals (swelling clay, kaolinite, micas, chlorite, talc, amphiboles or carbonates). This makes NIR spectroscopy an excellent tool for monitoring those soft minerals, even though they are not crystalline. NIR is very fast and requires only minimal sample preparation. NIR is quantitative using calibrations that are mining site specific. Those matrix effects are determined by XRD and for calibration of clays, cation-exchange capacity (CEC) tests are additionally performed. Used in this way, NIR can be used, complement or even replace XRD for the quantification of clay minerals.

The chart below presents schematically how XRD and NIR may be used, depending on the needs of the mine:

1. XRD only permits to monitor metal sulfides concentration, the hard minerals, and other phases that are not detectable by NIR.
2. The NIR can be calibrated for a variety of minerals (typically

the 'soft' minerals mentioned before). With just a FT-NIR instrument the mine can monitor selected minerals and use the data to improve processing. Though, they would need to calibrate the NIR data, which requires XRD work to be done, either in house or by 3rd party.

3. The study of the complete bulk and clay mineralogy require both instruments. In this case one may use the NIR for swelling clay only and use the XRD for the other phases.



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