X-Ray Diffraction While Drilling

Near-real-time mineralogical quantification at the wellsite

APPLICATION

- Formation evaluation using the EcoFlex* multifactor cuttings evaluation-while-drilling service (conventionals)
- Mineralogical quantification

BENEFITS

- Optimizes well placement
- Improves lithological description of cuttings
- Eliminates subjectivity in cuttings descriptions
- Enables well-to-well correlation
- Identifies formation tops

FEATURES

- Quantification of minerals common in sedimentary rocks
- Proprietary software for automatic and semiautomatic mineralogical quantification
- Direct data storage in Schlumberger acquisition system
- Real-time data transmission for near-real-time remote interpretation
- Compatibility with all drilling fluid types
- Main clay families identification: illite-muscovite, kaolinite, montmorillonite, and chlorite
- Feldspars quantification: plagioclase and potassium feldspars

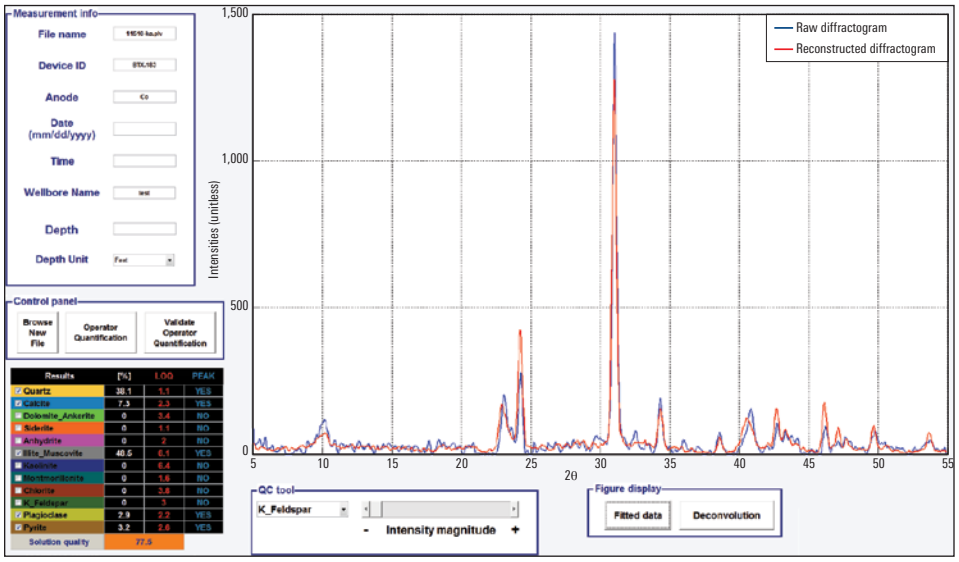
X-ray diffraction (XRD) identifies key mineralogical markers in near-real time while drilling. This quantitative analysis identifies formation tops and improves the quality of lithological descriptions, eliminating subjectivity in cuttings descriptions.

Methodology

Measurements are performed on cuttings that have been washed, dried, and crushed to a grain size of less than 150 ug. During analysis, light is scattered and diffracted by each crystal of the sample powder. Because every mineral has a characteristic crystal shape, the scattered light produces a unique diffractogram pattern. The analysis of the obtained diffractogram is done automatically or semiautomatically by an analyst located onsite or offsite. From the analysis of the diffractogram, the various minerals are identified and their concentrations are quantified.

Quantification

In combination with Schlumberger proprietary software, XRD automatically identifies and quantifies minerals present in cuttings. The software uses specific algorithms based on a database of mineral diffraction patterns and proprietary calibration process for various rock mixtures and matrices. In one click, the software refines raw diffraction patterns and identifies and quantifies the most common minerals present in rock samples. This process increases data consistency, reproducibility, and quality.



Automatic mineralogical quantification performed by proprietary software shows a close match between the raw and reconstructued diffractograms. This indicates that all minerals have been identified.

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Mineralogical Phases	Average Absolute Deviation, %	Limit of Quantification for Kα (Co) Radiation (Si-Rich Matrix), %	Limit of Quantification for Kα (Co) Radiation (Ca-Rich Matrix), %
Quartz	±5	–[†]	1
Calcite	±4	2.3	–
Dolomite-ankerite	±4	3.3	3.9
Siderite	±7	0.6	1.1
Anhydrite	±4	1.8	4.5
Total feldspars	±4	–	–
Microcline (K-feldspars)	±5	2.9	4.4
Albite (plagioclase)	±3	2.1	3.2
Total clays and micas	±4	–	–
Illite-muscovite	±4	5.8	9.2
Kaolinite	±5	6.2	7.8
Montmorillonite (smectite)	±3	1.5	2.4
Chlorite	±4	3.5	7.1
Pyrite	±5	2.3	5.1

[†] – = not applicable

XRD Specifications[†]	
XRD range	5° to 55° 2θ
Detector type	Two-dimensional Peltier-cooled charge-couple device (1,024 × 256 pixels)
X-ray target	Cobalt[‡]
X-ray tube voltage	30,000 V
X-ray power tube	10 W
Operating temperature	14 to 95 degF [–10 to 35 degC]
Dimension	12 × 7 × 19 in [30 × 17 × 47 cm]
Weight	27.5 lbm [12.5 kg]
Geiger count	0 mSv

[†] XRD does not use a radioactive source for measurement.

[‡] Higher 2θ spacing at low angle compared with standard copper tube improves visualization of clay mineral peak.

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