

X-Ray Fluorescence

GeoFlex quantitative cuttings analysis and imaging service component

APPLICATIONS

- Near-real-time chemostratigraphy at the wellsite
- Formation top identification
- Casing and landing point optimization
- Sweet spot recognition
- Paleodepositional environment identification

BENEFITS

- Enables well-to-well correlation and precise depth matching
- Improves lithofacies description from cuttings
- Provides additional information for geological basin and petroleum system modeling

FEATURES

- Calibration based on 40 reference samples
- Quantification of 28 inorganic elements (11 majors elements and 17 trace elements)
- Qualitative evaluation of 19 elements
- Synthetic total and spectral gamma ray calculation
- Six-minute analysis time
- Direct data storage in Schlumberger acquisition system
- Real-time data transmission

The GeoFlex* quantitative cuttings analysis and imaging service determines elemental composition of the whole rock by quantifying elements and trace elements using X-ray fluorescence (XRF) analysis. This technique provides measurements to parts per million and is highly useful for geochemical fingerprinting. With a geochemical fingerprint, it is possible accurately identify formation tops and casing points and to conduct well-to-well correlation studies.

XRF can also be used to refine mineralogical evaluation for drilling in complex lithologies. Analysis of trace elements can provide information key to improving geological and petroleum systems models by providing proxies of paleodepositional and redox environments. Quantification of uranium, potassium, and thorium allows you to reconstruct a synthetic spectral and total gamma ray, which can be compared to LWD or wireline gamma ray for verifying the depths of cuttings.

Methodology

Measurements are performed on drilled rocks that are cleaned, washed, dried, and ground to a grain size of approximately 80 ug. A small amount of cuttings powder is then mixed with wax before being compacted into pellets.

Quantification

XRF analysis is internally calibrated based on 40 standard reference samples from a wide range of geological formations. Accuracy and limit of quantification have also been quantitatively determined through extensive laboratory testing.

H																			He
Li	Be												B	C	N	O	F		Ne
Na	Mg												Al	Si	P	S	Cl		Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br			Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I			Xe
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At			Rn
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Uug	Uup	Uuh	Uus			Uuo
	La	Ce	Pr	Ns	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu				
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr				

- Quantitative major elements
- Quantitative trace elements
- Qualitative evaluation
- Elements not analyzed

X-ray fluorescence analysis from the GeoFlex service provides quantitative measurement (green) and qualitative evaluation (orange) of the elements above.

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XRF Proprietary Metrological Characterization

Major Element Compounds	Average Absolute Deviation, %	Limit of Quantification, %
Na ₂ O	0.3	0.04
MgO	0.5	0.08
Al ₂ O ₃	0.7	0.29
SiO ₂	1.8	0.21
P ₂ O ₅	0.8	0.008
SO ₃	1.1	0.017
K ₂ O	0.15	0.04
CaO	0.5	0.36
TiO ₂	0.04	0.1
MnO	0.004	0.0003
Fe ₂ O ₃	0.3	0.14
Trace Elements	Average Absolute Deviation, ppm	Limit of Detection, ppm
V	15	6
Ni	6	7
Cu	6	3
Zn	3	2
Ga	3	4
As	3	3
Rb	4	2
Sr	11	10
Y	7	3
Zr	30	47
Nb	10	5
Mo	4	3
Ba	77	66
Hf	3	3
Pb	5	3
Th	2	2
U	7	2

Specifications

Operating voltage range	95–120 V / 200–240 V [50 to 60 Hz]
X-ray tube	Palladium anode
Power	50 W
Max tension	50 kV
Secondary targets	Molybdenum, aluminum oxide, highly oriented pyrolytic graphite crystal
Analysis atmosphere	Helium
Detector	Peltier-cooled silicon drift detector
Detector size	0.1 in ² [7 mm ²]
Beryllium window thickness	8 μm
Sample preparation	Pellets

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