Application of the Portable Thermo Scientific Niton XRF Analyzer in Mud Logging

Southeast Asia Case Study

Application Note

Introduction

During mud logging, geologists examine rock chips that are brought to the surface by the circulating drilling media (most commonly mud). They look for any evidence to identify downhole lithology (rock type), mark positions of hydrocarbons with respect to depth, monitor natural gas entering the drilling mud stream, and finally create well logs.

Lithology identification is an important and crucial task in determining reservoir characteristics as well as oil/gas production (e.g. geo steering). Rock identification is usually done by examining thin sections of rock under optical microscope. This method is time consuming and requires a thin section preparation laboratory onsite. There is no instrumental technique to identify rock type directly. Laboratory methods such as x-ray diffraction (XRD) and Raman spectroscopy are used in mineralogy to identify mineral composition of rocks. Now, these techniques are complemented by field-portable x-ray fluorescence (FPXRF) which can not only be used to identify elemental composition, but also the subtle changes in geochemistry of reservoir rocks and monitoring of the gradual transition from one rock type to another. This application note summarizes one example of a case study from Southeast Asia.

Thermo Scientific Niton XL3t analyzing oil and gas core samples.

Field Portable XRF Analyzers

FPXRF is a technique that is gaining momentum and acceptance in addressing applications in various fields in geology and mining including oil and gas exploration and production. This technique delivers fast and accurate elemental analysis results, from a few ppm to 100% concentration, with little or no sample preparation. Some of the salient attributes of this type of instrument are as follows:

- Safe and user-friendly
- Easy to use by geologists and technicians after minimal (a few hours) training
- Capable of measuring up to 30 elements simultaneously from Mg to U
- Light and portable
- Analyzes any type of geological sample in real time (on-site)
- Adjustable assay time from 30 seconds to a few minutes depending on the accuracy and precision requirements
- Capable of measuring light elements (Mg, Al, Si, P, S)
- Li-ion battery technology: each battery lasts about 8 hours
- Built-in GPS in handheld analyzers which records GPS coordination for each sample that is analyzed
- Ability to calculate ratios and formulas defined by user
- Built-in type standardization which allows the users to adjust calibration to match their specific sample matrix type

Handheld Thermo Scientific™ Niton™ XL3t Ultra analyzers and the Thermo Scientific™ Niton™ Field X-Ray Lab (FXL) bring transformative improvements related to data acquisition time, and offer excellent limits of detection (LOD) while providing accurate results over a wide range of samples. Recent algorithm developments, such as z-CAL for the Niton FXL, a fit-for-purpose calibration and operation methodology for light elemental analysis, have improved detection limits for light elements, a critical requirement in oil and gas applications.

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Application

FPXRF can analyze a variety of sample types which are common in the oil and gas upstream exploration and production (E&P) industry including drill cuttings, oil and gas cores, outcrops, and piston cored sediments.

The geochemical data from these analyses can be used for several applications including:

1. Inferring Mineralogy
2. Inferring Lithology
3. Chemostratigraphy
4. Reservoir Characterization
5. Oil and Gas Productivity

Although FPXRF analyzers cannot analyze hydrocarbons, they can be used to characterize reservoir properties that influence porosity (cements), permeability (clays, cement type), fracture population (Si content), and productivity (e.g. V, Cr, Mo content). FPXRF is used on-site to determine elemental composition of a sample in real time. Then mineralogy of the sample can be inferred from its chemical composition. The mineralogy is subsequently used to infer physical properties of the rock unit. Such an application in oil and gas E&P can be shown as:

Elemental composition → Mineralogy → Physical properties of host rock → Process decisions in the field

As light elements such as Al, Si, and Mg are very important in lithological investigations, sample preparation is required. Thermo Fisher Scientific offers field portable sample preparation tools which are specified for oil and gas exploration and mining.

Method

This case study was carried out on 221 samples collected from an oil and gas drill site in Southeast Asia. The prepared samples were analyzed using Thermo Scientific Niton XL3t Ultra using 120 seconds total analysis time (30 seconds on each filter). Field studies and observations indicated that all these samples are sedimentary (with local bedding planes).

Results

Mud logging showed that there are three major intervals: 1) from 137 to 603m consists of thick siltstone layer with interbedded sandstone and minor claystone, 2) from 603 to 723m consists of thick sandstone layer interbedded with siltstone and local claystone, and 3) from 723 to 2232m dominated by claystone and siltstone interbedded with minor sandstone and rare limestone.

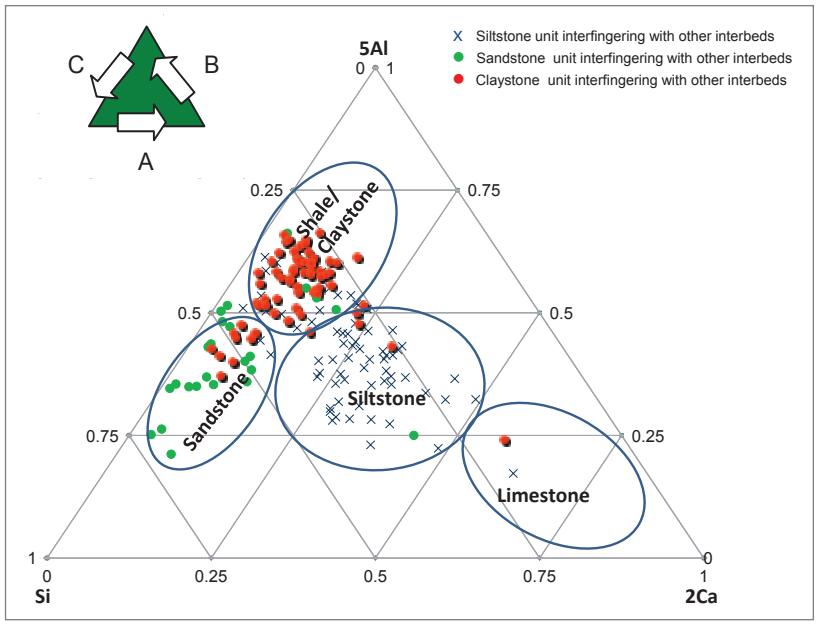

Figure 1. Classification of sedimentary rocks from Southeast Asia using Si-Ca-Al triangle developed based on PXRF data.

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The portable XRF data were evaluated and a Si-Ca-Al discrimination triangle was developed (see Figure 1). This triangle not only discriminates between various major interval lithologies, but also the thin interbeds along with subtle geochemical changes in beds and transition from one lithology to another can be monitored easily.

Conclusion

Field portable XRF is a very reliable and effective tool to analyze any type of sample not only in metal exploration and mining but also in oil and gas E&P. This application note shows how it can be used effectively to identify sedimentary rock types that are common in the oil and gas industry. This is just one way of using the data; other applications include mineral inference, chemostratigraphy, reservoir characterization, and oil and gas productivity. Sample preparation tools combined with the new z-CAL calibration for the Niton FXL offer improved detection limits for light elements, a critical requirement in mud logging and other oil and gas applications.

To discuss your particular application and performance requirements, or to schedule an on-site demonstration, please contact your local Thermo Scientific portable analyzer representative or contact us directly by email at niton@thermofisher.com, or visit our website at www.thermoscientific.com/niton.

thermoscientific.com/niton

Americas
Boston, MA USA
+1 978 670 7460
niton@thermofisher.com

Europe, Middle East, Africa & South Asia
Munich, Germany
+49 89 3681 380
niton.eur@thermofisher.com

Asia Pacific
New Territories, Hong Kong
+852 2885 4613
niton.asia@thermofisher.com

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