# Elemental Analysis

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### Portable ED- XRF

A higher level of understanding of reservoir stratigraphy (chemostratigraphy) and associated parameters is developed using the Bruker TRACER IV-SD energy dispersive X-ray fluorescence (ED-XRF) spectrometer. The technique uses a time-tested cleaning regimen and a proprietary calibration reference set to non-destructively quantify geochemical changes in core. The technique also provides a quantitative elemental analysis for drill cuttings.

*Figure 1: Bruker ED-XRF instrument.*

### Major Elements Reported (10):

Mg, Al, Si, P, S, K, Ca, Ti, Mn and Fe

### Trace elements Reported (18):

V, Cr, Co, Ni, Cu, Zn, Ga, As, Se, Rb, Sr, Zr, Nb, Mo, Ba, Pb, Th, and U

Major elemental analyses are generated using vacuum and a Rh tube set at 15 kV. For more sensitive analyses of light elements, like Mg and Al, helium (He) is used instead of the vacuum. Trace element analyses are generated without the vacuum pump at, 40 kV, with an Al-Ti filter.
The raw XRF spectra are calibrated using a Premier proprietary calibration comprised of 67 reference materials from a range of different formations.

### Quality assurance and quality control:

Internationally accepted geological reference materials (GRM), and Premier proprietary reference materials are analyzed twice every 24 hours to monitor instrument performance. Additionally, each raw XRF spectrum is visually examined during and after analysis.

### Tracer IV-SD Technical Specification:

Weight: 2 Kg (4.49 lbs.) with batteries; 1.77 Kg (3.9 lbs.) base weight.
Size: 30 cm (L) x 10 cm (W) x 28 cm (H)
Detector: 10-mm2 XFlash SDD; Peltier Cooled; Typical Resolution 145 eV at 100,000 cps
X-Ray Tube: Rh Target; max voltage 40 kV
Filter changer: 5-position computer controlled filter changer
Vacuum pump attachment: Yes
Software-driven voltage and current control: Included

### Tabletop ED-XRF

The tabletop Bruker S2 Ranger ED-XRF allows for improved resolution of lighter elements like sodium (Na) and magnesium (Mg). Elemental analysis using the S2 Ranger requires pellets be made from pulverized sample powder.

**Major Elements Reported (11):**
Na, Mg, Al, Si, P, S, K, Ca, Ti, Mn and Fe

**Trace elements Reported (18):**
V, Cr, Co, Ni, Cu, Zn, Ga, As, Se, Rb, Sr, Zr, Nb, Mo, Ba, Pb, Th, and U

**S2 Ranger Technical Specification:**
Weight: 96 kg (211 lbs.)
Size: 65 cm (25.4") x 80 cm (31.3") x 60 cm (23.4")
Detector: XFlash V5 SDD; Peltier Cooled; Typical Resolution 145 eV at 100,000 cps
X-Ray Tube: Pd or Ag anode; max power 50W; max voltage 50kV, max current 2mA
Filter changer: 28 position tablet; constant loading during measurements; max weight 220 gm
Vacuum pump: Integrated
Helium Flushing: Integrated
Operation Modes: Vacuum for solids, helium flushing for liquids and loose powders
Software-driven voltage and current control: Included

## Standard Operating Procedures

**XRF Analysis on slabbed core:**
Elemental analysis is performed by the portable Bruker Tracer IV-SD ED-XRF and corrected with the Premier Lab proprietary calibration.

- The core face is cleaned with water for the removal of possible contamination (chlorine, dust, and barite).
- The right side of the core slab is labeled at the desired resolution of analysis. Scans are completed in the center of the slabbed core face, directly across from the label.

*Figure 2: Bruker S2 Ranger ED-XRF instrument.*

- Sample contamination is evaluated immediately following analysis.

**XRF Analysis on drill-cuttings:**
Elemental analysis on drill-cuttings is performed by either the portable Bruker Tracer IV-SD ED-XRF or the Bruker S2 Ranger tabletop ED-XRF instrument.

- A powerful magnet is run over the drilled cutting samples to remove metal contamination from drill pipes.
- Cuttings are first washed in an ultrasonic bath with deionized water for 5 minutes to remove surface contaminants such as drilling mud.
- The washed cuttings samples are dried in an oven at 70˚C for one hour.
- The dried cuttings samples are pulverized and homogenized using a centrifugal mill or mortar and pestle.
- Homogenized powder is then pelletized to make a 13mm diameter pellet, for the Bruker Tracer IV ED-XRF analysis. A 40mm diameter pellet is pressed for the S2 Ranger analysis.