# GEM™ Elemental Analysis Tool

## Precise Evaluation of Complex Mineralogies

Halliburton's GEM™ elemental analysis tool offers quick and precise evaluations of complex mineralogies, using proven interpretation processes and integrated petrophysical analysis. A neutron-induced capture gamma ray spectroscopy logging system, the GEM tool is designed to derive elemental contributions contained within the total measured gamma-ray energy spectrum.

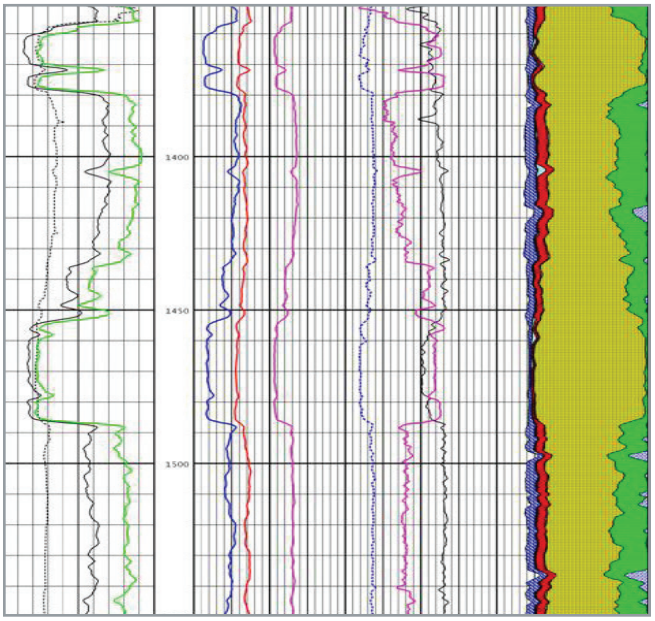
The GEM tool can measure elemental yields that are important to mineralogical evaluations in open holes to accurately assess the reservoir and complete the well.

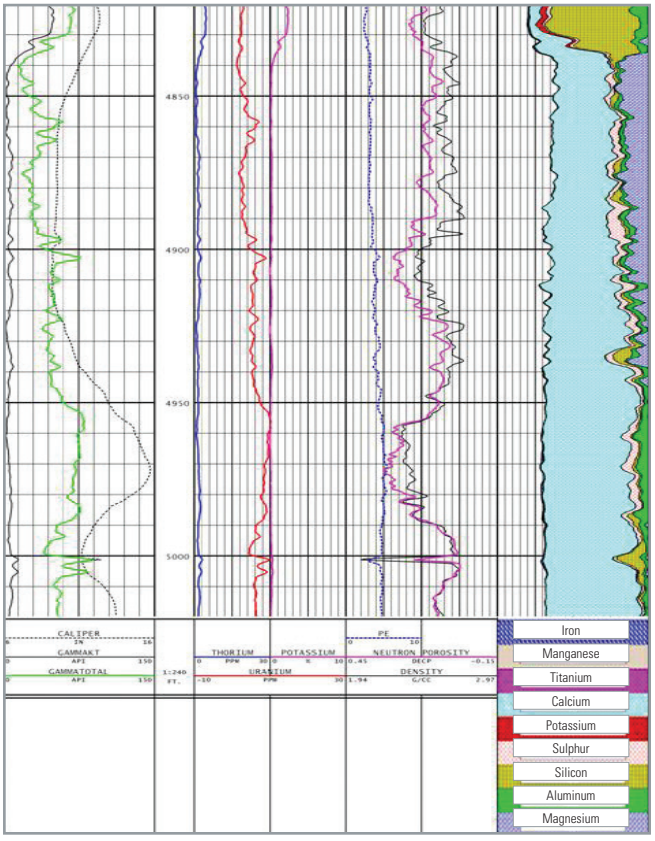
The GEM logging software calculates elemental concentration logs by using an oxides-closure methodology that can be used for quick-look or detailed mineralogical evaluations. These elemental concentrations can be used to identify geometrical-stratigraphic correlations from well to well. Elemental concentrations can also be used to calculate matrix-grain density and thermal neutron-absorption (sigma) properties.

The GEM tool uses a chemical source to promote wider application due to cost savings associated with its durability, shorter length, and simple usage requirements. The detector is enclosed in a flask with a eutectic heat sink to enable extended operation at downhole conditions. In addition, the software provides on-site or remote visualizations of the resulting data quickly and accurately, with proven, robust post-processing solutions.

### Benefits

- Improves accuracy of integrated petrophysical analysis
- Mineral fractions such as gypsum or anhydrite, carbonate, coal, pyrite, salt, siderite, quartz, feldspar, mica, and clay from complex formation analysis
- Matrix-density values for more accurate porosity calculation
- Sigma matrix for cased and openhole sigma saturation analysis and improved neutron-porosity environmental corrections
- Improves permeability estimates based on mineralogy
- Quick cool down of eutectic heat sink for rapid job turnaround
- Borehole shielding for reduced sensitivity to borehole fluids

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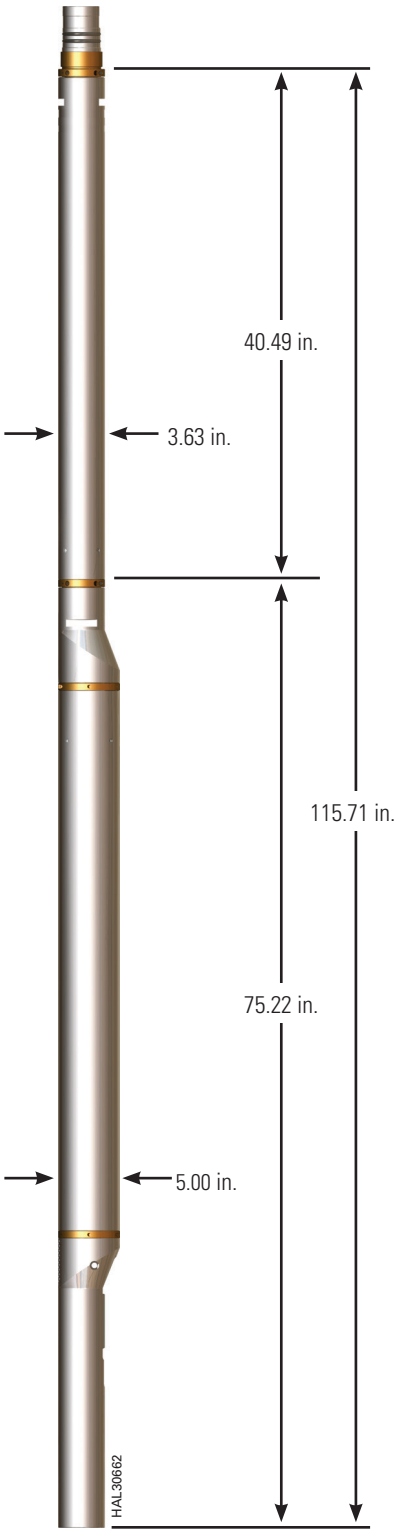


## Dimensions and Ratings

| | Standard | DeepSuite | | Standard | DeepSuite |
|---|---|---|---|---|---|
| **Maximum Temperature** | 350°F (177°C) | | **Maximum Pressure** | 20,000 psi (137 895 kPa) | 30,000 psi (206 843 kPa) |
| **Maximum OD** | 5 in. (12.70 cm) | 5.15 in. (13.08 cm) | **Minimum Hole** | 6 in. (15.24 cm) | |
| **Length** | 9.64 ft (2.94 m) | | **Maximum Hole** | 20 in. (50.80 cm) | |
| | | | **Weight** | 368 lb (166.9 kg) | 413 lb (187.3 kg) |

## Borehole Conditions

| | |
|---|---|
| **Borehole Fluids** | Salt ■ Fresh ■ Oil ■ Air □ |
| **Recommended Logging Speed** | 15 ft/min (4.6 m/min) |
| **Maximum Logging Speed** | 30 ft/min (9.1 m/min) |
| **Tool Positioning** | Centralized □ Eccentralized ■ |

## Hardware Characteristics

| | |
|---|---|
| **Source Type** | 15-Ci Americium-Beryllium |
| **Sensor Type** | One BGO Scintillation Counter |
| **Sensor Spacings** | Proprietary |
| **Sampling Rate** | 4 samples/ft (10 samples/m) |
| **Combinability** | LOGIQ® standard |

## Measurement

| | |
|---|---|
| **Principle** | Elemental yield based on neutron-induced capture gamma ray spectroscopy |
| **Range of Measurement** | 600 keV to 9.5 MeV |
| **Vertical Resolution (90%)** | 18 in. (45.72 cm) |
| **Depth of Investigation (50%)** | 6 in. (15.24 cm) |
| **Output Curves** | Mg, Al, Si, S, K, Ca, Ti, Mn, Fe, and Gd elemental weight fractions from oxides closure |

### Statistical Precision*

| | Mg (wt. %) | Al (wt. %) | Si (wt. %) | S (wt. %) | K (wt. %) | Ca (wt. %) | Ti (wt. %) | Mn (wt. %) | Fe (wt. %) | Gd (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| Austin Chalk** Indiana | 0.04±0.2 | 0.06±0.1 | 0.02±0.05 | 0.02±0.06 | 0.01±0.03 | 39.89±0.27 | 0.01±0.01 | 0±0 | 0±0 | 2.19±0.3 |
| Limestone** Kasota | 0.09±0.27 | 0.24±0.2 | 0.21±0.26 | 0.1±0.1 | 0.05±0.08 | 39.42±0.48 | 0.01±0.01 | 0.01±0.01 | 0.02±0.03 | 1.08±0.34 |
| Dolomite† Berea | 11.06±1.48 | 1.07±1.02 | 6.53±0.89 | 0.61±0.29 | 1.99±0.44 | 16.59±1.55 | 0.12±0.04 | 0.14±0.03 | 0.81±0.16 | 0±0 |
| Sandstone† Massillon | 0.35±0.7 | 1.62±1.43 | 37.55±2.05 | 1.14±0.43 | 2.36±0.45 | 3.75±0.76 | 0.09±0.06 | 0.16±0.05 | 1.19±0.22 | 0±0 |
| Sandstone† | 0.44±0.89 | 1.19±1.47 | 38.58±2.29 | 0.99±0.41 | 2.39±0.42 | 3.32±0.92 | 0.16±0.07 | 0.13±0.05 | 1.02±0.2 | 0±0 |

* From stationary logs recorded at 15 ft/min simulated logging speed in Halliburton's Sonde Acceptance Wells
** Freshwater-filled 8-in. borehole
† 166 Kppm saltwater-filled 8-in. borehole

## Calibration

| | |
|---|---|
| **Primary** | None |
| **Wellsite Verifier** | Stainless/polyethylene with 0.5 Ci Americium-Beryllium source |

## Physical Strengths*

| Hardware | Tension | Compression | Torque |
|---|---|---|---|
| Tool Joints | 130,000 lb | 130,000 lb | 600 ft-lb |
| | (59 000 kg) | (59 000 kg) | (814 N·m) |

* Strengths apply to new tools at 70°F (21°C) and 0 psi.

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