Roke Technologies Ltd

Low Risk

Cost Effective

Efficient

# Quad Neutron

## Fracture Evaluation

# Fracturing Evaluation Challenges

- Radioactive Fracture Tracing Materials
  - High HSE risk
  - Contamination control costs
  - Radioactive tag eventually expires
  - Cannot discriminate fracture direction

# Why Trace Your Frac?

- Identify offset well interference
- Identify frac stage interference
- Identify zonal coverage

# Existing Frac Tracing Methods

- Radioactive (RA) isotopes
- Harmful to our health and our environment
- Common Oilfield RA isotopes half life's
  - Iridium 192, 74 days
  - Scandium 46, 84 days
  - Antimony 124, 60 days

- RA Isotopes are not safe for 7 half life's
  - Iridium-192, **518 days**

# Quad Neutron & Boron Carbide Fracturing Evaluation Solution

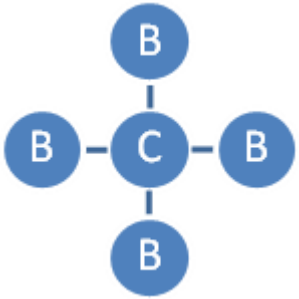
- Radioactive Fracture Tracing Materials
  - High HSE risk
  - No exposure risk to personnel
  - Contamination control costs
  - No Radioactive sand disposal and monitoring
  - Radioactive tag eventually expires
  - No time limit / Boron Carbide never expires
  - Cannot discriminate fracture direction
  - Quad Neutron dual physics can be used to discriminate fracture direction

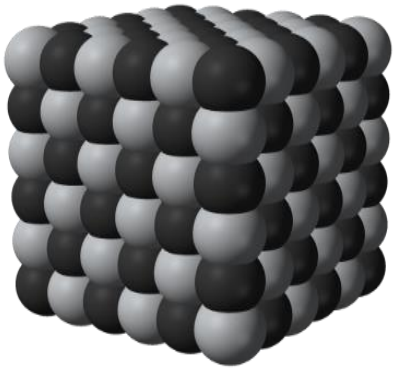
# Boron Carbide & Quad Neutron

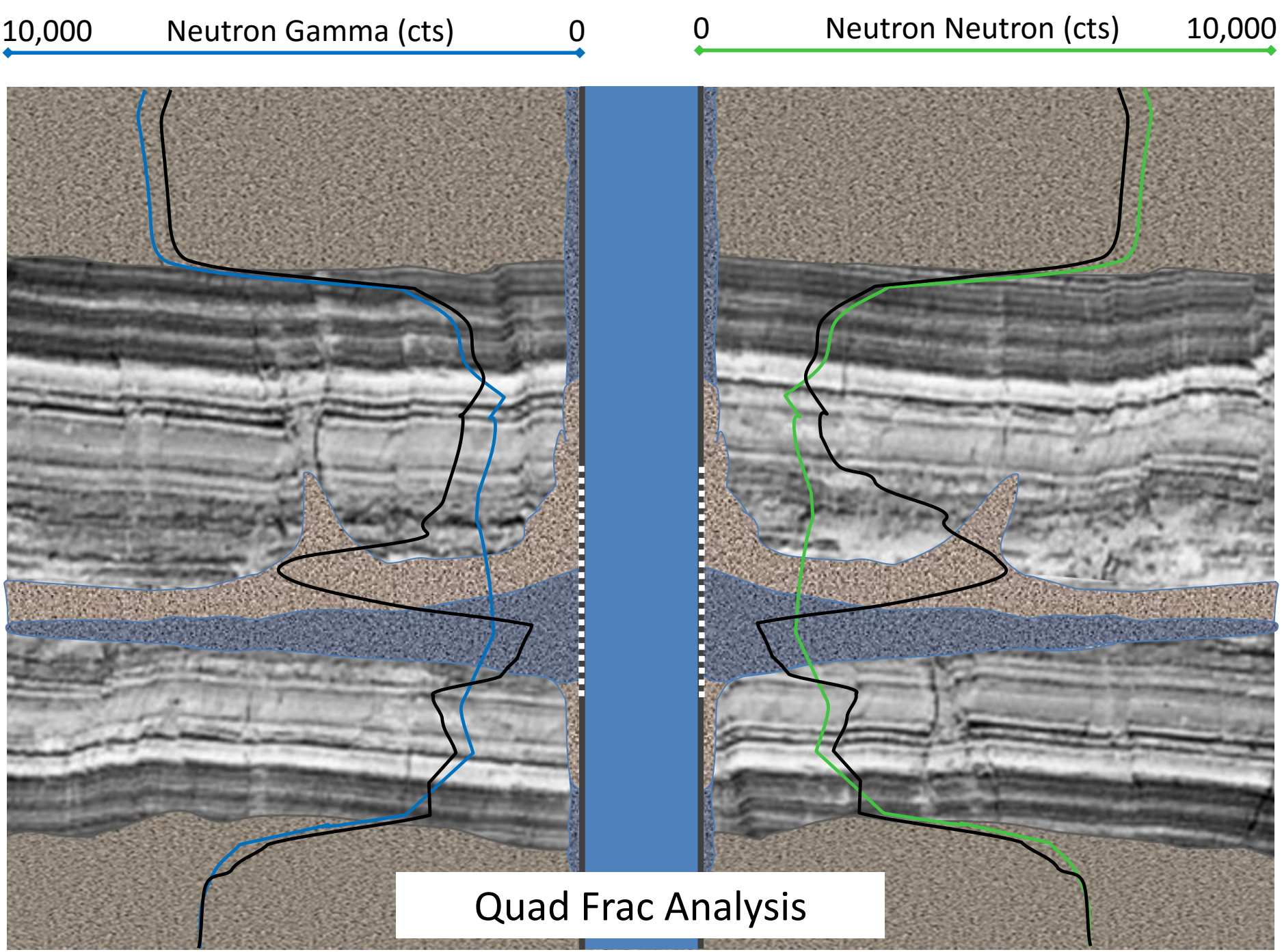
- Higher quality data to existing methods
- No exposure risk to personnel
- Matched to any proppent size
- All frac types including $N_2$
- No time limit / Tag doesn’t expire
- Near vs. Far tag placement using the Quad Neutron

# Why Boron Carbide (CB4)?

- **Characteristics:**
  - Similar density as frac sand
  - Chemically inert
  - Large absorber of neutrons
- **Pros:**
  - Higher quality data to existing methods
  - No exposure risk to personnel
  - Matched to any proppant size
  - All frac types including $N_2$
  - No time limit / Tag doesn't expire
  - Near vs. Far tag placement with Quad Neutron
- **Cons:**
  - Before pass required for neutron comparison
  - Only two tags available

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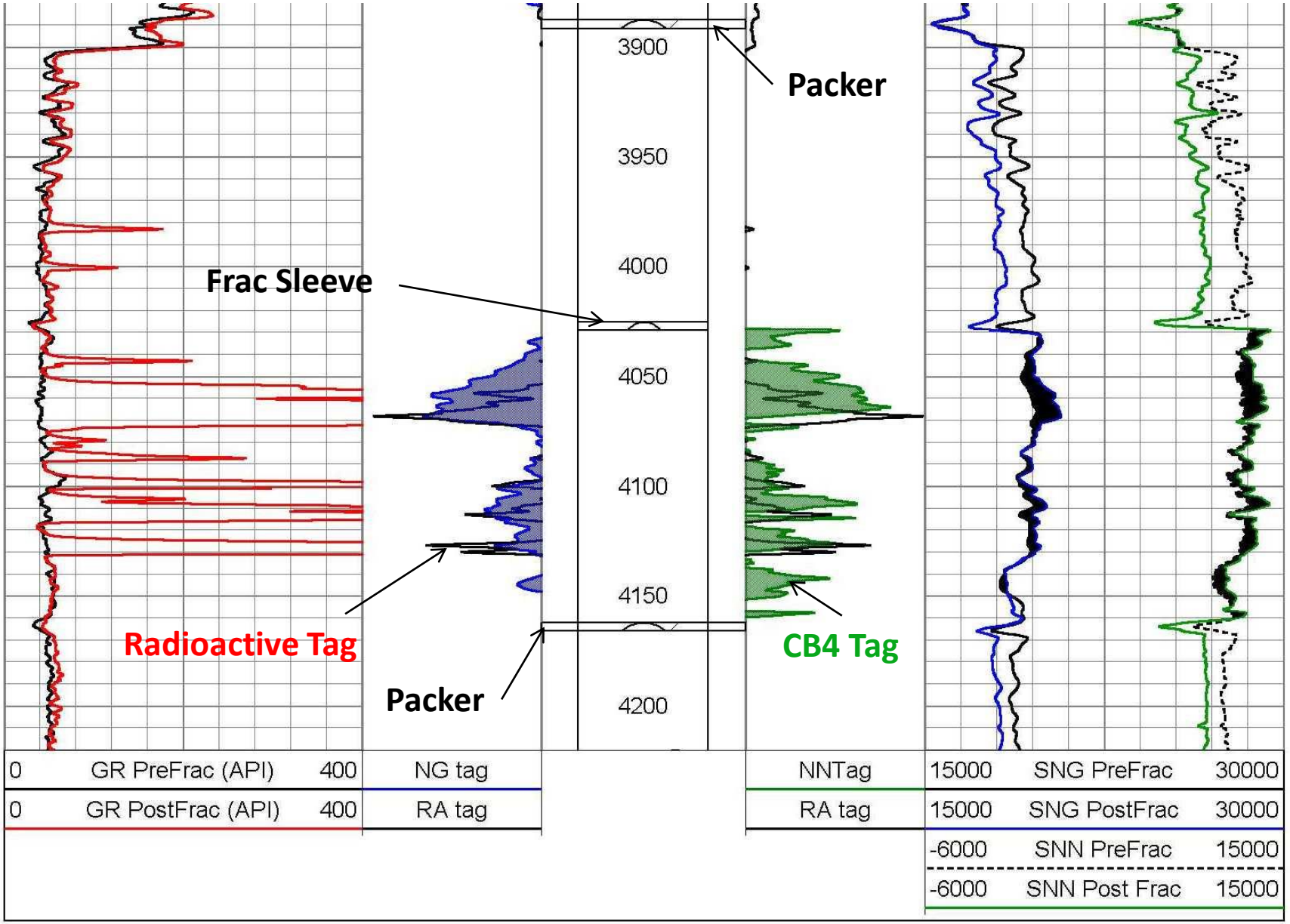
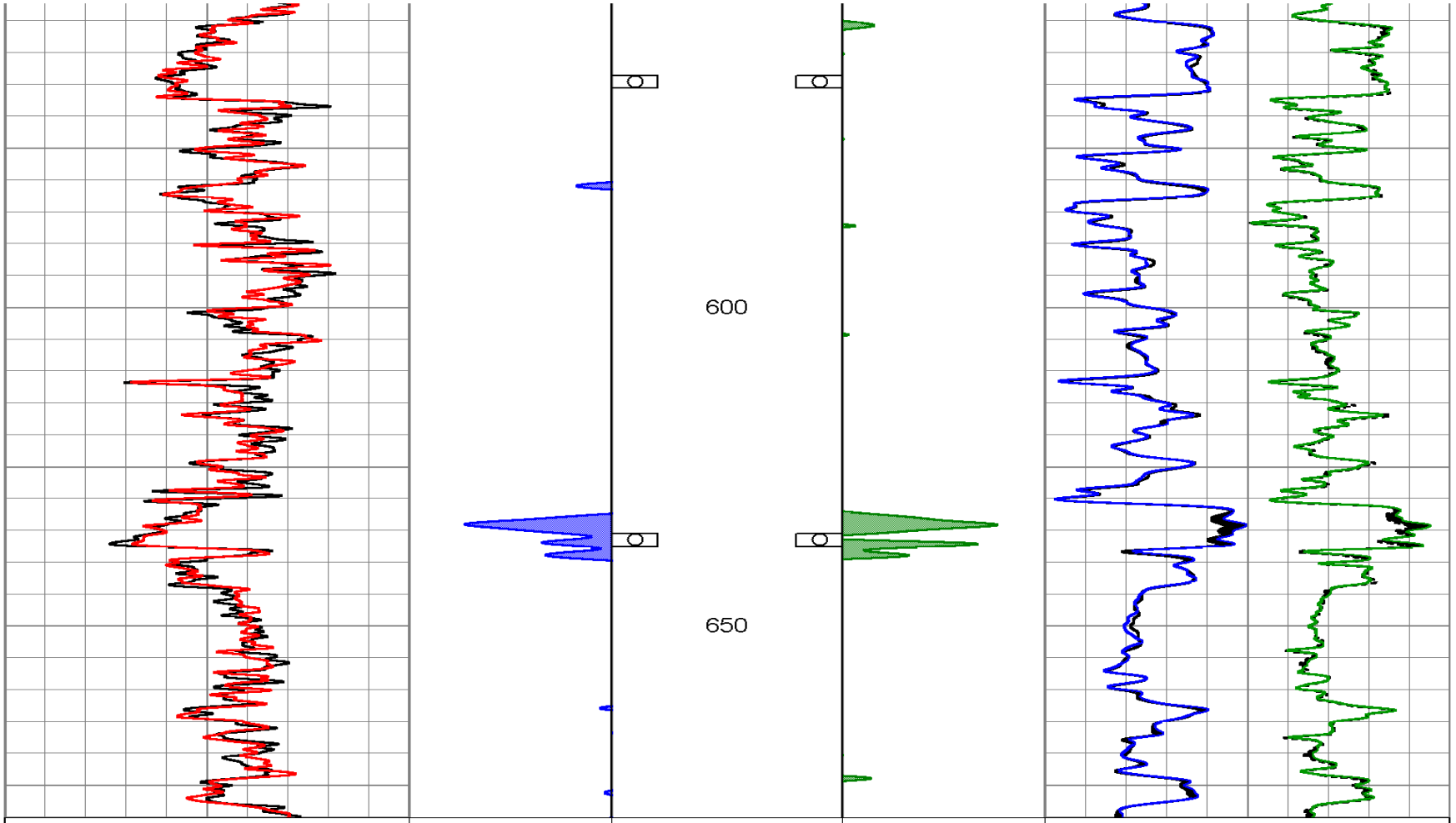
Neutron Gamma (cts)
0
0
Neutron Neutron (cts)
10,000
Quad Frac Analysis

# Boron Carbide vs RA Tag

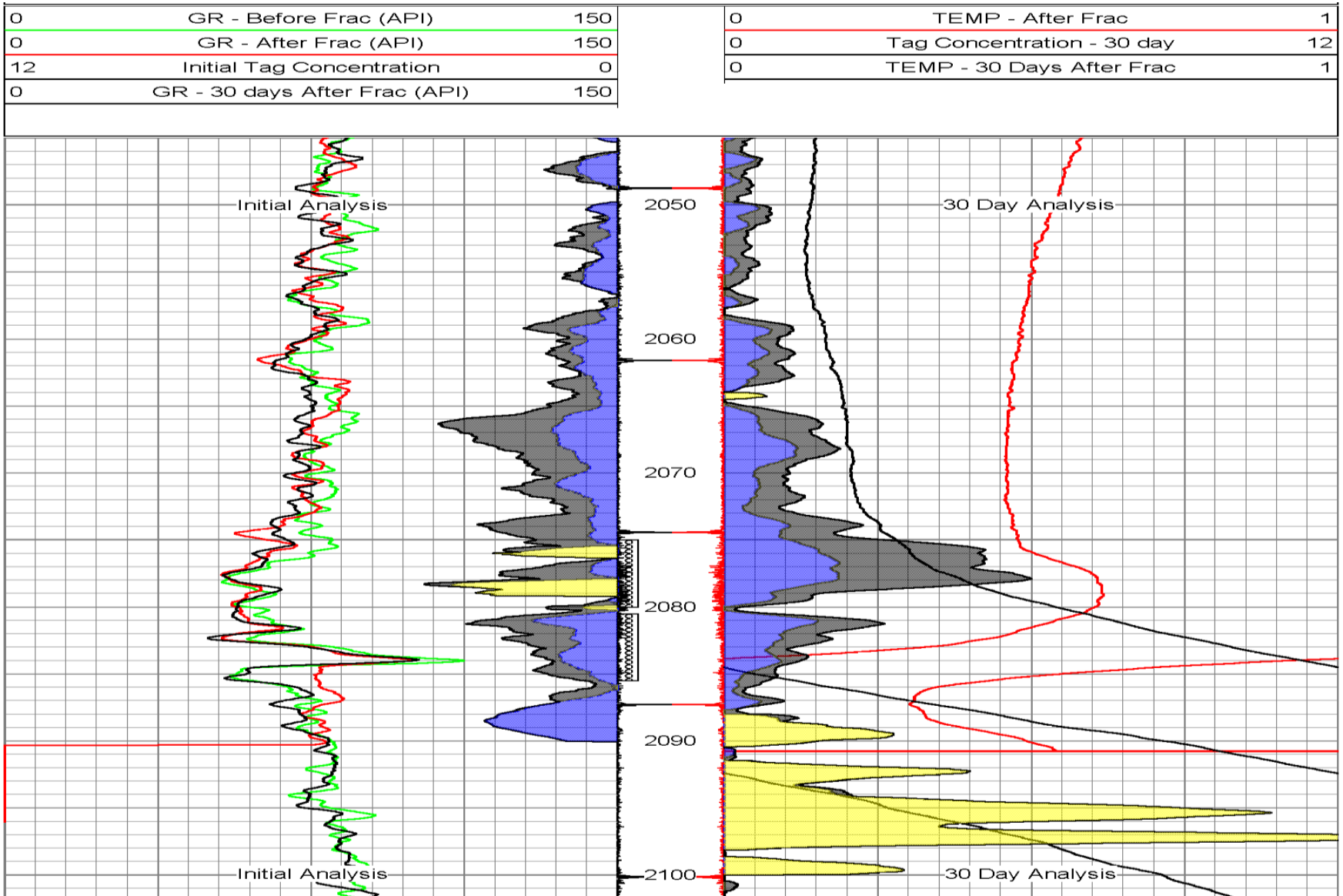


# 5 ton N2 frac with sand




5 ton energized N2 frac with sand

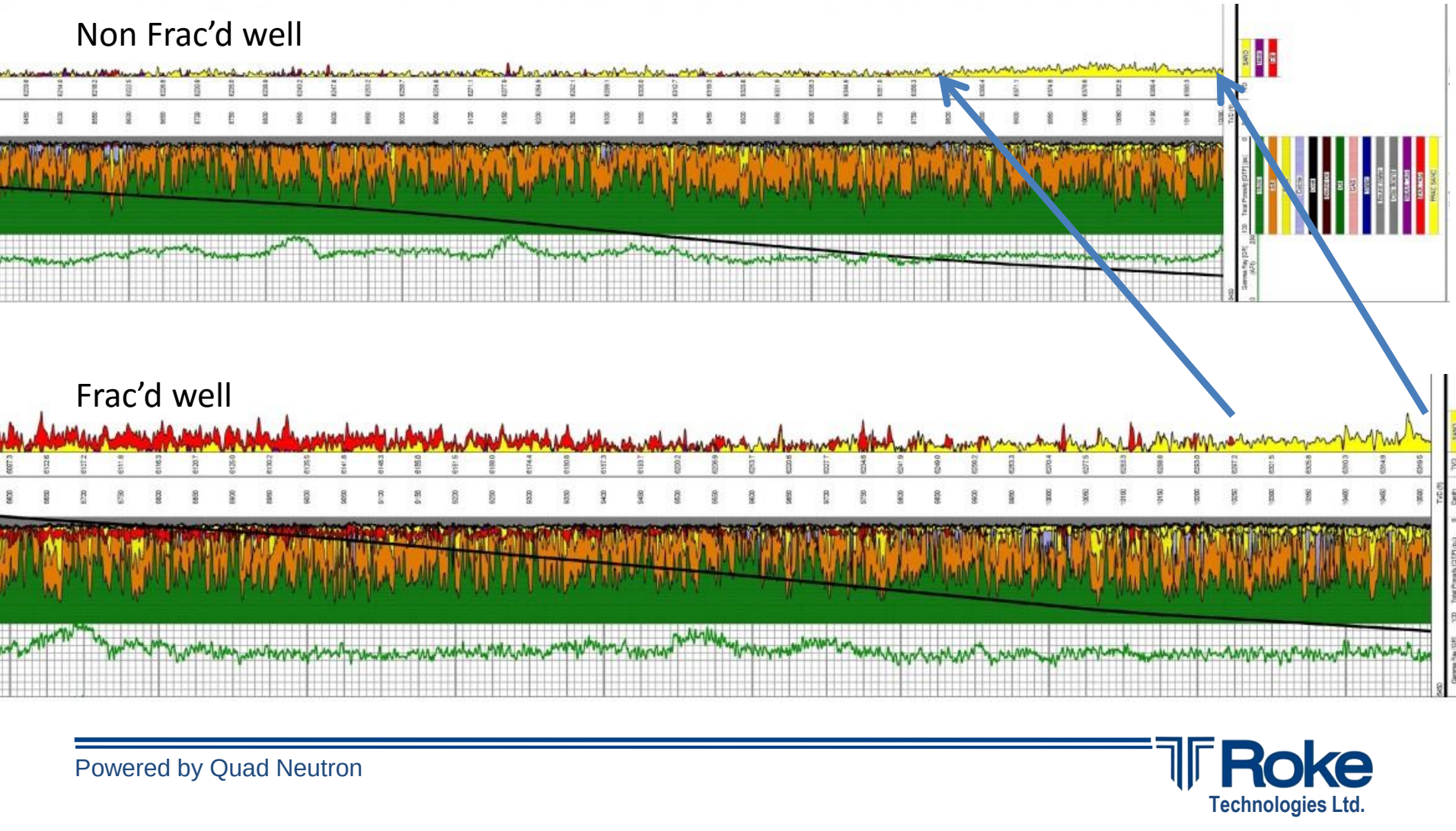
# Identifying Fracture Collapse



# Project Timeline Summary

- Drill and case 2 HZ wells
  - 750 ft spacing
- Log Quad Neutron on each well before fracturing
- Fracture stimulation 1 well
- Log Quad Neutron on each well

# Well Interference



# Stage Interference