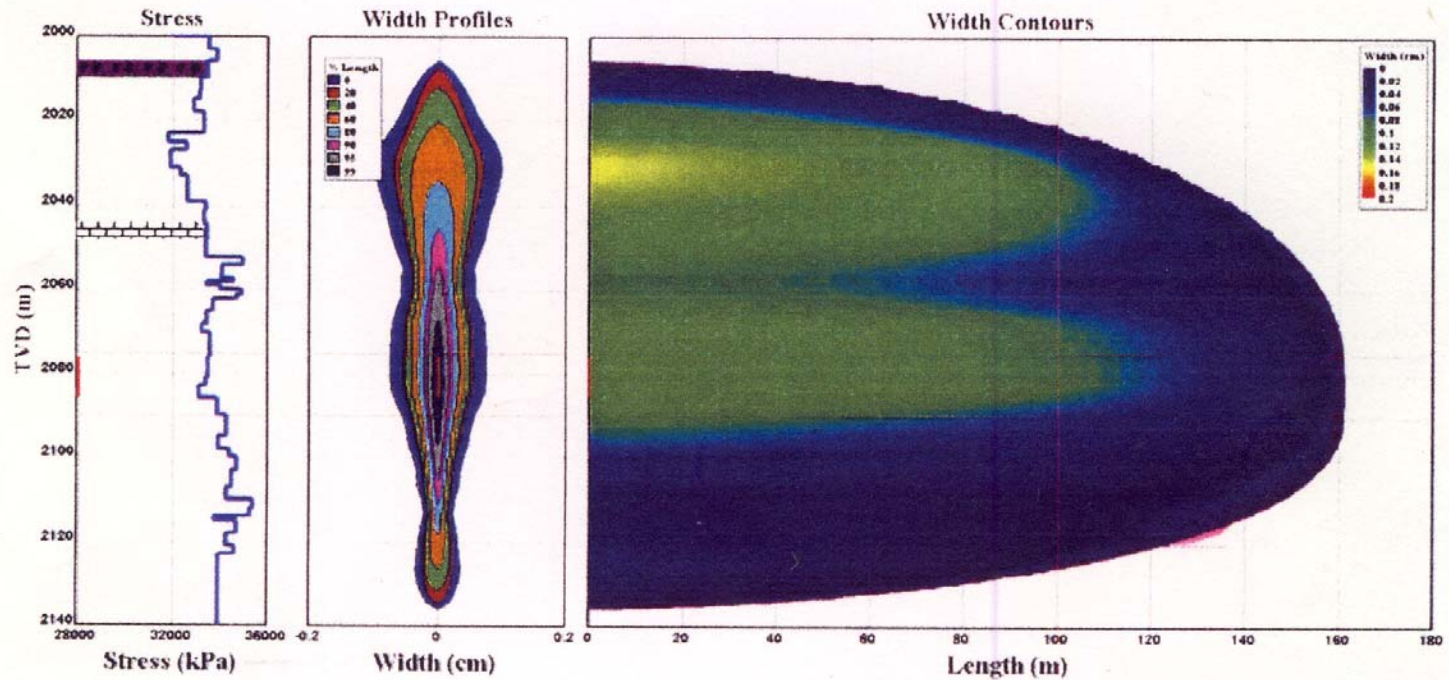




TRACERMAX

SCIENTIFIC, INC.



Patented *Tracermax* technology is the zero risk approach for tracing hydraulic fracturing or cementing operations for sub-surface zone location with maximum results.

TRACERMAX
SCIENTIFIC, INC.

APPLICATIONS

Tracermax technology can be used to determine subsurface zone location as follows:

- ▶ **The presence of light weight cement slurries (<1500 kg / m³)**
- ▶ **The height of cement “squeezes”**
- ▶ **The placement of fluids used for hydraulic fracturing**
- ▶ **Production logging**

- ▶ The addition of Boron Carbide to cement slurries will not affect the cross linking of the Calcium Silicate matrix, setting times or adversely affect compressive or tensile strengths of the cement.

- ▶ The addition of miscible Boron compounds can be added to well bore fluids to look at velocity or storage in production logging applications or where aqueous tags are applicable. Tags can be synthesized into water or oil soluble forms and can be matched to specific gravity.

- ▶ The density of Boron Carbide is the same as Silica (2.5 g/cm³). Particle sizing can be matched to any silica material that is to be tagged with it. This allows the Boron Carbide tag to move exactly the same in a fluid displacement containing Silica.

- ▶ Boron Carbide is a ceramic and chemically inert under typical conditions of a cementing or hydraulic fracturing operation. The dry chemical tags can be added with a variable speed screw feeder, aqueous tags with a metering volumetric pump.

- ▶ Cadmium based chemical compounds can be used where a second tag is required.

TRACERMAX
SCIENTIFIC, INC.

LOGGING OPTIONS

- ▶ The minimum of a single logging pass is required. This method provides N-N and N-G differences from prior nuclear reference data logs, if available. Reference data from any other nuclear measurement system can be made compatible using log normalization processing techniques. The concentration of tracer chemical can be increased in the injection profile of the fracturing or cementing operation to offset statistical error resulting from the use of data obtained from a differing down hole nuclear measurement system if a “lesser” logging tool is used. Lesser is defined as a tool that relies on smaller neutron population based on lower neutron source activity and energy or has less detector efficiency (increased K constant).
- ▶ More definitive information can be determined if an initial base line logging pass is conducted. This also allows for the preservation of original formation evaluation data prior to fracturing operations.

There are a few options available with respect the selection of logging tools depending on the quality of information required as follows:

- ▶ The use of a Roke “Quad Neutron” with 222 GBq. $^{241}\text{Am}/\text{Be}$ special form sealed source encapsulations coupled to a multi-spectral Gamma ray tool. (**Preferred**). This method shows both high resolution descending neutron and gamma count rates, as well as, capture gamma validation by energy discrimination across tagged intervals. This method will give both near and not near well bore dimension and provides N-N and N-G differences based on the initial base line reference data.

***TRACERMAX
SCIENTIFIC, INC.***

LOGGING OPTIONS ,cont'd

- ▶ The use of a single point logging tool (CNL) with a neutron source (minimum 111 GBq. $^{241}\text{Am}/\text{Be}$) coupled to a multispectral Gamma ray tool (**Basic**). This method shows descending neutron and gamma count rates, as well as, capture Gamma validation by energy discrimination across tagged intervals. The method will give basic information and only near well bore dimension. The concentration of tracer chemical can be increased in the injection profile of the fracturing operation to offset statistical error by increasing the probability of neutron capture based on the increased abundance of Boron atoms present in the field of investigation.
- ▶ The use of a Hotwell, Pulse N-N, Geophysical Accelerator. This method is recommended for logging fracturing operations that have had a selected interval tagged within a stage of the fracture fluid displacement. The chemical tracer is generally introduced as a slug or bolus into the selected interval when a stage of fracture fluid displacement is partitioned. The method will show not near well bore information given the high energy neutron population (14.1 MeV) generated from the accelerator and assuming that neutron travel through any medium is energy dependent.

***TRACERMAX
SCIENTIFIC, INC.***

QUALITY CONTROL

- ▶ The addition of Boron Carbide into the fracturing equipment process is introduced from the sand hopper directly into the blender or mixing components of fracturing or cementing equipment. This guarantees an optimum homogeneous mixture of the tracer compound into the tagged fluid displacements.
- ▶ The addition of Boron Carbide into cement blending equipment is done on a per batch basis at specified concentrations.
- ▶ The particle sizing of the chemical is matched to that of the fracturing fluids of each tagged stage or cement slurries; and with identical density to that of silica, the particles will travel with the same velocity as silica based proppants, through pumping equipment.
- ▶ Specific gravities can be adjusted to match sintered Bauxite or Alumina proppants.
- ▶ Tracer injection profiles are customized for each specific application by senior *Tracermex* scientists for quality control.
- ▶ Highly trained *Tracermex* field technicians are disciplined in all aspects of oilfield safety, product knowledge, technology application and injection methodology for quality and competency assurance at a field level.

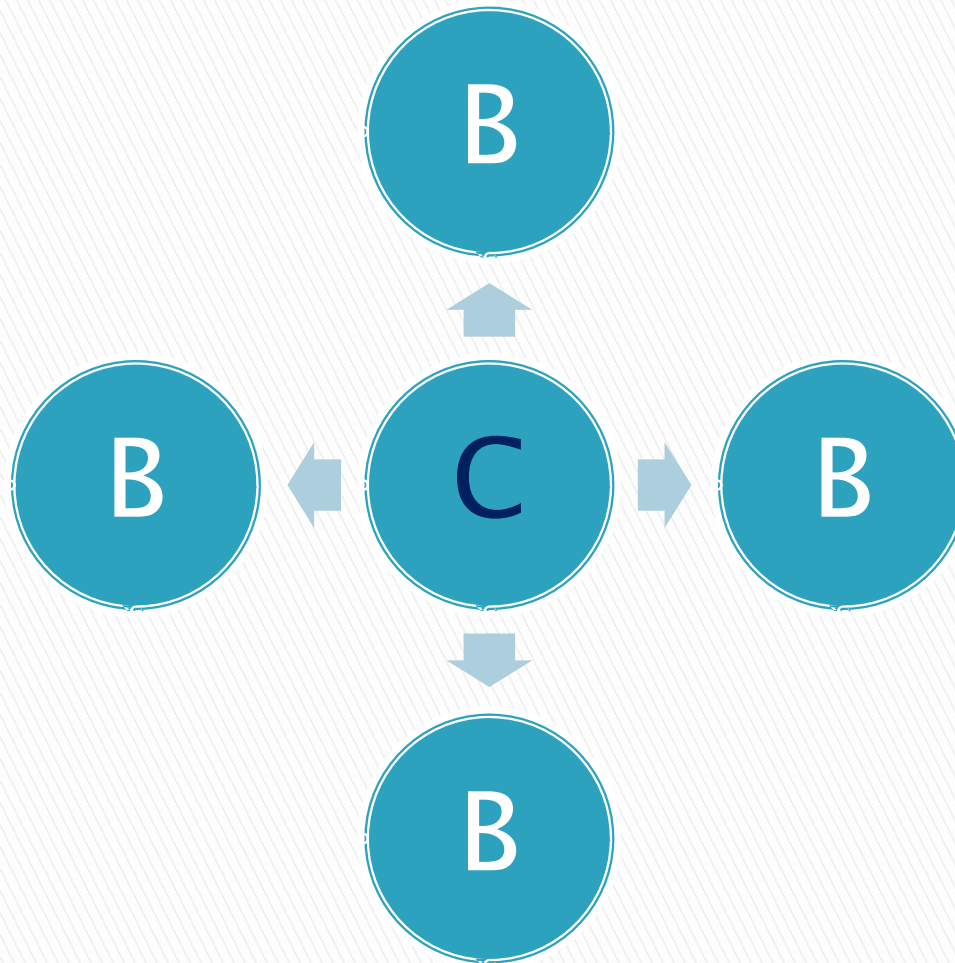
TRACERMAX
SCIENTIFIC, INC.

ADVANTAGES

Tracermax technology is very advantageous from the following perspectives:

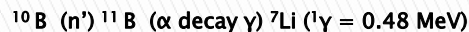
- ▶ The information obtained is by far superior to any former technology and can be used for 3 dimensional modeling with respect to fracture height and propagation.
- ▶ The use of the chemical tag material poses zero risk from an HSE perspective including the contamination and exposure of people, equipment and the environment.
- ▶ The use of Boron, Cadmium and their compounds do not require any special licensing in this application, apart from the radiation licensing required to use neutron sources for the well logging.
- ▶ There are no radioactive or chemically hazardous materials used in surface injection procedures or in recovered well flow back production or effluents.
- ▶ The use of the chemical additive will not screen out Naturally Occurring Radioactive Material (NORM). This information is corrupted by fracture tracing operations that involve the use of radioactive tracer chemicals.
- ▶ The use of the chemical additive will not screen out the post movement of tagged fracture fluids.

***TRACERMAX
SCIENTIFIC, INC.***

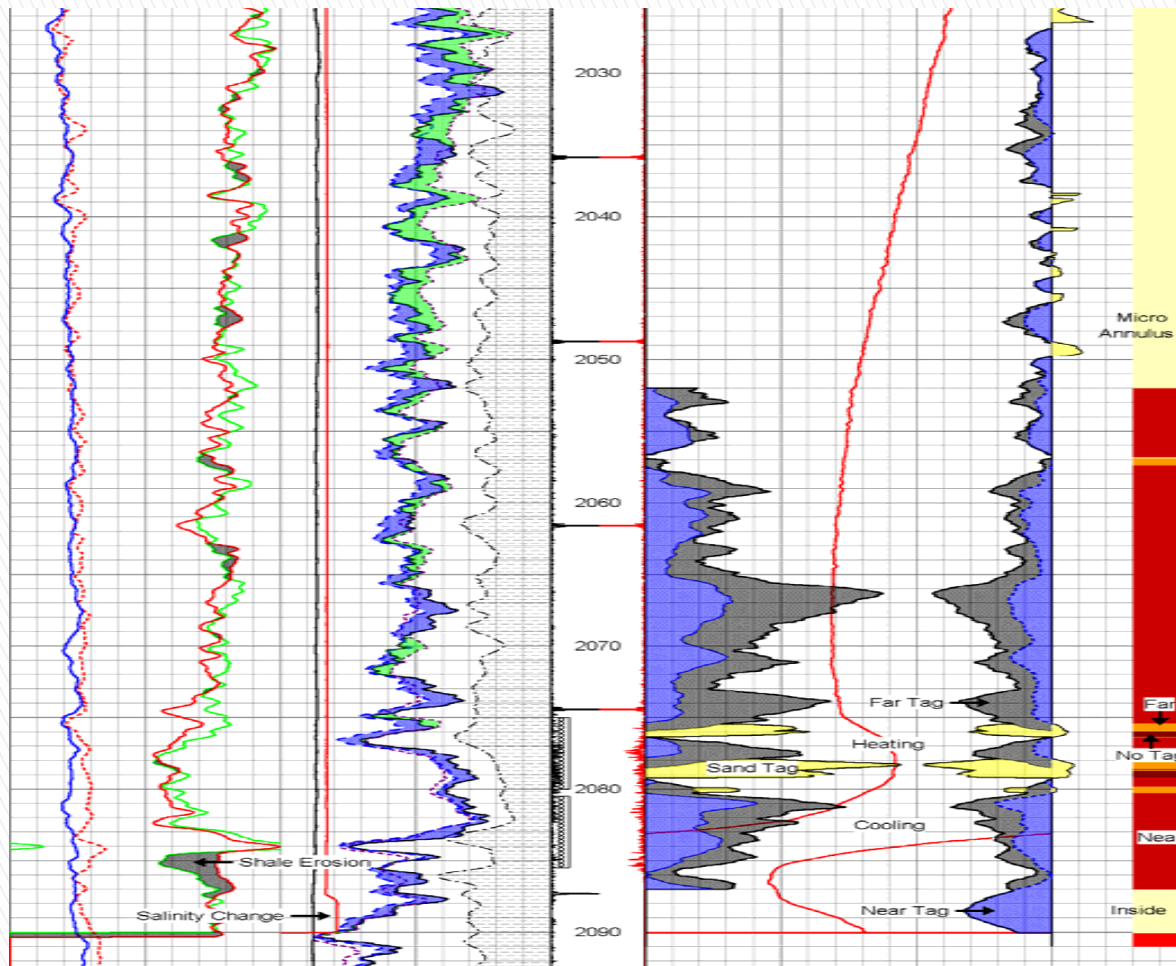


Boron Carbide

Boron Carbide (B₄C) is a ceramic compound, that has a 75% abundance of Boron by weight and the same density as Silica. It is chemically inert under typical conditions in a hydraulic fracturing operation. Boron is a neutron absorber. Boron nuclides capture thermalized neutrons that have a maximum energy of 0.025 eV. Boron transmutes into Lithium under alpha decay. The absorption of a neutron by a Boron nuclide with subsequent radiation emissions is a one time nuclear event. The Lithium transmutation byproducts also pose zero risk from an HSE perspective. The nuclear reaction is shown in the empirical formula as follows:



The capture gamma of Boron is the same as the principle gamma photon energy of Iridium-192, the most commonly used radioisotope used for radioactive frac tracing. The main difference is that the capture gamma emitted by Boron is a one time nuclear event and Iridium-192 has a half life of 74 days meaning it emits the 0.48 MeV gamma energy for 740 days or 10 half lives.



Sample well log from a triple stage fracturing operation

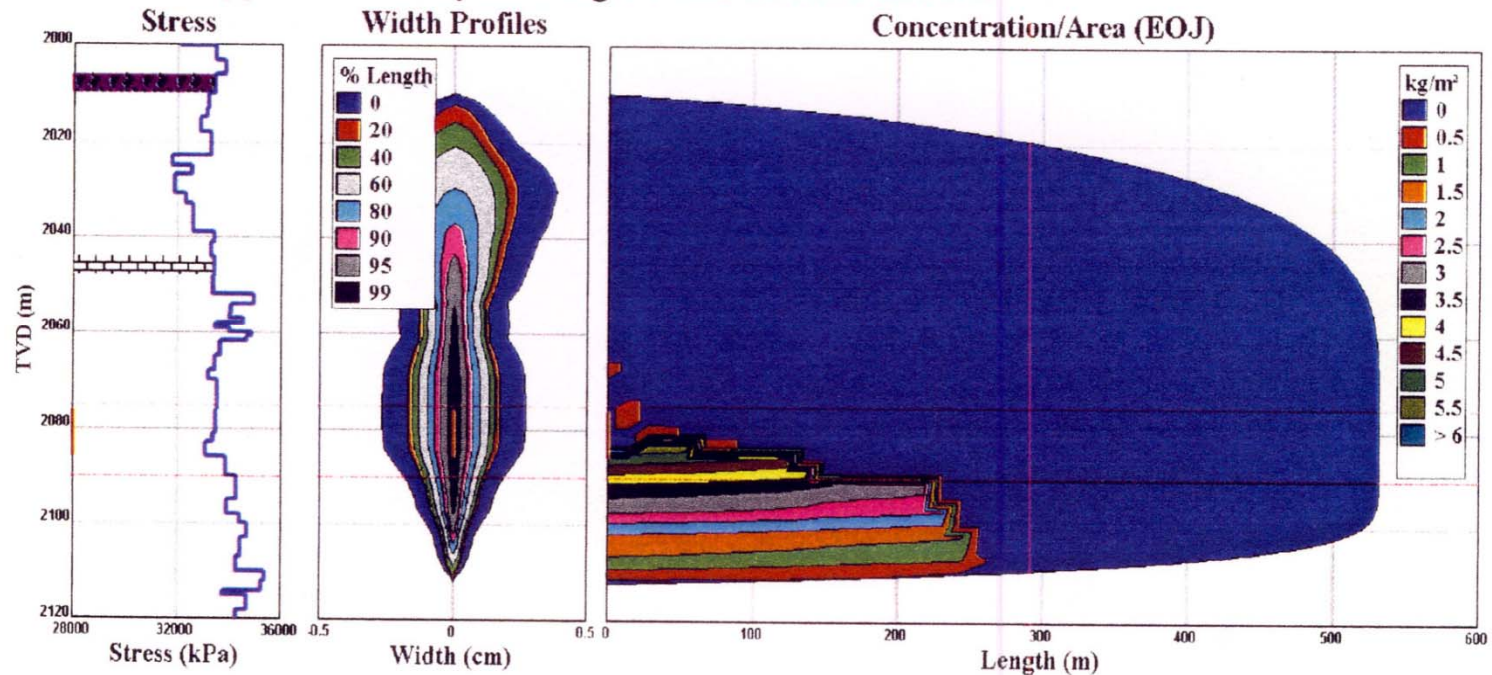
**TRACERMAX
SCIENTIFIC, INC.**

Field Test Fracture Analysis Log

- ▶ **Gamma Effect** – Measured reduction in Neutron Gamma counts per second between Pre-Frac and Post-Frac.
- ▶ **Neutron Effect** – Two times the measured reduction in Neutron Neutron counts per second between Pre-Frac and Post-Frac. Two times multiplier used to compensate for differences in total count rates between neutron neutron and neutron gamma.
- ▶ **No Tag Effect** – Four times the increase in Neutron Gamma and Neutron Neutron counts per second between Pre-Frac and Post-Frac. Four times multiplier used to exemplify effect on presentation.
- ▶ **GR Increase** – Increase in natural gamma ray counts per second between Pre-Frac and Post-Frac.
- ▶ Increased natural gamma ray response from deposition of fracture operation erosion of the higher natural gamma formation immediately above.

***TRACERMAX
SCIENTIFIC, INC.***

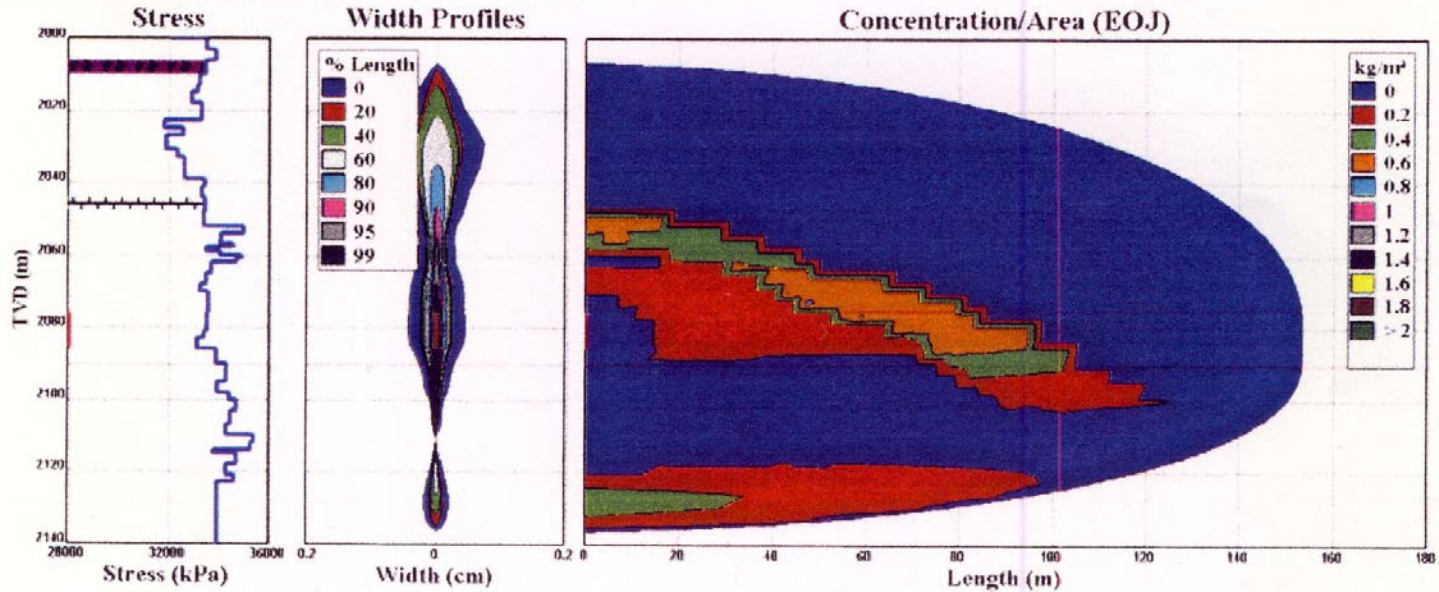
Predicted Proppant Geometry for Single Plane fracture Growth



The use of *Tracermx* technology to profile hydraulic fracturing operations provides superior information. The technology is a major break through with respect to proving theoretical calculations in the field of Rock Mechanics. The calculations used to develop the modeling shown above are in agreement with the well log shown in the previous frame.

TRACERMAX
SCIENTIFIC, INC.

Predicted proppant profile



Tracermax injection profiles are custom designed for each tagging application. By partitioning segments of stages within a multistage fracturing operation and injecting the tracer compound as a slug or bolus, it is possible to determine the fracture height of the selected interval using comparison calculations for log data against volumetric displacement values.

***TRACERMAX
SCIENTIFIC, INC.***

CEMENT TAGGING

- ▶ The use of *Tracermax* technology to tag alternate stages of a cement slurry displacement and the patented “S” stitch signature shown on log data can be used to definitively prove the presence of light weight cement (<1500 kg/cubic meter) behind well casing. The addition of Boron Carbide will not interfere with the cross linking of the Calcium Silicate matrix in the slurry and not adversely affect the compressive or tensile strengths. The optimum concentration for the detection of Boron Carbide into any fluid displacement is 350 mg / cubic centimeter or 35 g / cubic meter. It is recommended to log formation evaluation data prior to cement treatment to preserve original information. This technology is beneficial where sensitive ecology systems exist, such as offshore locations that can be adversely affected by the dispersal of hydrocarbon based fluids. A high level of confidence is required to insure that well bore integrity insofar as containment of hydrocarbon based fluids is maintained and where the presence of cement behind casing is required.
- ▶ Cement squeezes for remedial intervention are tagged on a per batch basis. The addition of the tracer compound at predetermined concentrations is blended in mixing equipment.



***TRACERMAX
SCIENTIFIC, INC.***