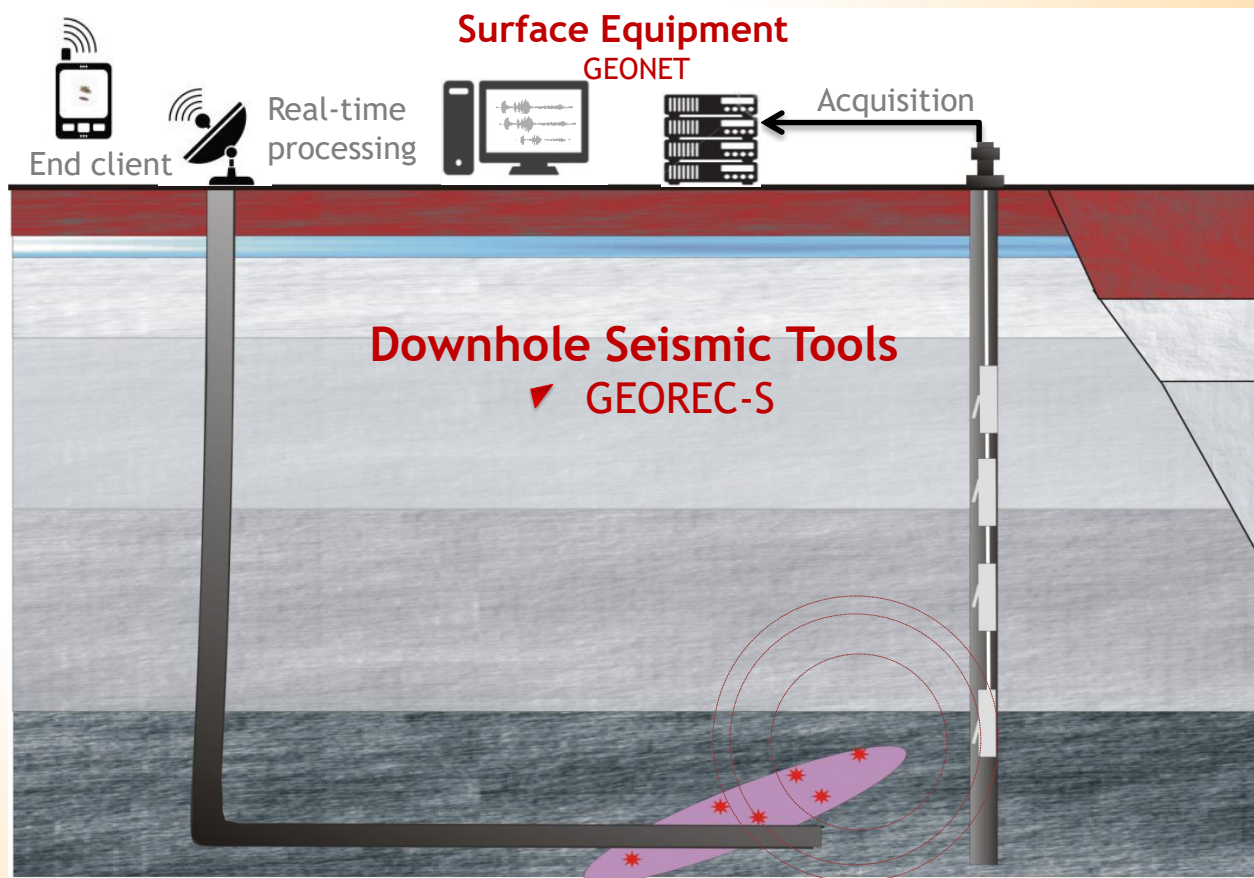


Why mapping fractures?

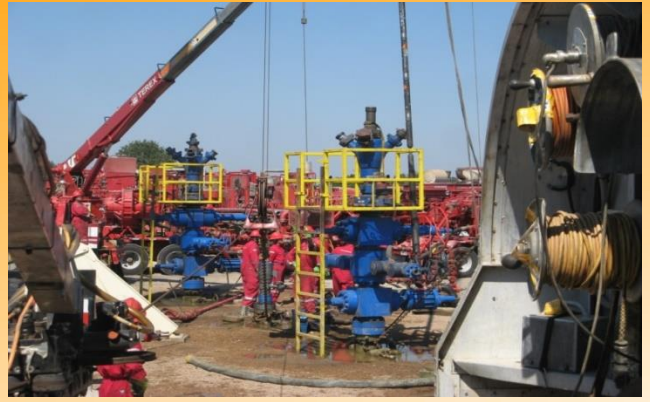
- ▼ In new oil or gas field :
 - ▼ Better positioning of deviated wells
 - ▼ Optimize well spacing by better knowledge of fractures distributions in the reservoir
 - ▼ Optimized completion design
- ▼ In existing oil or gas field :
 - ▼ Better knowledge of the downhole pressure
 - ▼ Managing the risk of unsuitable fractures extension

Why real-time Microseismic Monitoring?

- ▼ The location, size and timing of induced microseismic events provides an image of the evolution of the fracture network
- ▼ Informs on the effectiveness and productivity of the stimulation:
 - ▼ Estimate of stimulated reservoir volume
 - ▼ Correlation between injection and stimulation
- ▼ Prevent Potential Risks
 - ▼ Overlapping and interaction between stages or neighbouring wells
 - ▼ Interaction with pre-existing fractures and faults
 - ▼ Potential uncontrolled extension out of target formation (e.g. aquifers, non hydrocarbon-bearing formations..)



To improve Oil & Gas production, it's common for operating companies to stimulate the wells by hydraulically fracturing the reservoirs. Nowadays this technique is widely applied to the production of shale gas, as natural gas has remained trapped in the impermeable source rock. It has also become a standard practice in the exploitation of unconventional reservoirs such as Enhanced Oil Recovery in mature reservoirs, tight-gas sands, coalbed methane, heavy oil and tar sands, and gas-hydrate deposits, or the exploitation of Engineered Geothermal Systems.

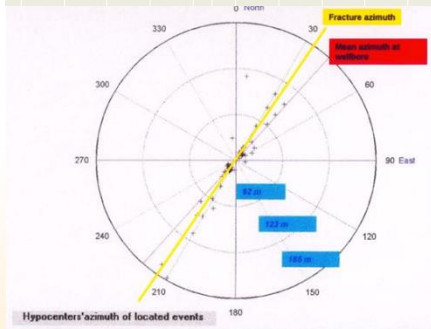
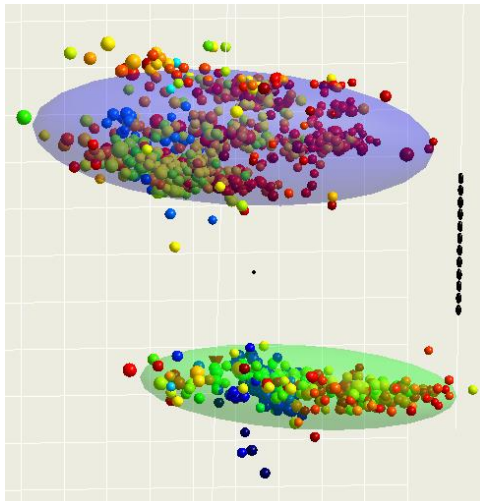


To optimize well spacing, better design fracture treatment and to evaluate fracture development, while managing the risk of unsuitable extension, it's more and more frequent to map the stimulated fracture by using the associated induced microseismic activity. Vinci Technologies is positioned in this niche segment with its fracture mapping system. Specially, in the scope of deep fracture mapping, the tools have been designed for deep downhole use, making the recording of low magnitude events feasible. The tool can be operated in an observation well and/or in the treated well (until propping agent is injected). The association of data from treatment and observation wells allows answering to different monitoring configurations.

The Vinci's fracture mapping system may provide:

- In "real-time", an accurate fracture mapping, due to the positioning of the tool in the treatment well (during a minifrac job) i.e. very close from the source; or in the observation well (during a main fracture job).
- Estimation of fracture azimuth and extension.
- Better decision of positioning of wells, in particular for horizontal ones.

Vinci Technologies is involved in the microseismic monitoring of hydraulic fracture well since the 90's and has benefited from the long term IFPEN expertise in that domain.



Geonet Fracture Monitoring System

Vinci's fracture monitoring system brings together the latest development in the downhole tools a surface acquisition system "GEONET" which includes:

- The power supplies, the telemetry interface interconnection boxes (GPS in option)
- The acquisition software for the system and tools control, the QC software and the Process software.

Vinci's fracture monitoring system GEOFRAC can be used in multiple configurations:

- as a single level downhole tool in the treatment well
- in the observation well, by using a multi-level downhole tool.
- It can be used in open or cased holes.
- It has a small diameter design, 2", to be operated through the well completion. The tool can be located at the reservoir level, i.e. below the Packer.
- The sensors used are accelerometers (high bandwidth).
- Transmission is operated by using a mono, bi or hepta conductor cable when operated with BOP at highly pressurized wells. High sampling rate (0.2ms) can be selected for higher accuracy.

Vinci's downhole fracture monitoring tool is the only system that includes in a unique level the sensors, the anchoring arm, the power supply and the telemetry.

Vinci's downhole fracture monitoring tool works at up to 180°C continuously without any cooling system and at up to 150MPa.

System Principle

The Georec-S tool is fitted with triaxial accelerometers, and pressure and temperature gauges. The tool is attached to a standard mono or bi or seven conductors logging cable and lowered down into the well to be fractured or into an observation well. The tool is connected to a real time surface recording system.

The occurrence of seismic events during falloffs is due to rearrangement of fractured rock faces following depletion in association with stress redistribution. During falloffs following hydraulic fracturing, the GEOFRAC tool records, via the accelerometers, the seismic activity associated with the closure of the fracture. Thereby the orientation and half length of the fracture are determined by interpretation of the induced microseismic events.

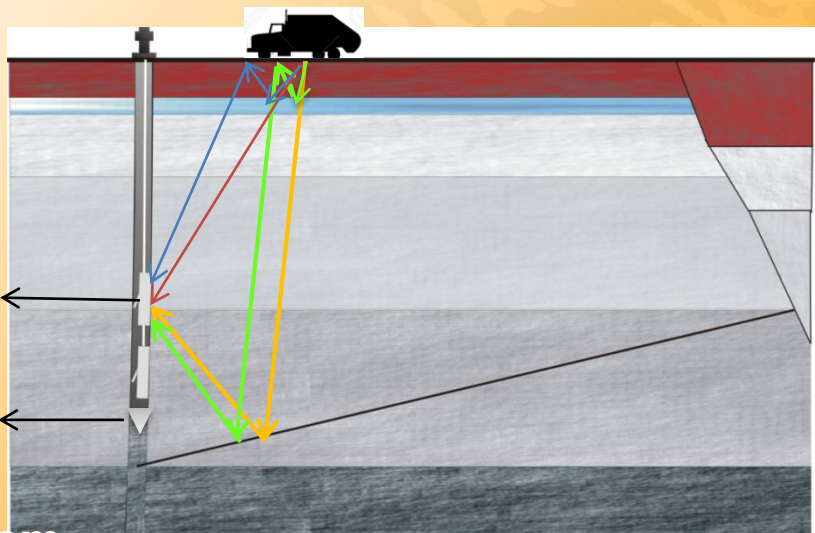
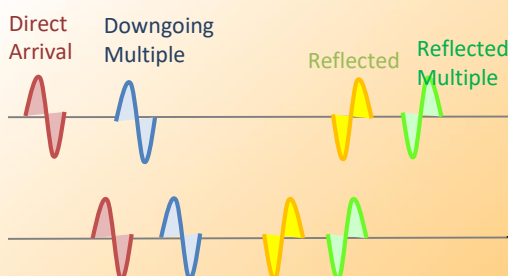


The use of Accelerometers and/or Geophones as sensors provide a versatile and complete seismic and microseismic monitoring:

- ✓ Accurate and linear measurements of the ground motion over a large bandwidth (0-1000Hz).
- ✓ Avoid 'Magnitude Saturation', providing realistic energy measurements for full spectrum of microseismic events. This is crucial for risk assessment and 'traffic light' systems.

Active Seismic Survey Imaging

- ✓ Vinci Technologies' Tools can be used in in passive microseismic monitoring of induced fractures or in active surveys for imaging of in-situ structures before treatment or during well drilling;
- ✓ VSP is the main link between time-based surface seismic imaging and depth/based well logs. It provides a high-resolution image of the structure in the vicinity of the instrumented well;
- ✓ Downhole receivers allow recording in lower noise conditions as well as recording direct arrivals, recording higher frequencies (->higher resolution) than surface tools;
- ✓ Temporal spacing between direct and reflected arrivals and their multiples allow outlining the position of reflectors such as formation horizons or in-situ fractures.
- ✓ Triaxial tools allow the use of source vectors and polarisation for the phase identification and determining the direction of propagation of the phase.



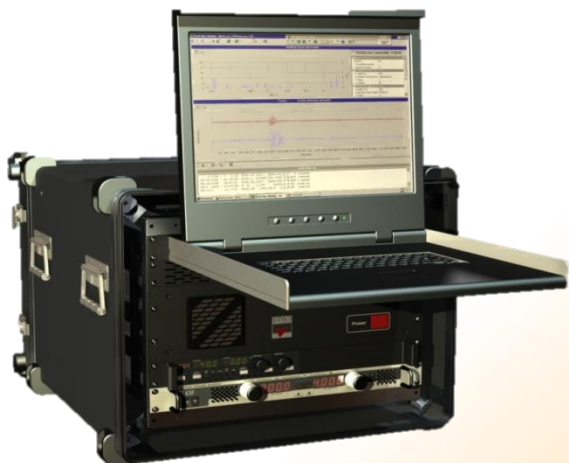
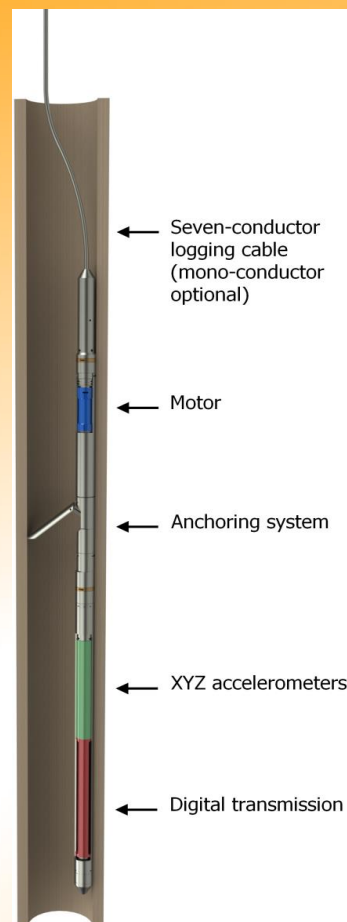
System Description

Mechanics

Maximum temperature	180 °C continuously (356 °F)
Maximum pressure	1,500 bar (21,500 psi)
Maximum number of levels	48
Diameter	50 mm (2")
Total tool length	1,450 mm (57")
Compatible casing diameter	3" to 13"
Locking force ratio range	5:1 to 20:1
Maximum cable length	6,000 m
Distance between levels	5 m to 50 m

Electronics

Cable equalization	Fully automatic
Sampling rates	0.25, 0.5, 1, 2 ms
Input noise	0.1µV rms
Gain settings	24, 36, 48dB
Dynamic range	120 dB
Digitalization	24 bits



Vinci Technologies' services for the Energy industry

- High P-T Downhole Seismic and Microseismic Monitoring Tools
- Broadband Monitoring
- Real-Time fracturing monitoring
- Monitoring array design
- Data QC and analysis
- Staff training and capacitation