



Oil & Gas Monitoring with DAS

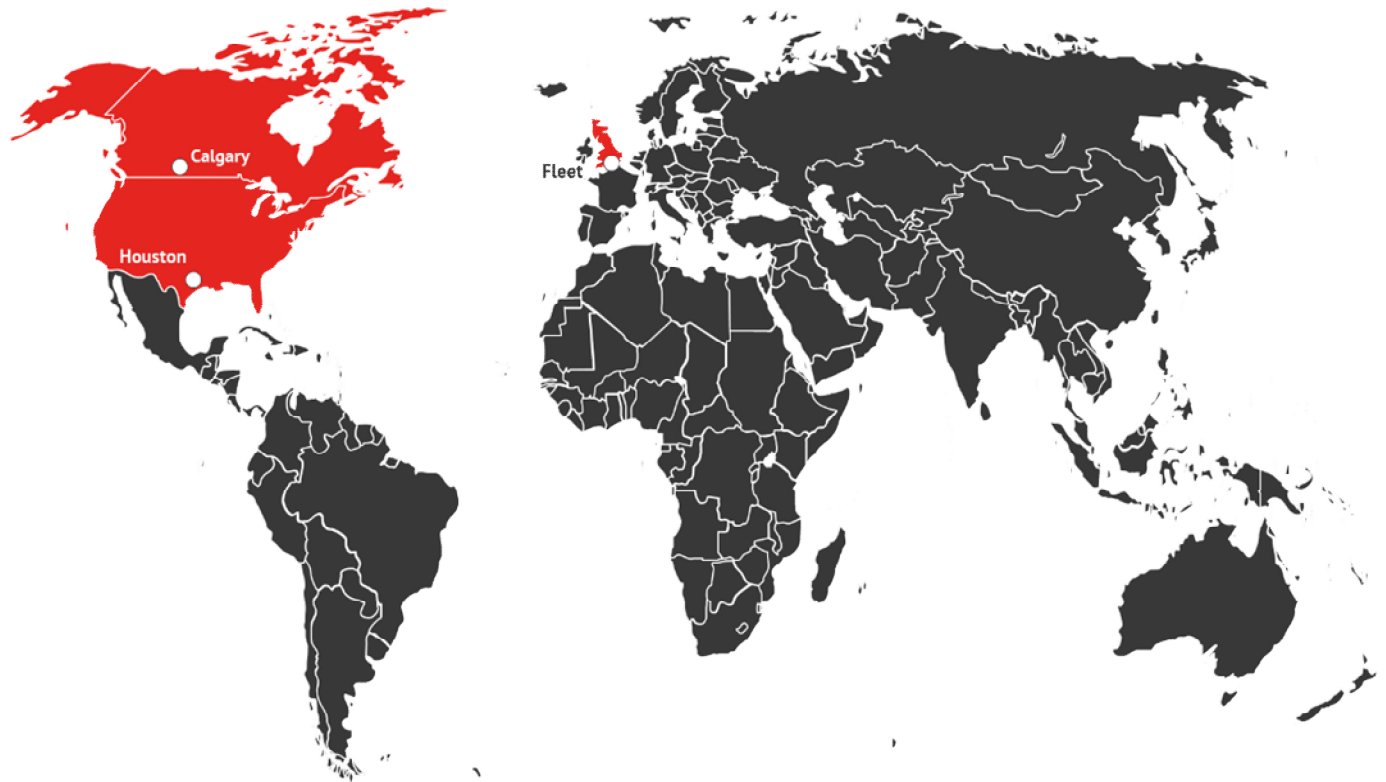
**How Distributed Fibre Optic Sensor
technology optimises Well Interventions and
produces a more economical Abandonment
strategy**

**Fotech Group
Ltd**

Delivering
**Distributed
Acoustic
Sensing**
Solutions to the
Energy Markets



energy
ventures



**Fotech Group
Ltd**

**Helios®
Technology**
Distributed
Acoustic Sensing

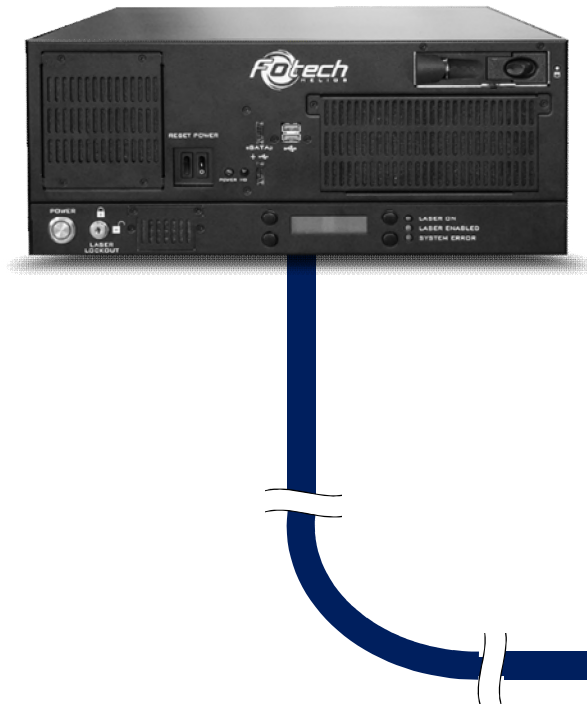
Introducing Helios® DAS

Converting 40km of optical fibre into highly-sensitive vibrational sensors.



How it works

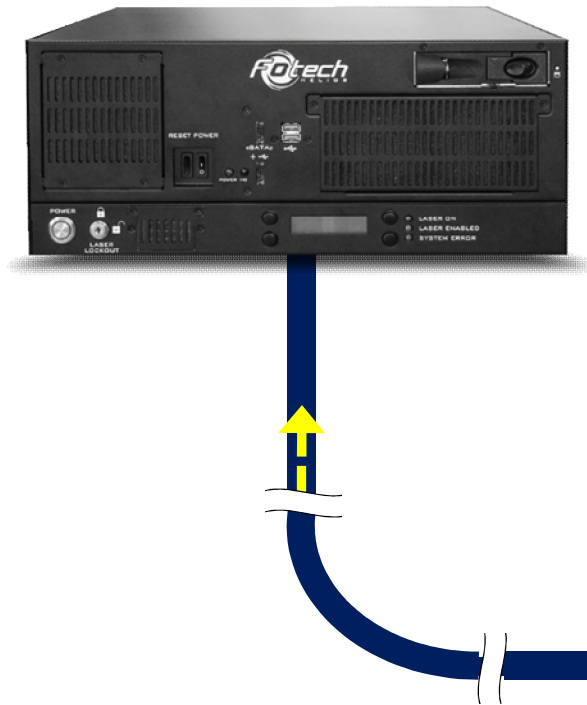
Distributed Acoustic Sensor (DAS)



The Fibre is the Sensor

How it works

Distributed Acoustic Sensor (DAS)

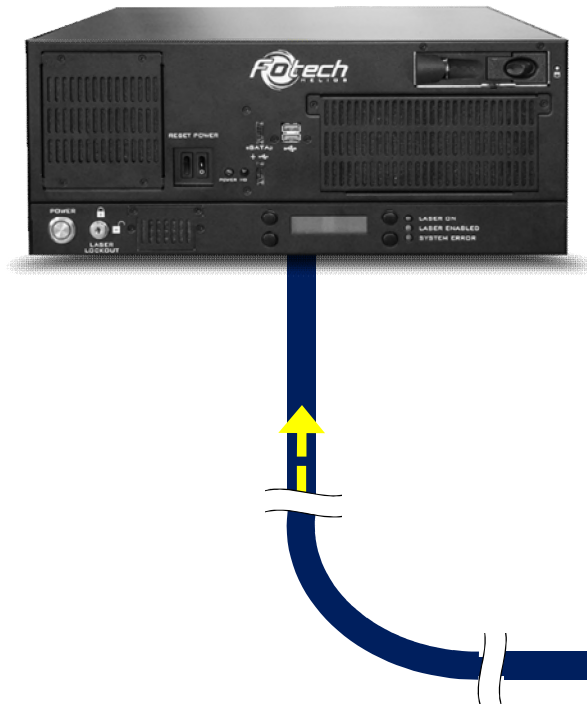


Using standard Single optical fibre:

Pulses of light are **sent**,
Backscattered light is **received**.

How it works

Distributed Acoustic Sensor (DAS)



The backscatter is interrogated for:

Changes in characteristics
Caused by acoustic energy
Confirmed at least 2,500 times per second.

Distributed Acoustic Sensing

Helios® DAS Interrogator

Core system comprises of:

- An interrogator unit
- Connected to single mode fibre optic cable

Providing continuous detection & location of events:

- Resolution is up to 1 metre
- 40km of fibre becomes 40,000 sensors
- Frequency content <5Hz to 20kHz

Frequently run in combination with:

- DTS (Distributed Temperature Sensing)
- Downhole gauges.

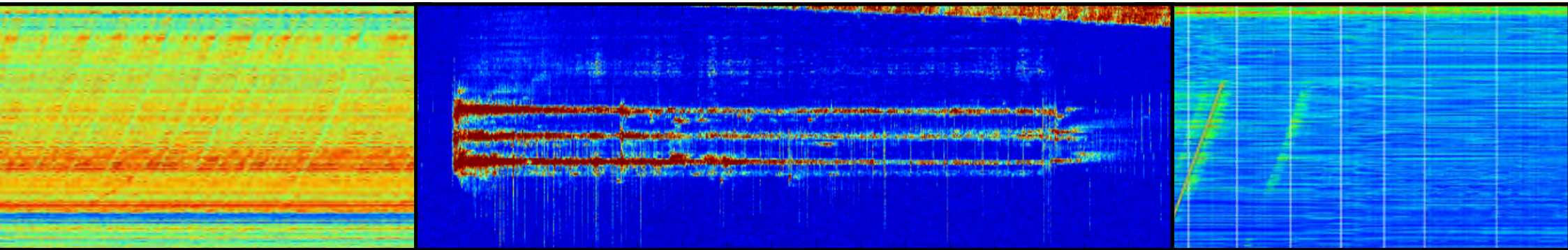


Offers Multi-Industry Application



DAS Applications

All events with an acoustic signature



- Fracture Completion Monitoring
- Vertical Seismic Profile - Borehole
- Production/Injection Profiling
- Enhanced Oil Recovery (EOR)
- Sand Detection
- **Well Integrity**
- **Well Abandonment**
- Gas Lift Mandrels
- Electric Submersible Pumps
- Smart Completions

Fibre deployments

Choice of methods

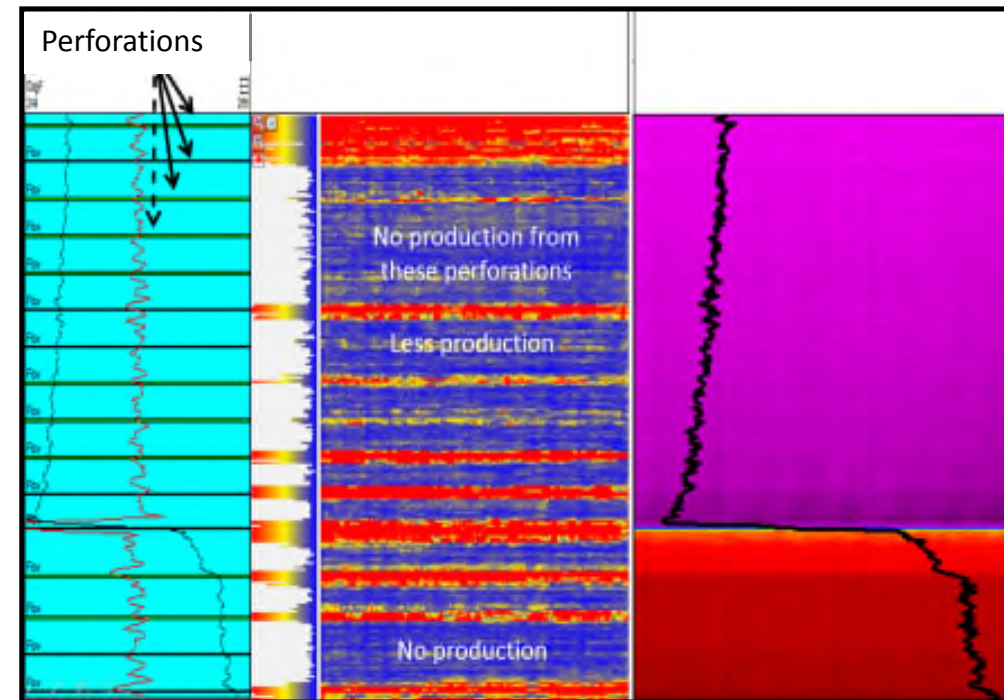


- **Permanent Installation** - For the life of a well.
- **Coiled Tubing** - Deploys in horizontal wells, protects the fibre.
- **Carbon Rod** - Deploys in horizontal wells, with minimum impact to flow regime.
- **Slickline** - Lowest cost and simplest for pressure control.
- **Wireline** - Allows Wireline tools to be run in real time too.

Control water-cut and enhance production

Enhance production by controlling water ingress

- Fibre deployed with carbon rod.
- Well shut in for minimal time to allow access.
- Production re-established while the rod was injected into the well.
- After an initial short period of data acquisition, the injection rate was doubled in the supporting well



Courtesy of Ziebel

Control water-cut and enhance production

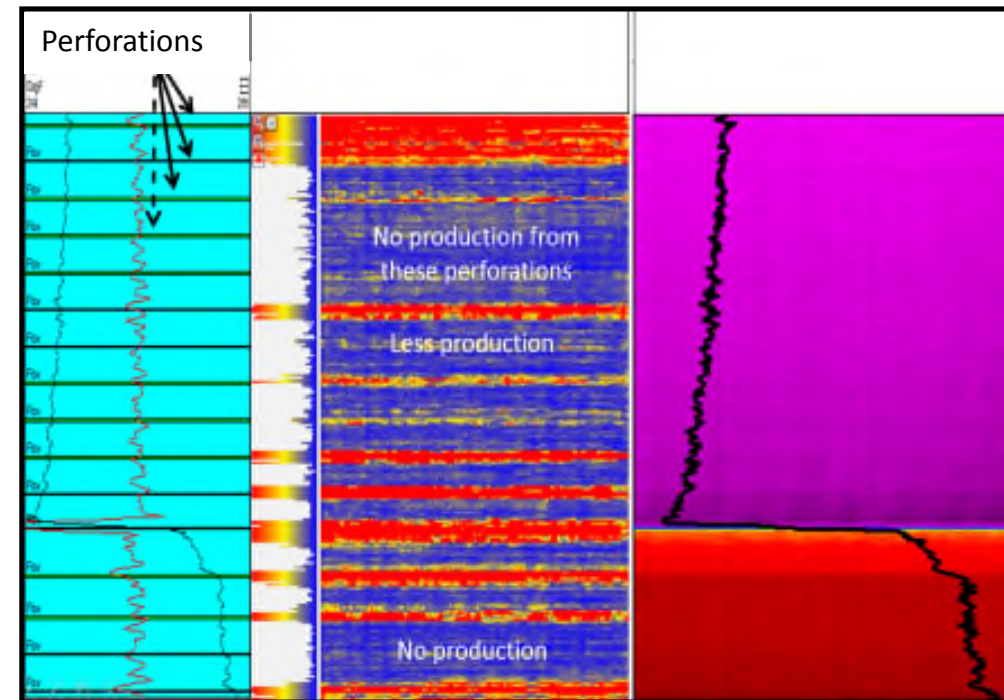
Enhance production by controlling water ingress

DTS identified the zone of water production and provided valuable information about the temporal connection between the wells.

DAS data provided further information about production and clearly contributing perforations.

Results

- Water producing zone identified
- Deferred production only 3 hours
- Contributing perf. zones identified



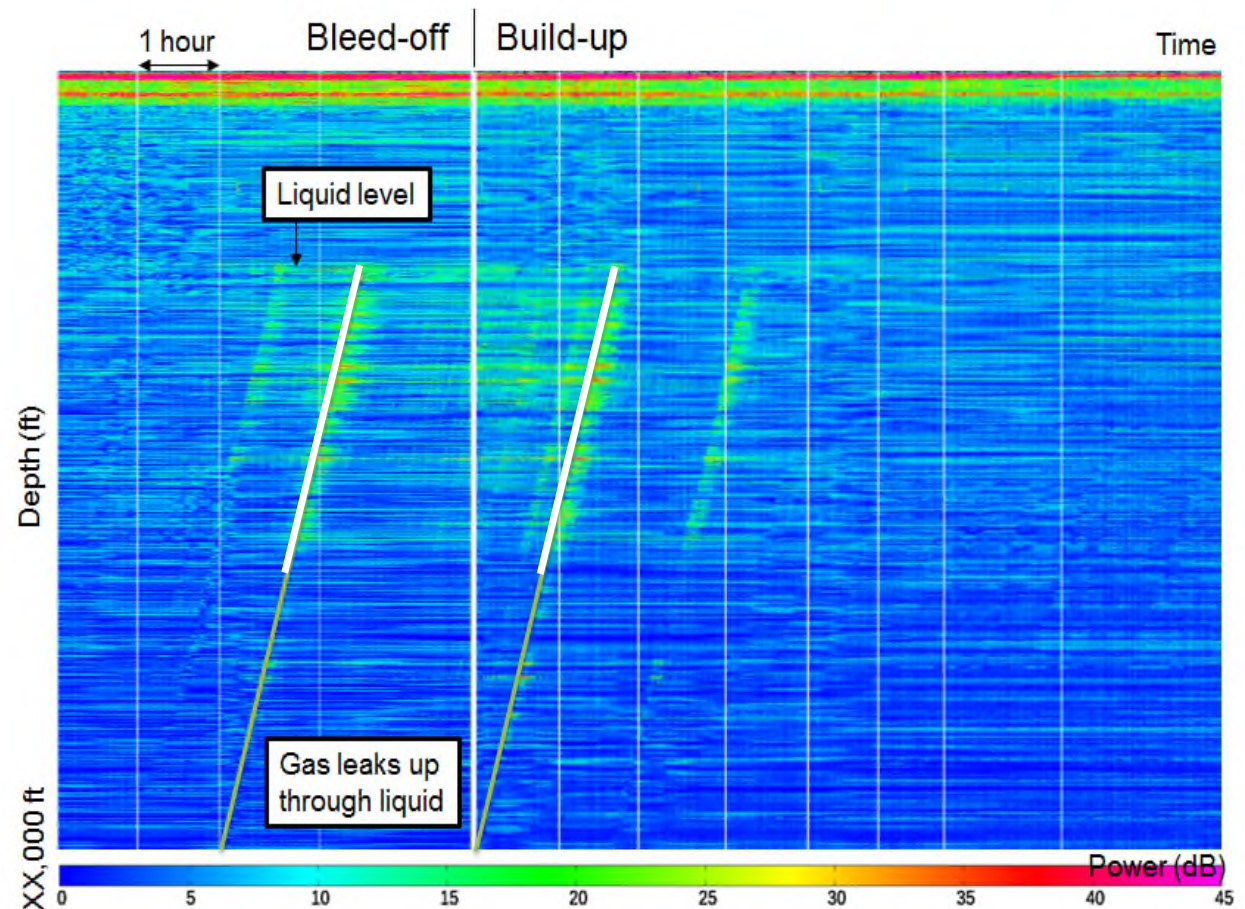
Courtesy of Ziebel



Dynamic Event Tracking

Bubbles rising in a liquid column

- Fibre deployed with carbon rod.
- Continuous sensing along entire wellbore.



Courtesy of Ziebel

Well Integrity & Abandonment

Intervention with Wireline tools

Vertical Wells

Fibre-enabled **Slickline**

- Memory logging tools

Fibre-enabled **Wireline**

- Surface Read Out logging tools

Horizontal Wells

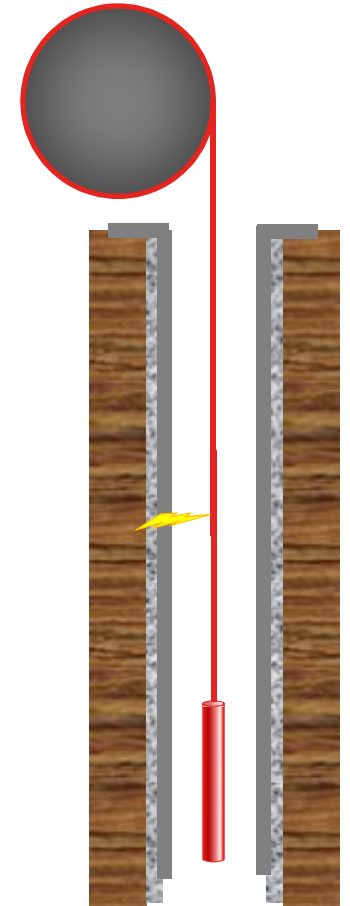
Tractor with fibre-enabled **Slickline** or **Wireline**

Fibre-enabled **Carbon Rod**

Fibre-enabled **Coiled Tubing**

Economics:

Checking Well Integrity with fibre deployment, prior to arrival of rig for P&A, provides opportunity to address all the identified problems with minimal rig time, and therefore saves dollars.

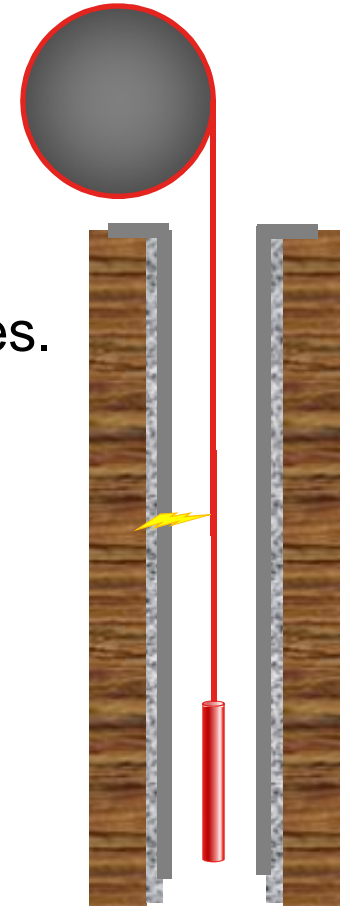


Well Integrity & Abandonment

The Advantages of fibre with logging tools

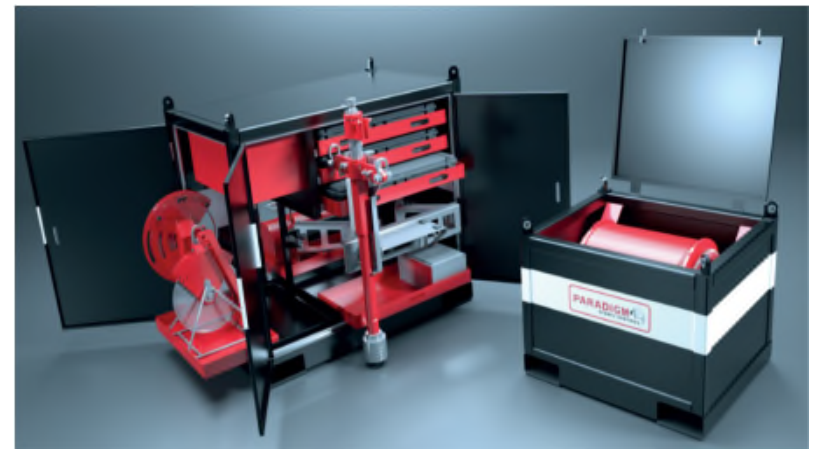
- Identify “Periodic” leaks that Wireline tools alone may miss.
- Identify ALL issues in the well at one time.
- Save time, by directing Wireline tools directly to interesting zones.
- Monitor changes in the well over time.
 - Draw down
 - Shut in
 - Choke changes

Experiment with well pressures to stimulate a leak that generates an audible noise.



Drum Packages

- Allows customer to utilize slickline equipment currently on contract.
- Advantage of using competitively bid slickline spread and crews.
- Peace of mind utilizing existing crews familiar with customer's systems.
- Retrofit to a third party unit:
 - SFL Wire drum
 - Panel
 - Sheaves
 - Logging Cabin (Optional)



Courtesy of Paradigm Geokey

Cost & Time Efficiencies

Acoustic Survey

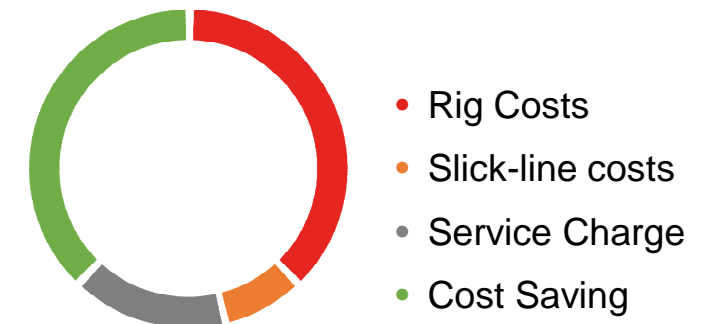
This comparison is for an acoustic survey in a 10,000ft well.

- Assume conventional service is a station every 10ft with a 45s 'listening' period.
- Therefore total time for the Conventional log is 22.3 hrs and the SFL is 10.3 hrs.
- The cost savings come through Rig Time and Slick-Line time savings.

Conventional Slick-Line



Slick Fibre-Line

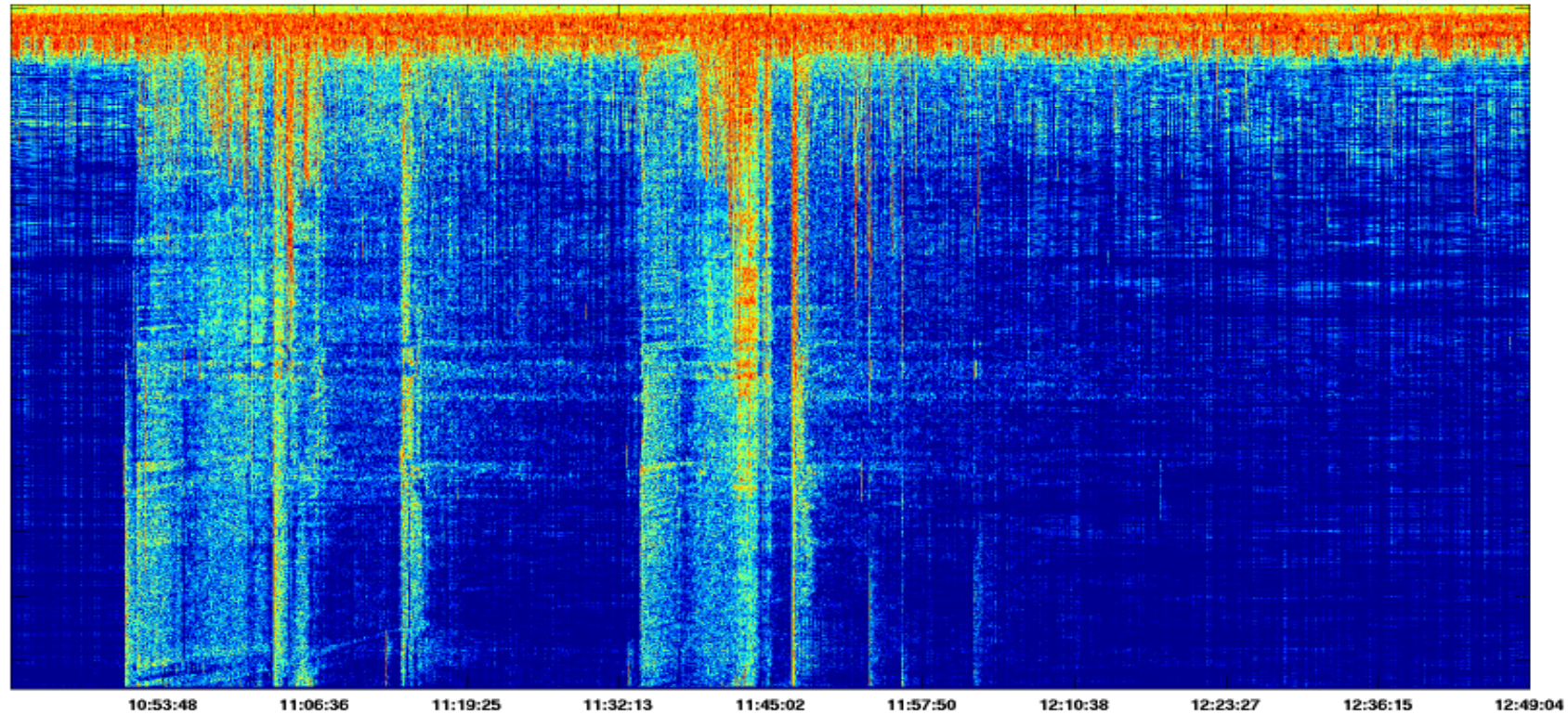
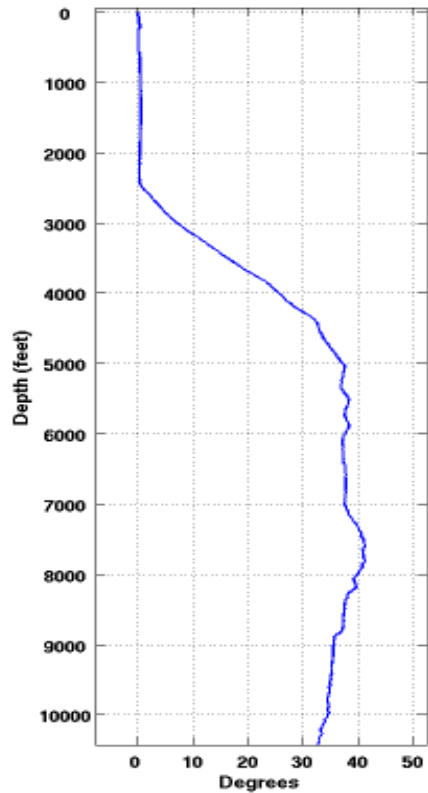
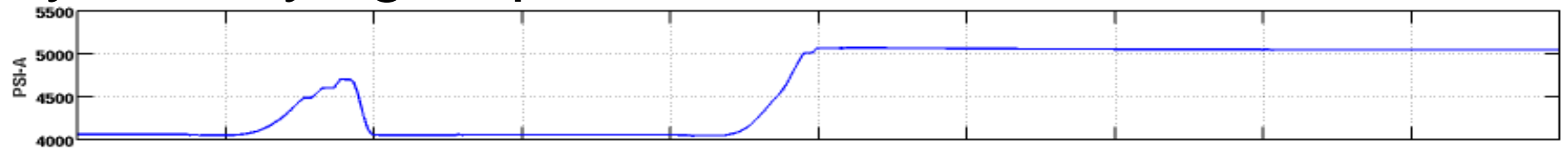


Example of Well Abandonment

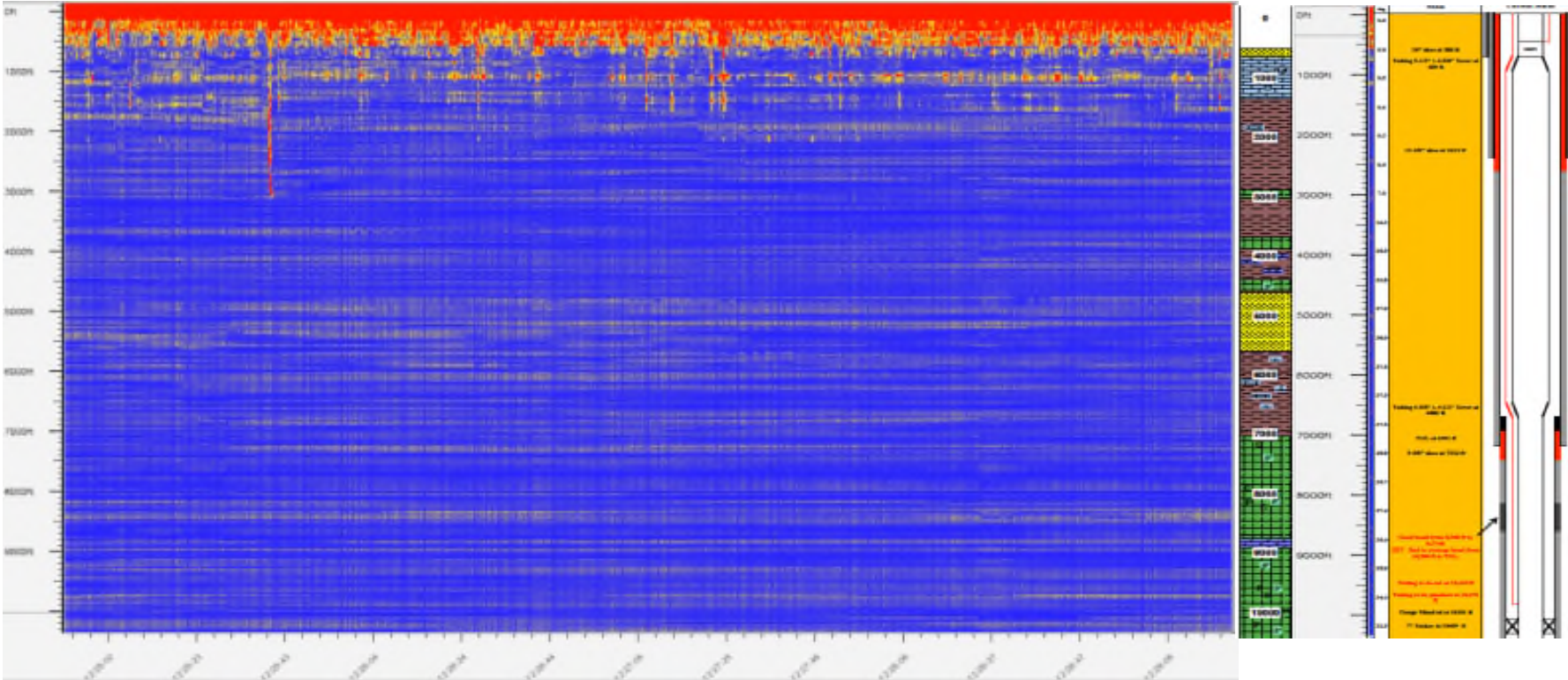
Objectives

1. Confirm hydraulic isolation of annulus
2. Confirm if there is evidence of hydraulic seals in two formations such that no fluid movement is seen to travel past the shales intended to provide a natural barrier.

Energy Display Identifying Depth Locations



Quiet Period



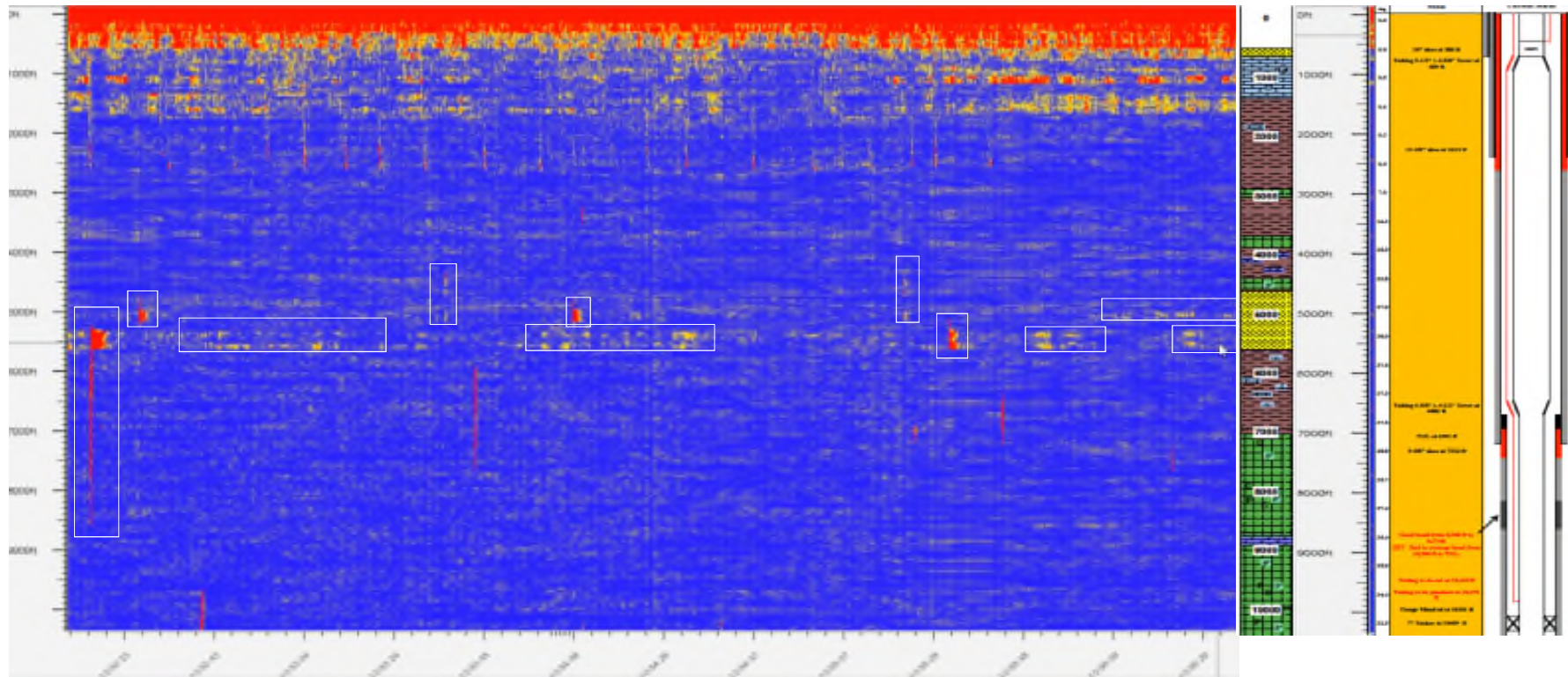
Courtesy of Paradigm

Cookov



Well Abandonment Example 1

Induced Fluid Movement in B Annulus



Courtesy of Paradigm

Geeky



Cost & Time Efficiencies

P&A Potential

Acoustic and Thermal investigation of P&A Wells through tubing leading to:

- Rig cost savings through the ability to perform surveys in advance and offline.
- Preparation of a clear plan to resolve each problem.
- Savings of inefficiencies caused by unplanned deviations from an abandonment plan.
- The ability to evaluate whether a rig is required for P&A on satellites, or if a smaller intervention will suffice.



Save Pulling Tubing?

Regularly contaminated with LSA*

If the annular seals can be evaluated without the need to pull the tubing then this could save:

- CBL run
- Cutter run
- Cost and time to pull tubing
- Shipment & disposal of tubing

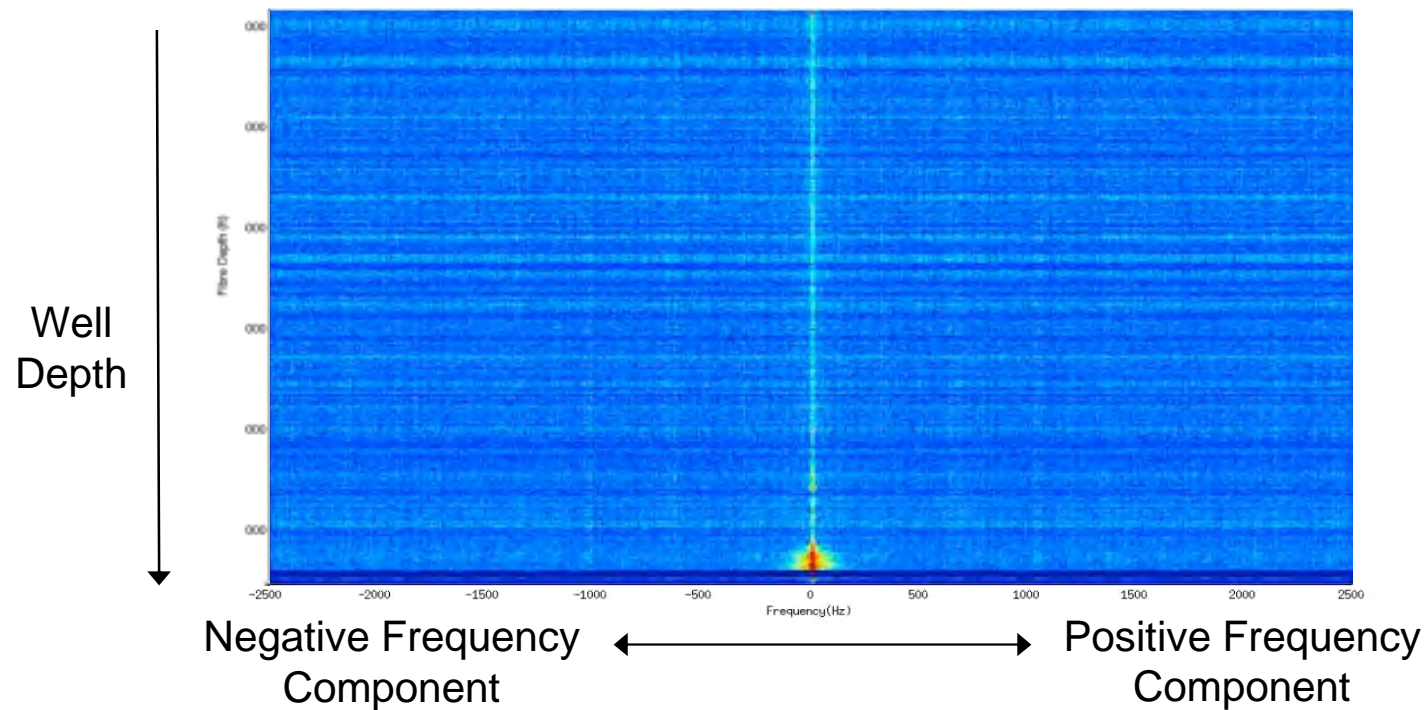


**LSA: Low-specific-activity scale.*

Well Abandonment Example 2

Casing Vent Leak: 'Gas Slugs'

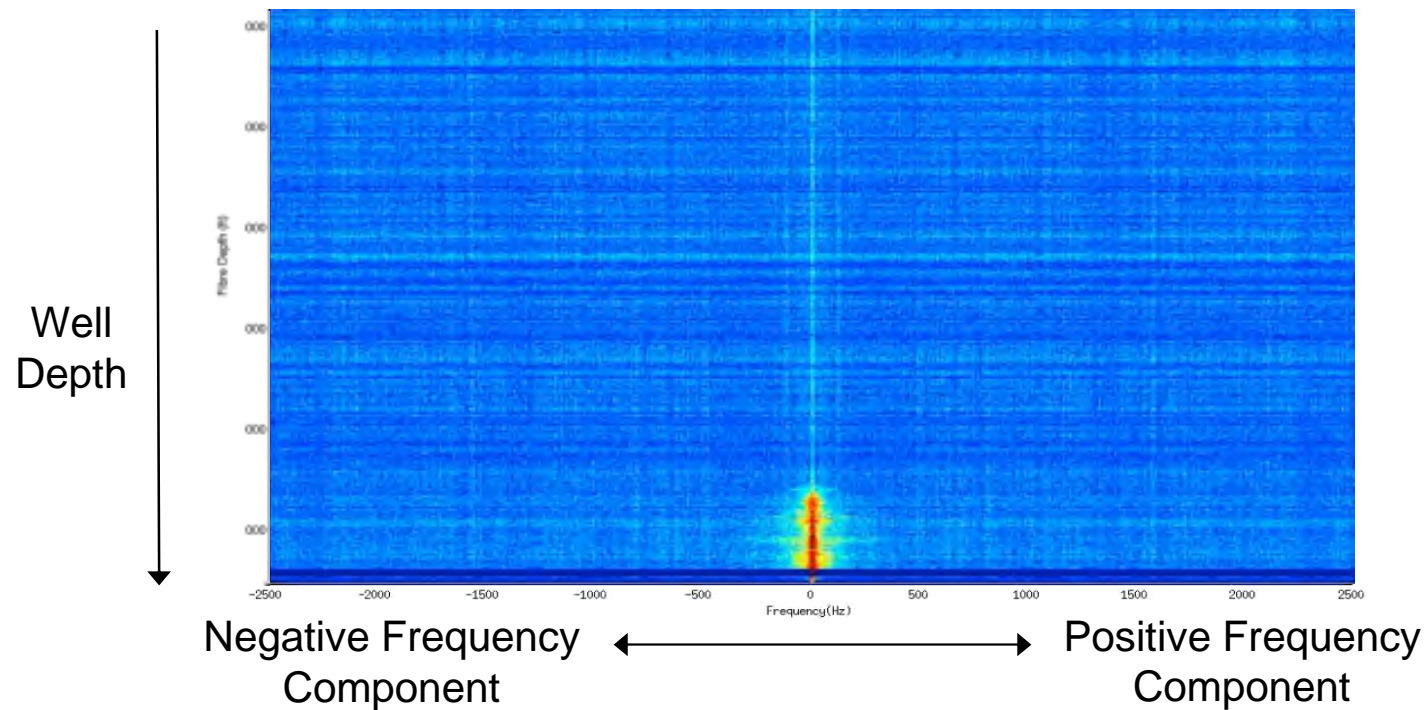
Small slug of gas entering annulus at breach location



Well Abandonment Example 2

Casing Vent Leak: 'Gas Slugs'

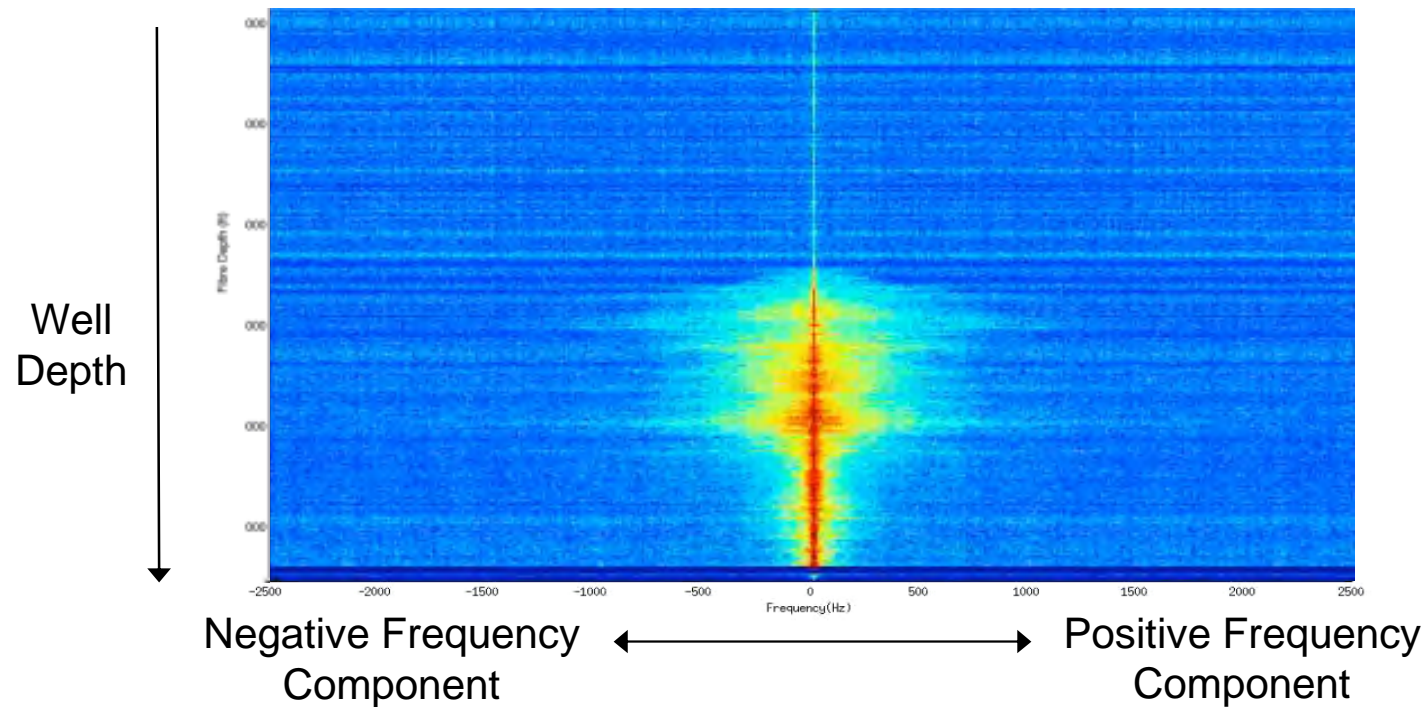
Seconds Later: Slug of gas increasing in volume and starting to 'lift'



Well Abandonment Example 2

Casing Vent Leak: 'Gas Slugs'

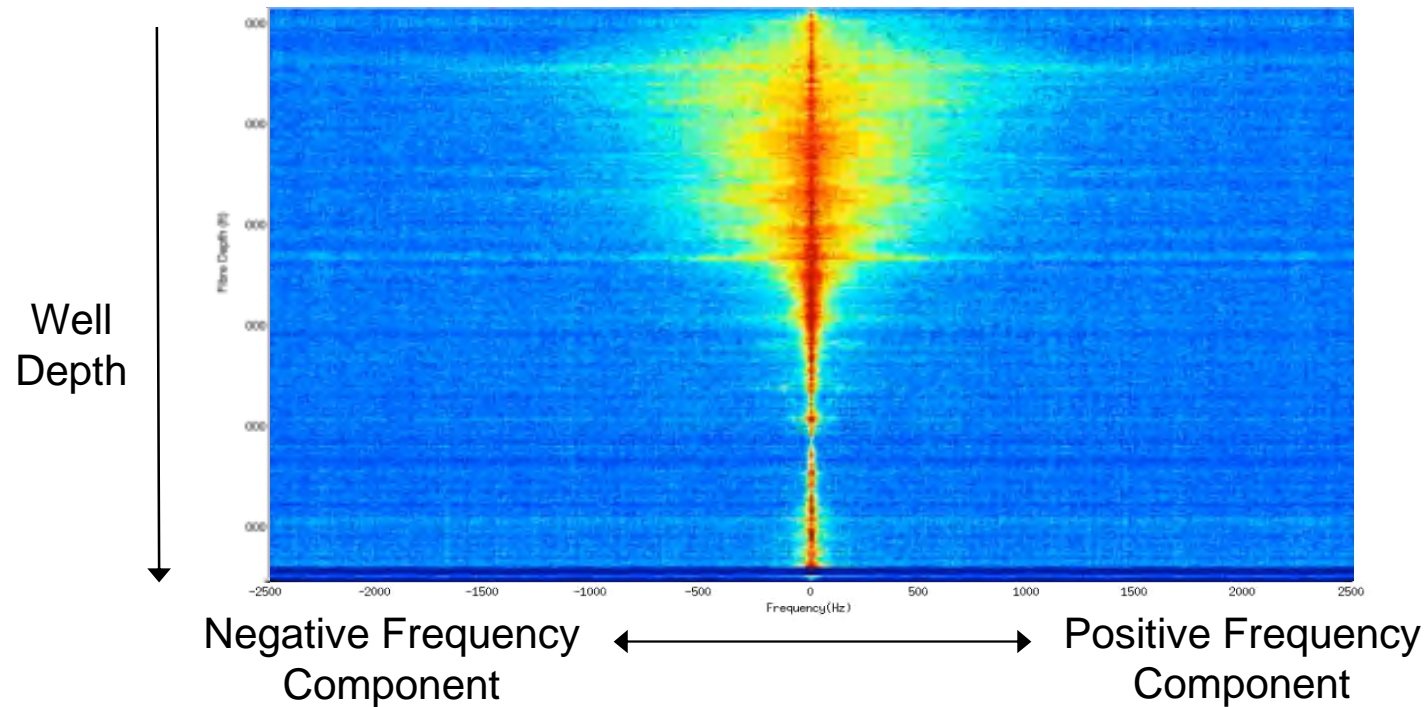
Slug of gas continuing to 'lift'



Well Abandonment Example 2

Casing Vent Leak: 'Gas Slugs'

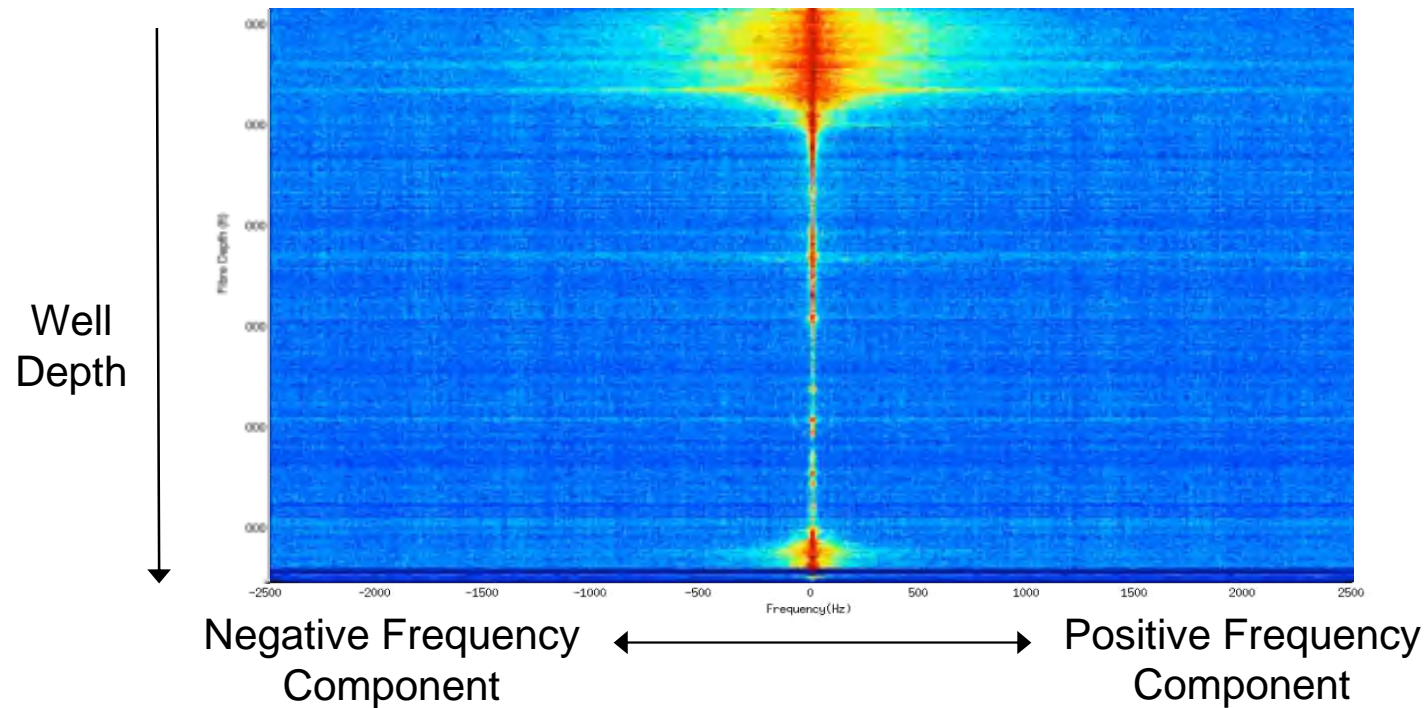
Slug of gas reaching the surface



Well Abandonment Example 2

Casing Vent Leak: 'Gas Slugs'

Slug of gas exits the casing at the surface (through a casing vent).
Next slug enters annulus.



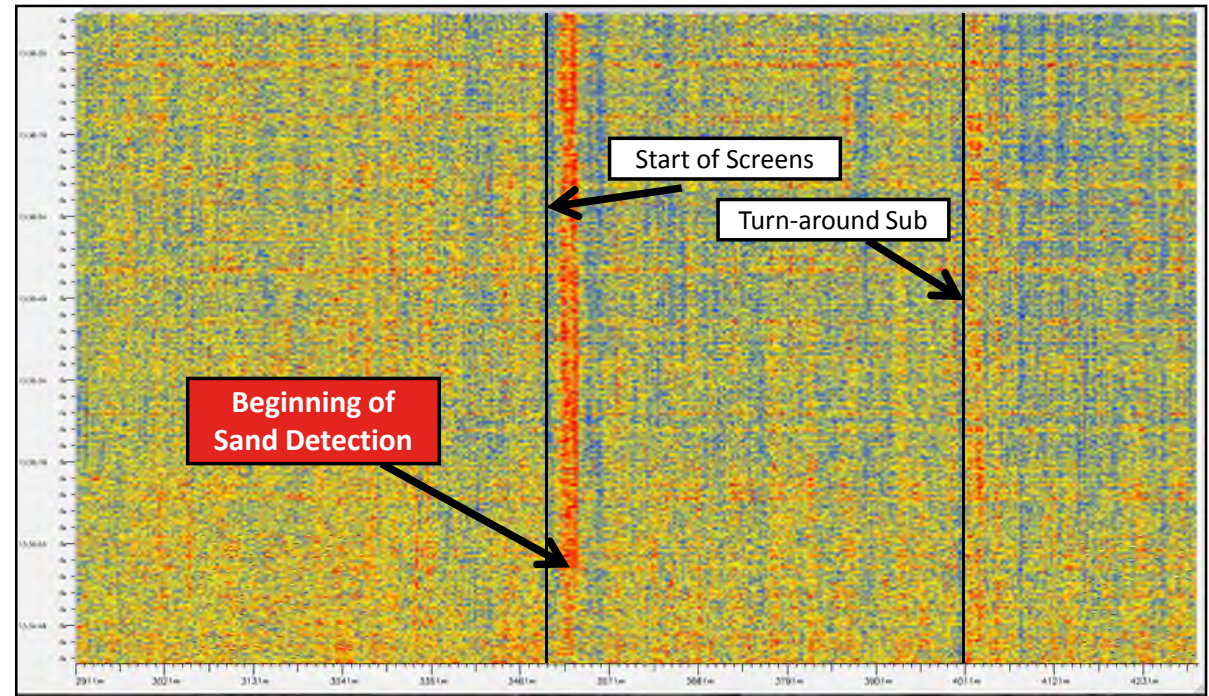
Sand Detection

Detection of sand ingress

With the choke removed

- Sand production was detected between 3510m and 3530m
- This grew in intensity as time elapsed.

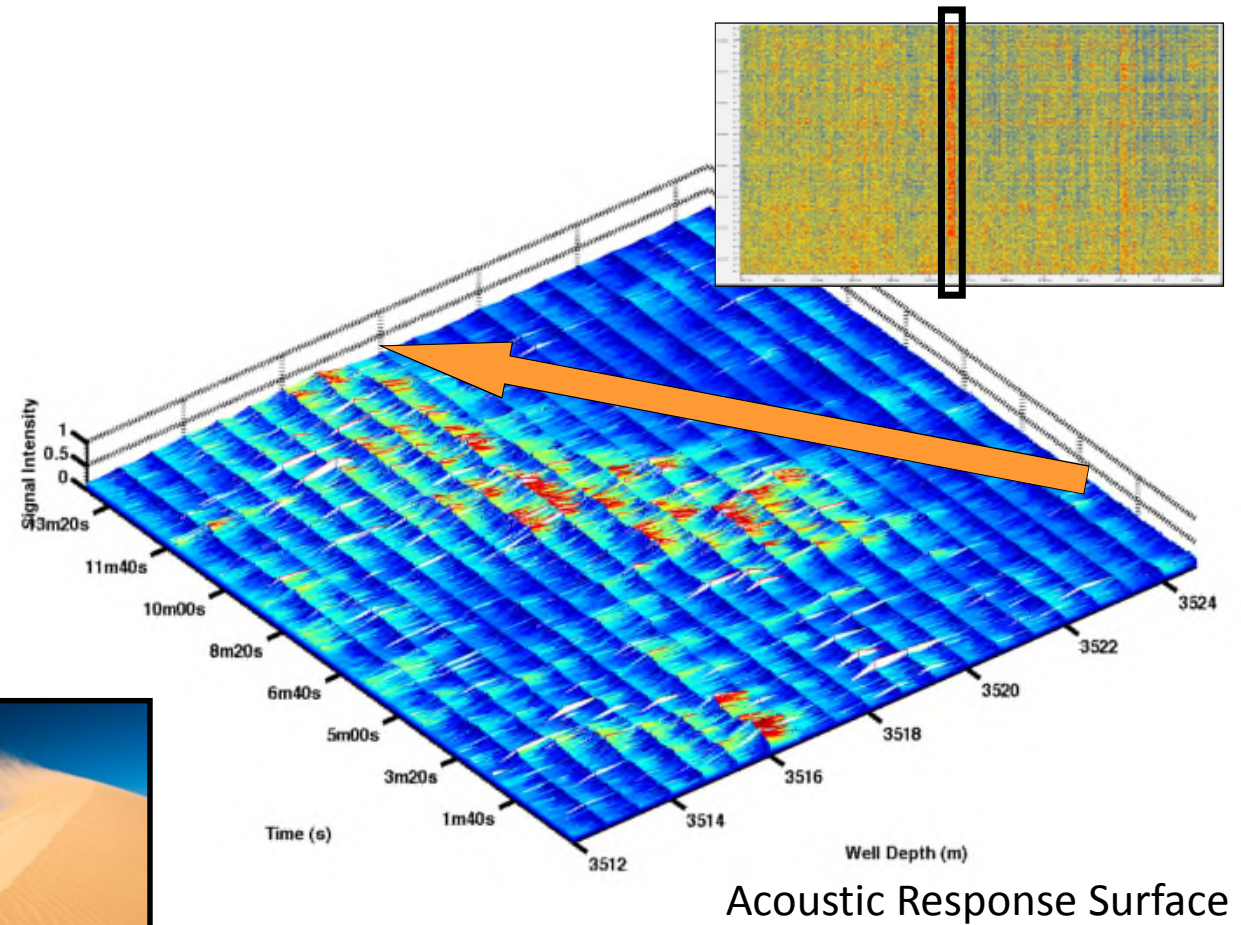
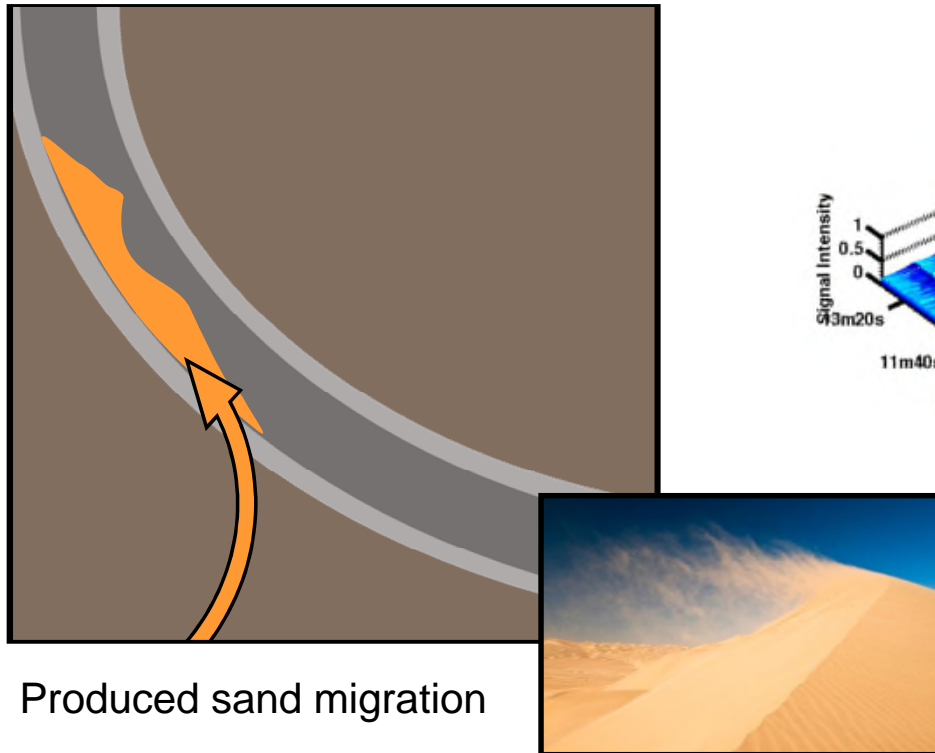
Single mode fibre would provide improvement in signal to noise ratio.



Example of DAS functioning on DTS Multimode Fibre

Sand Detection

Processed Acoustic Surface

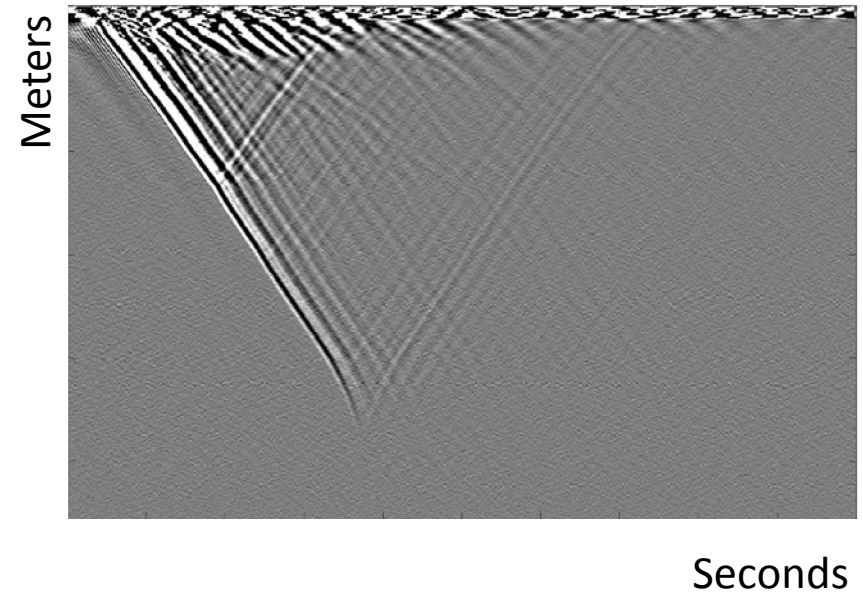


Borehole Seismic

Seismic acquisition with fibre

Fibre may be used to acquire seismic data without the need for Geophones.

- Vertical Seismic Profile while still producing the well
- No need to remove the completion string
- Borehole seismic without intervention
- One excitation – Full wellbore coverage
- High spatial resolution compared with geophones
- Allows opportunity for 4D (time based) monitoring
- Low cost compared with existing techniques





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