

## «Reservoir Live»

### A paradigm shift in reservoir management

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VP Sales & Business Development

## Agenda

- ❑ Set the stage
- ❑ Description of the technology
- ❑ Examples
- ❑ Summary

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## A little bit of intervention history – 50 year cycles?

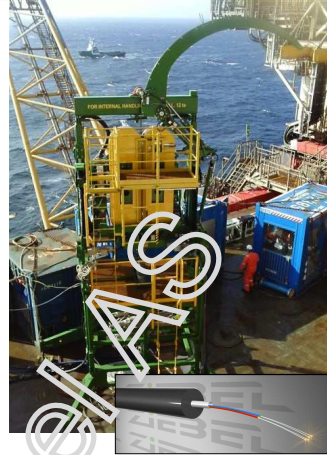


**1912:**  
Conrad Schlumberger  
recorded the first map of  
equipotential curves



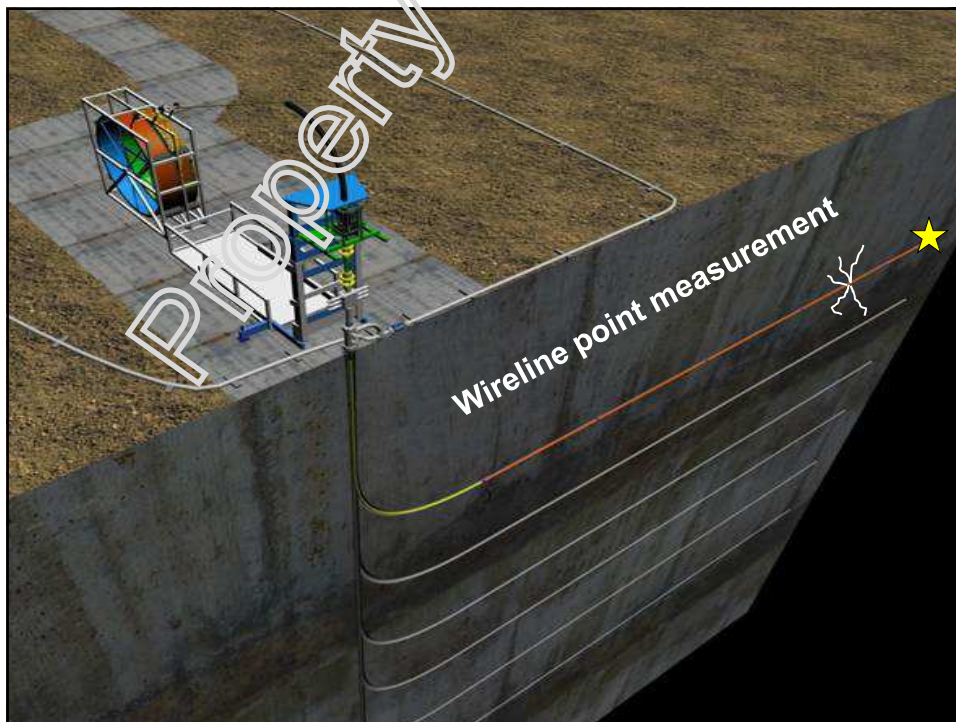
**1944:**  
Pipe Lines Under The Ocean  
(PLUTO)  
Flexible pipes to transport  
fuel from England to the  
Continent to supply the  
Allied armies

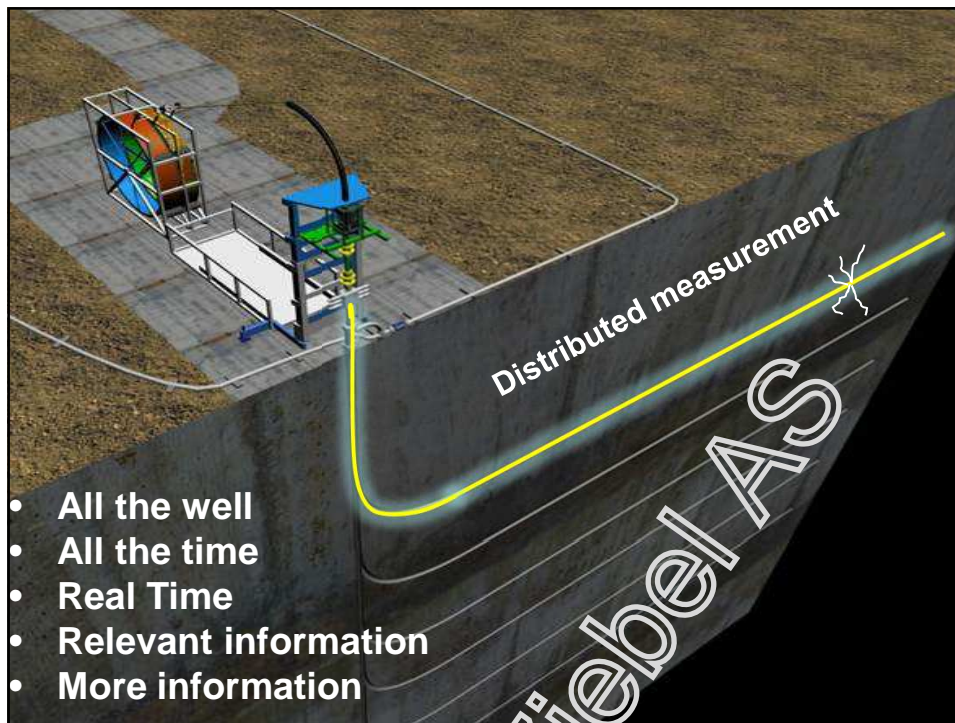
**1962 (+50 years):**  
California Oil Company and  
Bowen Oil Tools developed  
the first Coil Tubing unit



**2011/12 (+50 years):**  
Zibel Z-System™  
Deployed offshore

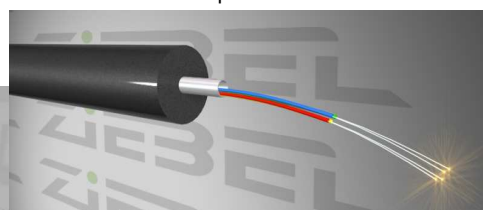
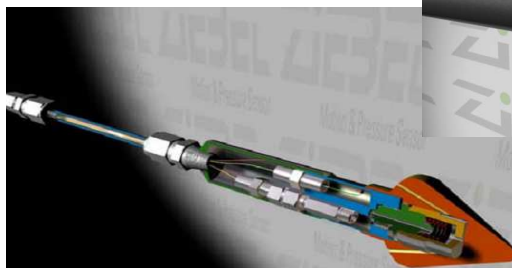
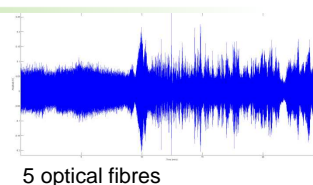
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### Fiber optic system – High Resolution Sensing

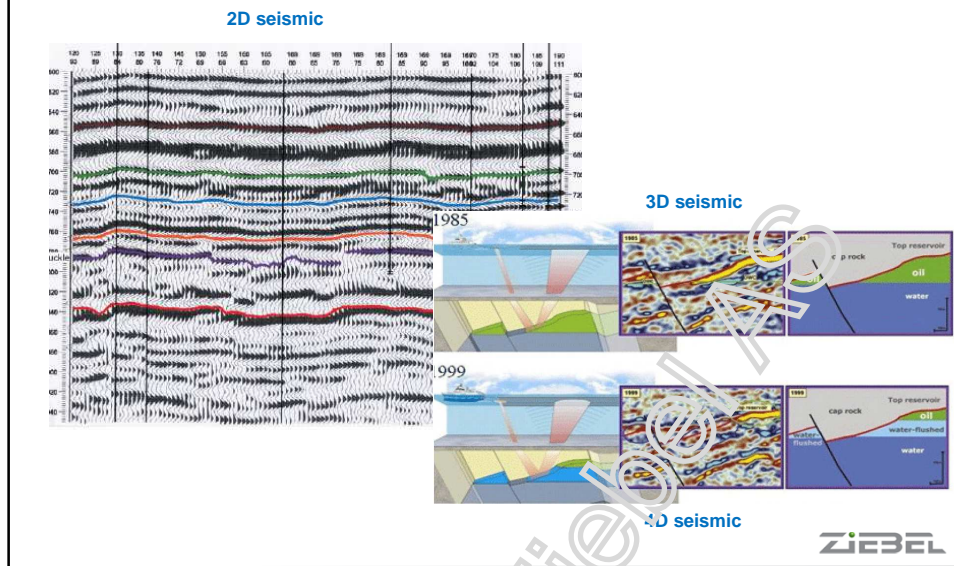
- ❑ DTS – Distributed Temperature Sensing
- ❑ DAS – Distributed Acoustic Sensing
- ❑ Point sensors
  - ❑ Pressure
  - ❑ Temperature
  - ❑ Vibration



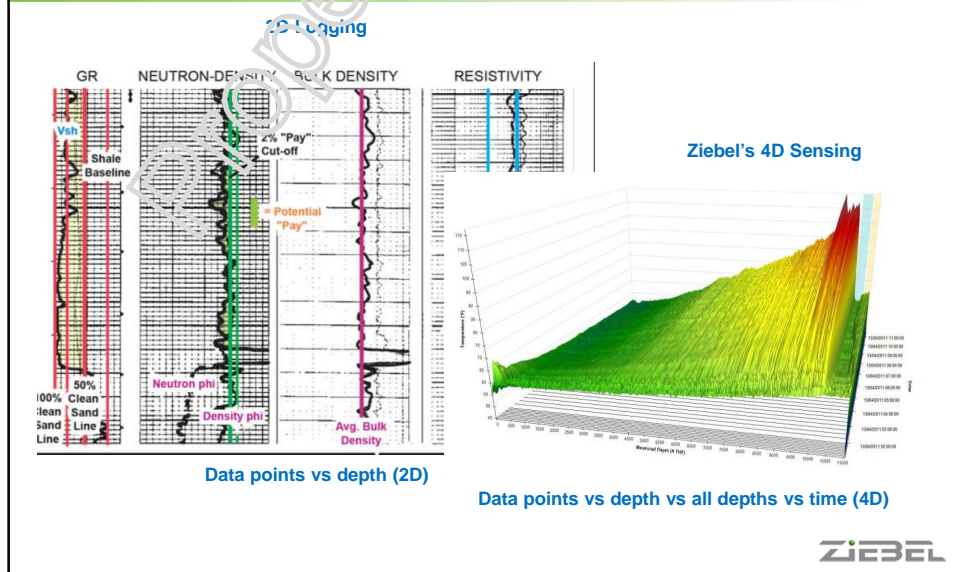
Bull nose with  
Pressure,  
Temperature and  
Vibration

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## Logging vs Sensing - In the footsteps of seismics

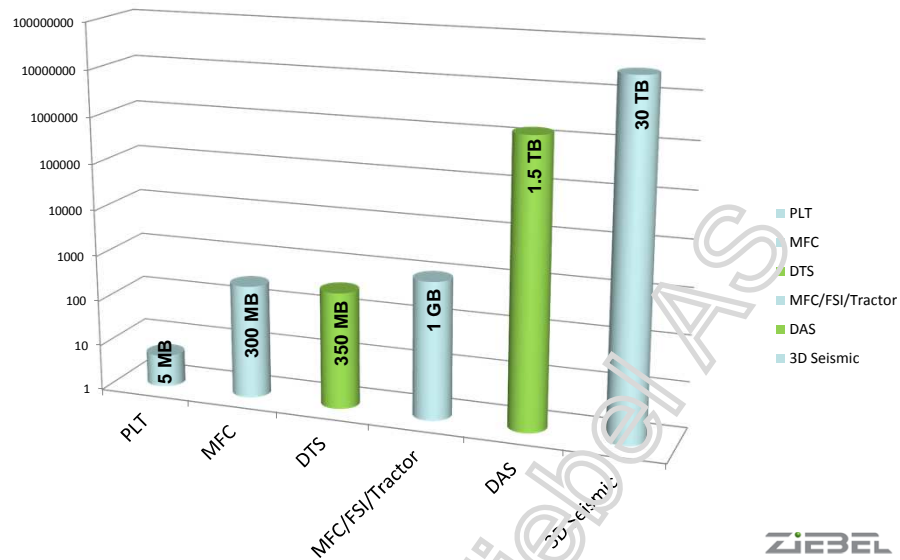


## Logging vs Sensing - in the footsteps of seismics

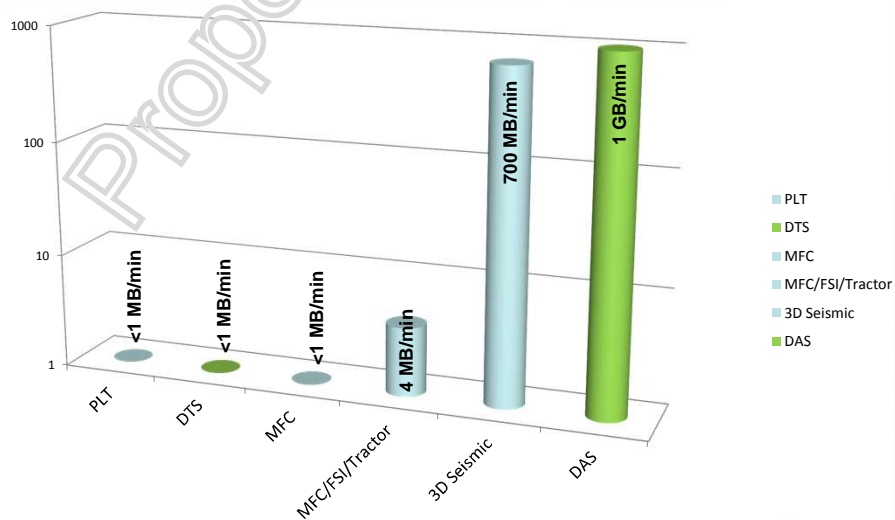




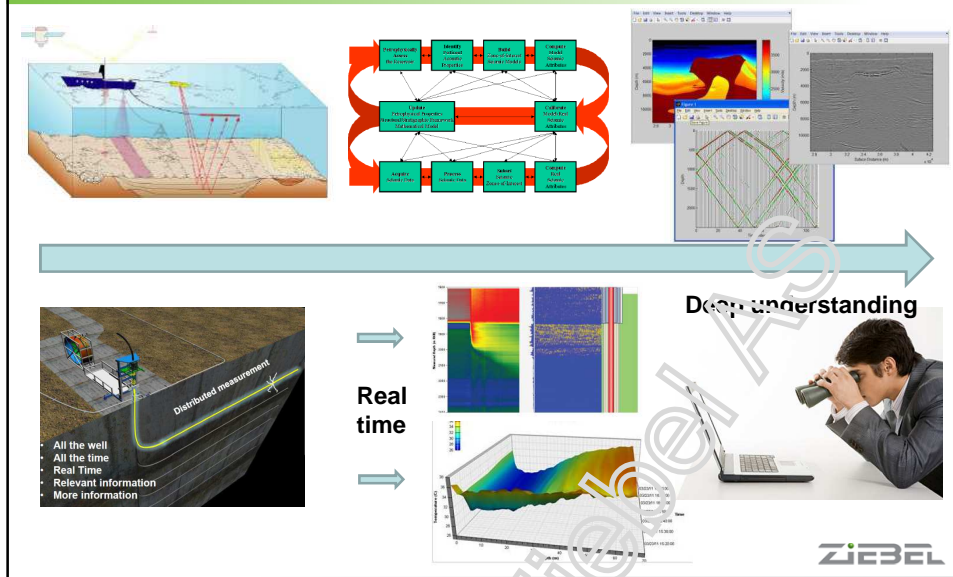
## File size per job



## File size per acquisition time (MB/min)



## Distributed measurements give real time value



## Applications

Flow Allocation

Zonal definitions

Gas Lift Optimization

Flow behind casing

Top of Cement

Restrictions in wellbore

Leak detection

Fluid density

Fracturing / stimulation

Water breakthrough

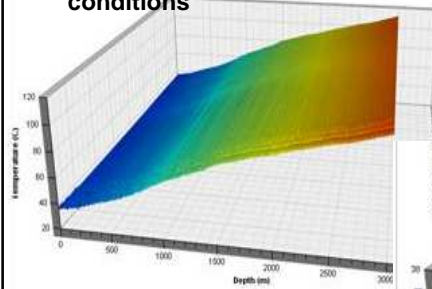
Conveyance

*Dynamic reservoir management optimization tool*

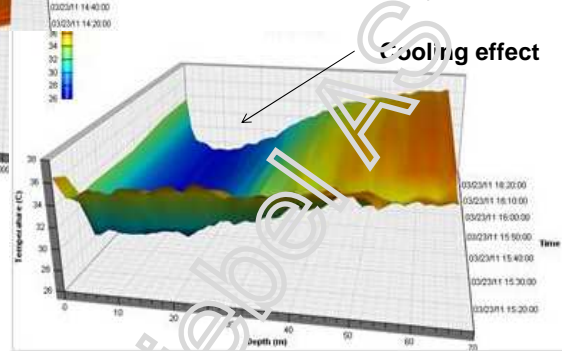
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## Leak detection job – high pressure gas producer leaking to A-annulus

Initial Shut In – Establish stable conditions

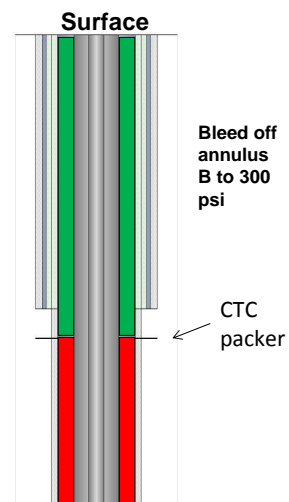
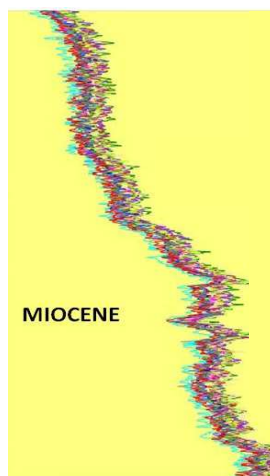


Bleed Off A-annulus – any effect?



## Pressure in the B-annulus - DTS

Finding the needle in the haystack...

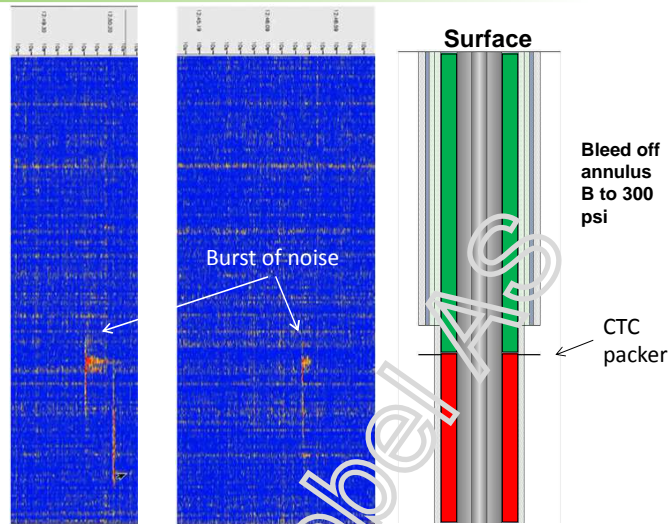


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## Pressure in the B-annulus - DAS

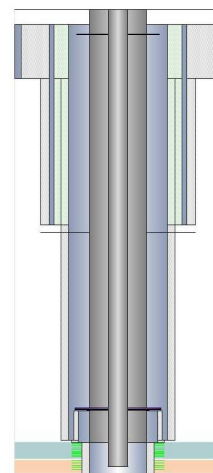
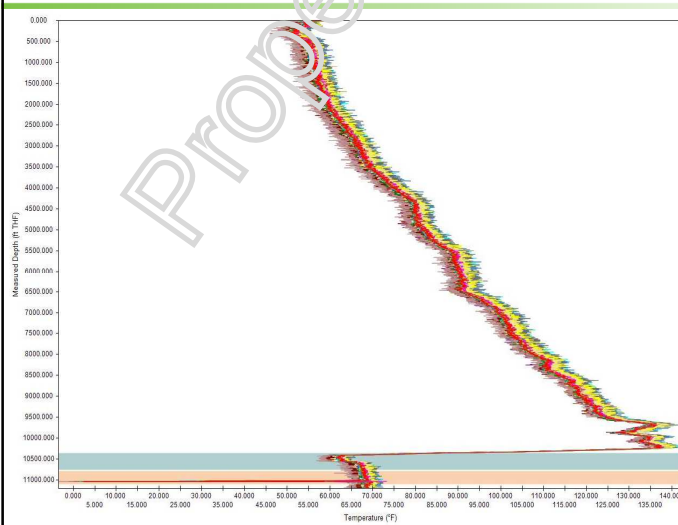
Finding the needle  
in the haystack.....

Anomaly at packer



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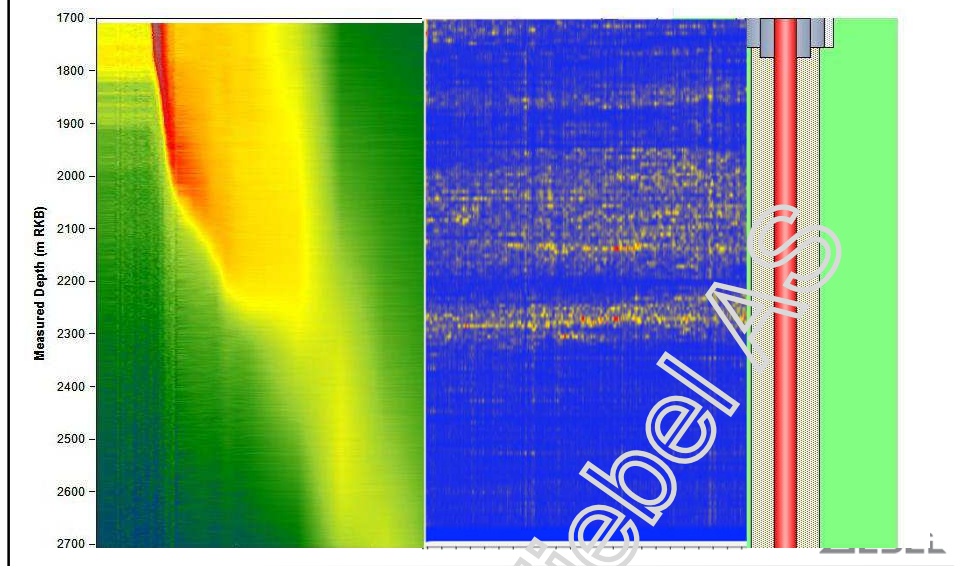
## Start injection – DTS information



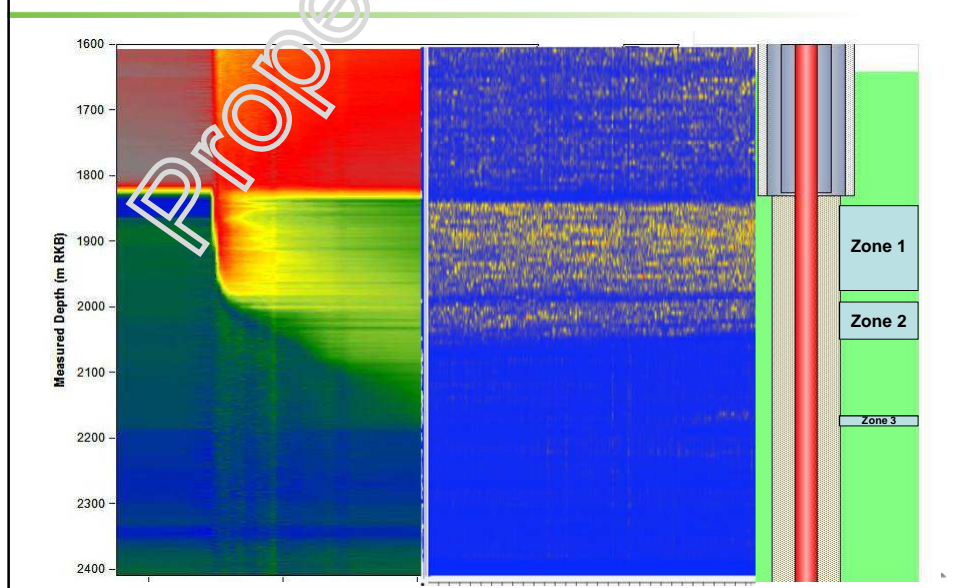
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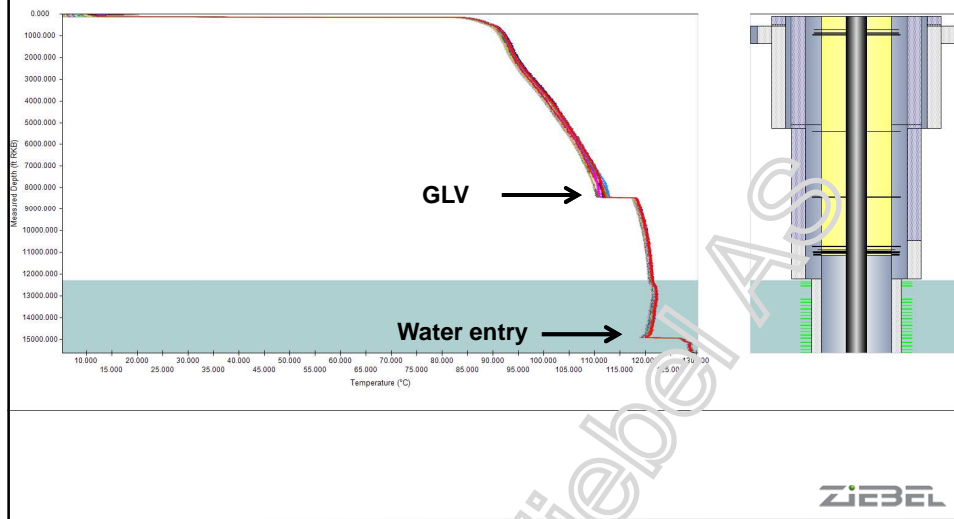
## DTS and DAS - Zonal definition – Hot slug example



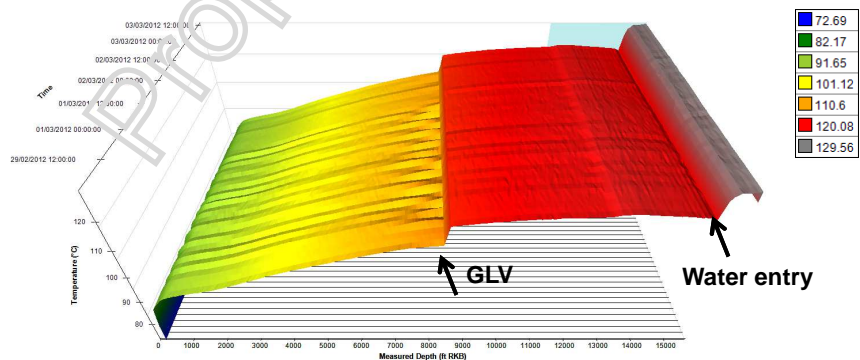
## Injection – Hot Slug – DTS & DAS combined



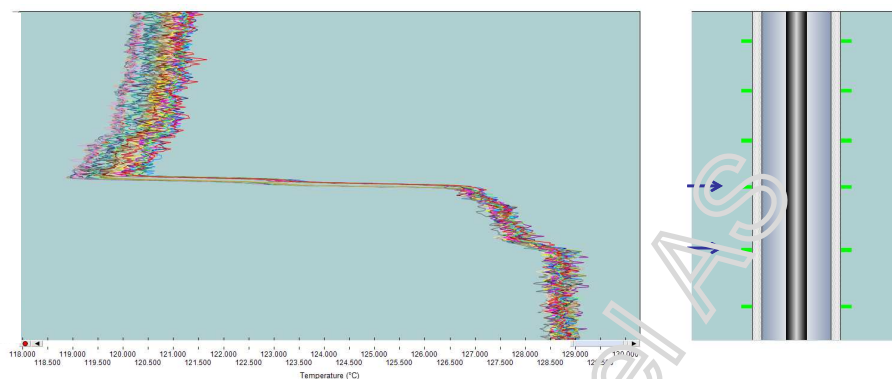
## DTS traces during an entire operation



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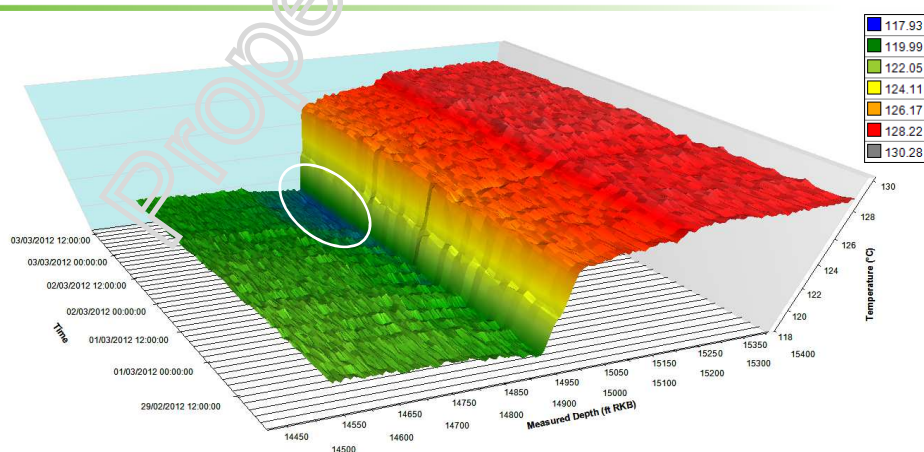


## Cooling with water entry from an adjacent injector

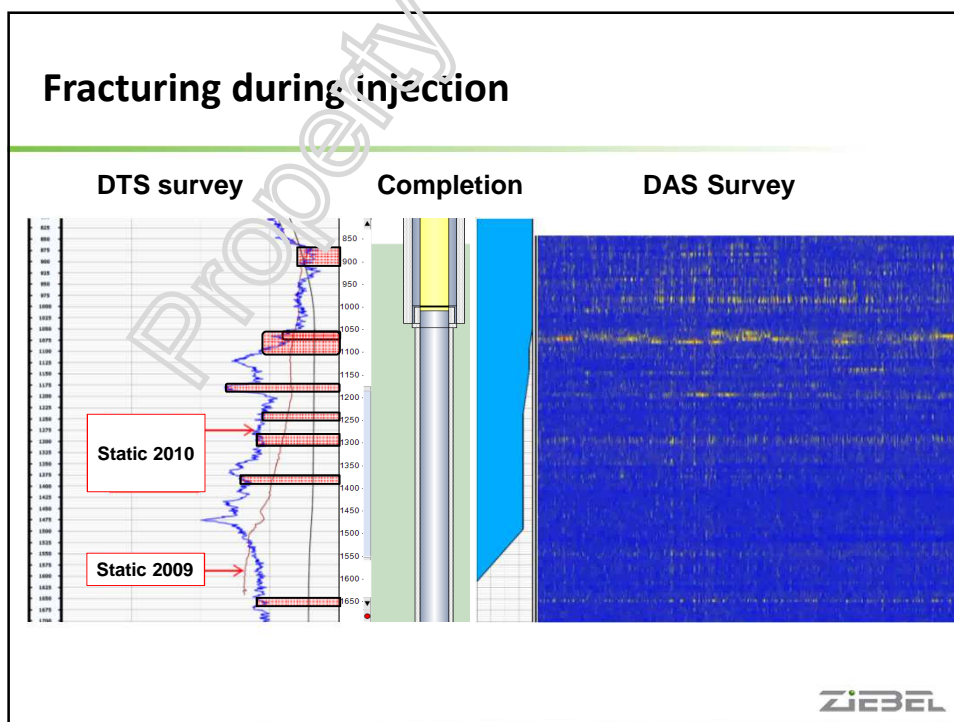
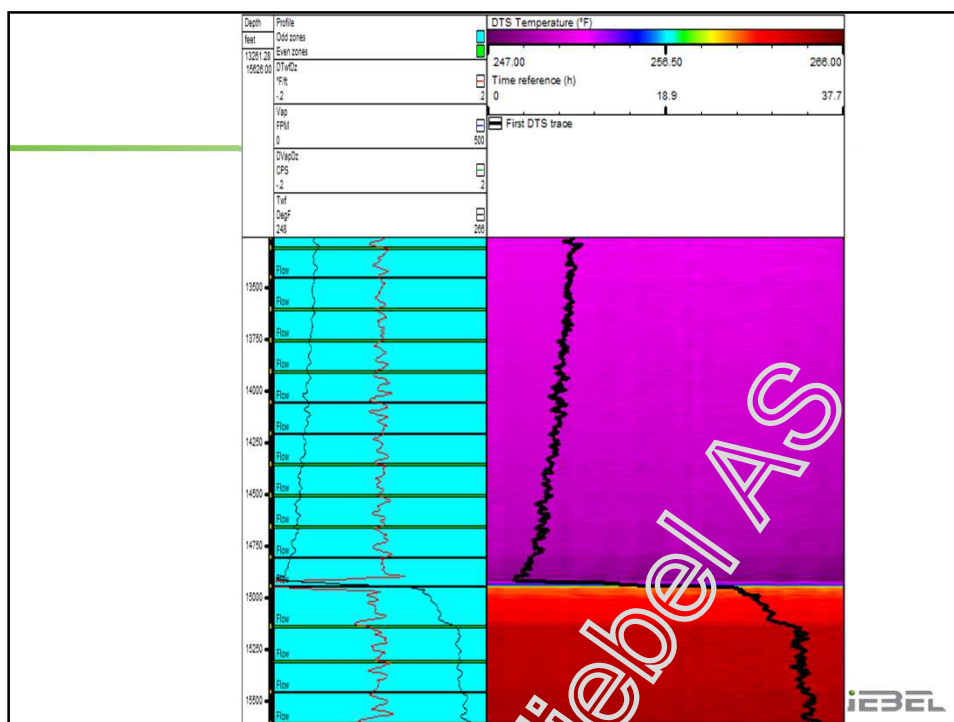


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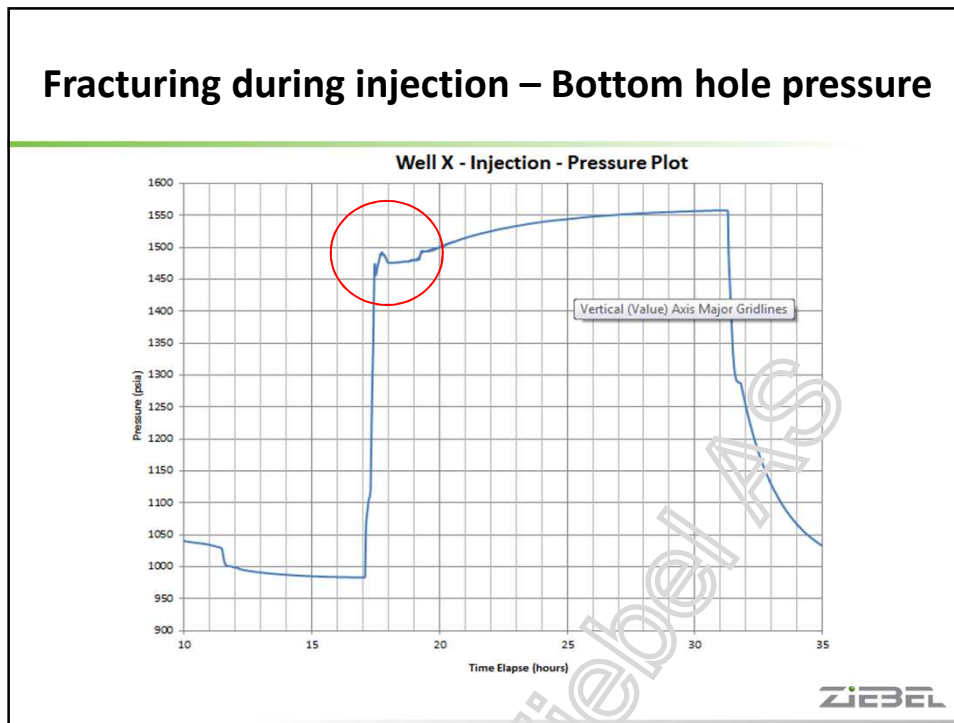
## Cooling effect due to increase of water injection rate



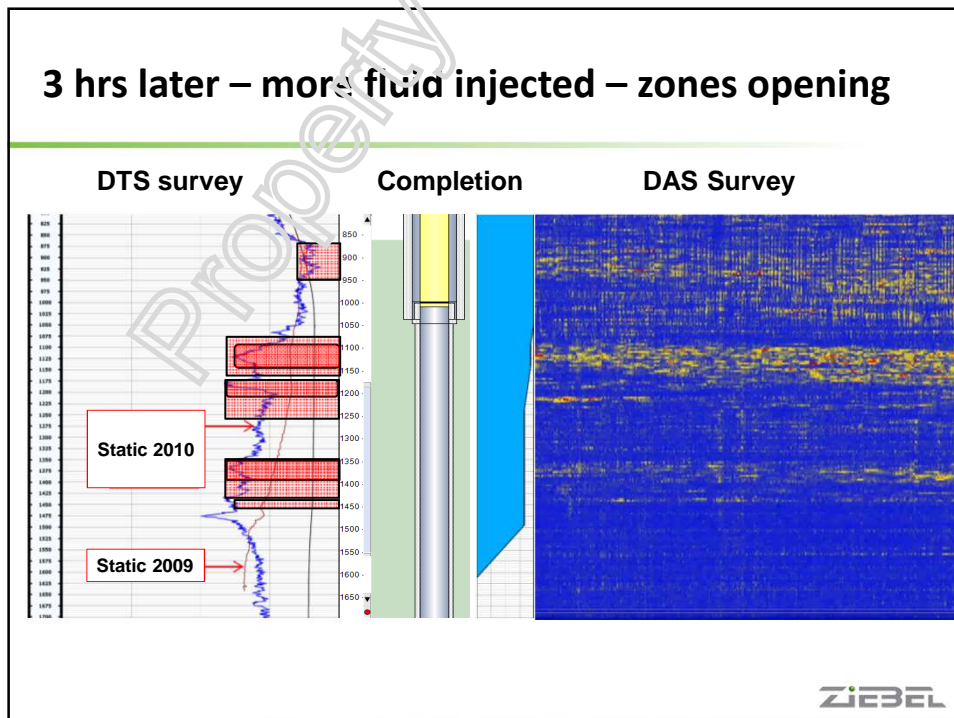
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## Fracturing during injection – Bottom hole pressure



## 3 hrs later – more fluid injected – zones opening





## Summary

1. The simultaneous application of Distributed Temperature and Distributed Acoustic has increased the value of distributed measurements
2. Senses all the well, all the time
  - Reservoir management optimization
  - Integrity – wherever and whenever
3. Less deferred production during intervention work
4. Negligible choking effect

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