

Distributed fiber optic technology – potential monitoring opportunities for geothermal applications

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What is distributed fibre optic sensing?

- Measure different physical and chemical properties surrounding an optical fiber in a spatially resolved way.
- Send high intensity laser pulses in to a standard optical fibre
- Unique properties of glass return different backscatter components at different frequencies
- Time domain analysis of the backscatter allows to build a profile of temperature, strain and acoustic disturbances along the fibre.

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Distributed Temperature Sensing (DTS)

- Like an array of indepdently addresable temperature sensors
- CMR DTS-unit
 - 5km measurement range
 - 1.5 meter spatial resolution
- General purpose, wide range of applications
- Example: Long term monitoring of borehole temperature profiles
 - Post drilling cooling vs depth
 - Permafrost zones
 - Sealed wellbores





Distributed Acoustic Sensing (DAS)

- Like an array of independantly addressable acoustic sensors
- CMR has developed a DAS interrogator
- Data quality sufficienty good for frequency analysis of signals
- Acheivable capabilities:
 - 10 km+ fibre

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- 10s kHz acoustic sampling
- Sampling resolution ~ 0.5 m
- Next generation «phase sensitivie» interrogation unit under development



Active DAS example – Hammer blow location





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- Part of project to investigate application of DAS to CCS
 - Simpler / cheaper /better for active seismics
 - Monitoring and location of seismic activity (e.g. during CO2 injection)
- Locate position of hammer blow using DAS data
- Possible DAS applications in geothermal:
 - Flow monitoring throughout collector systems
 - Seismic characterisation



Distributed Strain Sensing (DSS)

- Like an array of independanly addressable strain gauges
- Can measure 1 part in million length change of an optical fibre
 - Several kms in length
 - 10 cm spatial reslution





Strain vs. Curvature



- Use special 4-core 'helical' optical fibre.
- Use measuured strain to 'track' path of cable in space



Distributed Chemical Sensing (DCS)

- The ability to measure chemical paramaters in a spatially resolved way along an optical fibre
- CMR have been developing a distributed humidity/ water sensing technology
- Desire to focus on pH/salinity sensing technology



DCS example: ODIMS

- Online Distributed Integrity Monitoring System for Corrosion Under Insulation
- Multi parameter
- Flexible, scalable, modular
- Easy integration of point sensors
- ODIMS will enable targeted and cost efficient CUI inspection and maintanance







ODIMS - Primary sensing mechanism

- Sensing fibre with hygroscopic coating
- Water uptake by coating leads to strain in fibre
- Strain profile along the fibre is measured via elastically backscattered laser light





ODIMS - Humidity response





ODIMS – Sensing range

• Have demonstrated excellent measurement resolution over 2 km fiber with high spatial resolution (<10cm)



Complex humidity profile

Possible DCS applications in geothermal:

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- Integrity monitoring of collector system
- Borehole water chemistry (deep applications?)

RENEWABLE ENERGY Thanks for your attention!

