Long Range Seismic Acquisition with DAS: Challenges in Production and Subsea Environments

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  - Reservoir and production monitoring with DAS
- New Developments in IU technology for Subsea and long tieback wells
  - Ocean Bottom survey
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- Conclusions
Offshore Applications of Fiber Optic Distributed Sensing

- Reservoir monitoring
  - 4D Seismic Timeshifts (Total’s North Sea Work: Merry et al Seismic2020 EAGE2020)
  - 4D VSP from producing wells
  - 4D Seismic Waterflood Mapping
  - Carbon Capture and Storage

- Production Monitoring
  - On-demand Optical DAS – PLT
  - Sand control
  - Screen analysis

- Smart Well monitoring
  - Artificial Lift control
  - ICV Control
CO2 Plume Tracking with TimeLapse DAS VSP

Repeatable DAS Surveys capture subtle amplitude anomalies from CO2 storage facilities

- Validation of first time lapse DAS CO2 plume tracking in 2016
- DAS technology is able to detect the progression of CO2 in storage facilities
- Third generation IU provided repeatability
  - Two new IU’s have been released since then
- Four vintages of DAS VSP have shown progression of plume
- Fiber Optic data provides a cost saving repeatable technology to monitor increasingly critical carbon storage and EOR facilities
TimeLapse from DAS → Repeatable and Cost Effective
Multiwell VSP Acquisition from Active Producers and Injectors

Mateeva et al, SEG 2017

Kyyashenko et al, SEG 2019
DAS Survey for Gas Lift Assessment
Production and Seismic Monitoring from DAS

Multiwell 3DVSP acquired during dual production string activity

Noise in Seismic Data is the Signal for Production and Completions Engineers

Fluid/Thermal Monitoring  Well Dynamics  Artificial Lift Monitoring

AbdulRahim et al, 2017
Subsea Wells and Ocean Bottom Fibers

The Need for Long range DAS: Ability to use long fibers with optical losses from subsea infrastructure

- **Umbilical**
- **Wet-mate Connector**
- **Subsea Wellhead**
- **OB-Fibre Optic** i.e. 30-50km
- **15, 20, 25, 40km Lead Ins**
- **5.0km in-well fiber**
DAS – Seismic
Rapid Changes in IU for seismic measurements

- **2007 → Version 1**
- **2008 → Version 2**
- **2010 → Version 3**
- **2017 → Version 4**
- **2019 → V4 HBSF Fiber agnostic**

**First Interstage 4DVSP; Byerley et al. 2018**
**First Commercial Microseismic with Tensors, Cole et al. 2018**

**2019 → Version 5**
First Long Range Seismic Acquisition and active seismic survey up to 50km. 50k channels 2019
15-40km Umbilical testing
50km Long Standard Fiber
Airgun Source – Ocean Bottom Cable 50000 channels
Challenge in Subsea Wells → Optical Losses

25km Long Fiber with Attenuators from Wetmate connects and Subsea Template

20 Km Lead

4dB = One Subsea well feedthrough (3.5) + One wetmate connector (0.5)
Long Range DAS 25km Umbilical – Interrogating 5km Single Mode Fiber

Minivibe single sweep source

Reflections observed in borehole data without any processing

20000 channel - Only 5000 channels at 1m spacing are shown
Autonomous Systems → DAS Data Streaming Solutions
Remote Operations: IU(s) to Remote Processing Centers at Full DS Bandwidth

Optical Fibres

Optical Switch

OptaSense System

OptaSense DAS Interrogator Box

PU

Kafka Consumer

Kafka Producer

Server: running OptaSense acquisition and raw sensor data streaming software

REST API to allow control over profile at each PU

Data serialisation using Apache Avro schemas and Apache Kafka streaming

Data products / off-line analysis

(Near) real-time pre-processing and analysis on client’s Kafka server cluster

Hewlett Packard Server

Equinor Server

Seismic2020
Conclusions

▪ New IU technology can acquire seismic data from fiber optic at long range

▪ Subsea monitoring
  ▪ Long Tie-ins to Subsea Templates with SM fiber (15-25km validated)
  ▪ Flow profiling monitoring validated with 15-40km tie ins (Summer 2020)

▪ Surface Seismic and OceanBottom-FiberOptic monitoring
  ▪ Long offset DAS can be deployed for long fiber optic spreads on the surface or ocean bottom
  ▪ Deployed with 30-50km standard fibers
  ▪ Commercial Seismic Survey with 50km standard fiber
  ▪ Radiation patterns for surface seismic are addressed with omnidirectional fibers

▪ Data streaming (raw or processed) makes Distributed Sensing products available in personal devices
Questions
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