

# Managing declining fields with geophysics

# Seismic Permanent Reservoir Monitoring

Solutions, Challenges & Opportunities



27 Nov. 2012 Al-Khatib Habib



# **Permanent Reservoir Monitoring ?**

Permanent Seismic Reservoir Monitoring

>Equipment <u>permanently</u> installed

Continuous monitoring



>Highest seismic repeatability – Active & Passive

#### 10-25 years of monitoring

Closer long term interaction between contractors & clients

Reservoir oriented



Challenges of Permanent Reservoir Monitoring

- Existing CGGVeritas PRM solutions EKOFISK & Schoonebeek
- Conclusion PRM opportunities



Seismic Permanent Reservoir Monitoring – Solutions, challenges & opportunities

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# **O&G challenge: Optimized hydrocarbons Recovery**

Worldwide average recovery factor is 32%
 Enhanced Oil Recovery (EOR) is key
 Maximized value of O&G assets

> 4D seismic demonstrated benefits



PRM is designed for managing declining oil fields
Highest seismic repeatability



# **PRM challenge: Demonstrate value**

#### >Are PRM solutions too expensive ?

>PRM solutions are more expensive than conventional solution

PRM costs are loaded upfront





# How to make a profitable movie ?

➤Good scenario

- Initial investment
   \$237 000 000
- Famous actors

Great film director

# → Tell a story



# 2 782 275 172 \$



Seismic Permanent Reservoir Monitoring – Solutions, challenges & opportunities

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# How to make a profitable <u>seismic</u> movie ?

#### ➤Good scenario

Finding the optimum repeatability
 4D geophysical response & turnaround

#### PRM Engineering & feasibility study



Operating cost/Capital cost ~ 6%



Knowledgeable actors



2 782 000 000\$ ~ 27,820Mbbl ~ 0,8% increase on EKOFISK

Great film director - Integration

# $\rightarrow$ Tell where the oil is going





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# **CGGVeritas field of expertise in PRM**





# **Offshore example of Ekofisk (CoP/PLO18)**

#### **Project location**







Ekofisk formation

Tight zone

Tor formation

#### Key reservoir information:

- Fractured chalk High porosity (30-50%) but low permeability
- Elliptical anticline at 2900-3250m
- SOA ~ one-third of the field
- Subtle 4D amplitude changes  $\rightarrow$  highly repeatable 4D seismic



# **Ekofisk: a CGGVeritas integrated solution**

### An Optical passive solution : OPTOWAVE

First operating full scale fiber optic system

#### A dedicated source

Flexible containerized source

#### >Advance 4D Processing:

PRM Processing Imaging

#### >2,5 years full-field integrated experience on Ekofisk

4<sup>th</sup> survey acquired June-July 2012



### **Ekofisk Results** NRMS in 2800ms-3300ms window full stack





#### **Ekofisk Results** NRMS in 2800ms-3300ms window full stack



## Dip filtered stack, 4D difference - Raw

LoFS1

1.00

LoFS3

#### 4D diff (scaled up by 2)





# Dip filtered stack, 4D difference - after time alignment





# **Capitalization on experience**





Integrated team with 2,5 year's intensive experience



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# **Onshore example of Schoonebeek (Shell/NAM)**

#### **Project location**



#### Schoonebeek new field development:

>44 productions wells 25 injectors wells

Expected recovery 100 to 120 million bbl (out of 300, 40% extra recovery)



# **A Continuous Land Seismic Monitoring**





## **Seismovie layout**

#### Seismovie on Schoonebeek:





### **3D Continuous Seismic Monitoring: Movie**

#### Current Day: 07-Apr-2012





### Where is the steam going ?





### **3D View of steam chamber ?**





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# **PRM new opportunities – Field of experiment**

#### New challenges:

- Carry high sensor resolution benefits to the reservoir & overburden characterization
- Reduce turnaround & price with integration
- >Master sensor/source coupling with the underground
- Enhance source repeatability
- >4D Data/knowledge Management

#### New Opportunities: Extend the usage of PRM

- Go Beyond 4D imaging
- Geomechanical effect on field
- Noise & fracture monitoring
- Seismic While Drilling
- Link with downhole monitoring solutions





# **Conclusion PRM – a new age for our industry ?**

> Feasibility & integration are critical to leverage PRM value

Complete on-off shore offering are helping the industry to enhance PRM solutions – <u>Fields of experiment</u>

We showed two integrated industrials successful solutions

- Multi-disciplinary coordination together with client is key
- Synergies between the two does exist

New R&D opportunities – PRM isn't delivering it full potential



# **Thanks for your attention**

**Special thanks** for their support & for granting us the right to present today to

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