

# **Seismic to Geological Modeling Workflow, an Integrated Approach to Determine the Reservoir Quality of a Natural Fractured Limestone Reservoir: Oseil Field Example\***

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\*Adapted from oral presentation given in Bali, Indonesia at the Geoscience Technology Workshop (GTW) on Reservoir Quality of a Fractured Limestone Reservoir, 15-17 February 2012

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## **General Comments**

Oseil field, on the island of Seram, eastern Indonesia, is used as the example to apply an integrated approach to determine the quality of a naturally fractured limestone reservoir. Field data include:

Discovery date	1998
Type hydrocarbon	heavy oil
Reservoir type	fractured limestone
Limestone type	oolitic, mudstone/wackestone-grainstone
Age and name of reservoir	Jurassic Manuseal Formation

The following is the conclusion resulting from following the workflow associated with this approach:

- Integration of well and seismic data provides better comprehensive understanding.
- The result of seismic fracture intensity is aligned with the well.
- Total loss circulation during drilling correlates with the intensity of fractures.
- Seismic attributes should constantly be utilized to identify anomalies.
- More effort is needed to incorporate mud loss and drilling parameter into the update model.



***Seismic to Geological Modeling Workflow,  
an Integrated Approach to Determine the Reservoir Quality  
of a Natural Fractured Limestone Reservoir:  
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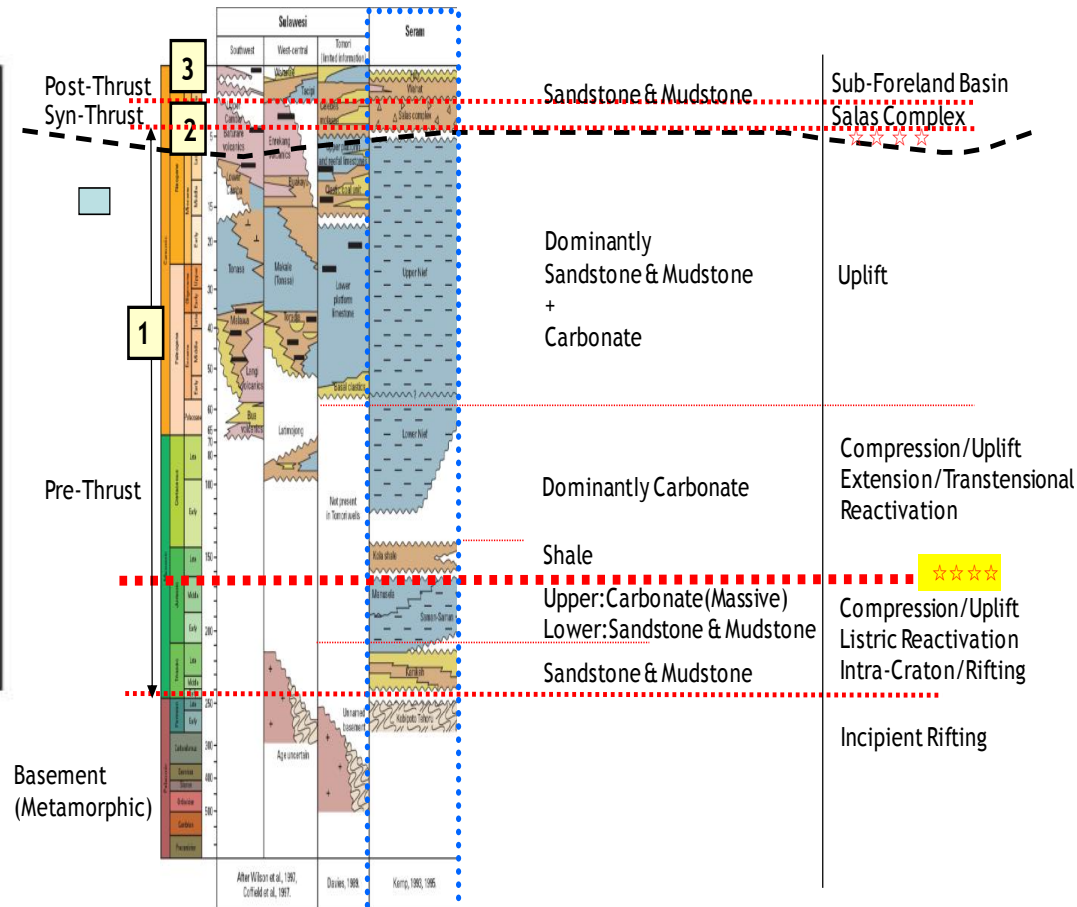
## Agenda

- Introduction
- Background
- Workflow
  1. Fracture Analysis
  2. Seismic Anisotropy
  3. Geological Modeling
  4. Discrete Fracture Network
  5. Well Placement
  6. Seismic Attribute
- Conclusion



## Introduction

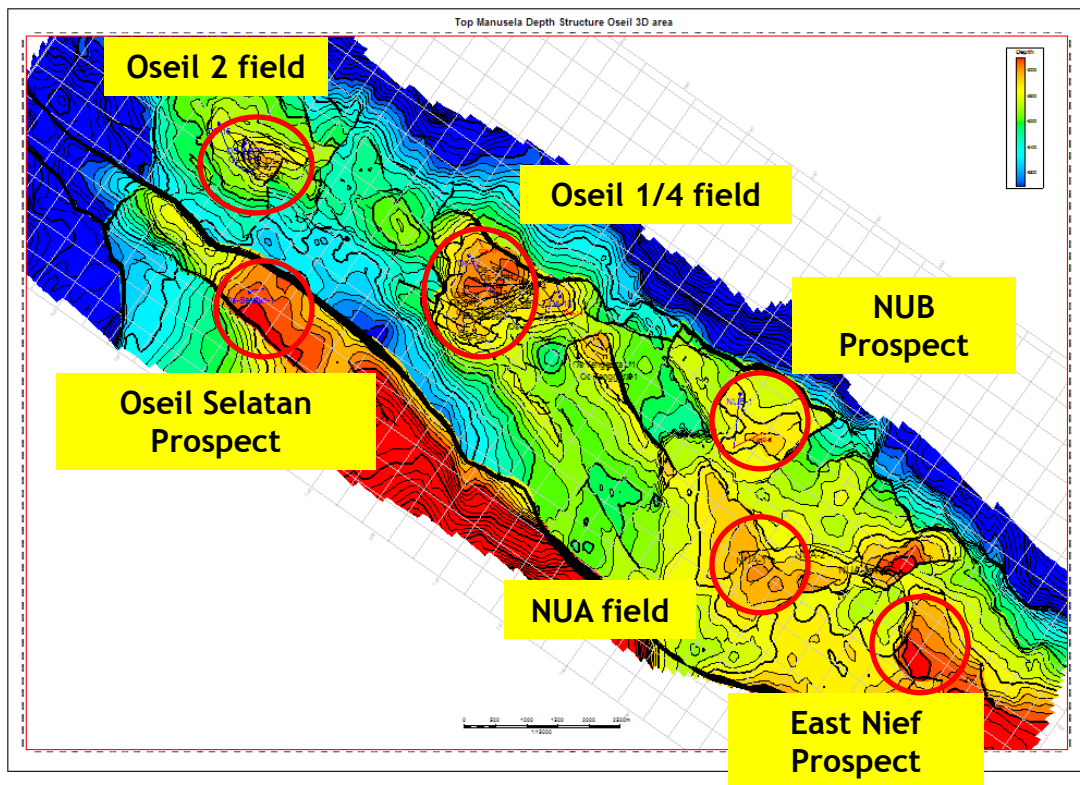
## Regional Geology





## Introduction

### Oseil Field Depth Structure Map



#### General Info :

- Discovery of Oseil : 1998
- First Oil : Dec 2002
- Hydrocarbon Produced : Heavy Oil
- Reservoir type : Fractured Carbonate
- Formation name : Manusela Fm
- Age : Jurassic
- Limestone type : oolitic limestone, mudstone/wackestone - grainstone



## Background

### Main Challenges in Oseil Field

- High Heterogeneity Reservoir
- Fast & Severe Water Break-through
- Complex Fracture System
- Time Depth Conversion
- Drilling / operation challenges (total loss)
- Remote areas - high operating cost

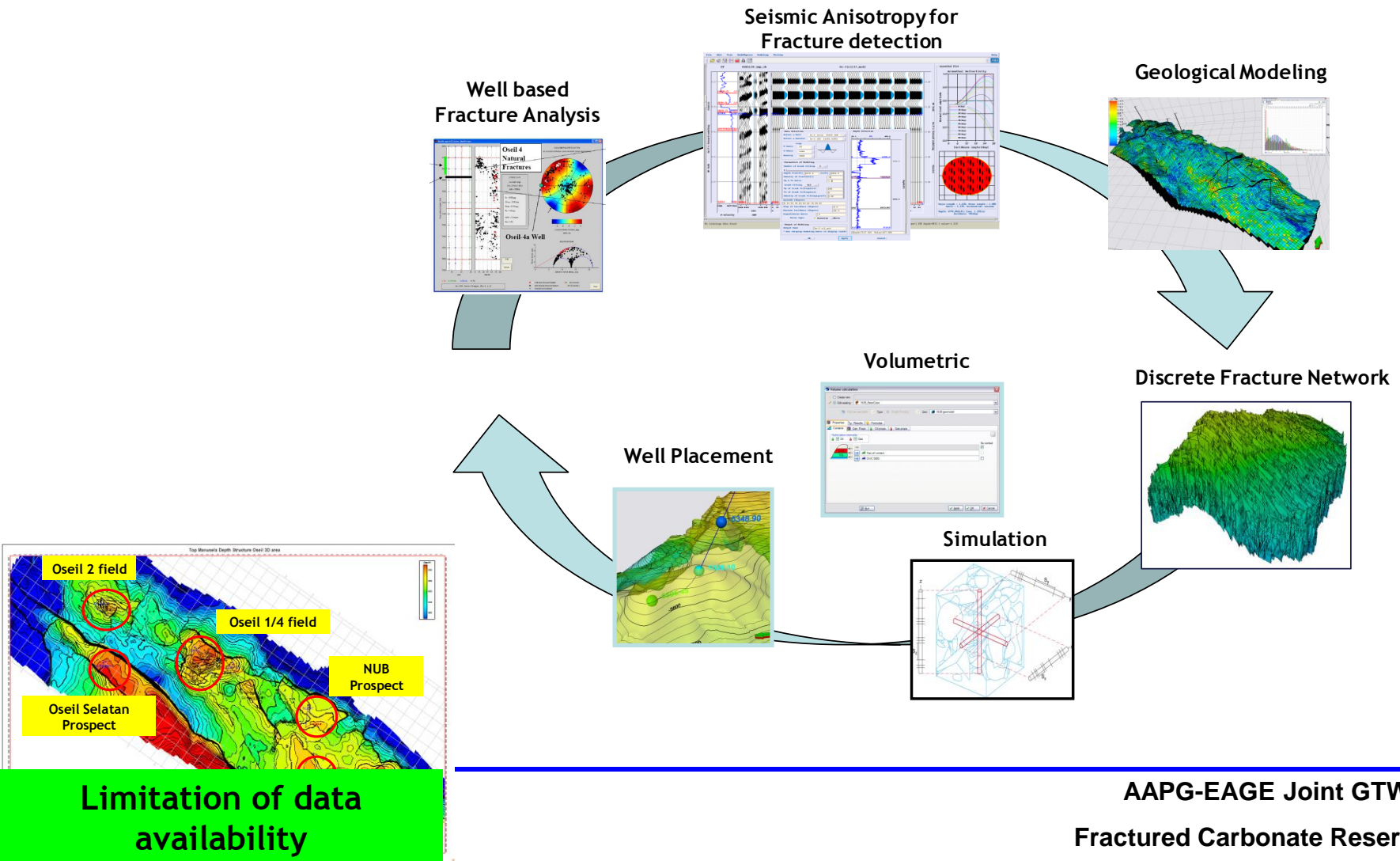


## Background

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### Study Purpose

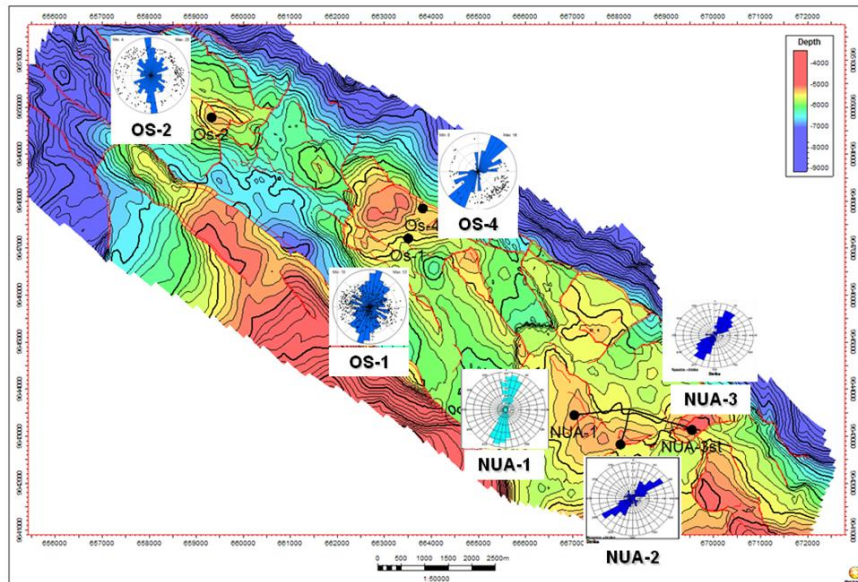
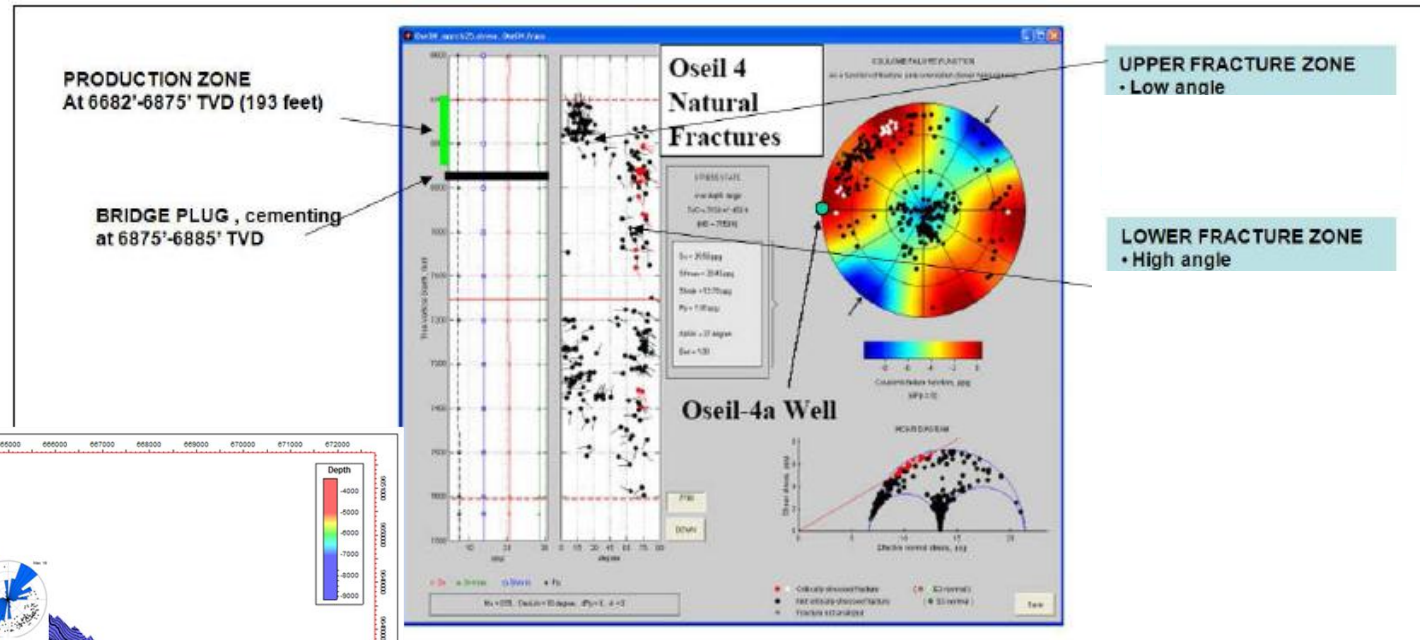
- Better understanding of the Reservoir
- Increase accuracy in Well Placement
- Increase Production





## Workflow - Well Based Fracture Analysis

### Fracture Analysis



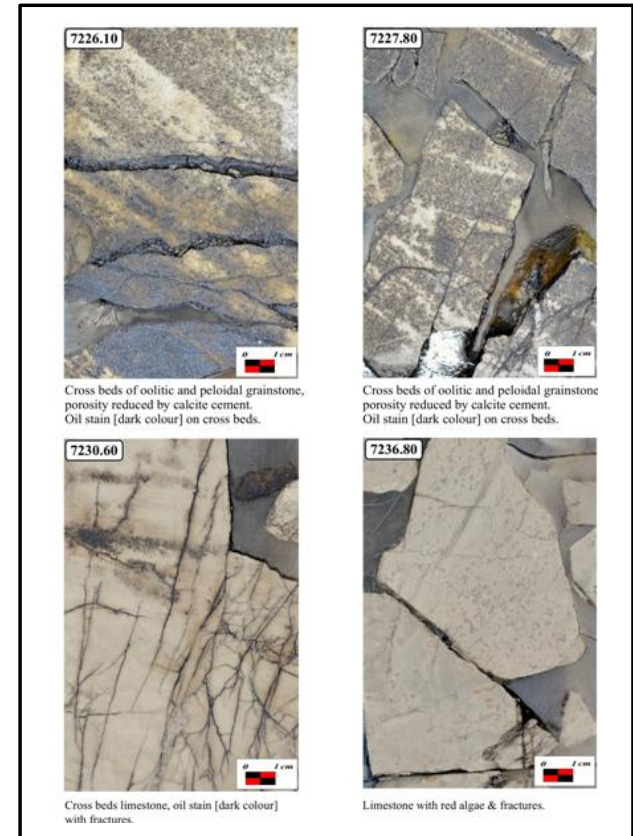


## Workflow - Well Based Fracture Analysis

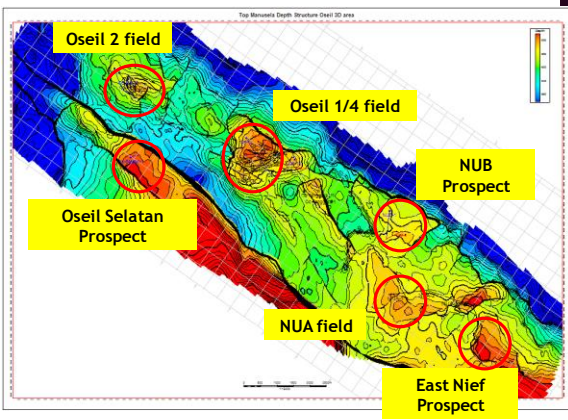
### Fracture Analysis based on core data



Photographs well OS-2 of Manusela Formation



Close-up whole core photographs well NUA-3 of Manusela Formation





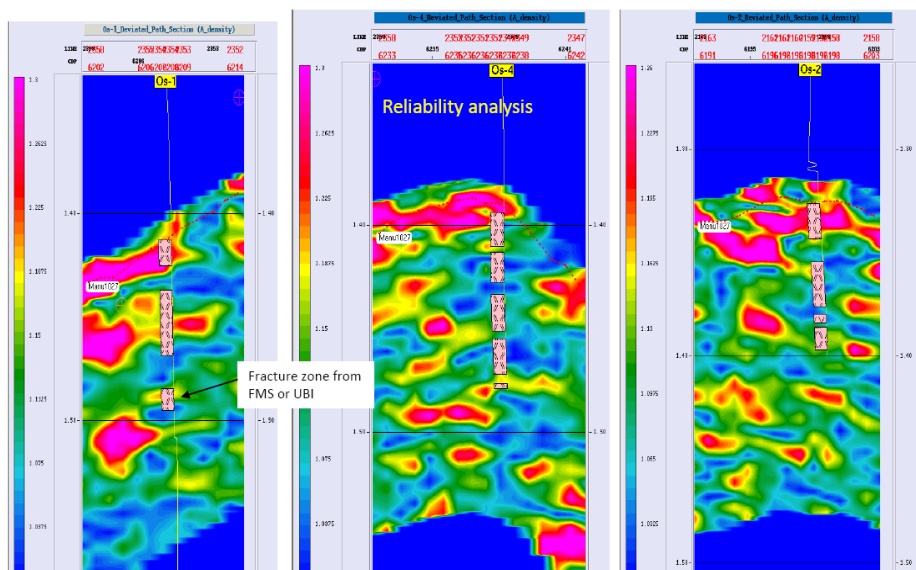
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## Seismic Anisotropy for Fracture Detection



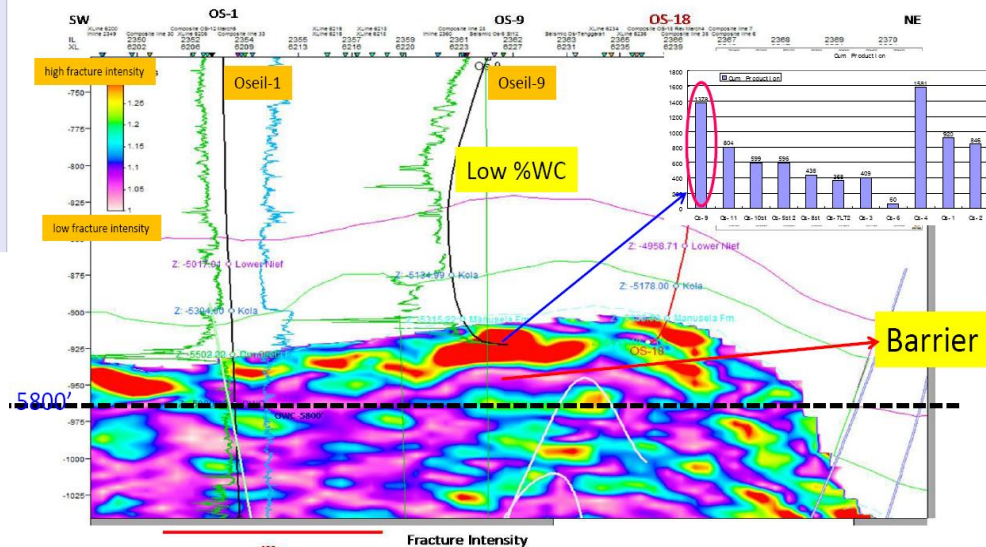
Workflow - Seismic Anisotropy

### Fracture Intensity Wells Vs Seismic



The correlation of fracture intensity between the 3 exploration wells and the seismic inversion result shows a good match

Seismic Inversion section of Os-1, Os-9 to Os-18



15-17 Feb 2012

Bali Indonesia

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Fractured Carbonate Reservoir



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## Workflow - Geological & Fracture Modeling

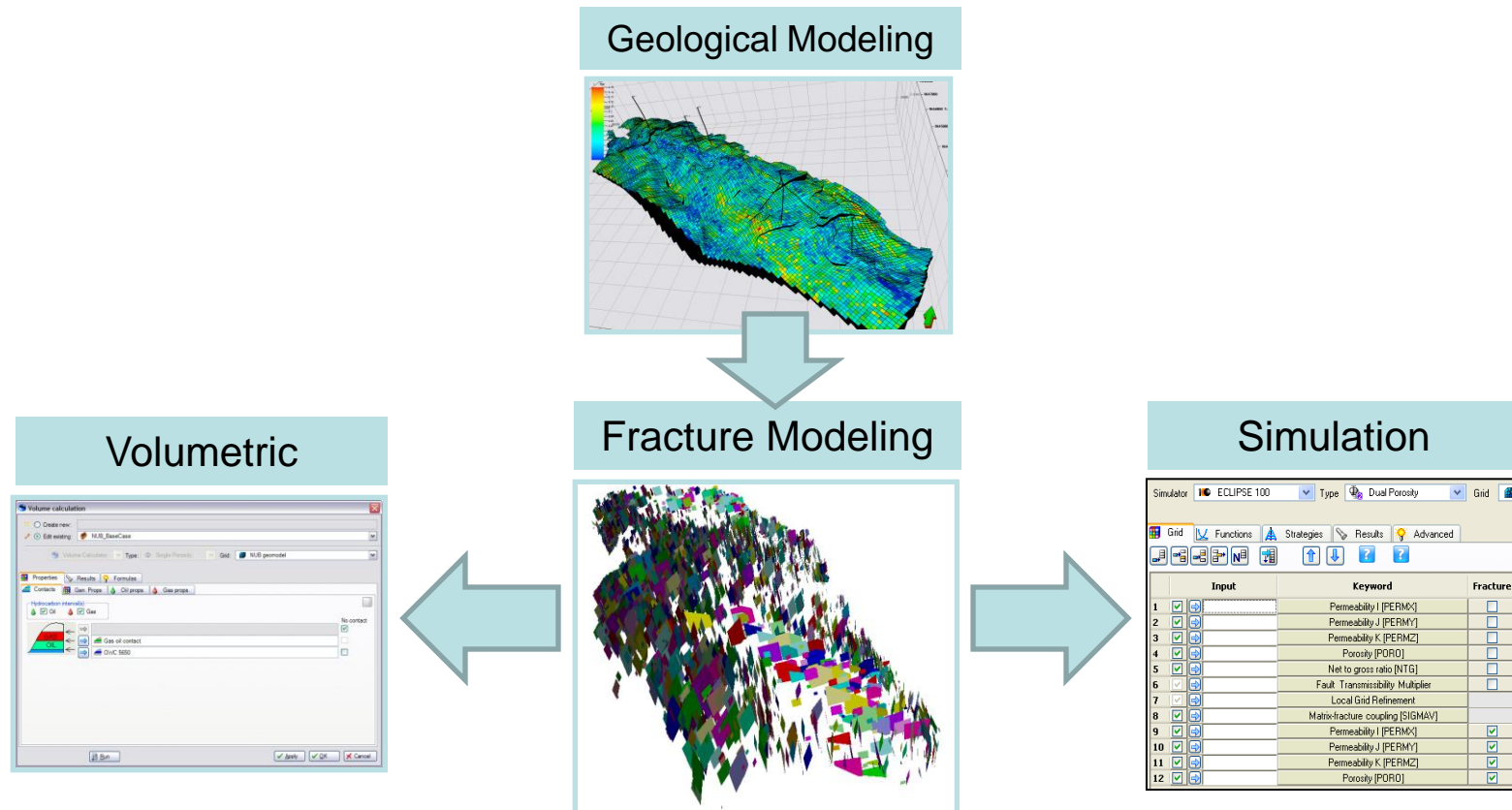
### Geological & Fracture Modeling of Oseil field

- High-quality static reservoir model is *required to perform simulations* in order to predict the fluid dynamic
- A 3D reservoir model enables us to *integrate multidata* (well data, seismic data, conceptual models, production data) for a more reliable result
- Ability to generate and simulate a *dual-poro dual-perm* reservoir behavior



## Workflow - Geological & Fracture Modeling

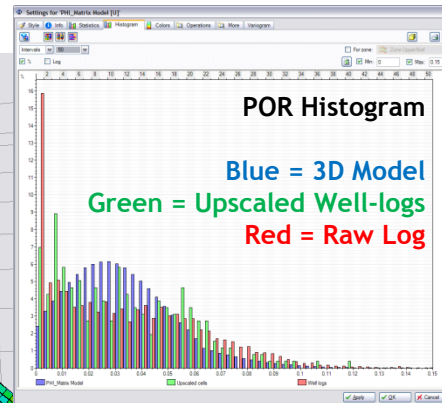
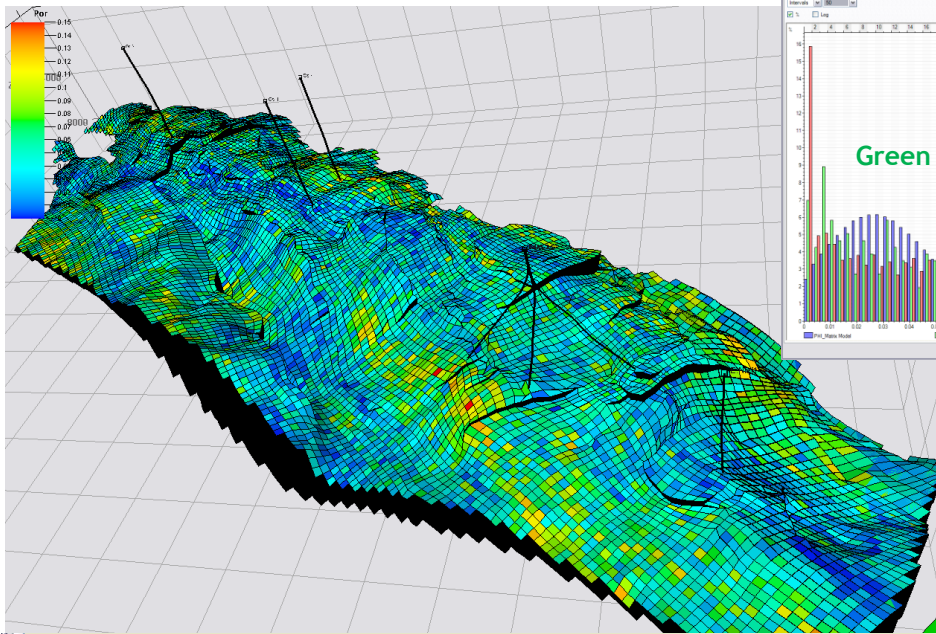
### Geological & Fracture Modeling of Oseil field





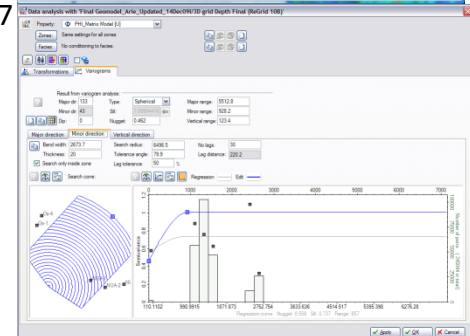
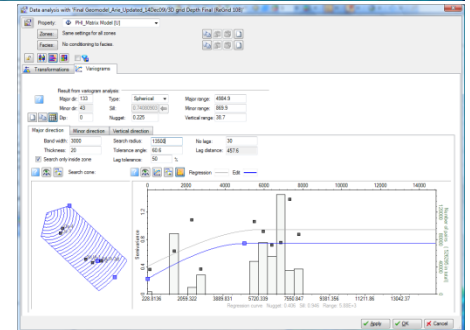
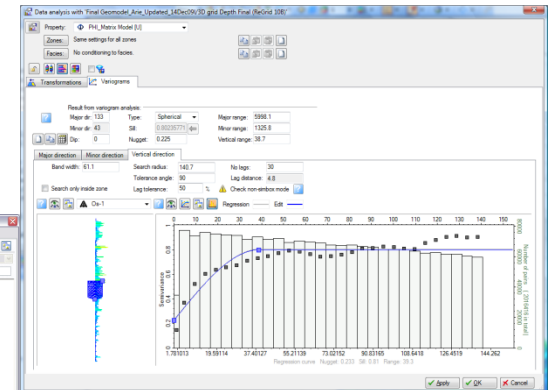
## Workflow - Geological & Fracture Modeling

### Example : Matrix Porosity Modeling Result



#### Variogram Analysis

Major Dir : 133  
Minor Dir : 0.1097  
Major Range : 4985  
Minor Range : 928.2  
Vert. Range : 38.7  
Nugget : 0.225

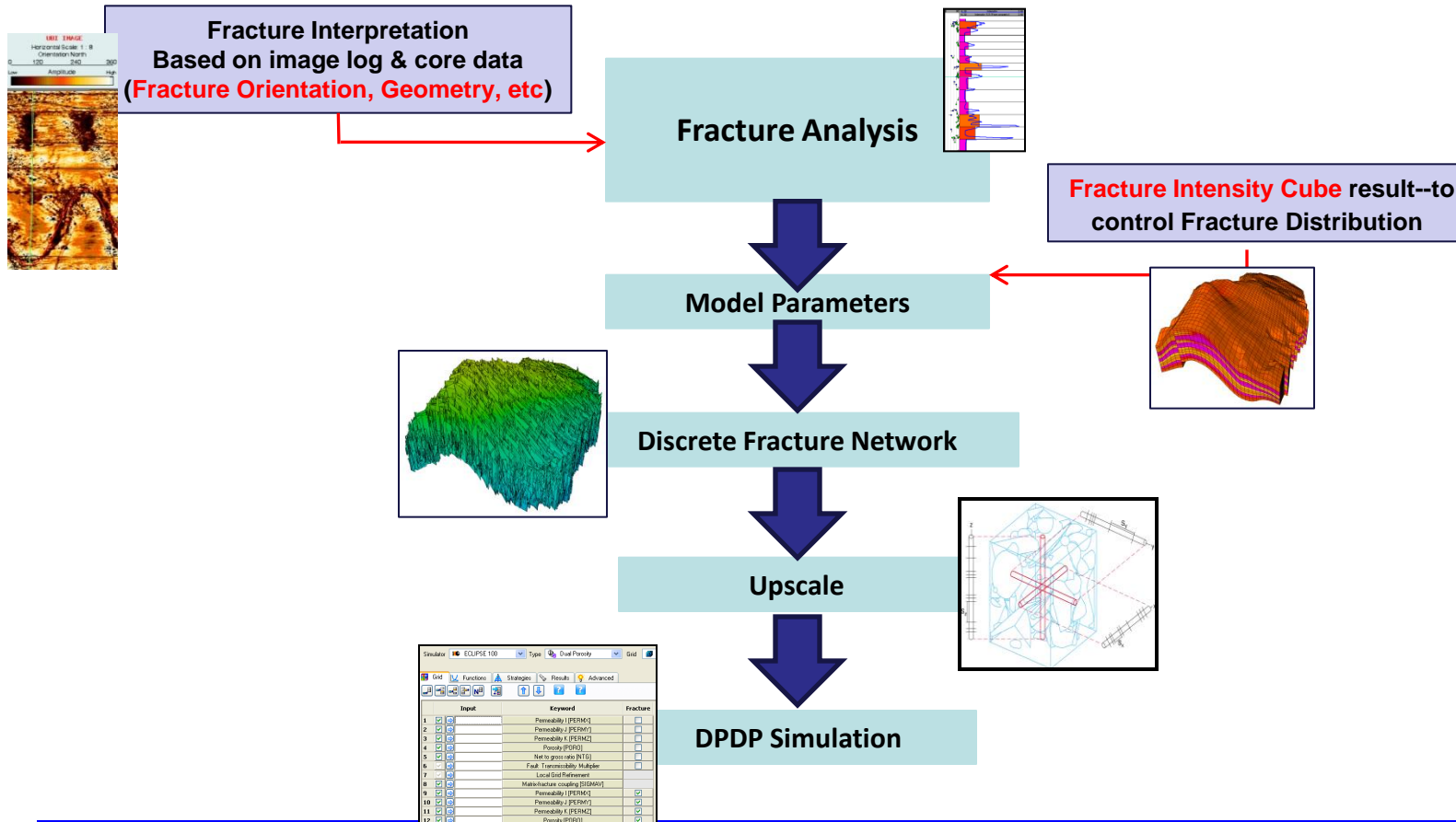


Name	Type	Min	Max	Delta	N	Mean	Std	Var	Sum
Property	Cont.	0.0000	0.2054	0.2054	730928	0.0339	0.0209	0.0004	24800.6951
Upscaled	Cont.	0.0000	0.2054	0.2054	259	0.0332	0.0261	0.0007	8.5865



## Workflow - Geological & Fracture Modeling

### Fracture Modeling



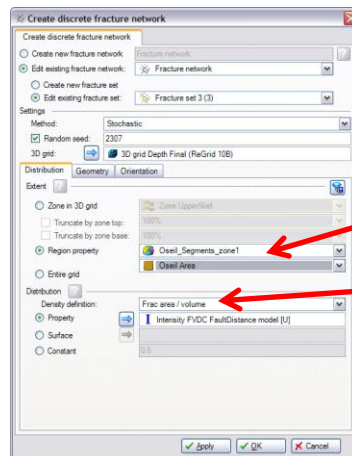


## Workflow - Geological & Fracture Modeling

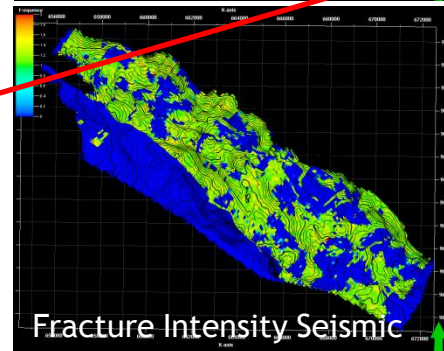
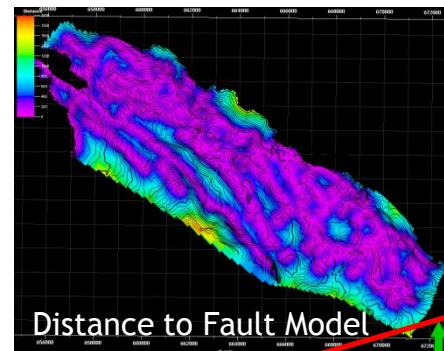
### Input for Model Parameter

Model parameters are the object that controls the intensity of the fracture, called fracture drivers.

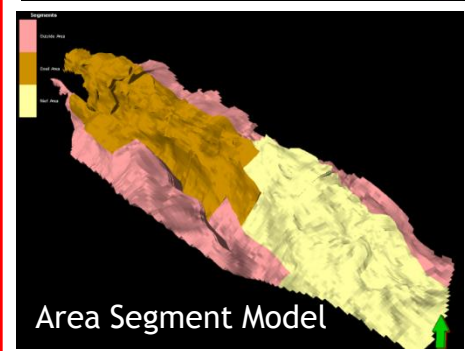
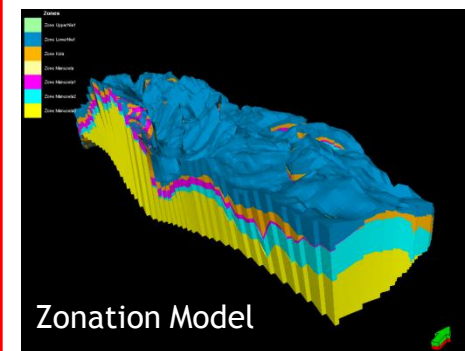
- Lithological/Facies drivers
- Seismic drivers
- Mechanical drivers



Main input for the fracture distribution



Main input for the area extension of the fracture

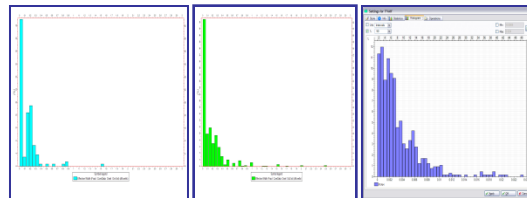
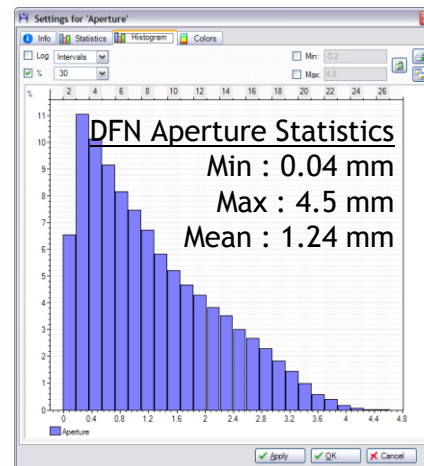
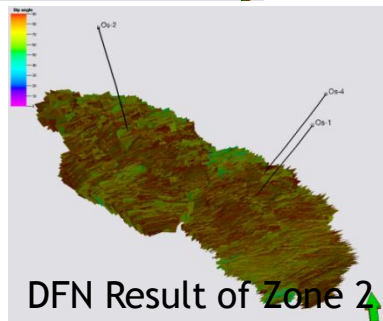
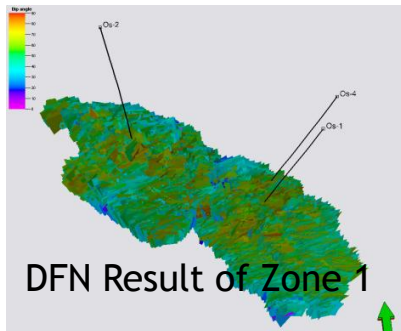




## Workflow - Geological & Fracture Modeling

### Discrete Fracture Network

- A fracture network is a group of planes representing fractures.



#### Distribution Method :

Use the Intensity from distance to fault and seismic fracture intensity

#### Geometry :

Fracture Aperture, QC with the data from image log & core data

#### Orientation :

Main trend of azimuth/dip should be inline with the fracture from well



## Workflow

# The Well Placement in Oseil Field

- Undrained area
- The distance from oil-water contact and target zone in upper part of Manusela fm
- Fracture intensity
- Interference well analysis
- Avoid the fracture directly connected to aquifer zone
- Horizontal length



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Workflow - Well Placement

## Well Placement Results

- 4 new development wells were proposed & designed based on this integrated study
- The positive economic results shown from these 4 wells. The most successful well (Os-2 ST2) and Os-16 well with < 0.5% water cut.

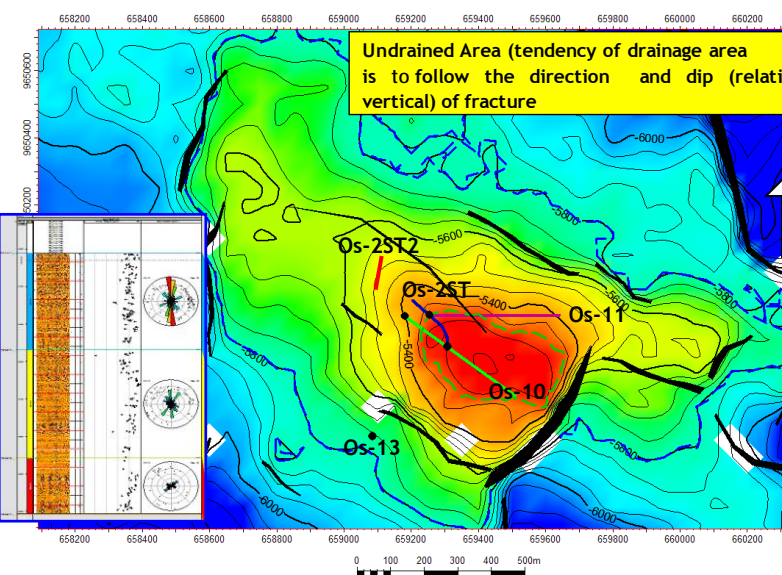


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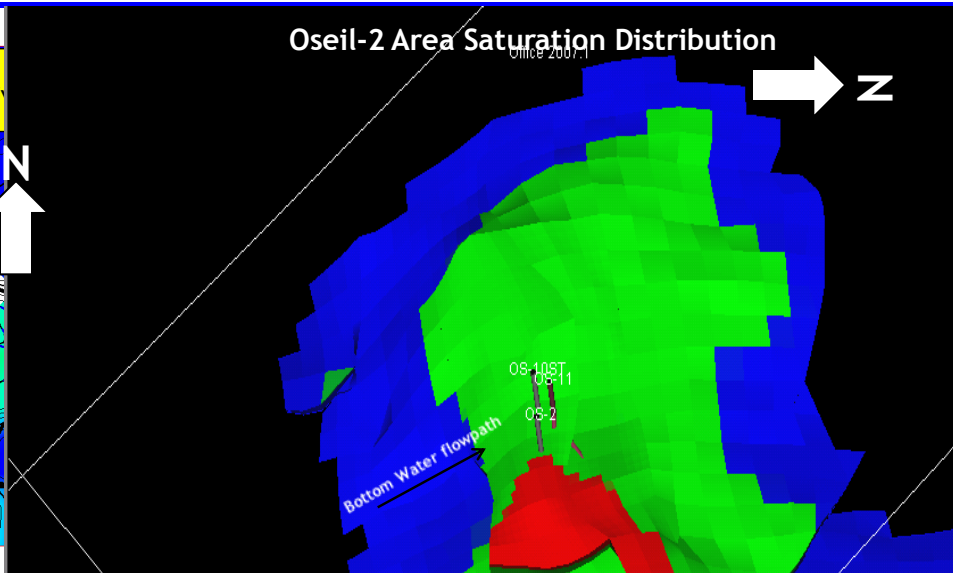
## Os-2ST2



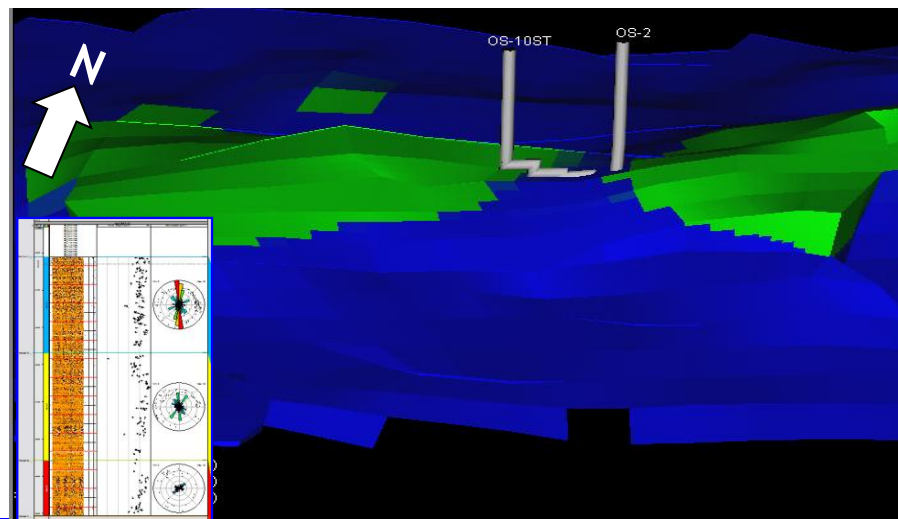
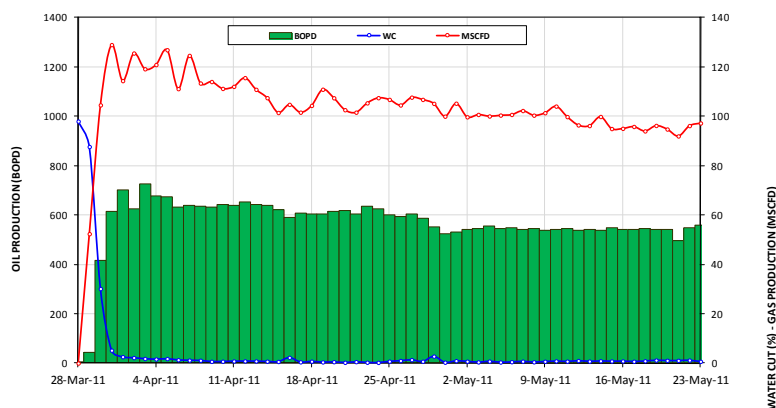
### Undrained Area



### Oseil-2 Area Saturation Distribution



### OS-2 ST2 INITIAL WELL CLEAN UP AND TEST DAILY AVERAGE



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Fractured Carbonate Reservoir

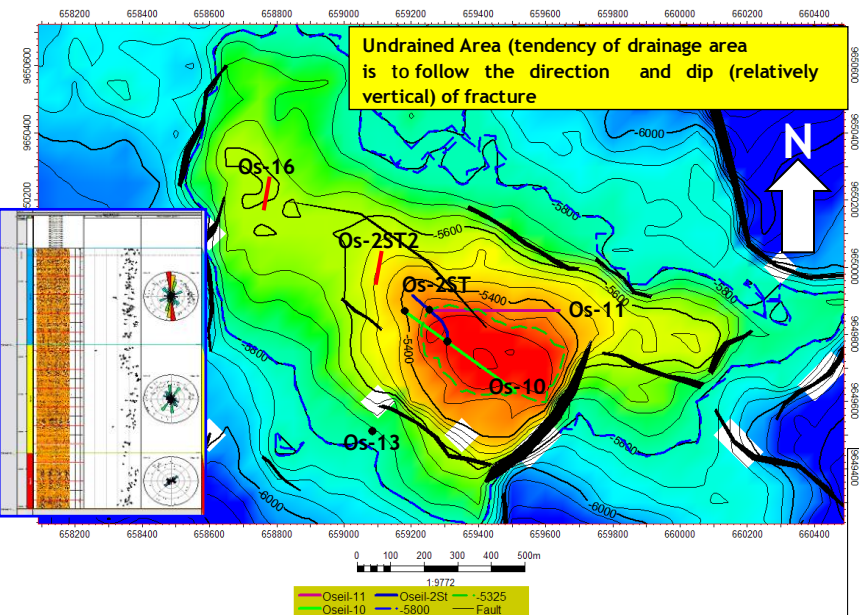


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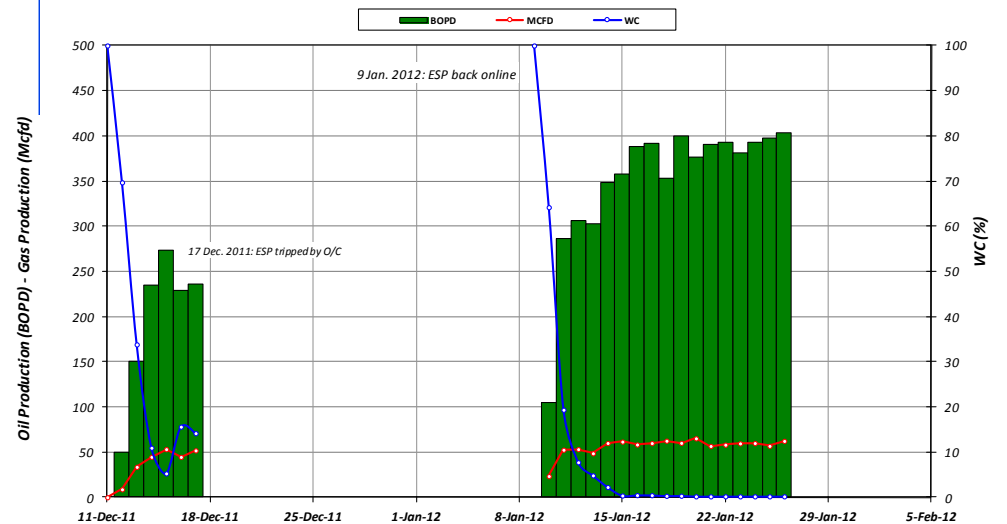
## Os-16



### Undrained Area



### OS-16 Initial Well Test (ESP) - Daily Average



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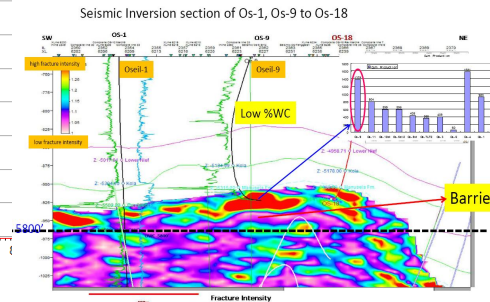
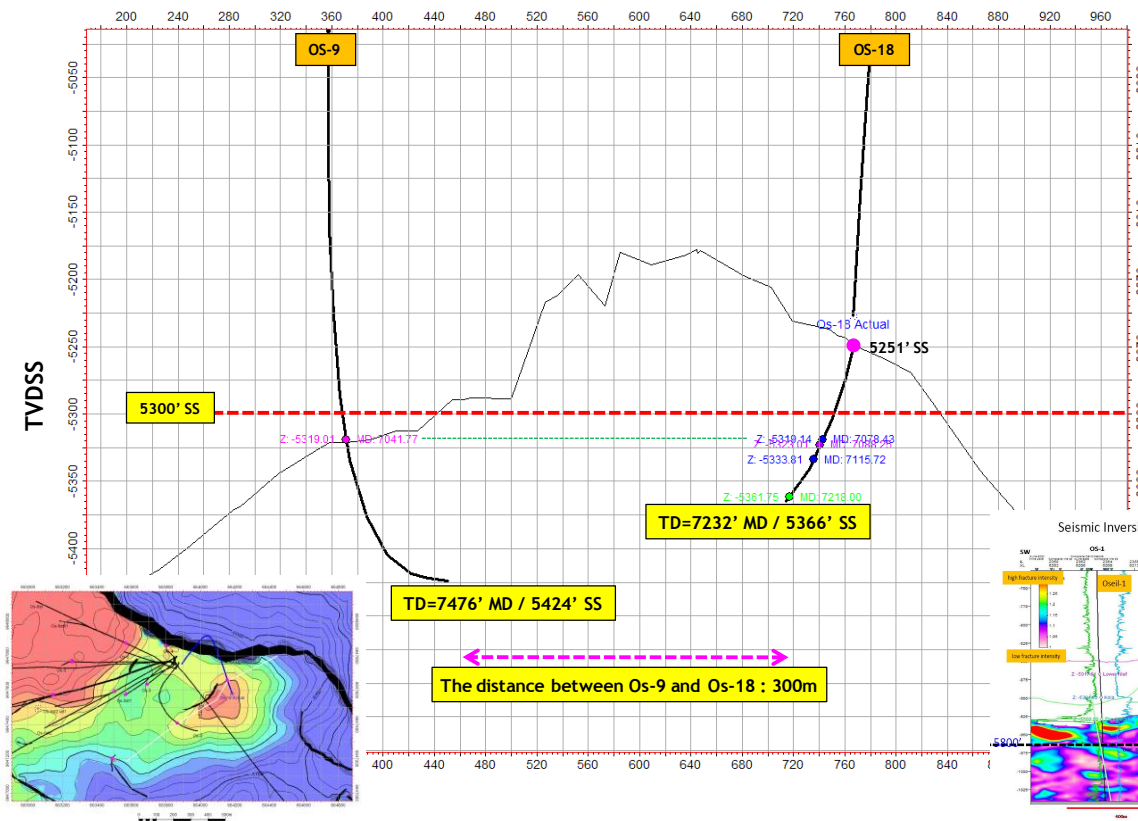
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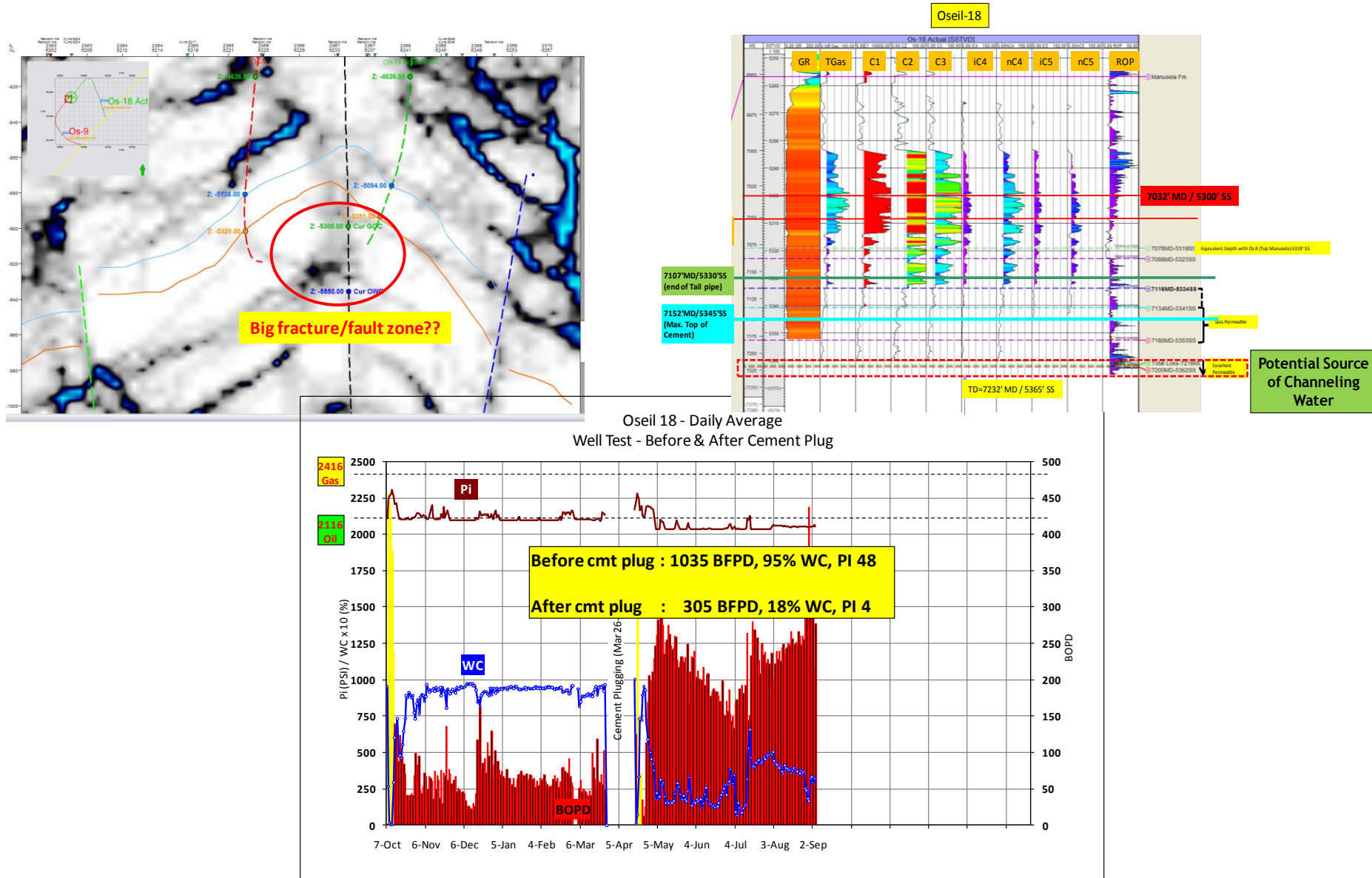
## Avoid the fracture directly connected to aquifer zone Well with early water break-through

- New well with TD **shallower--60** ft--than nearby well
- Both penetrate the high intensity fracture zone with total loss encountered at bottom of the well
- New well suffers early water breakthrough with **water-cut reaching 95%**



## Workflow - Seismic Attribute

### Ant-Track result-- Avoid the fracture directly connected to aquifer zone





## Conclusion

- Integration of well & seismic data provides better comprehensive understanding
- The result of seismic fracture intensity is aligned with the well
- Total loss circulation during drilling correlates with the intensity of fractures
- Seismic attributes should constantly be utilized to identify anomalies
- Need more effort to incorporate mud loss and drilling parameter into the update model



## Questions



**Thank You**