



# What's Next in Seismic Interpretation

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## Frontier exploration, deepwater or ultra-deepwater plays.

- Finding and exploitation costs are high, commerciality cannot be guaranteed for even large discoveries.
- Success requires diligence, imagination and as much geological information as possible.

## Mature basin, near infra-structure exploration & development

- Understanding geological subtleties is critical successful brown-field exploration and maximising recovery to extend the life of existing infrastructure.
- Large discoveries still possible but require new insights from available data.

~\$8000M global annual spend on seismic acquisition and processing.

11,500,000 sq km of “licensed” offshore acreage most covered by seismic

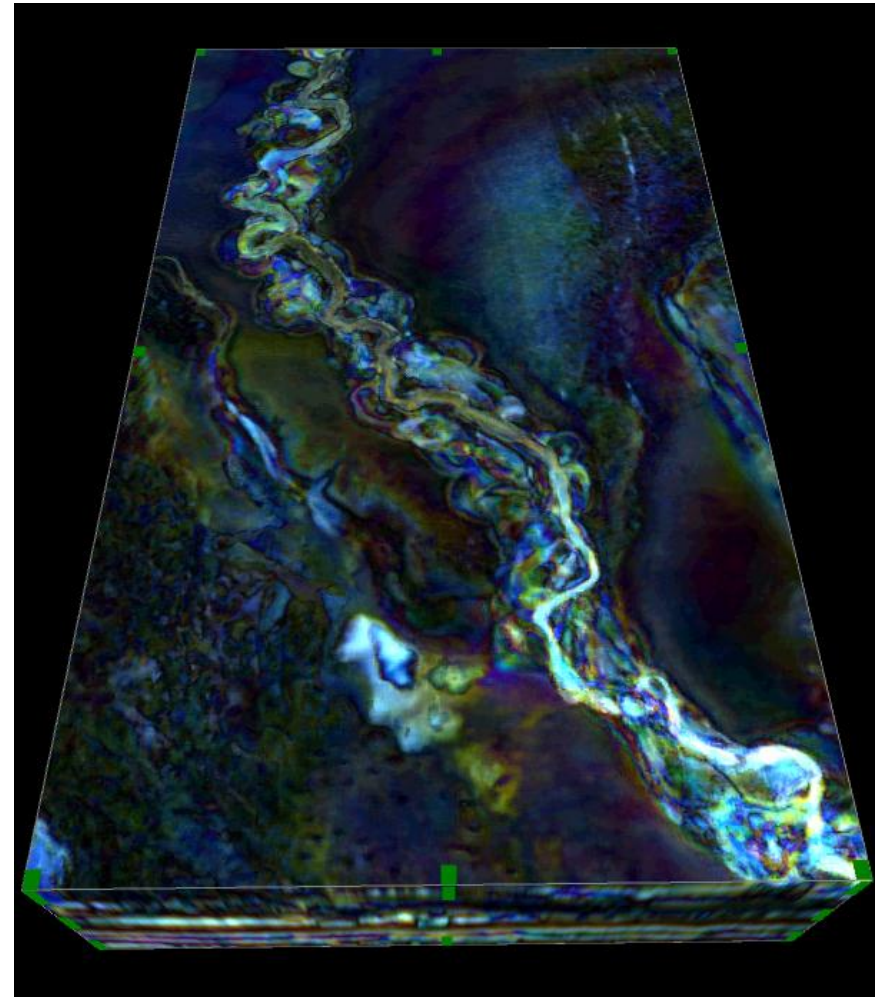
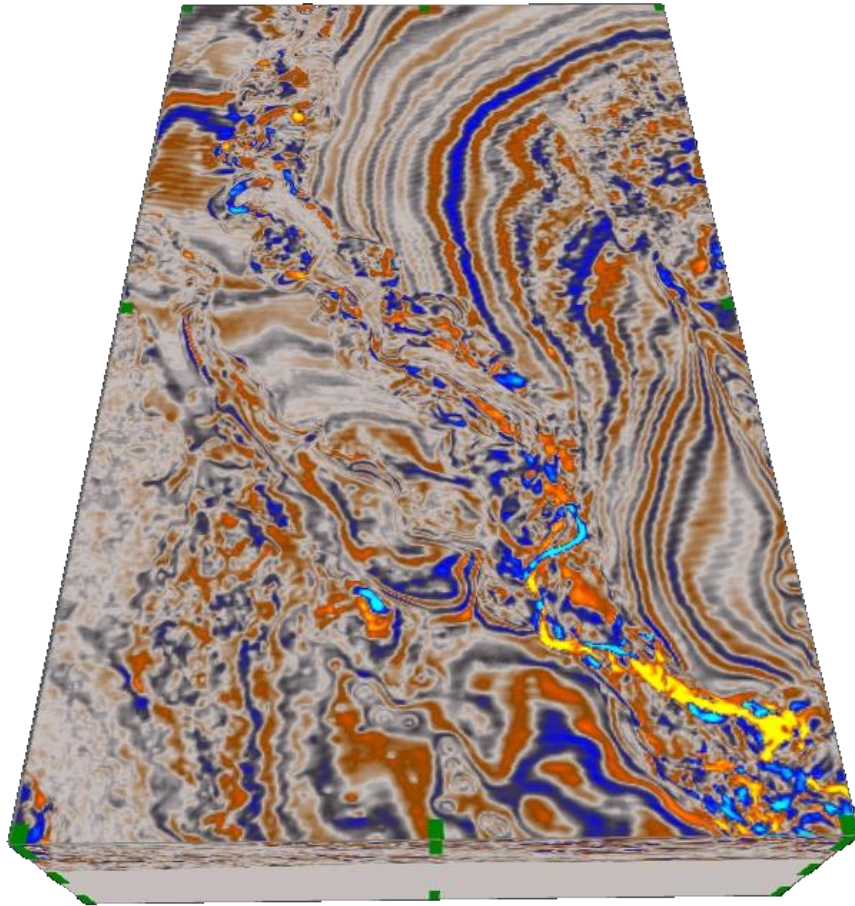
## The **Value of Data** comes from the **Information** it contains...

- > Conventional horizon and fault interpretation captures only a small fraction of the information contained in seismic data.
- > **The majority of information is only accessed by analysing the geological expressions contained within seismic data.**
- > Geological expression analysis techniques already exist and are based on post-processing of seismic data.
- > More “processing” can lead to information overload rather than better understanding.

..the **Value of Information** is in the **Understanding** it confers.

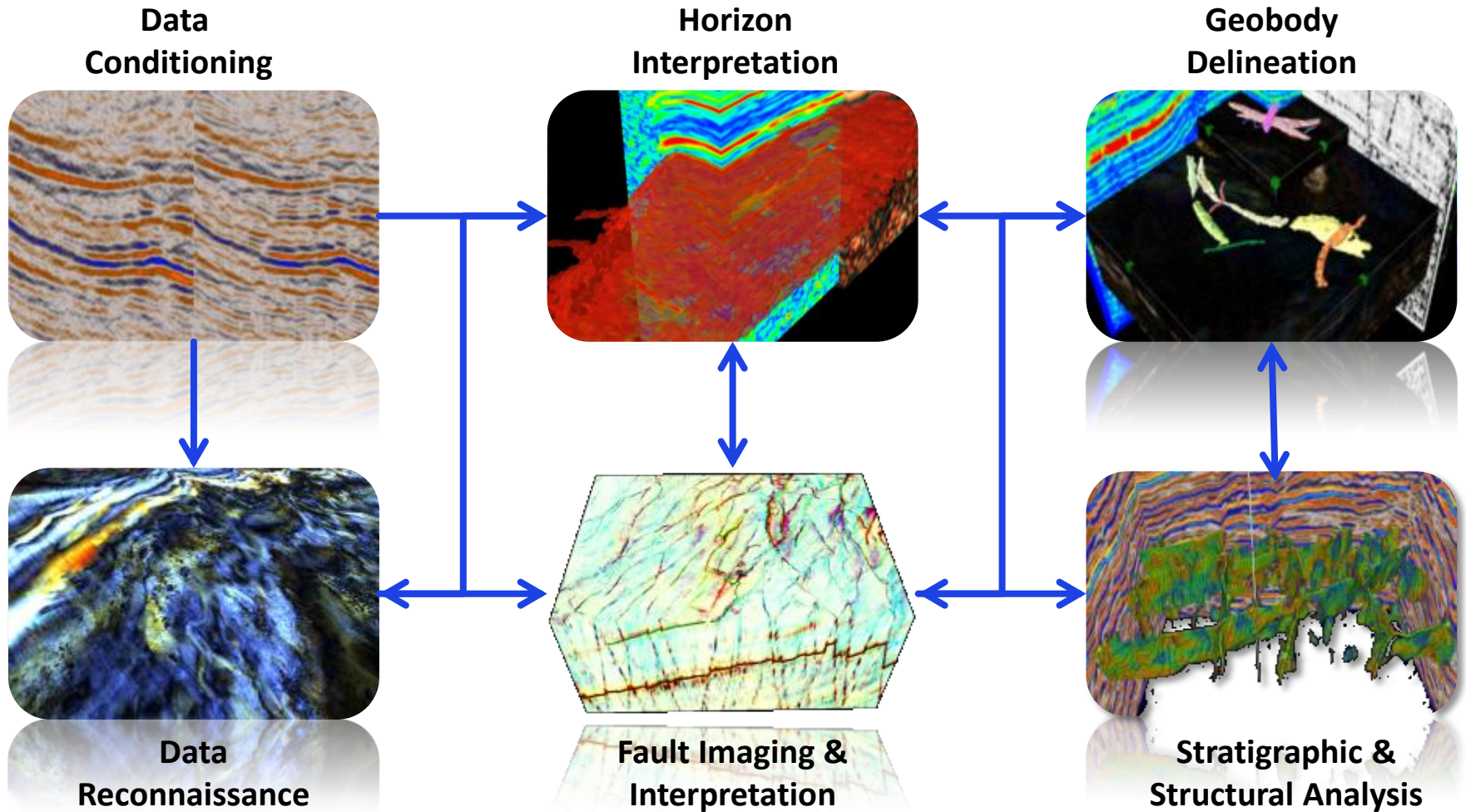
**The solution is to make geological expression the core of a data driven – interpreter guided fully interactive interpretation workflow.**

# Geological Expression





# Geological Expression workflow

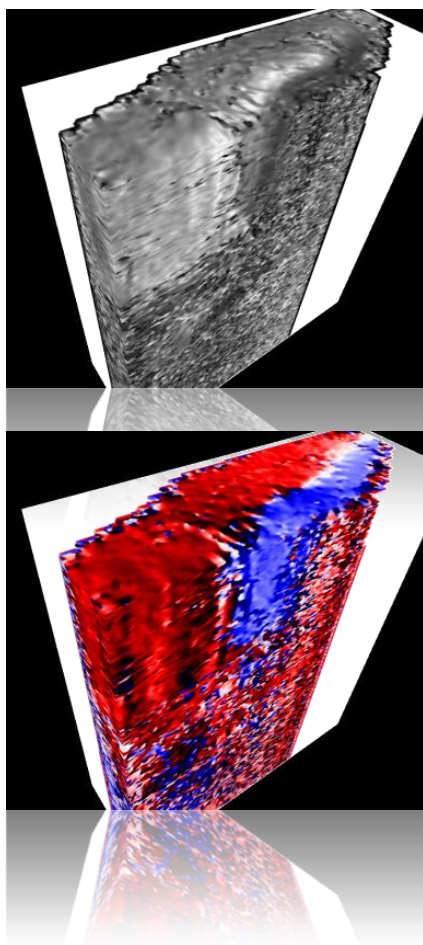


A practical Geological Expression workflow requires a new Data Driven  
– Interpreter Guided interpretation paradigm incorporating:

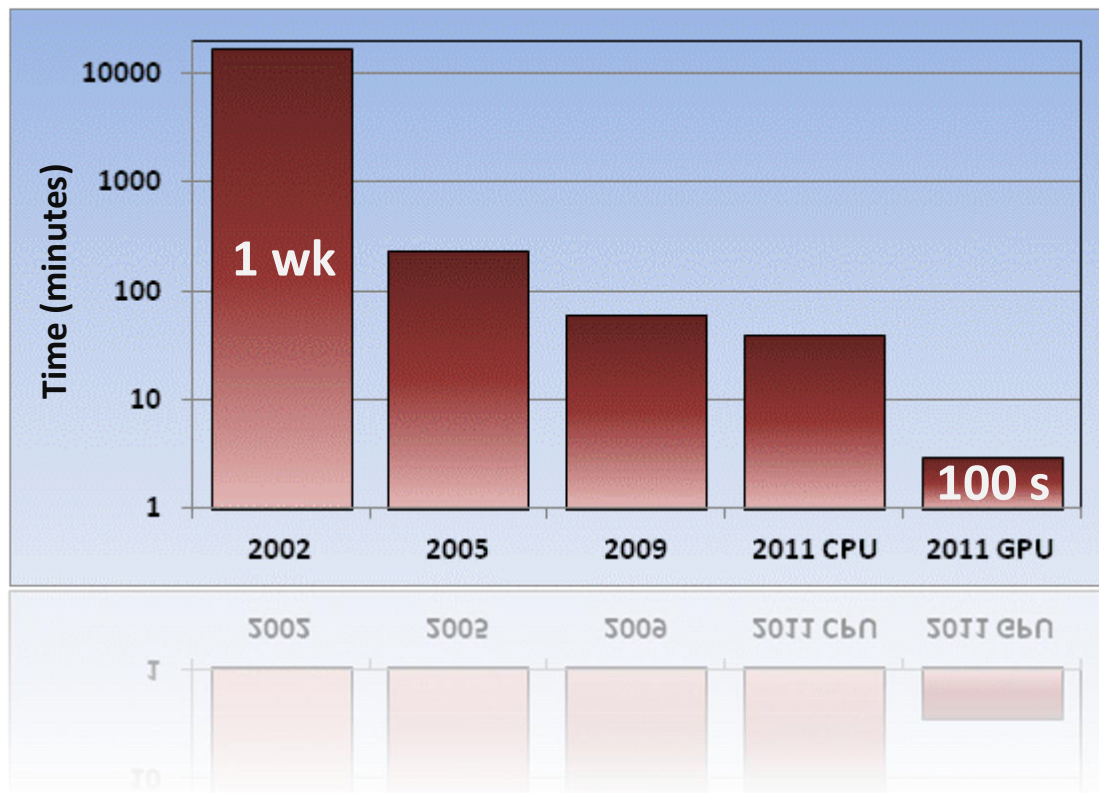
- On-demand extraction of geological expressions.
- Interactive fault delineation.
- Interactive geobody delineation.
- Interactive well / seismic facies classification.

**Speed of Analysis = Speed of Interpretation**

# Compute power at your desktop



## Volume Attribute Computation Times (200 sq km)



## Why is speed important?

- Seismic data is an incomplete and ambiguous representation of geology.
- Interpretation has to combine objective analysis of the geological expression contained in the seismic with expert assessment.
- Geological expression results have to be available instantly to avoid upsetting the interpreters thought process.
- Minimise data overload.

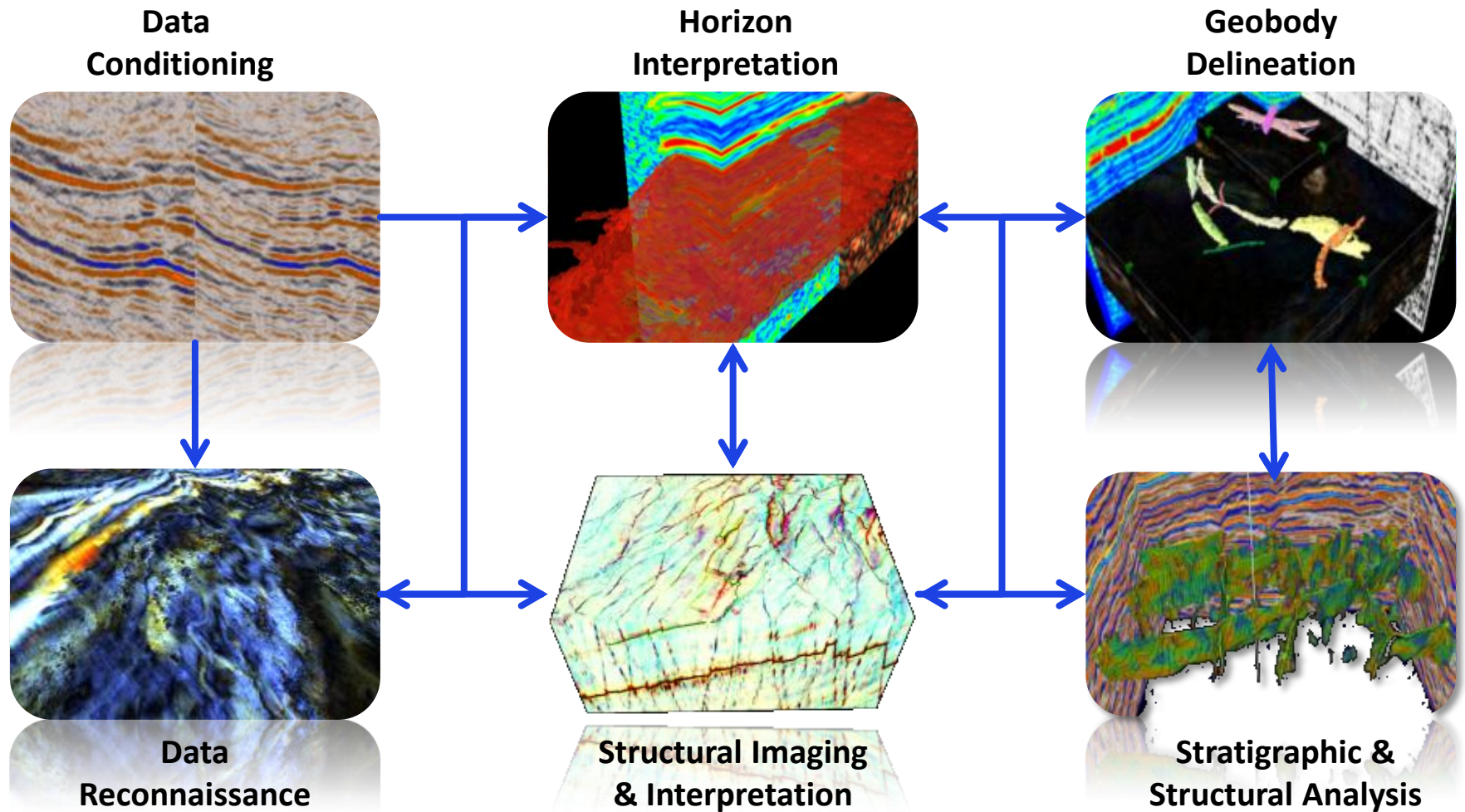
## Hardware & Software

- Interpretation likely to be desktop workstations based for several years.
- Almost all modern workstations are CPU / GPU heterogeneous clusters.
- Taking advantage of the performance heterogeneous workstations requires changes to software architectures.
- Minimising hardware dependencies increases the cost of development .

Computing technology has not reached a steady state.  
Costs (£/Gflop) will continue to fall: Architectures will continue to change.



# Geological Expression workflow

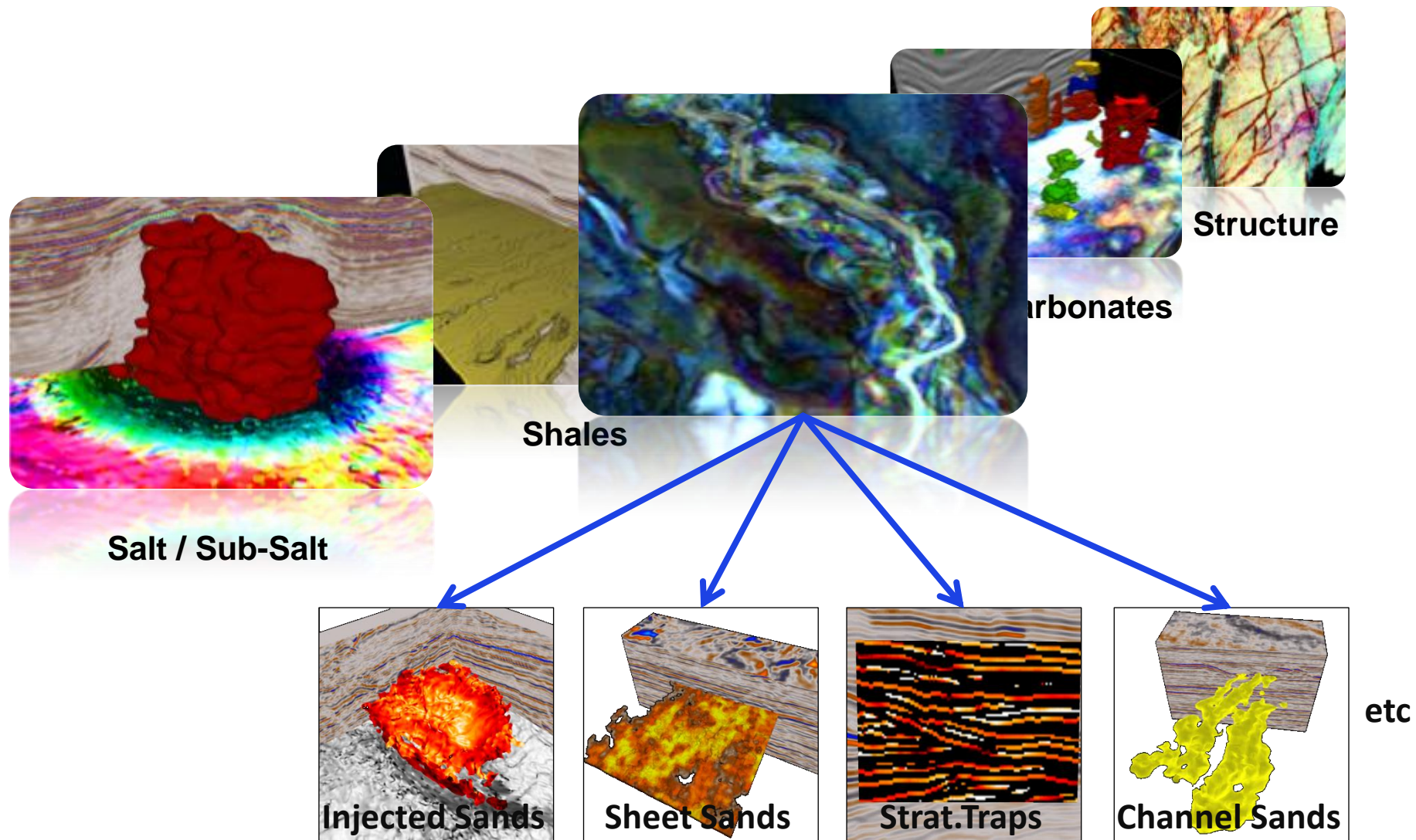


# Geological Expression Challenges & Solutions



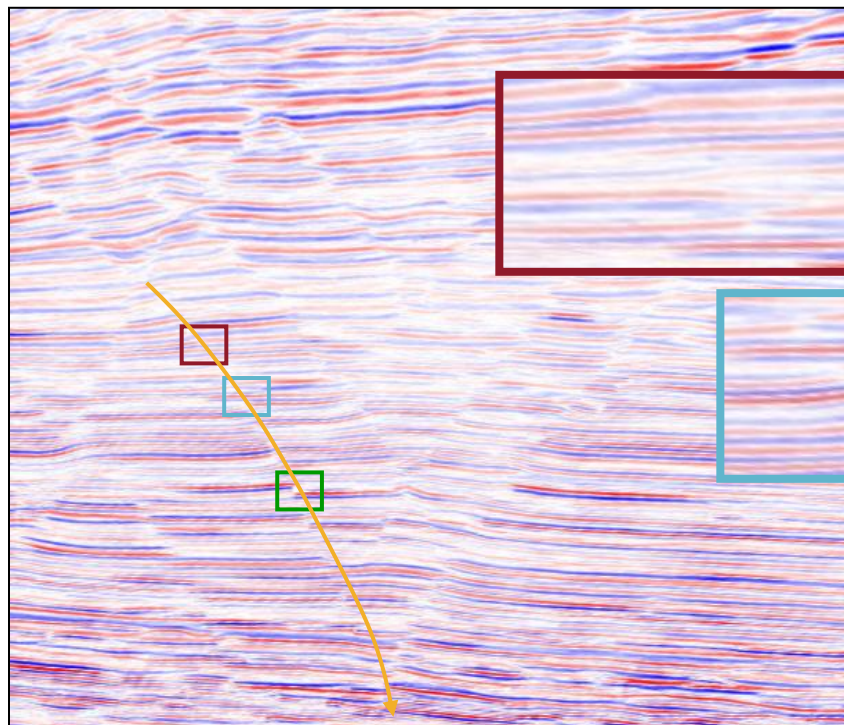
1. Must accommodate large geological variations and large data variations.
  - i. Geology direct workflows,
  - ii. Colour visualisation .
  
2. Must recognise that seismic doesn't give the whole answer.
  - i. Data driven – interpreter guided workflows,
  - ii. Combined well / seismic workflows.
  
3. Must provide new information.
  - i. New seismic analysis workflows.
  
4. Mustn't exacerbate the problem of data overload.
  - i. Interactive processing / information on demand.
  
5. Must facilitate a smooth flow of information.
  - i. Integration.

# Geology Directed Workflows





# Colour Visualisation and Analysis



**Reflectors are continuous with no amplitude variation across the fault plane**

**Reflectors are continuous and present an abrupt amplitude variation across the fault plane**

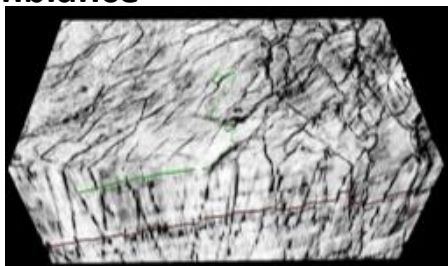
**Reflectors are discontinuous with amplitude variation across the fault plane**



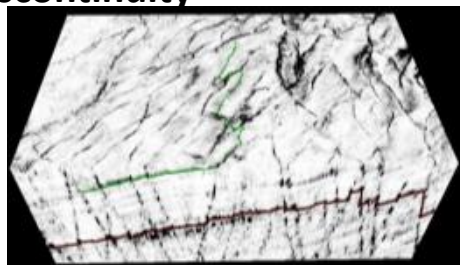
# Colour Visualisation and Analysis

## Improved Attribute Algorithms – Colour Blending

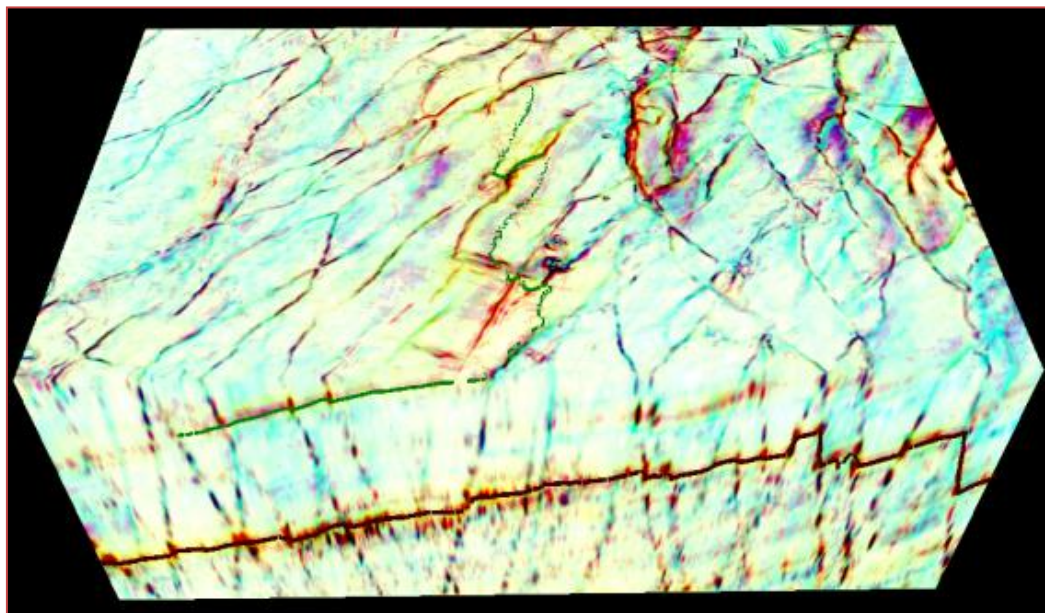
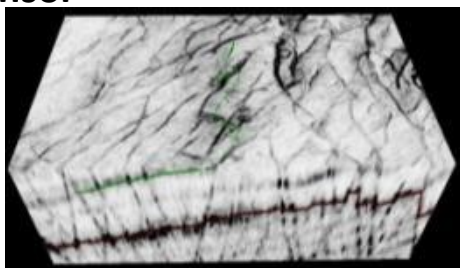
Semblance



Discontinuity



Tensor



Flexures

2km

Semblance



Phase discont.

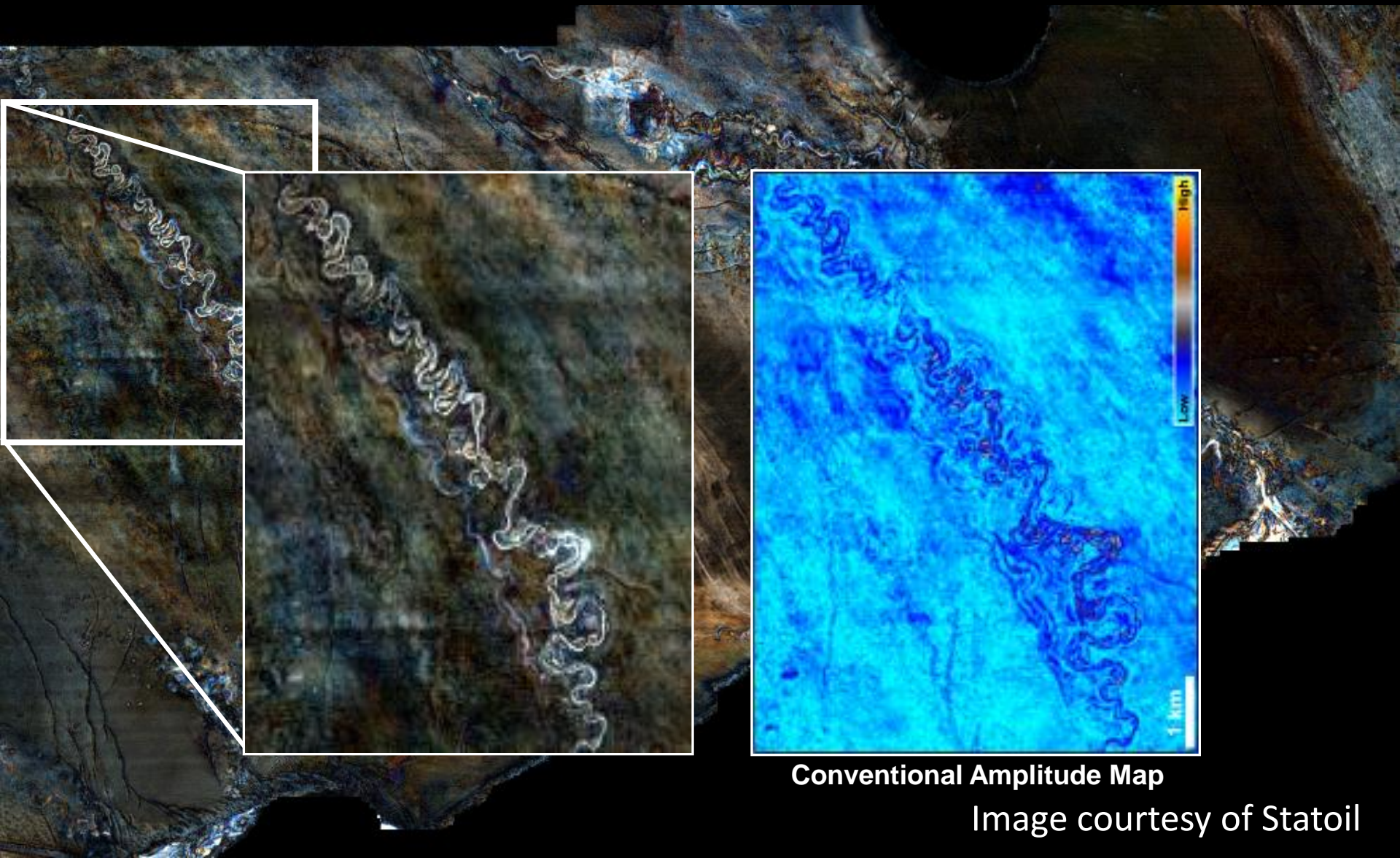
Amp discont.



Discontinuity

Tensor

# Colour Visualisation and Analysis

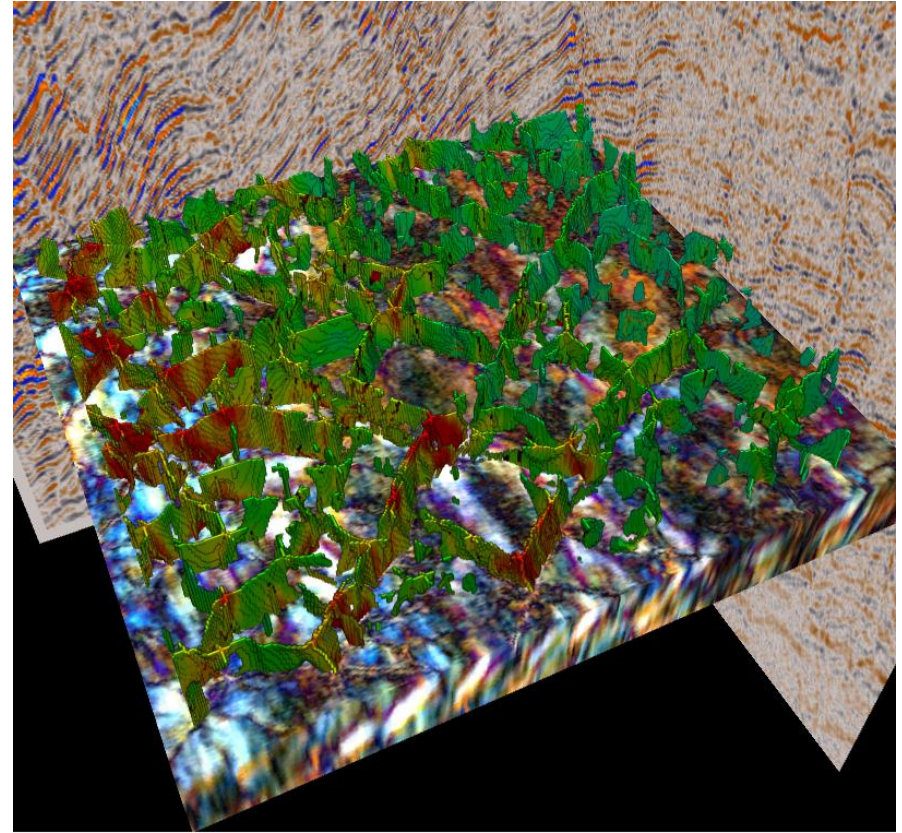
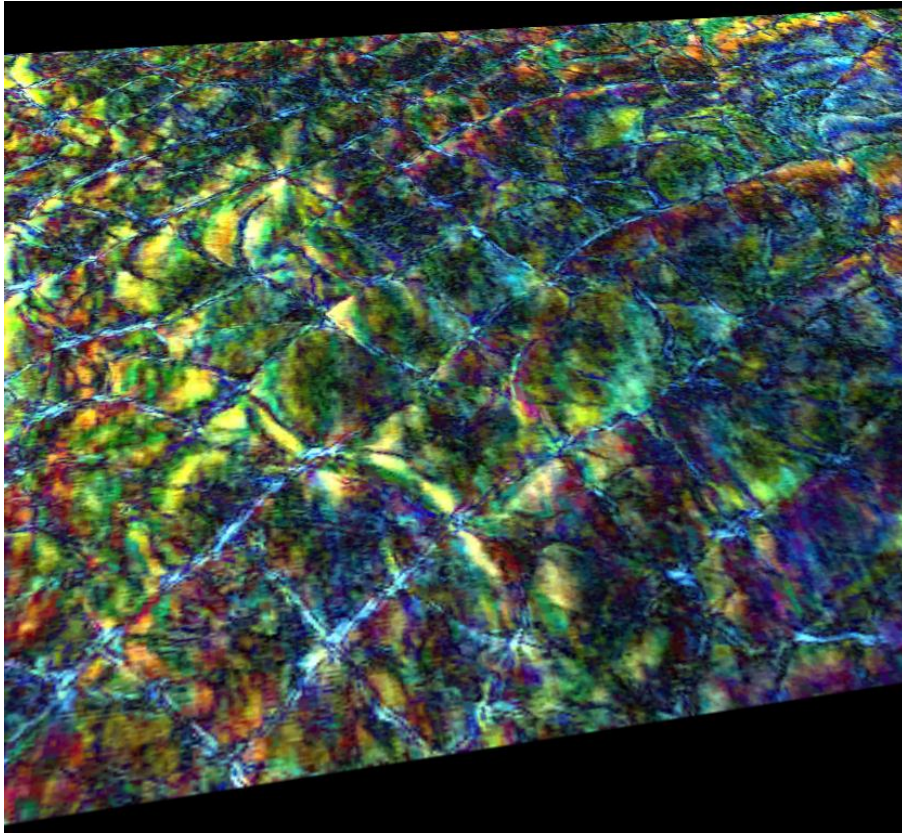


Conventional Amplitude Map

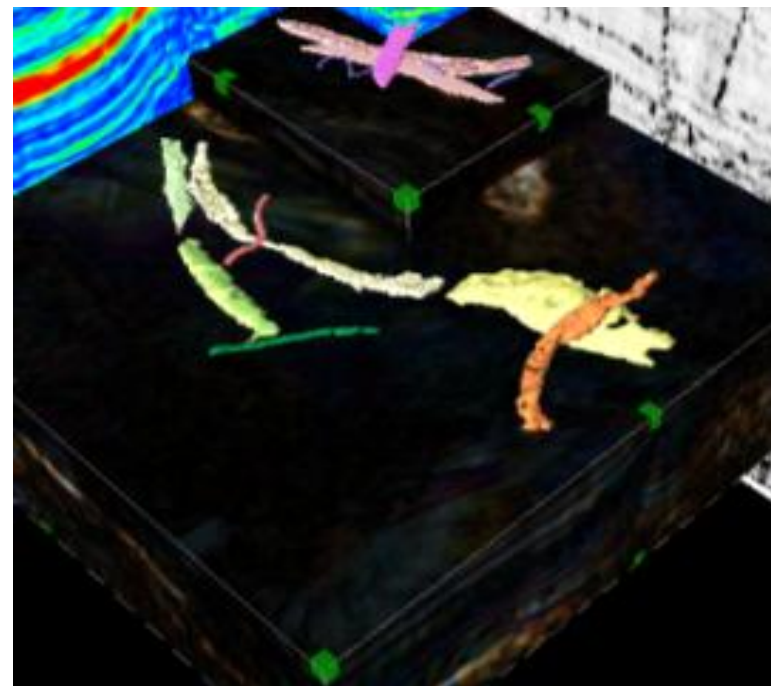
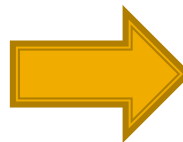
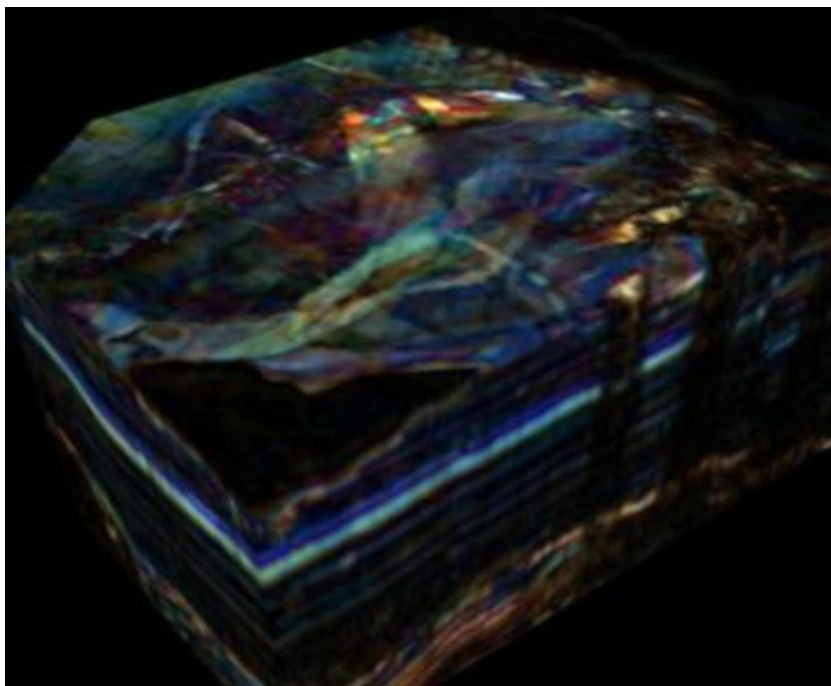
Image courtesy of Statoil



# Colour Visualisation and Analysis

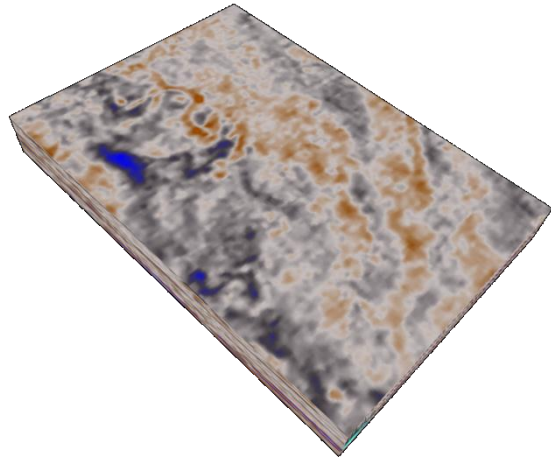


# Data Driven – Interpreter Guided Workflows

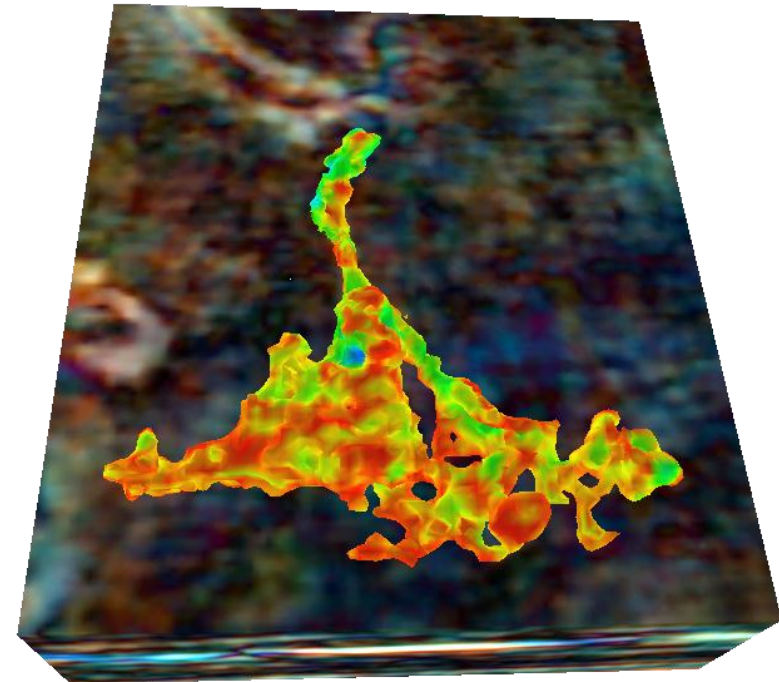
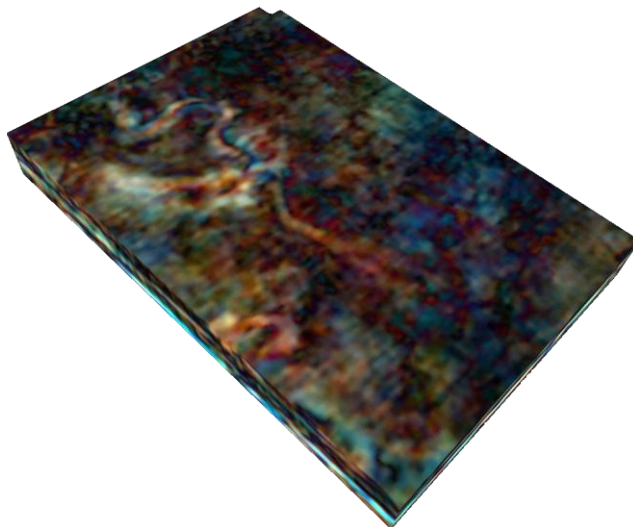




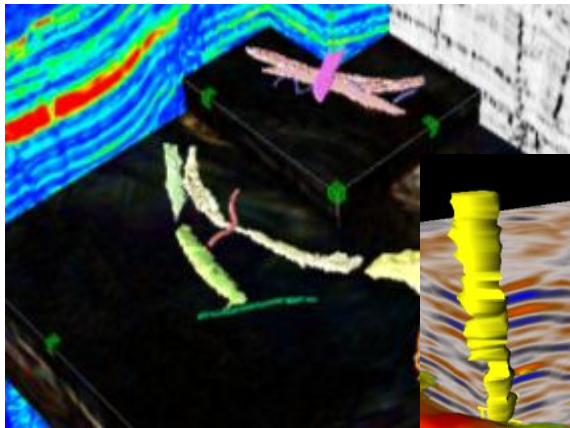
# Data Driven – Interpreter Guided Workflows



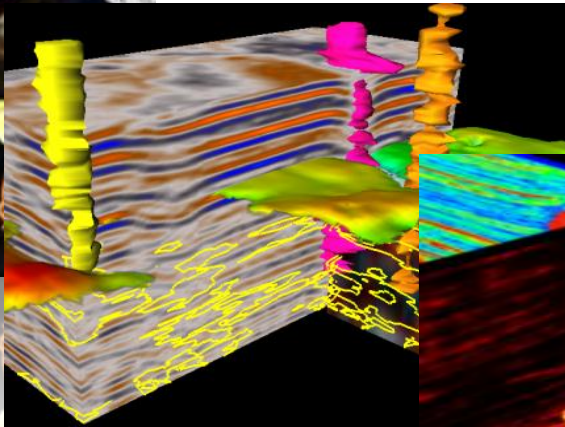
**Accurate delineation of 3D geological elements that were previously impossible to define from seismic data.**



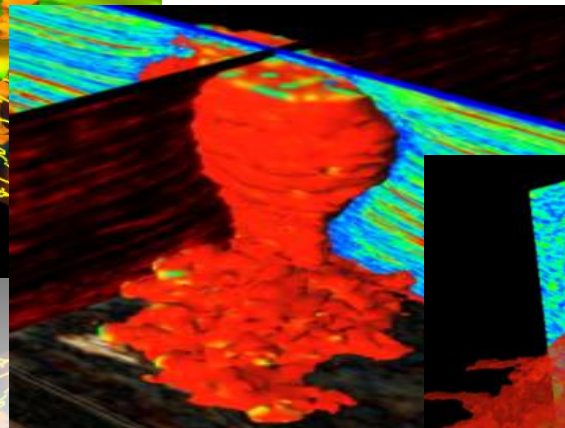
# Data Driven – Interpreter Guided Workflows



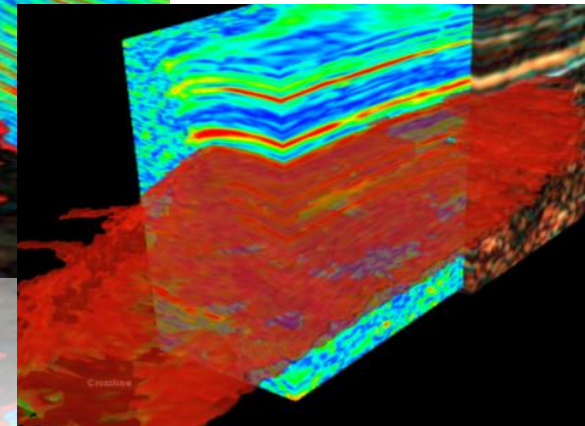
**Channels**



**Karsts**

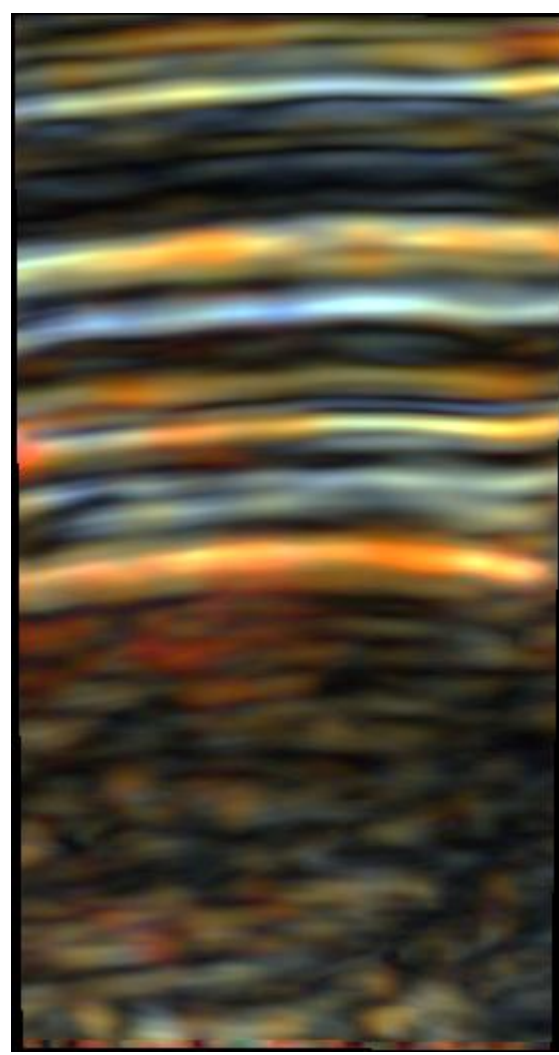
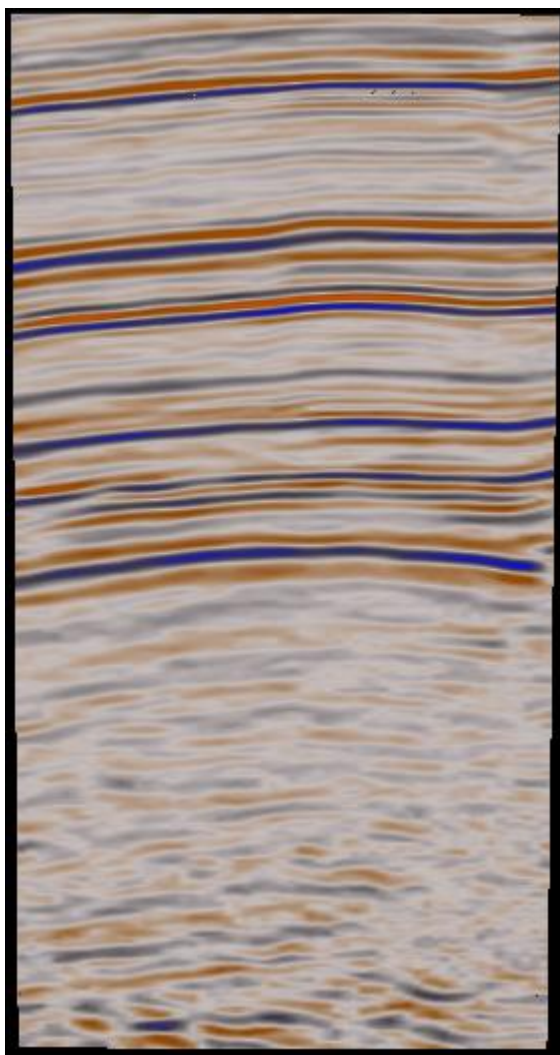
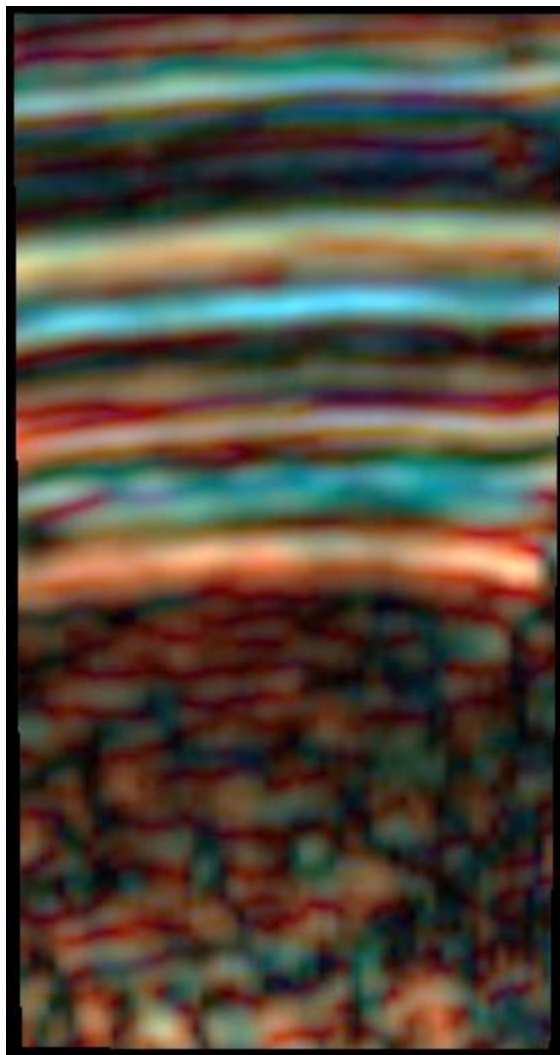


**Salt**



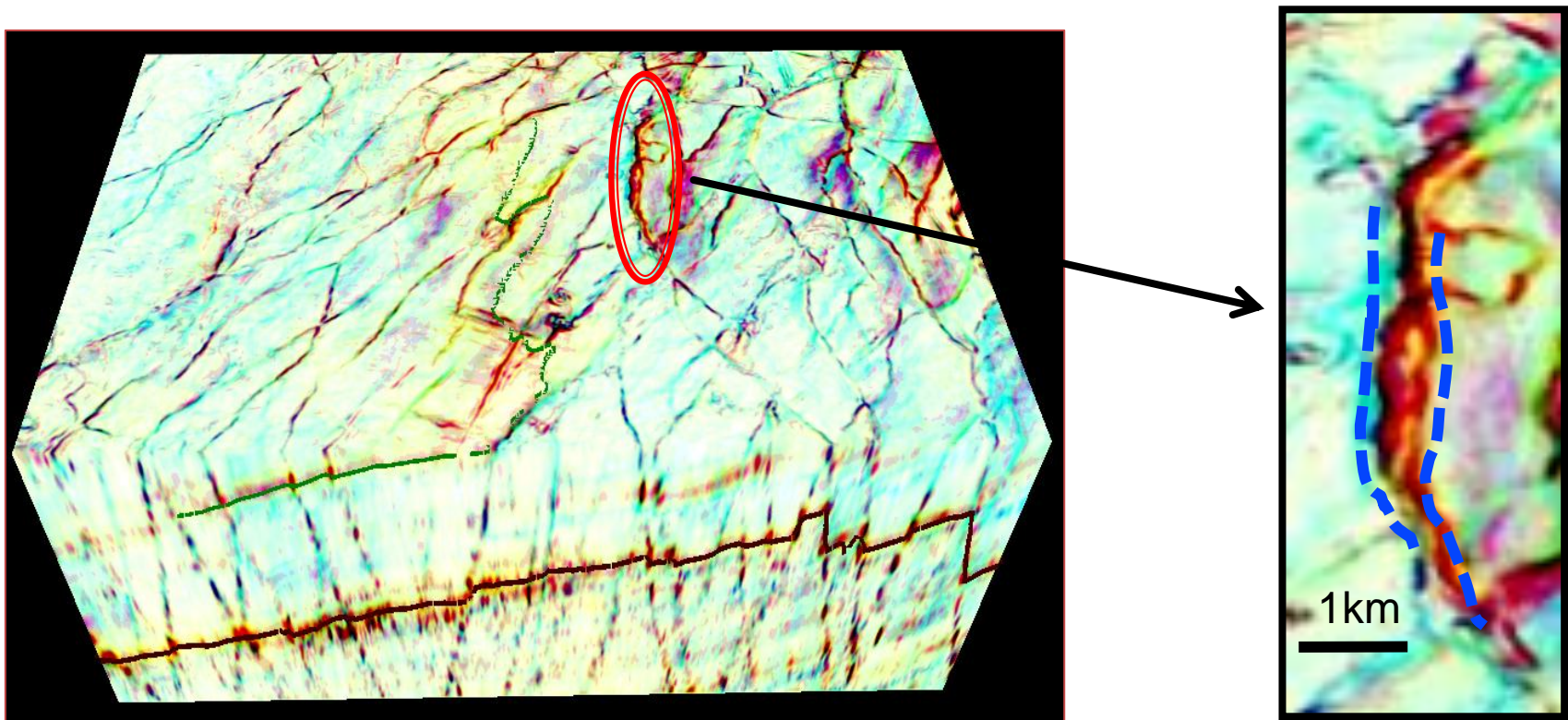
**Horizons**

# New Seismic Analysis Workflows





## Seismic Fault Damage Zone Analysis.



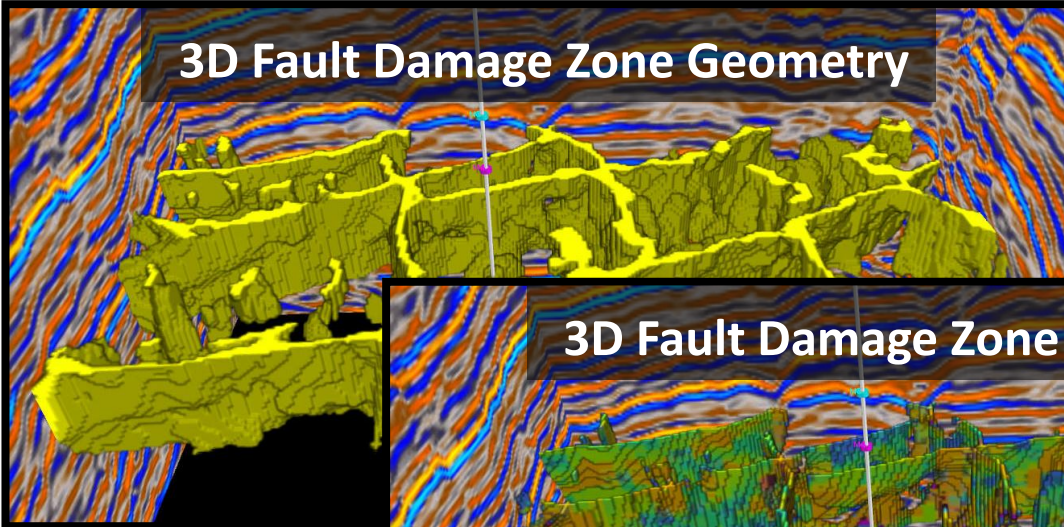
**Providing access to more and previously inaccessible information.**



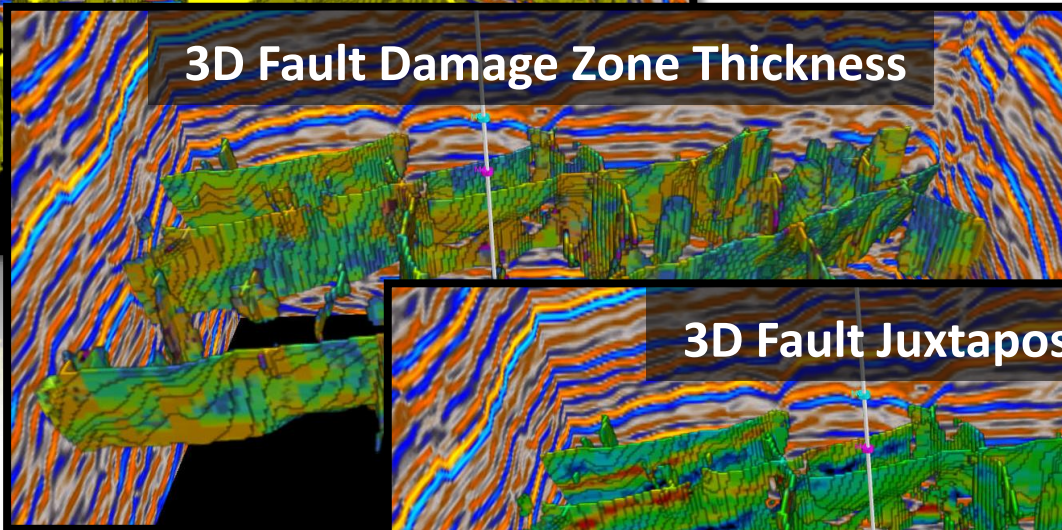
# New Seismic Analysis Workflows



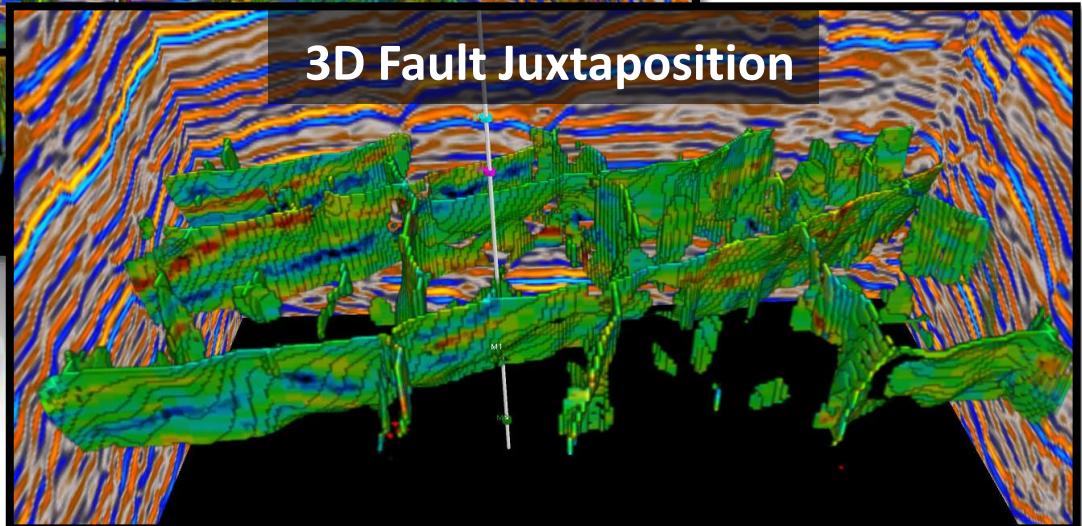
3D Fault Damage Zone Geometry



3D Fault Damage Zone Thickness



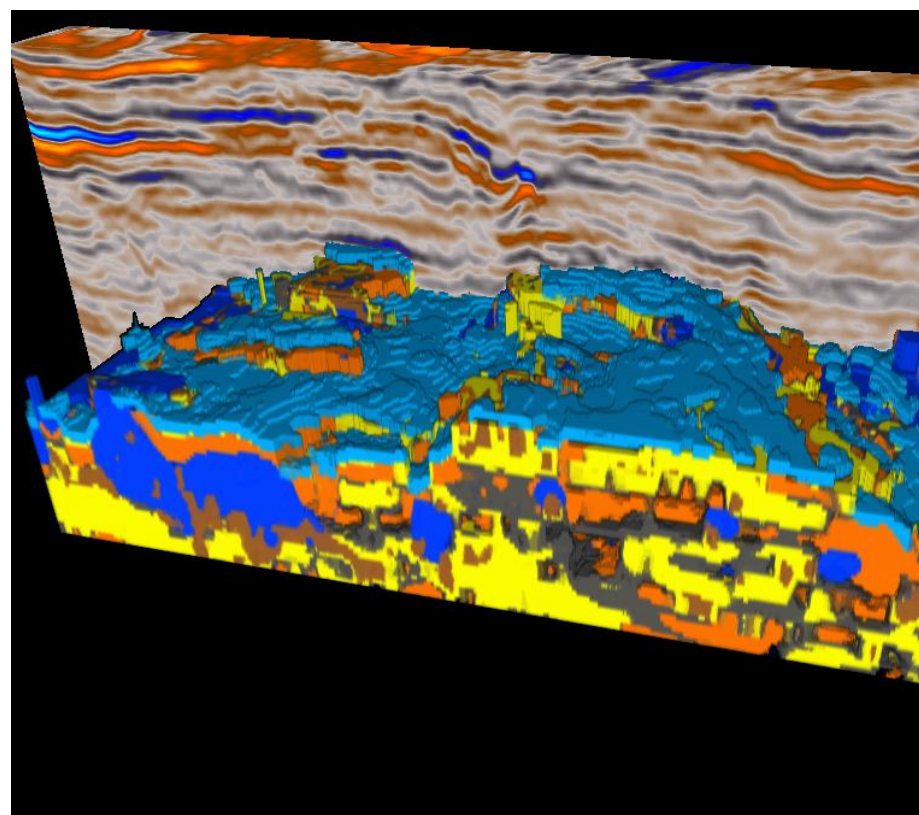
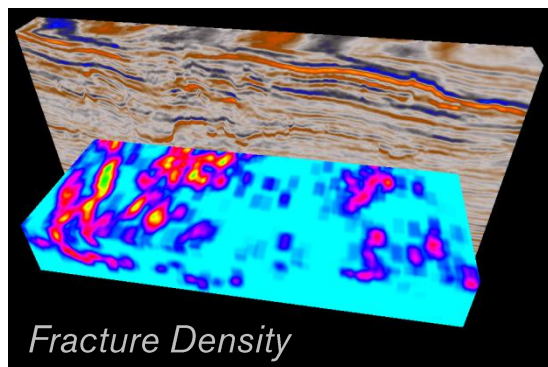
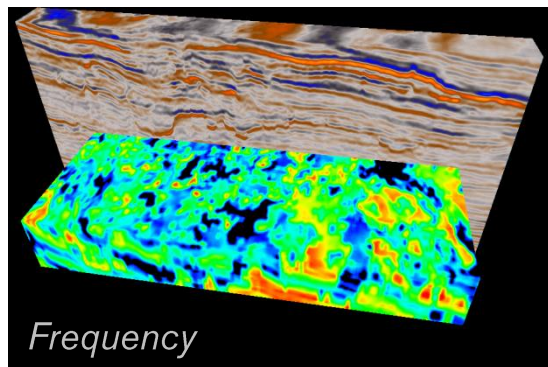
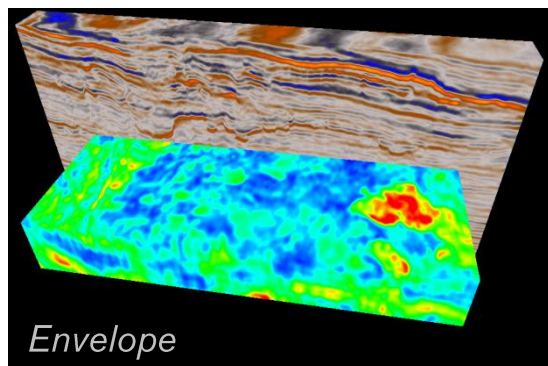
3D Fault Juxtaposition



# Combined Well & Seismic Data Workflows



## Interactive Facies Classification



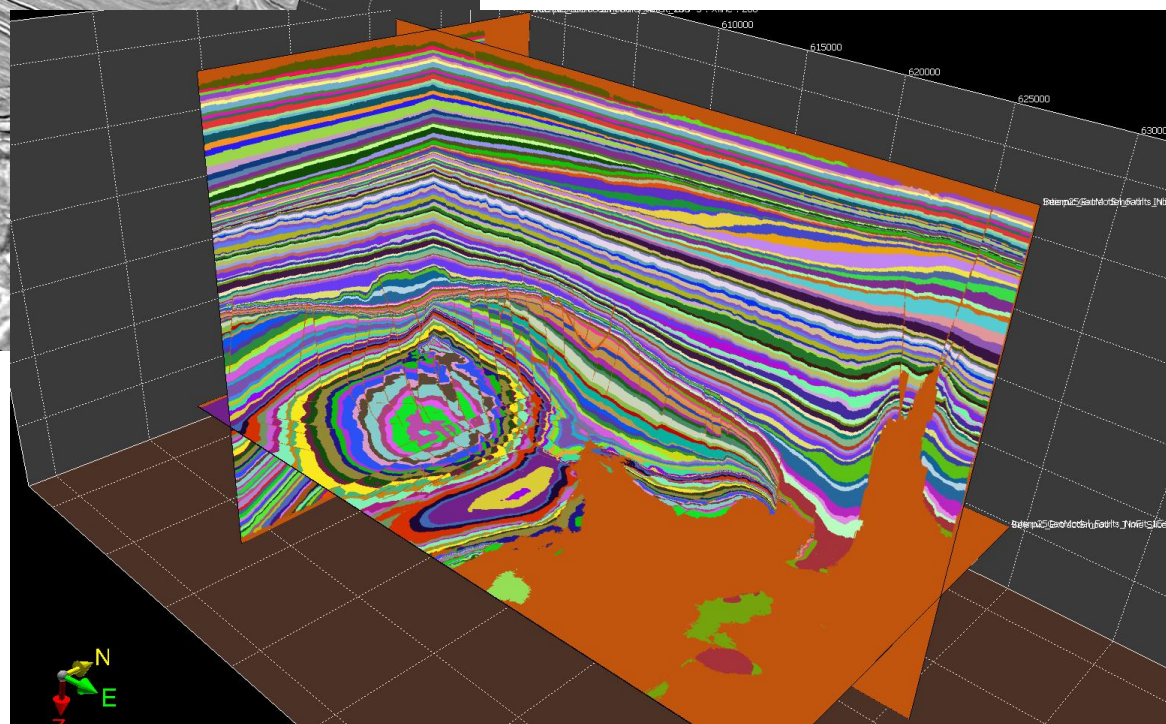
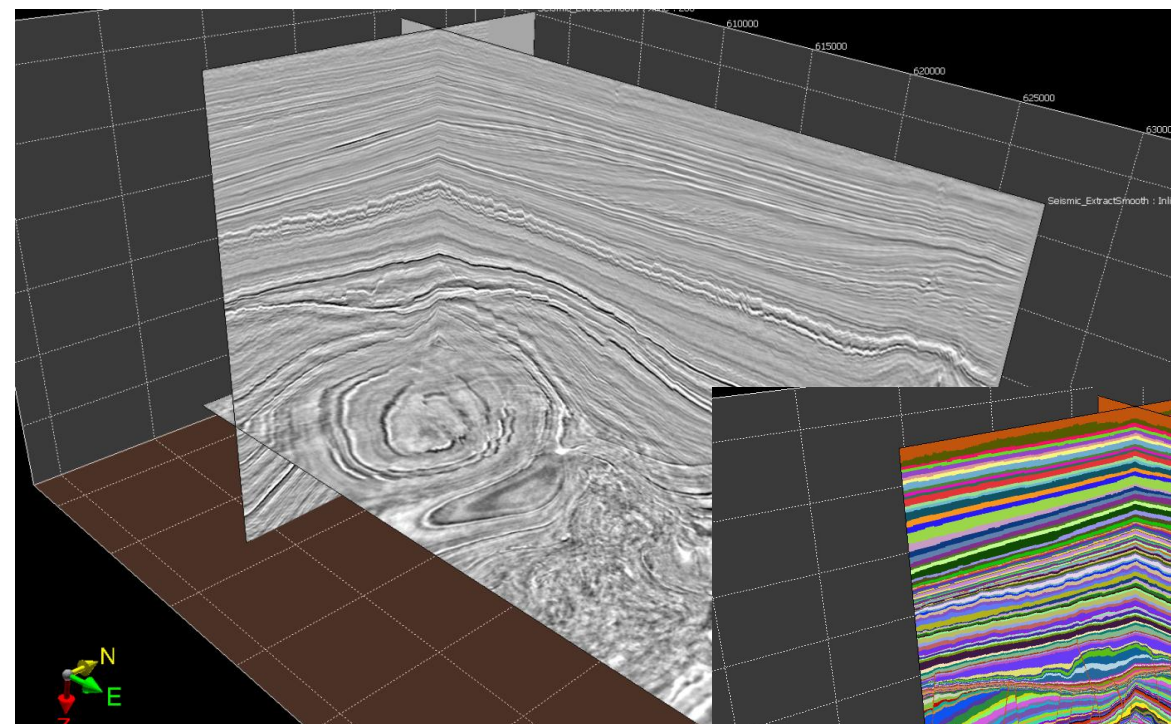
**Facies definition in seconds not hours or days.**



What Else?

ffa

## Automated Stratigraphic Delineation

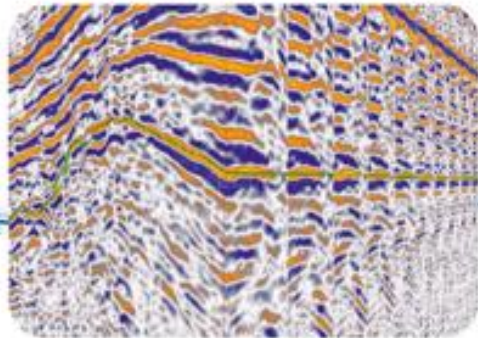




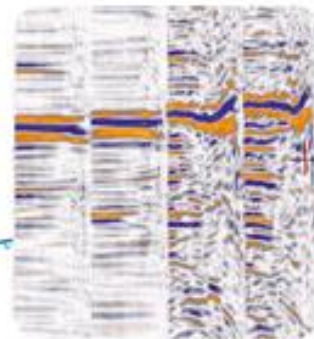
# What Else?

## Interactive Pre-Stack analysis and Conditioning

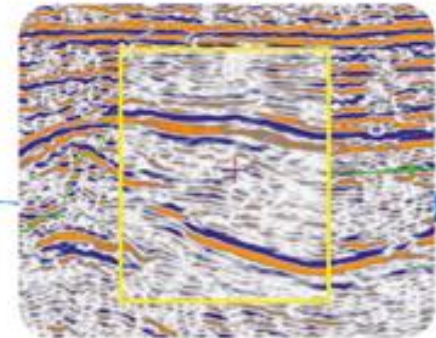
Visualize



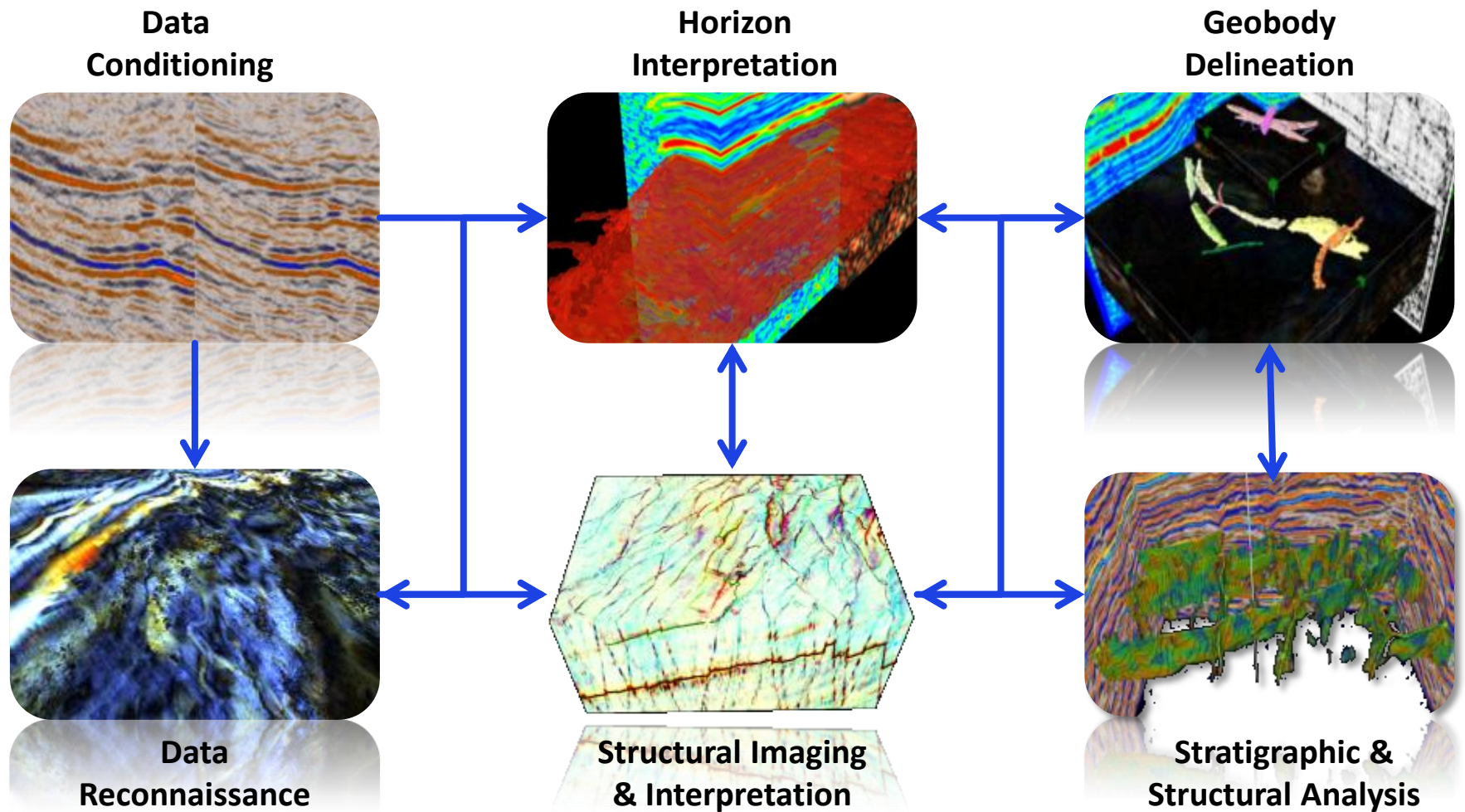
Process



Re-Stack



# Summary

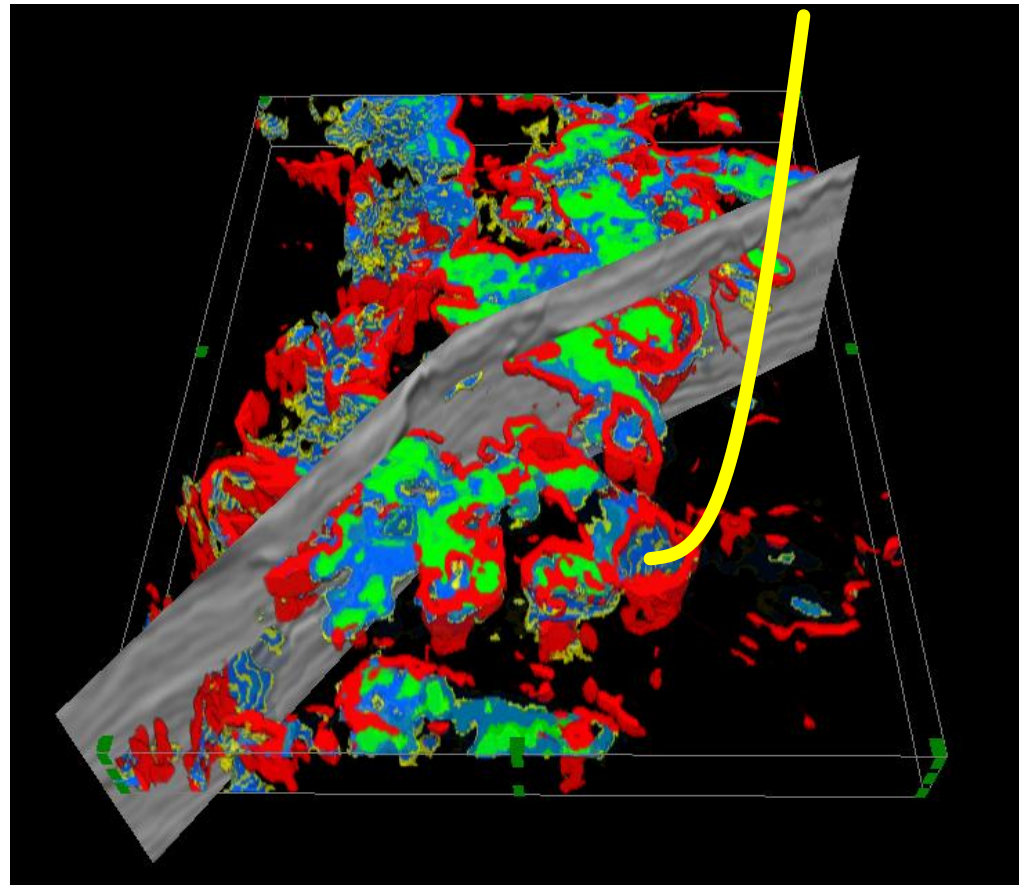


# Summary

Geological expression offers such large productivity gains that it's adoption is already gathering pace and it will be at the heart of next generation seismic interpretation workflows.

These productivity gains come from the interactive Data Driven – Interpreter Guided approach which represents a paradigm shift towards a more natural and effective way of working.

Geological expression workflows will enable us to make better informed decisions with greater confidence from seismic data than ever before.

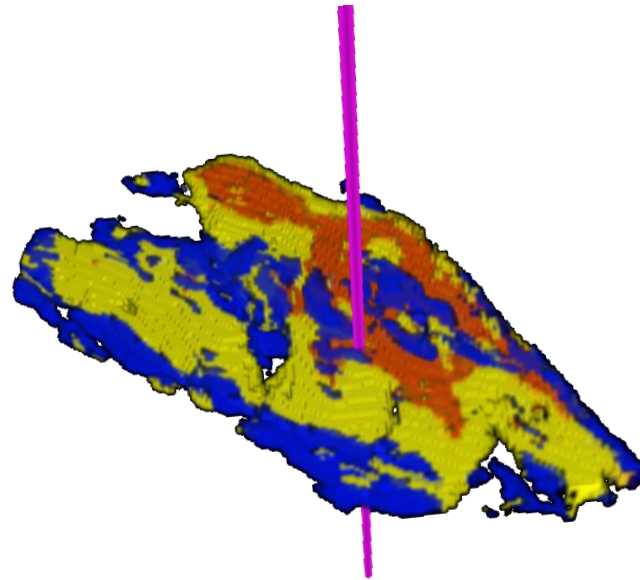




# Summary



**Geological expression: A more efficient path from seismic to drilling..**



**..delivering more accurate results with greater certainty.**

