

Agile Iterative Reservoir Modelling

SIS Forum 2019

Mark Baker

Subsurface Technology Lead



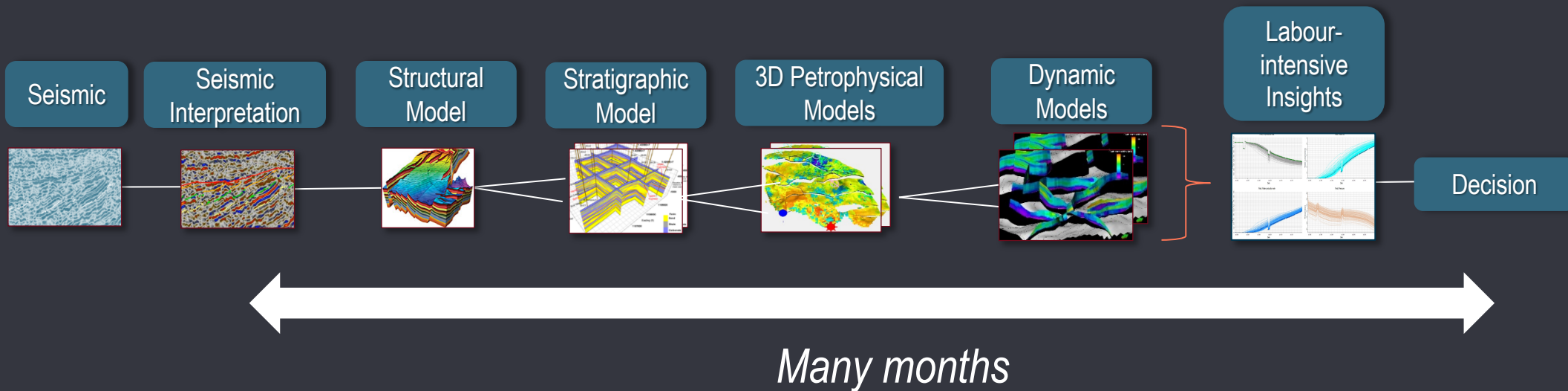
Disclaimer and important notice

This presentation contains forward looking statements that are subject to risk factors associated with oil and gas businesses. It is believed that the expectations reflected in these statements are reasonable but they may be affected by a variety of variables and changes in underlying assumptions which could cause actual results or trends to differ materially, including but not limited to: price fluctuations, actual demand, currency fluctuations, drilling and production results, reserve estimates, loss of market, industry competition, environmental risks, physical risks, legislative, fiscal and regulatory developments, economic and financial market conditions in various countries and regions, political risks, project delay or advancement, approvals and cost estimates.

All references to dollars, cents or \$ in this presentation are to US currency, unless otherwise stated.

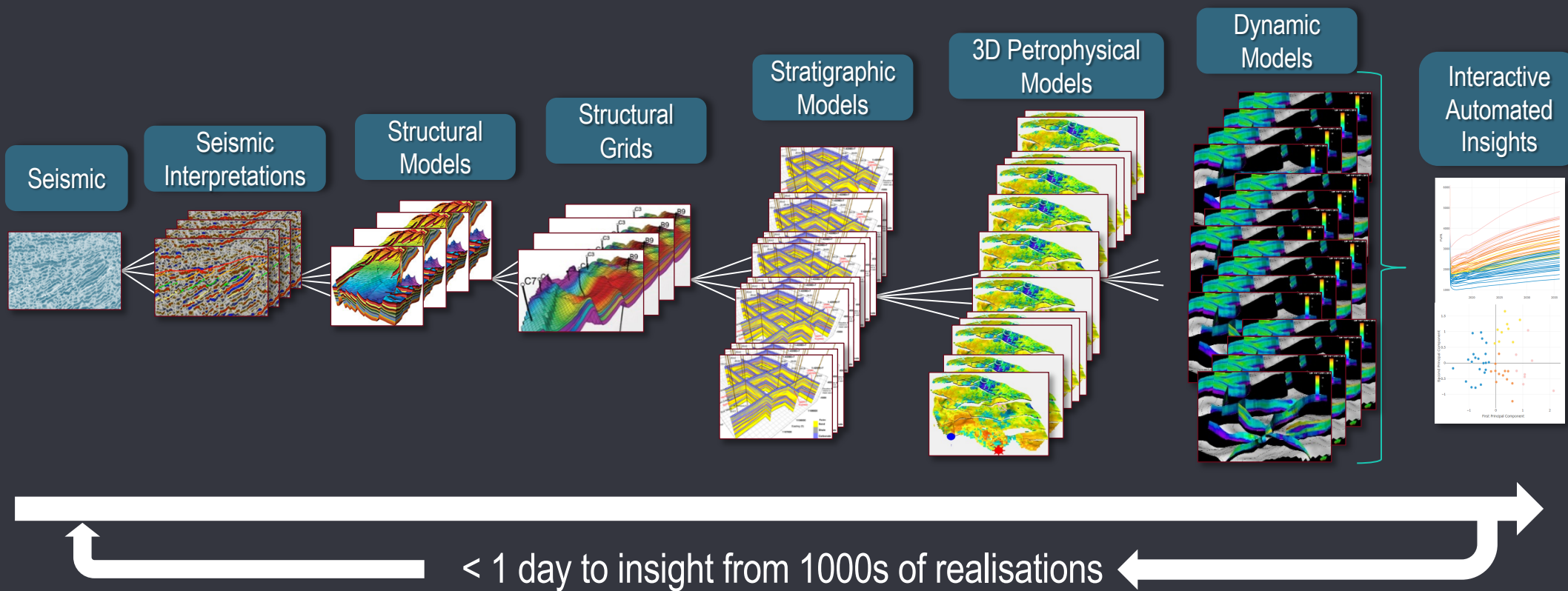
References to "Woodside" may be references to Woodside Petroleum Ltd. or its applicable subsidiaries.

The Subsurface Interpretation Challenge



Limited realisations, limited integration, linear

The Subsurface Interpretation Challenge



Agile Iterative Reservoir Modelling

Woodside worked with Schlumberger to explore what is possible with the new technology behind DELFI and show the power of openness for reservoir modelling

Objectives:

- Build an assisted reservoir modelling application to:
 - Reduce reservoir modelling cycle time
 - Enable collaborative, iterative working styles for integrated teams
 - Improve information for decision-making
 - Unlock subsurface and production data for next-level analysis
- Explore the flexibility and openness of DELFI by developing a new tool inside the DELFI environment
- Enable assisted quality control at each step to build trust in the process



Agile Iterative Reservoir Modelling

Parallel Petrel and Intersect processes

Woodside Analytics Engine

Spotfire

DELFI web app

Data Ecosystem

Custom
Databases

DELFI
Stores

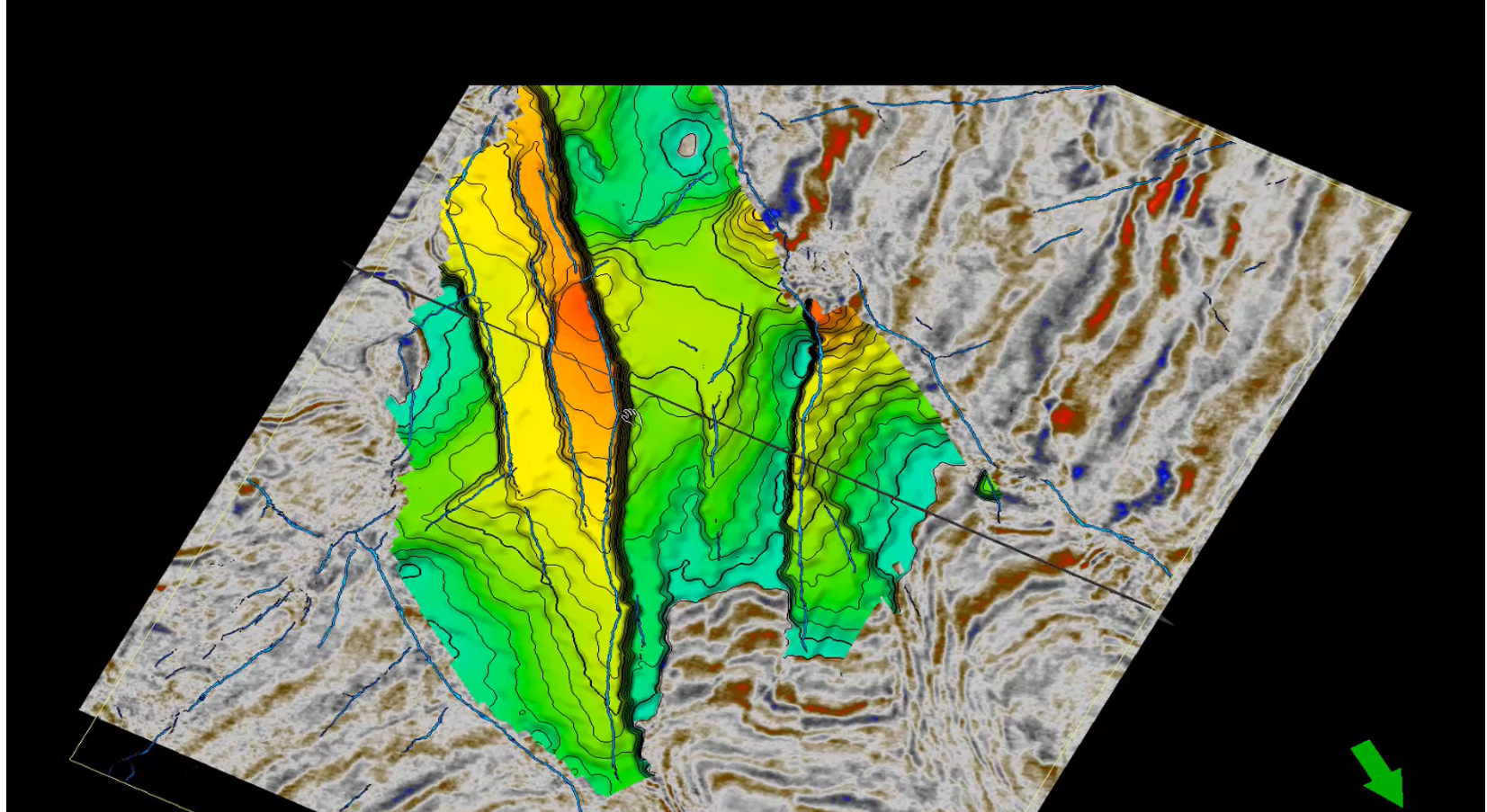


Greenfield Development Application

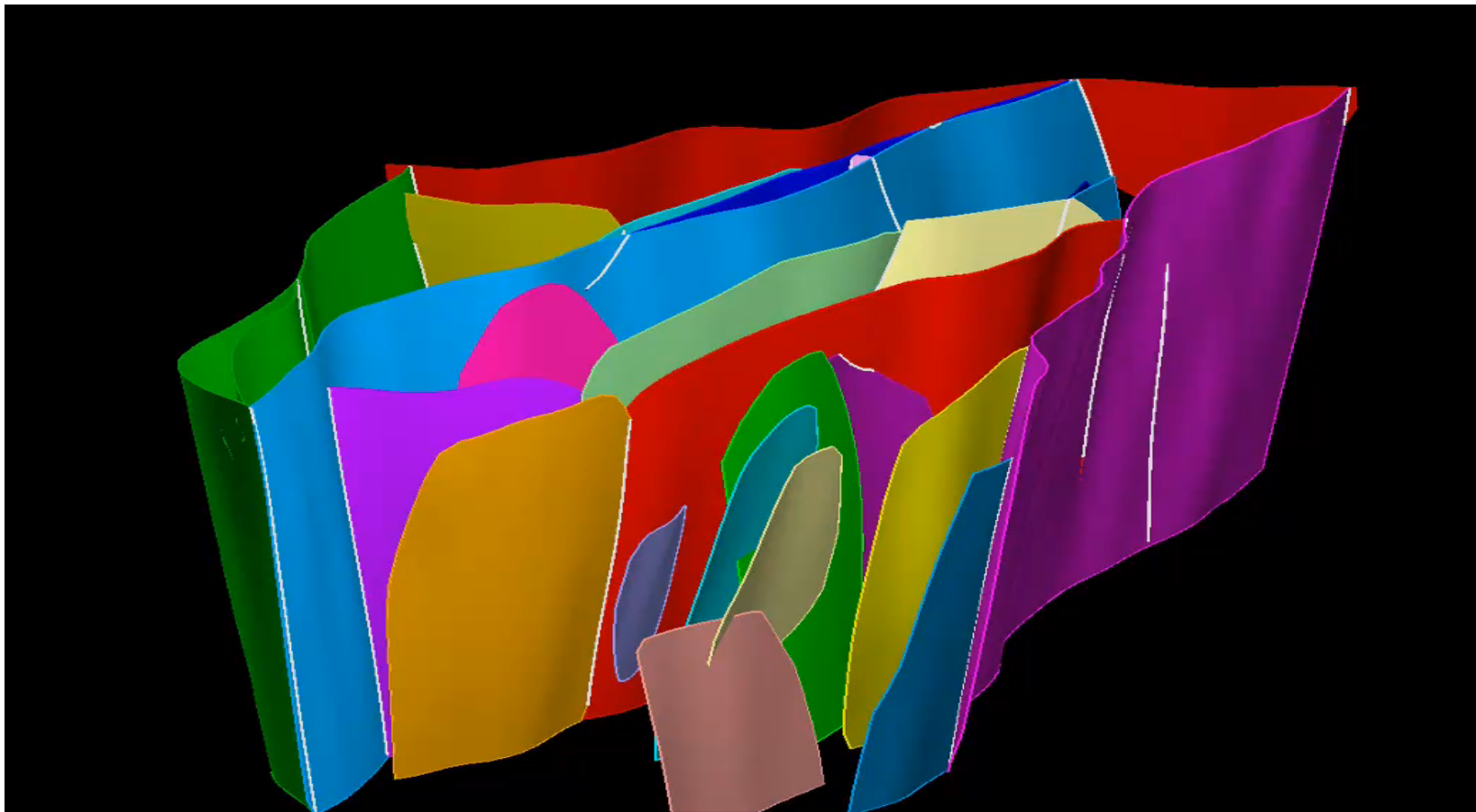
Objective: field development insights with focus on subsurface uncertainty

- Full modelling workflow from seismic interpretation to simulation
- Incorporated Schlumberger's seismic interpretation and static model automation
- Quality control incorporated at all steps – tracked throughout process using Data Ecosystem and viewable on Spotfire
- Process is automated and highly parallelisable

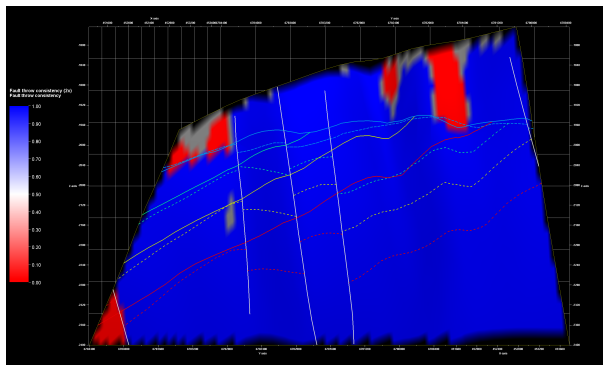
Automated Structural Modelling



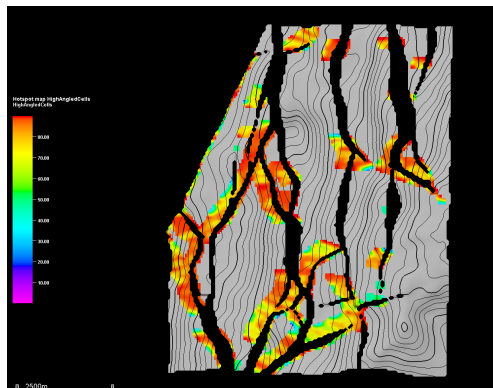
Automated Static Modelling



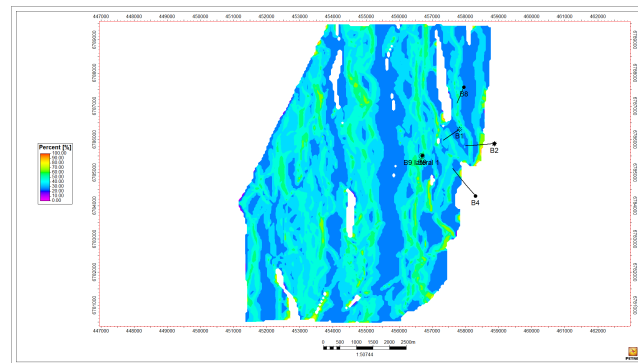
Assisted QC



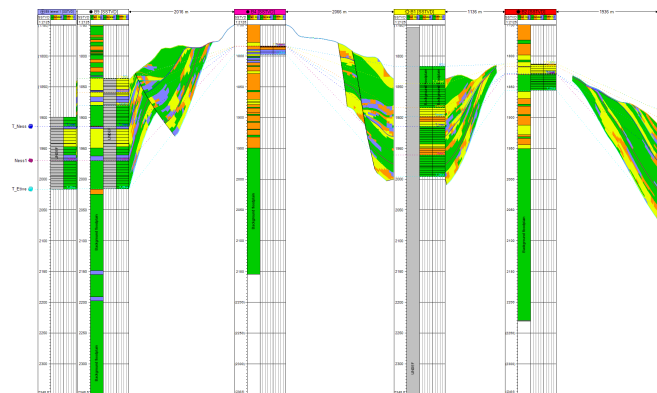
Fault throw consistency



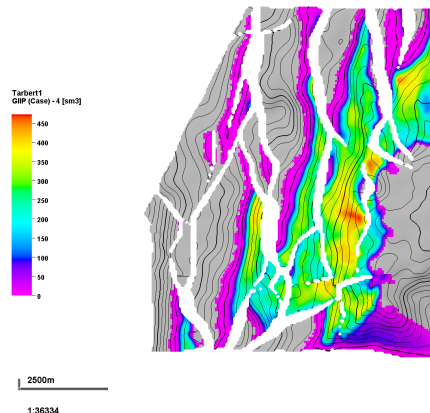
Problem cell hotspot map



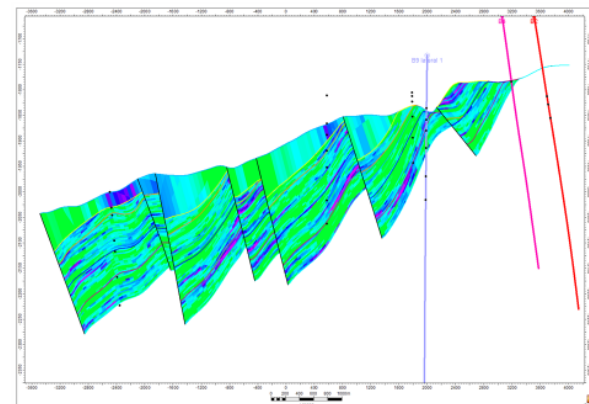
Facies proportion map



Well section




GIIP map



Model cross-section



Automated Static Modelling

 DELFI | Automated static modeling

OTYPE: Automated static modeling

Version 2


Please load the workflow metadata file before doing anything.

static_modeling_workflow_params.txt

Browse

Iteration

Iteration id

 4d357da6-0604-4548-7e91-a209b1c1c489

Start date

Mon Jun 25 2018 10:05:28 GMT+0100 (British Summer Time)

Workflow sequence

Name

WorkflowSequence1

☐ Requires GPU

Workflows

Select all

Select the workflow that will be run during the realisations.

Workflow data

Variable	Context	Description	Type	Value	Uncertainty (mean, sd)
----------	---------	-------------	------	-------	------------------------

Realisations

Automated Static Modelling

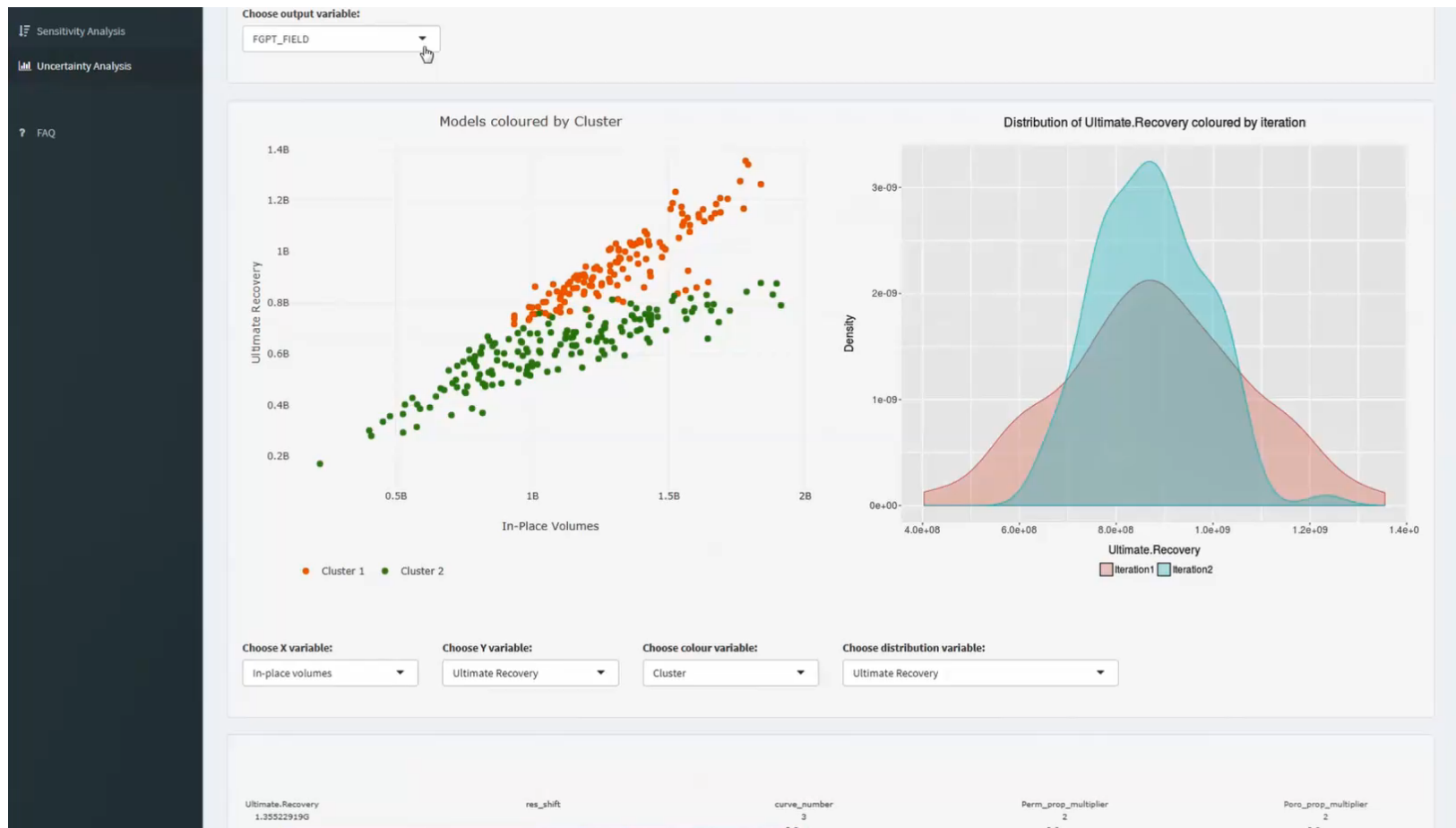
The screenshot shows a web browser window with the URL `https://static-modeling-app-dot-sis-lift-and-shift-dev.appspot.com/status`. The browser's address bar and tabs are visible at the top. Below the browser window, the application header reads "Prototype DELFI Automated static modeling". The main content area is titled "PROTOTYPE: Automated static modeling".

Inside the application, there is a section titled "View iteration status". It contains a form with the following elements:

- A label "Iteration id" followed by a text input field containing the value `3bd1ba3e-ce8b-e1b5-db68-27a5eb6f06b9`.
- A button labeled "View all instances" to the right of the input field.
- A table with three columns: "Name", "Status", and "Actions". The table is currently empty.

At the bottom of the application window, there is a file upload bar showing a file named "DataInsights_recor...zip" and a "Show all" button.

Automated Insights

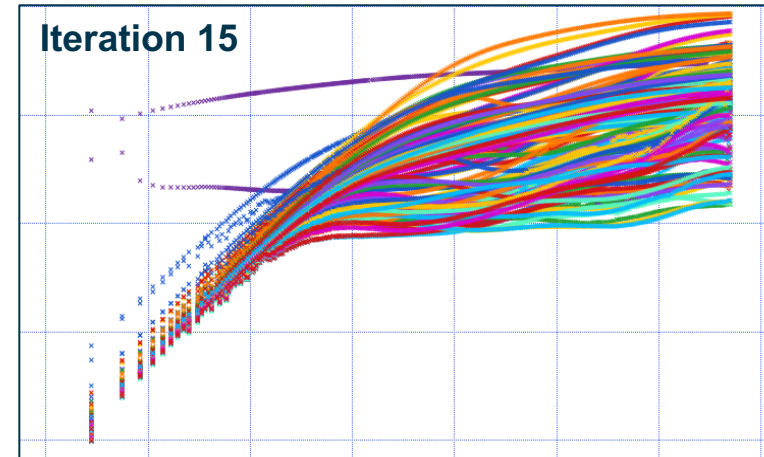
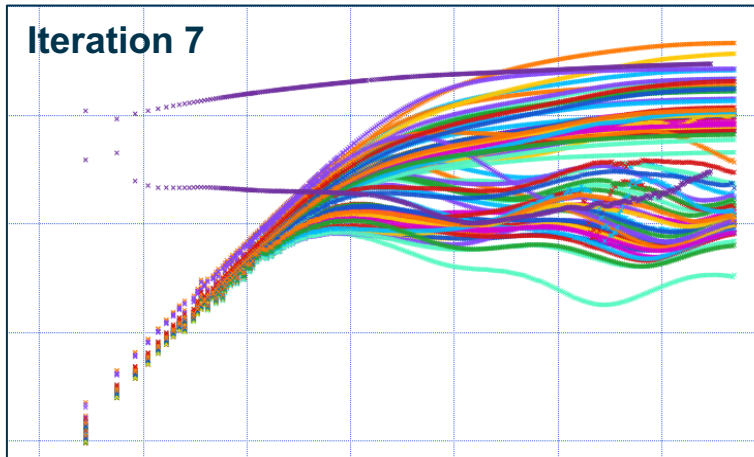
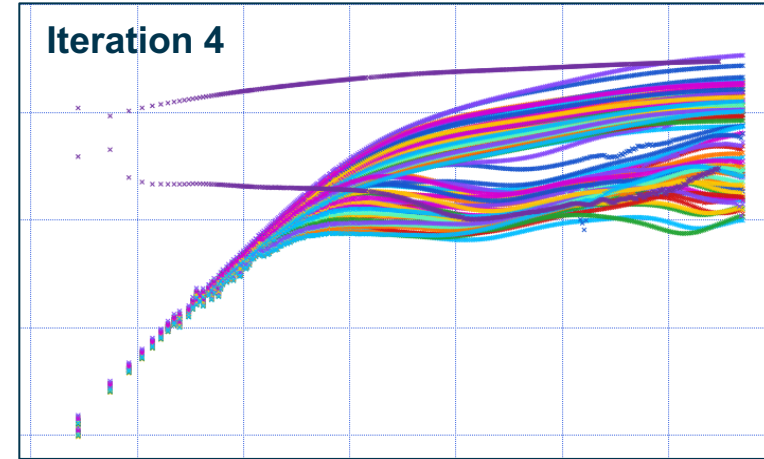
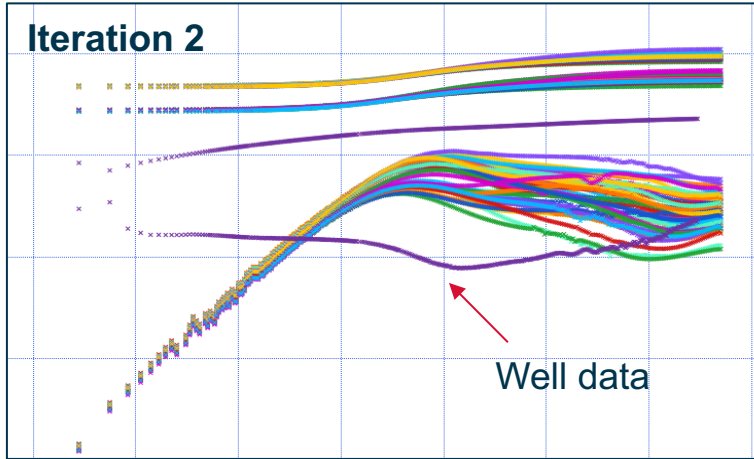


Appraisal Insights Application

Objective: field development insights from appraisal well test

- Integrated subsurface team identified 36 uncertainties from seismic interpretation to spatial distribution of facies to aquifer strength
- 15 complete iterations in less than a week – each iteration 50 to 100 reservoir models from seismic to simulation
- Process allowed different hypotheses to be robustly tested within an hour
- Twice daily meetings with integrated subsurface team to examine results, discuss hypotheses and plan next iteration
- Prompted a fundamental rethink of net-to-gross and permeability log interpretations

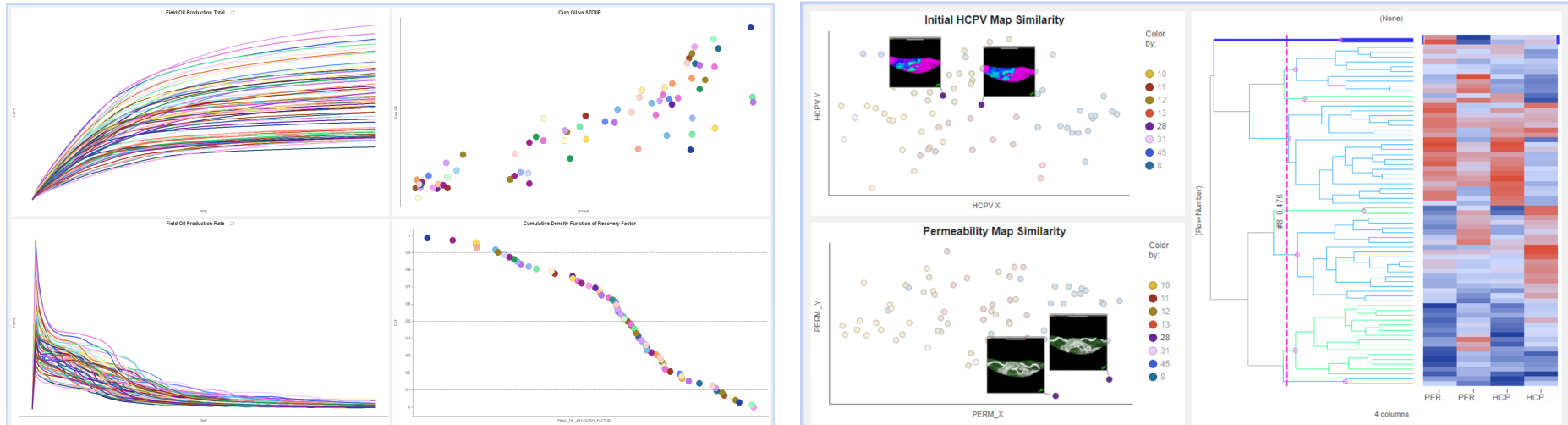
Appraisal Insights Application



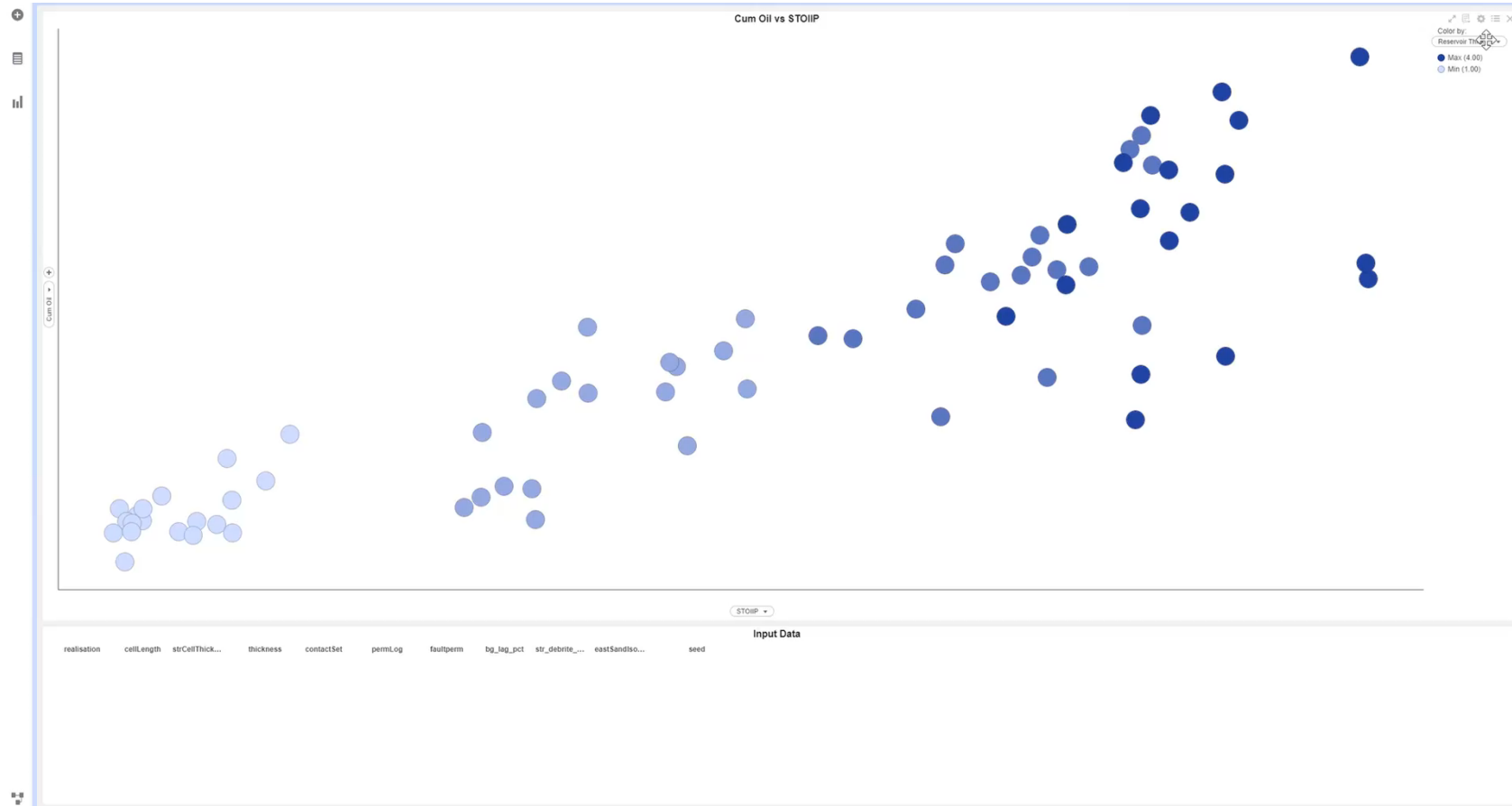
Oil Field Development Application

Objective: reserves update for oil field development with production data

- Two hours to complete full iteration of 300 unique reservoir models with forecasts
- Fully linked static and dynamic QC with production data calibration for model falsification
- 75% reduction in model cycle time



Oil Field Development Application



Conclusions

- DELFI's openness allowed for a fundamental reframe of the reservoir modelling process, with a strong focus on automation, speed and data management.
- Applied to greenfield, appraisal and brownfield applications with significant improvement in model cycle times, collaboration between disciplines and better uncertainty range quantification.
- Access to APIs and cloud compute can streamline workflows to get almost real-time results from modelling studies.
- Removing manual and siloed work allows subsurface professionals more time to collaborate, to explore, and to improve development outcomes.

Special Thanks

Thank you to Steve Freeman and everyone at SIS Perth, Leeds, Abingdon and Oslo.



Woodside Energy Ltd
11 Mount Street
Perth, WA 6000

GPO Box D188
Perth, WA 6840 Australia

T: +61 8 9348 4000
F: +61 8 9214 2777
E: companyinfo@woodside.com.au

woodside.com.au

