Standardizing Reservoir Modeling Best Practices in Petrel

Successful Implementation of Automated Quality Control Tools
Agenda

1. Timeline
2. Static modeling quality control challenges
3. Business requirements
4. Technical solution
5. Results
Repsol looking for solution to tedious QC of Geoscience Data & Models

Q1 2020

SLB Initially proposed solution with GURU Guided Workflows

2021

Q1 2021

Development of Plugin

but then expanded this solution to customization of tests within the “Petrel Test & Report Manager”

Had heard about GURU guided workflows
1. TIME-CONSUMING MANUAL TASKS, SEEKING TO STANDARDIZE PROCESSES TO REDUCE USER BIAS

2. CAPTURING AND PRESENTING THE RESULTS OF THE QC PROCESS FOLLOWING THE REPSOL GUIDELINES

3. TO DEVELOP A TOOL THAT INSTANTANEOUSLY RUN AND GENERATE HIGH-QUALITY REPORTS ACCORDING TO REPSOL STANDARDS
BUSINESS REQUIREMENTS
Data audit and assessment tools

• Development of a tool that **automates** and guides the end-user on the elaboration of the 3D static models audit, assessment and report generation.
BUSINESS REQUIREMENTS
QAQC 3D static models

• QAQC 3D static models following the methodology defined by Repsol and,

• To generate a final report including a summary of the main modelling steps followed by the geomodeler and the results of the QAQC analysis

<table>
<thead>
<tr>
<th>QAQC 3D static models</th>
</tr>
</thead>
<tbody>
<tr>
<td>QAQC tests definition for each model construction step</td>
</tr>
<tr>
<td>Input data tests</td>
</tr>
<tr>
<td>Structural model tests</td>
</tr>
<tr>
<td>3D properties tests</td>
</tr>
<tr>
<td>Facies</td>
</tr>
<tr>
<td>Petrophysics (Phi, Perm, rock type, Sw)</td>
</tr>
<tr>
<td>NTG</td>
</tr>
<tr>
<td>Volumetrics</td>
</tr>
<tr>
<td>Define KPIs for model acceptance (traffic lights)</td>
</tr>
<tr>
<td>Quality report design/sketch/outline</td>
</tr>
<tr>
<td>QAQC tests outline</td>
</tr>
<tr>
<td>Modeling steps outline</td>
</tr>
<tr>
<td>Results outline</td>
</tr>
<tr>
<td>Quality report build</td>
</tr>
</tbody>
</table>

3D STATIC MODEL QAQC REPORT

3D MODEL INFORMATION:

Model name XXX

3D MODELING STEPS:
1. Fault modeling
2. Grid gridding
3. Horizon modeling
4. Layering
5. Property Modeling
6. Volumetric calculation

STRUCTURAL MODEL TESTS:
1. Cell angle

90% of the cells below 30 degrees?
BUSINESS REQUIREMENTS
Type of QCQA Tests

Cell size analysis
QC to honor hard data: Cell size: it should be smaller than average/minimum well spacing.

Fault trajectory/throws
Analyze consistency of the fault trajectory and fault throws for each horizon along the fault (for every surface and fault)

Sw property ranges
Check for realistic bounds of the calculated properties (0-40%; not below Sw; not negative values)

Poro realizations statistics
Calculate 3D property standard deviation from all the stochastic realizations (at least 30) and generate average maps per zone

Fine vs Upscaled grid Volume statistics
QC after upscaling includes a comparison between the fine grid and upscaled models by reservoirs, by blocks and by totals for of the following resultant properties: • Bulk volume (BV) • Pore volume (PV) • Hydrocarbon PV (HCPV) • Hydrocarbon in place (HCIP)

HCPV maps
Generate HCPV maps (Gross x NTG x Porosity x SHC). Can get Hydrocarbons, Gas, Oil, or Oil & Gas depending on inputs
Petrel Test & Report Manager

- Proposed solution that exists as part of Petrel
- Offering a versatile & customizable solution for running QC tests
- Intuitive to run
- Validation of inputs item types
**Petrel Test & Report Manager**

- Tabs with Information and Overview
- Customized with Instructions
- REPSOL logo
- Images
- Tables
- Descriptions
- Keys for traffic lights
  - ...

### Traffic Light Report Result Explanation

<table>
<thead>
<tr>
<th>Traffic Light</th>
<th>Report Result Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>All three properties are within the acceptable range.</td>
</tr>
<tr>
<td>Orange</td>
<td>At least one of the three properties is slightly above the acceptable range.</td>
</tr>
<tr>
<td>Red</td>
<td>At least one of the three properties is above the acceptable range.</td>
</tr>
</tbody>
</table>

#### Examples:

- Tables showing distribution of property for whole grid and filtered to distance, and for threshold
- Images showing property filtered to a certain distance from model faults, images showing filtered thresholds entered for each property and histograms showing property distribution before filtering
TECHNICAL SOLUTION
Petrel tools

Workflows behind scenes:

- Grouped by domain
- Long complex workflows (hundreds of lines)
- Subroutines
- Able to carry QC operations on major part of Petrel Inputs and Models

Test with Subroutines
Complex workflows run behind tests with infinite possibilities

- Run modeling
- QC Models
- Get Statistics
- Filter displays
- Create Cross plots
- Create Histograms
- Display data in 2D, 3D and Maps
- Filter through zones
- Generation of customized, structured and detailed reports
- Incorporation of test traffic lights based on thresholds
Plugin for Petrel

- Instigated the idea to develop a Plug-in for Petrel
- To develop a plugin that allows the launching of multiple QC tests with a single click
- The plugin uses the modules Petrel Test & Report Manager and code implemented in the workflows
- Use of json configuration files for plugin maintenance that facilitates agile fixes and updates
- Integrated with GURU customized content
TECHNICAL SOLUTION
Development methodology

DevOps

- Agile methodology implemented with DevOps QC Models
- Daily, Sprint Retrospectives and Reviews Filter displays
Had heard about GURU guided workflows."

SLB Initially proposed solution with GURU Guided Workflows.

but then expanded this solution to customization of tests within the “Petrel Test & Report Manager”.

Development of Plugin

1. REPSOL Excel Checklist
2. Guru
3. Test & Report Manager
4. Plugin
Results

- The time-saving and overall consistency in results obtained, have significantly impacted the efficiency and value attained using Petrel

- We are currently adding more multifaceted and crucial tests to the portfolio and expanding to other domains such as three dimensional geomechanics modeling, reservoir simulation and engineering

- The outcome of the project has remarkably improved the entire geomodelling process within Repsol and has a great potential for optimizing the handling of more and more complex scenarios