

Standardizing Reservoir Modeling Best Practices in Petrel

Successful Implementation of
Automated Quality Control Tools



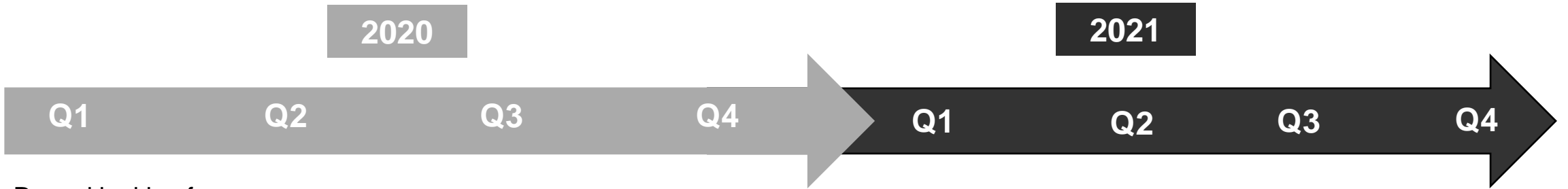
Agenda

1. Timeline
2. Static modeling quality control challenges
3. Business requirements
4. Technical solution
5. Results



Repsol Compromiso
Cero Emisiones Netas
2050

TIMELINE



Repsol looking for solution to tedious QC of Geoscience Data & Models

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

STATIC MODELING QUALITY CONTROL CHALLENGES

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

General Information | Input Data | Deliverables per discipline | Integrated Deliverables

Region	
Business Unit	
Asset name	
Operatorship	
Type of Play	
Type of Reservoir	
Type of Fluid	
Surface Location	

Date	
Project Status	
Input Data	
Deliverables per discipline	
Integrated Deliverables	
3D Modeling Deliverables	
FDP Deliverables	



REPSOL DATA AUDIT AND ASSESSMENT REPORT

GENERAL PROJECT INFORMATION:

Business unit	Department XYZ
Asset name	COUNTRY XYZ
Project status	In progress
Region	REGION NAME
Date	JUNE 2020

INPUT DATA:

Type	Available	Origin	Confidence level
Well log	Y	Non-proprietary	●
2D seismic	Y	Proprietary	●
Pre-stack seismic	N	N/A	N/A
Fault interpretation	Y	Proprietary	●



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

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



REPSOL 3D STATIC MODEL QAQC REPORT

3D MODEL INFORMATION:

Model name: XXX

3D MODELING STEPS:

1. Fault modeling
2. Pillar 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

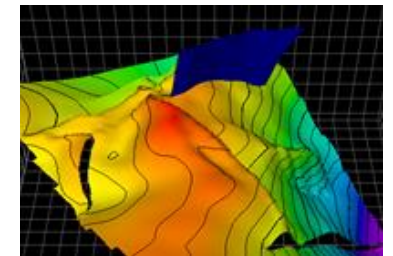
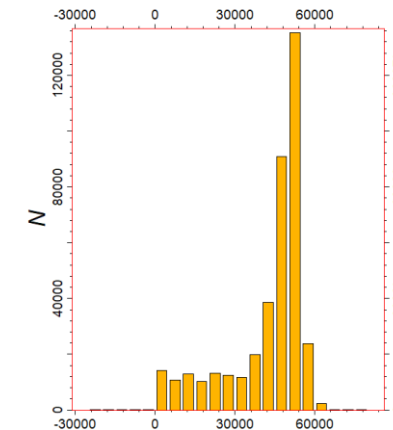
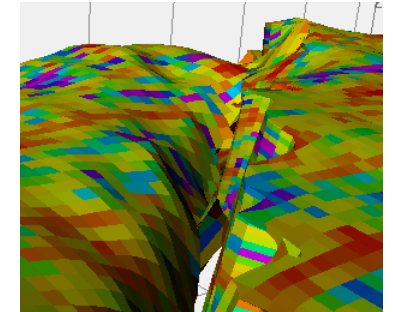
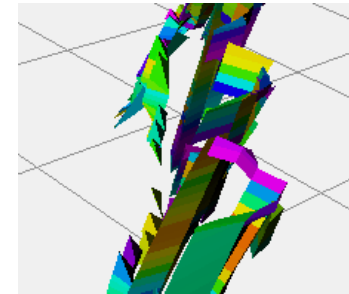
Calculate 3D property standard deviation from all the stochastic realizations (at least 30) and generate average maps per zone

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



TECHNICAL SOLUTION

Petrel tools



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

The screenshot displays the 'Test & report manager' application window. It features a search bar with the number '13' and a table of test results. Below the table, there are three panels: 'Test templates', 'Tests', and 'Reports', each showing a summary of the selected test.

Type	Name	Result	Valid	Domain	No. of runs	Date last run	Author	Date mox
57	SM-13 REPSOL - Structural and Stratigraphic Modeling - Cell QC Near Faults		✓	Geology	3	06/01/2021 18:04:16	gsoberman	06/01/20...
58	SM-5 REPSOL - Structural Modeling - 3D grid - cell geometry and property d...		✓	Reservoir Engineering	2	03/25/2021 19:04:20	gsoberman	04/08/20...
59	SM-7 REPSOL - Structural Modeling - Surface - well top mistie QC			General	-	-	Structural M...	03/11/20...
60	SM-7 REPSOL - Structural Modeling - Surface - well top mistie QC		✓	General	1	03/11/2021 12:49:48	gsoberman	03/11/20...
61	SM-8 REPSOL - Structural Modeling - Fault plane - Fault top mistie QC		✗	General	8	04/22/2021 10:56:30	EZordan	04/14/20...
62	SM-8-A REPSOL - PREQUISITE FOR CPG		✓	Geology	14	04/22/2021 12:03:37	EZordan	04/21/20...
63	SM-8-A REPSOL - PREQUISITE FOR CPG			Geology	-	-	EZordan	04/14/20...
64	SM-8-B REPSOL - PREQUISITE FOR SG			Geology	-	-	EZordan	04/14/20...

Test templates

Name	Type
SM-13 REPSOL - Structural and Stratigraphic...	

Tests

Name	Valid
SM-13 REPSOL - Structural and Stratigraphic Mo...	✓

Reports

Name	Result
QC Grid Cells Near Model Faults 06/01/2021 18:0...	●

TECHNICAL SOLUTION

Petrel tools



Petrel Test & Report Manager

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

SM-13 REPSOL - Structural and Stratigraphic Modeling - Cell QC Near Faults

Information Overview **Input** Statistics

Test information

This test generates a report that analyzes cells around faults on the 3D Grid to see if there is any correlation between very thin cells, cell angle or inside out cells and faults. The maximum distance from faults is entered by the user and for each of the three properties: thickness, cell angle and inside out are evaluated for full grid as well as within limits of this maximum distance criteria. For thickness, the threshold for cell thickness is entered by the user and then it is seen if the proportion of thin cells closer to faults is greater than in entire grid. For Cell angle, the threshold angle is entered by the user and then it is seen if the proportion of high angle cells is localized around model faults. In the same fashion, it is also analyzed if the proportion of inside out cells nears faults is greater than in the entire grid.

The results are shown in tabs, histograms and map views for both thickness and inside out cells.

If one of these shows poor quality especially near model faults the test will fail.

A table shows pass or failure per property and overall report tests status:

Traffic light	Report result explanation
Pass ●	All three properties are classified with a pass, meaning thresholds are not exceeded in fault proximity. The model grid does not need to be reviewed.
Caution ●	At least one of the three properties shows some correlation between quality and proximity to faults. It is recommended that the model grid be reviewed.
Fail ●	At least one of the three properties is classified with a fail, meaning that for one of them the permitted threshold was exceeded. This means cells quality around faults in the model need to be reviewed.

Examples :

For each you get

- Tables showing distribution of property for whole grid and filtered to distance, and for threshold
- Images showing property filtered to a user-input distance from model faults, images filtered on thresholds entered for each property and histograms showing property distribution before filtering

Run Apply OK Cancel

SM-13 REPSOL - Structural and Stratigraphic Modeling - Cell QC Near Faults

Information Overview **Input** Statistics

Test overview

Structural & Stratigraphic Modeling

Repsol - 3D Grid - QC Cells Near Faults

Test inputs:

1. 3D pillar grid.
2. Preconfigured 2D Window to be used in output Report
3. Preconfigured Histogram Window to be used in output Report
4. Distance to Model Faults to analyze cells near faults
5. Cell Thickness threshold
6. Cell Angle Threshold
7. Inside Out Cells Value Indicator
8. Option to View faults in Map Views or not

Run Apply OK Cancel

TECHNICAL SOLUTION

Petrel tools

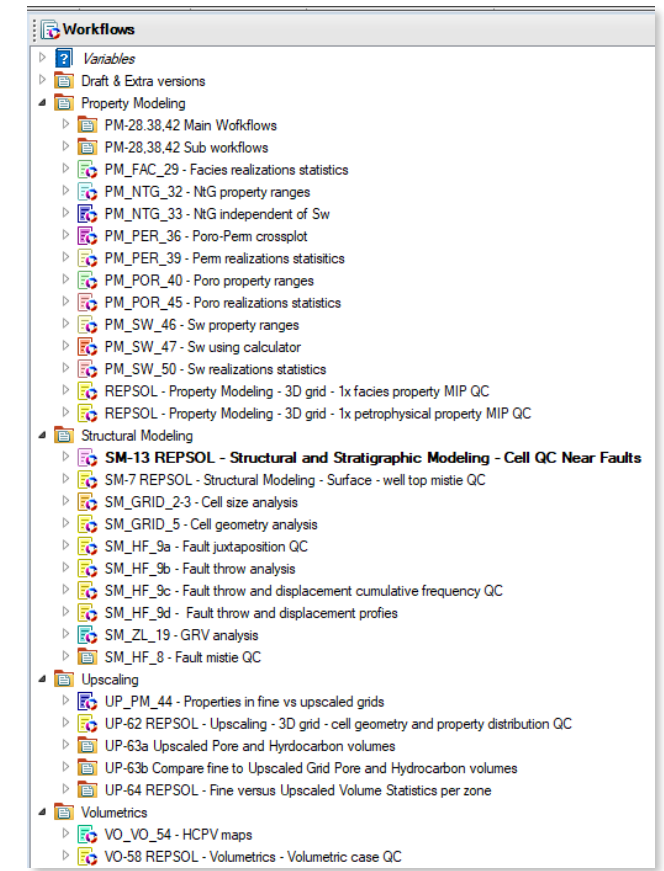
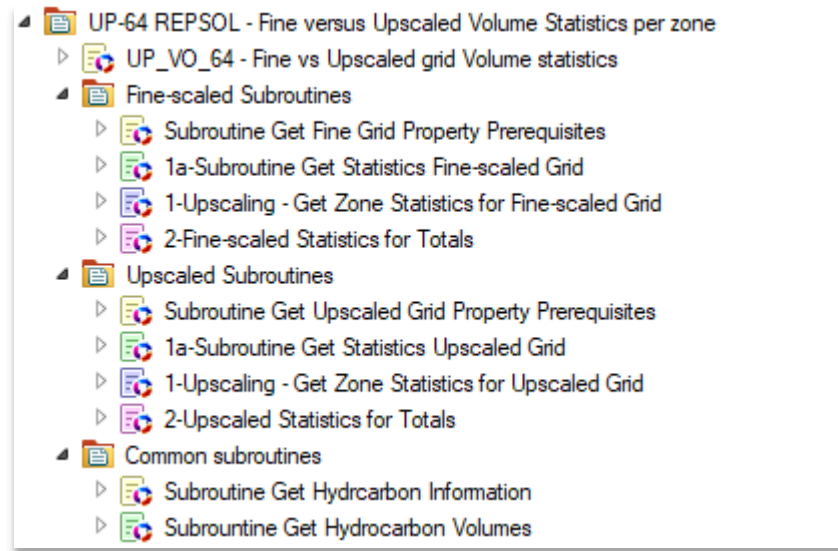


Workflows behind scenes:

- 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

Workflows in Structured folders



HR EXCELLENCE IN RESEARCH

TECHNICAL SOLUTION

Petrel tools



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

SM_GRID_5 - Cell geometry analysis 04/08/2021 17:54:37

ASM – Quality Control

Quality Control Workflow built following the recommended practice proposed in Repsol's corporate RCM manual and in agreement with Repsol Data Standards (20-00168PR).

Results per Zone

Values per zone (Fine-scaled)	Property for Grid	Values per zone (Upscaled)
Copy of 1-Fine-scaled 50x50 3D grid depth		Copy of 2-Upscaled 100x100 3D grid depth
Top - Base		Top - Base
20674830000	BULK VOLUME	15499060000
42783	NTG Cells (1)	10671

Overview:
This report illustrates key geometrical properties for context. The following properties are checked:

- Inside out cells
- High angled cells
- Cell size smaller than minimum well distance
- Bulk volume

The report generates a result column.

[Edit](#)

Structural Analysis

Bad Cells (Combined)

- 1 bad (Yellow)
- 2 bad (Cyan)
- 3 bad (Magenta)

Test type	Result	Traffic light
Cell size smaller than minimum distance between wells	Fail, average cell size is bigger than minimum well distance	●
There are at least 3 cells between wells	Fail	●

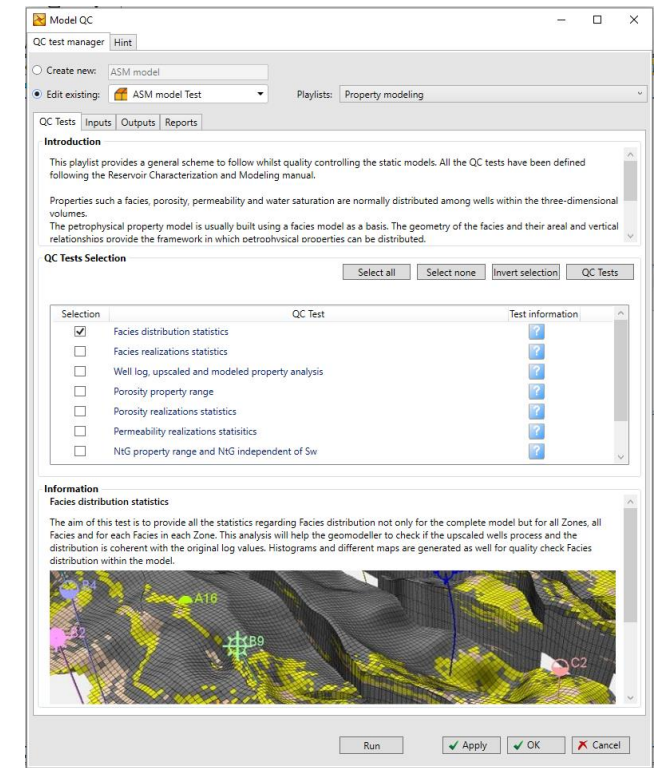
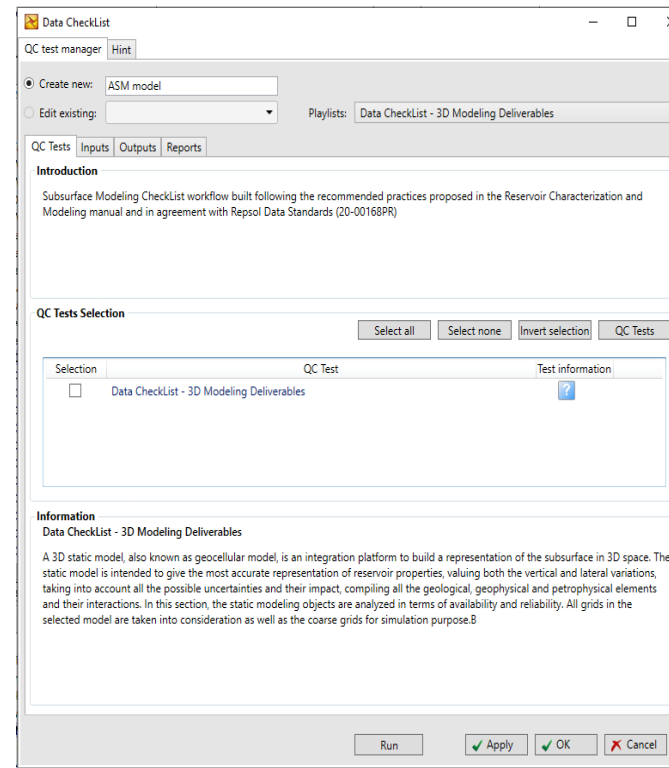
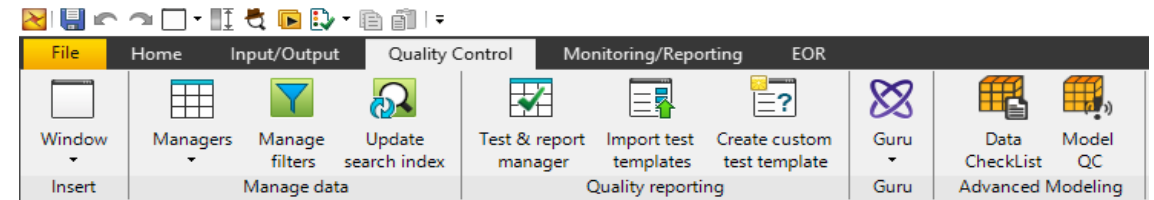
TECHNICAL SOLUTION

Plugin



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



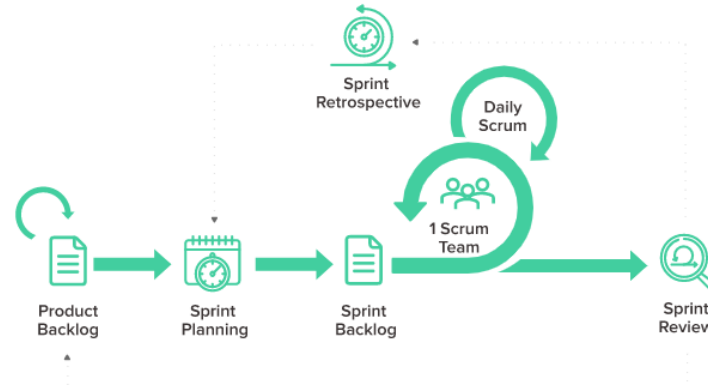
TECHNICAL SOLUTION

Development methodology



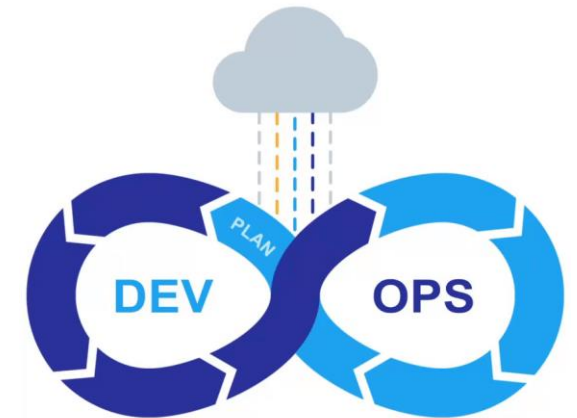
DevOps

- Agile methodology implemented with DevOps QC Models
- Daily, Sprint Retrospectives and Reviews Filter displays



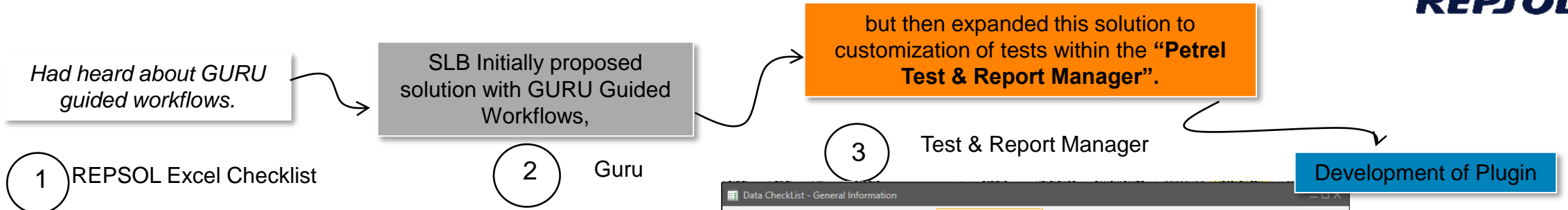
Azure DevOps interface showing a backlog for the team 'repsol-digital-team / ASMOD01 / Boards / Backlogs'. The interface includes a navigation sidebar on the left with options like Overview, Boards, Backlogs, Sprints, and Retrospectives. The main area displays a table of work items.

Order	Work Item Type	Title	State	Effort	Value Area	Iteration Path	Tags
16	Product Backlog	Porosity	Committed		Business	ASMOD01	Tool B
17	Product Backlog	Sw	Committed		Business	ASMOD01	Tool B
18	Product Backlog	Property Upscaling	New		Business	ASMOD01	Tool B
19	Product Backlog	Upscaling	Committed		Business	ASMOD01\Sprint 5	Tool A
20	Product Backlog	Upscaling	Committed		Business	ASMOD01	Tool B
21	Product Backlog	Repsol Testing	Committed		Business	ASMOD01	Tool B
22	Product Backlog	Input Data	New		Business	ASMOD01	Tool B
23	Product Backlog	Enhancements and bugs	Committed		Business	ASMOD01	Tool A
24	Product Backlog	Enhancements and bugs	Committed		Business	ASMOD01	Tool B
25	Product Backlog	Scale-up	Committed		Business	ASMOD01	Tool A
26	Product Backlog	Petrophysical properties	New		Business	ASMOD01	Tool B
27	Product Backlog	Plugin requirements	New		Business	ASMOD01	Tool A
28	Product Backlog	Plugin requirements	New		Business	ASMOD01	Tool B
29	Product Backlog	SLB Review	New		Business	ASMOD01	Tool B
30	Product Backlog	Repsol Review	New		Business	ASMOD01	Tool B
31	Product Backlog	Update workflows	New		Business	ASMOD01	Tool B



TECHNICAL SOLUTION

Summary



General Information

Region	
Business Unit	
Asset name	
Operatorship	
Type of Play	
Type of Reservoir	
Type of Fluid	
Surface Location	

Date	
Project Status	
Input Data	
Deliverables per discipline	
Integrated Deliverables	
3D Modeling Deliverables	
FDP Deliverables	

Guided Workflow

Welcome to the Model Checklist Workflow. This workflow will provide a summary Petrel model in terms of availability and quality attributes. Please, run the complete workflow, the final report will be stored in the same folder with an automatic workflow, although some questions will be asked for you to answer.

You are about to start the General Information section. Do you want to proceed?
Answer: Yes

Please indicate the project region (indicate number)
1: North America/ 2: Latin America/ 3: South East Asia & Russia/ 4: Europe, Africa, BR Exploration
Answer: 1

Please indicate the Business Unit
Answer: GOM

Please provide the Asset Name
Answer: Shenzi

Please provide the project Operatorship (indicate number)
1: Operated/ 2: Non-Operated/ 3: Shared Holder/ 4: Joint Venture

Data Checklist - General Information

Information Overview Input Statistics

Test inputs

Enter a name for the test.
Data Checklist - General Information

1. Please indicate the project region (indicate number)
1: Regional Unit Americas/ 2: Regional Unit Europe, Africa, A
* Optional

2. Please indicate the Business Unit
- Enter a Value - * Optional

3. Please provide the Asset Name
- Enter a Value - * Optional

4. Please provide the project Operatorship (indicate number)
1: Operated/ 2: Non-Operated/ 3: Shared Holder/ 4: Joint Ve
* Optional

5. Please provide the type of Play (indicate number)
1: Conventional/ 2: Unconventional
* Optional

6. Please provide the type of Reservoir (indicate number)
1: Clastic/ 2: Carbonate/ 3: Shale/ 4: Basement/ 5: Fracture/ 6
* Optional

Run

Data Checklist

Test Manager Hint

Create new: Data Checklist

Edit existing: [dropdown]

Playlists: General Information and Input Data
General Information and Input Data
Discipline Outputs
3D Modeling Deliverables

Introduction
Subsurface Modeling Checklist workflow built following the recommended practices proposed in the Reservoir Characterization and Modeling manual and in agreement with Repsol Data Standards (20-00168PR)

Tests Selection
Select all Select none Invert selection

Selection	Test	Test information
<input type="checkbox"/>	General Information	?
<input type="checkbox"/>	Input Data	?

Information
General Information
This section includes general information of the asset related to the Petrel project as well as some basic details of the play. Project objective is also included due to its impact in the modeling strategy (i.e. factors initiating the reservoir characterization study and common understanding of the issues to be resolved).

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



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REPSOL

Technology Lab

from ideation to real business

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