DELFI G&G deployment helps reduce modeling time for multiple reservoirs by 92-96%

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Agenda

➢ Asset background
➢ Geological Settings
➢ Main challenges
➢ Workflows implemented in DELFI
➢ Results
➢ Conclusions
Project Background

- 17 fields scattered over +100 Km (NS) ≈ 783 Km^2
- Seven reservoirs, 500 wells
- Excellent quality reservoir properties: $\Phi=12-17\%$, $K=200-700$ mD
- Gravity [API]= 33 - 15
- Producer Mechanisms:
  - Res1 active aquifer
- Reservoir management currently migrated from primary to secondary recovery.
Main Challenges

- 17 Fields: 3 North Area, 9 Central Area & 5 South Area
- Complex Reservoirs
  - Drastic thickness changes
  - Relatively heterogeneous with lateral facies variations, Lateral and vertical heterogeneity
  - Highly depleted reservoirs with limited active aquifer (except Res 1)

A better assessment of the waterflooding strategy has been obtained, guiding the full-field implementation by integrating adequate Hydraulic Units (HU) identification, heterogeneity modeling, uncertainty management, and lessons learned from an existing pilot.
Source Rock: The interbedded Napo shales are rich in organic matter type II and III,
Seal: Interbedded cretaceous marine shales
Res 1: Fluvial Environment channels/bar with distal positions to the tops, tidal influences
Res 2 Base: Estuarine tidal dominated. Top: Lower Shorefaces, marine System
Res 3 & Res 5 are interpreted as tide dominated estuary that grade to marine deposits Res 4 & Res 6.
Res 7 It is the result of a rapid progradation (tidal deltaic facies).
Log Type and facies

- AFO: Fluvial channels
- AF1: Tidal Channels/Bars
- AF2: Overbank channels
- AF3: Tidal Plain
- MF1: Sandstones Lower Shorefaces
- MF2: Shale Lower Shorefaces
- M5: Limestone
- M6: Mudstone

Marine Deposits

Platform Deposits

Estuarine Tidal Dominated

Comparación Complejo Estuarino Rio BramaPutra vs. Bioge 63

Regional Stratigraphic Wells Section

- Well 1
  - RES 1: NP = 11 Million STB
- Well 2
  - RES 2 Sep 1996: NP = 7.2 Million STB
  - RES 6 May 2016: NP = 2.5 MMSTB
  - RES 6 Sep 2016: NP = 482 MSTB @Agust2020
- Well 3
  - RES 3 Ene 2017: NP = 790 MSTB
  - RES 3 Jul 2013: NP = 5.7 MMSTB
  - RES 3 Ene 2017: NP = 270 MSTB @Jun 2020
- Well 4
  - RES 2 May 2012: NP = 455 MSTB @Mar 2022
- Well 5
  - RES 1 Ago 2011: NP = 749 MSTB
  - RES 1 Ago 2011: NP = 855 MSTB @Jun 2020
  - RES 3 Sep 2013: NP = 1.1 MMSTB @Sep 2005
- Well 6
  - RES 1 Ago 2011: NP = 5.7 MMSTB
  - RES 3 Sep 2000: NP = 12.5 MMSTB @Dic 2010
  - RES 5 Nov 1993: NP = 680 MSTB
  - RES 5 Nov 1993: NP = 4.3 MMSTB Sep 2011
- Well 7
  - RES 2 Sep 1996: NP = 749 MSTB
  - RES 3 Sep 2013: NP = 129 MSTB
  - RES 3 Sep 2000: NP = 17 MSTB @Jul 1982
- Well 8
  - RES 5 Nov 1993: NP = 690 MSTB
  - RES 5 Nov 1993: NP = 14 MSTB @Dic 2015
- Well 9
  - RES 5 Nov 1993: NP = 4.3 MMSTB Sep 2011
  - RES 3 Sep 2000: NP = 3.4 MMSTB Sep 2005

Seismic attributes correlation Well to Seismic
Geological Modeling Workflow

➢ For run this workflow for Regionals Static Models (Several fields Integrated) is necessary to have powerful computation processing capacity as is only available in the virtual Machine in DELFI.
Before For Central Area: 8 Statics Model with 9 fields and only 6 reservoirs, 269 wells, Cells size: 100 x 100 m, 3 ft average cell height, Total Cells =12.2 million.

Currently for the Central Area there is only one Regional Static Model that includes the 9 integrated fields with their 7 Reservoirs, 286 wells, Cells size 50 x 50m, 1.5 ft average cell height Total Cells =54 million.
Before: A coarse grid reservoir model that was used on a sector-based simulation to be able to run and produce a forecast for field development.

After high resolution required for waterflooding optimization capturing the correct interaction between fields for optimum analysis in field development planning.

- The time that took to finish a specific sensitivity analysis (evaluation of well performance) with 100 runs on average.

- The use of DELFI had significantly decreased the time (50 – 75%) for this analysis allowing more time to evaluate additional scenarios.
Regional Reservoir Model can be done only in DELFI

- High-resolution reservoir model with detailed Physics
- Capture complex geology
- Robust model definition
- Model construction automation
- Significantly reduce calibration process
- Faster new wells update
- Assess commingled opportunities
- Waterflooding strategy Optimization
- Faster decision making
Managing Field Uncertainty: Probabilistic results

- Orange line is the base Case HM and FDP WF case
- Purple case is the primary scenario (New and existing wells, without water injection)
- Run >200 cases with no limitations in time and computing power due to the cluster available in DELFI
Waterflooding has been certainly the biggest success in the block
Currently highest historical Injection
Total Incremental average production stable (last months) due to best practice in pattern balancing
Conclusions

DELF1 has significantly advantages and benefits:

✓ G&G faster and parallelized computations:
  ✓ Update 3D Regional Statics model (several fields): time is reduced from 1 day down to 2 hours
  ✓ Run Original Oil in Place Uncertainty in those regional static models (Probabilistic result): time is reduced from 1 Week down to 6 hours.
  ✓ Run Original Oil in Place Uncertainty in 1 Fields time is reduced from 2 Hours down to 6 minutes.
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✓ Powerful VM – no need workstations
  ✓ Accessibility & portability
  ✓ Centralized & QC’ Data (Repository) & Sharing data through VM, is simpler compared to other traditional means (Mail, OneDrive, Disc…)
  ✓ Regionals 3D Models with Several Fields & multireservoirs can be processing only in DELFI.

✓ No longer working in silos and removing manual work giving geoscientists more time to collaborate, to explore, and to improve subsurface characterization/representation.

✓ DELFI Petrotechnical Suite and On Demand Reservoir Simulation drastically reduce modelling and simulation times by 50-75%

✓ This solution allows better planning and support to operations and permit to have integrated strategy (combining horizontal, directionals wells and waterflooding) changed significantly the production trend in the area which then allowing for better field development plans and more robust portfolio opportunities for production and reserves increase.