

RCP

Offshore Deepwater Project (Jubarte Field – Brazil)

*Andrea Damasceno**

Max Velasques

Moacyr Bezerra



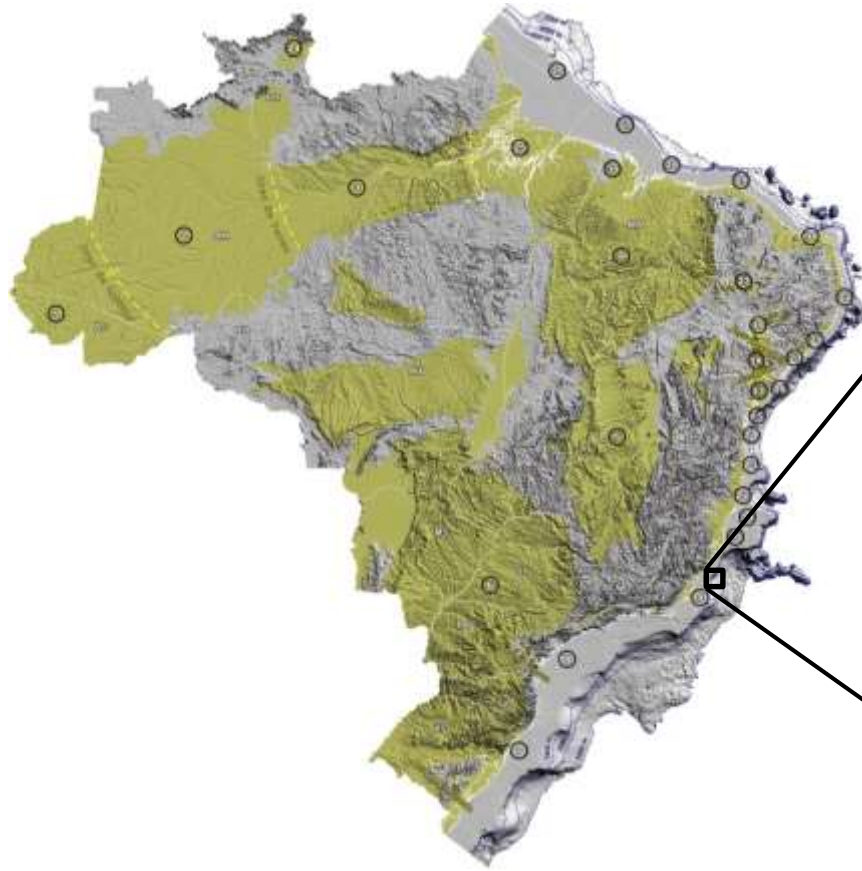
Agenda

- 💧 Field & Data Overview
- 💧 Project Research Topics

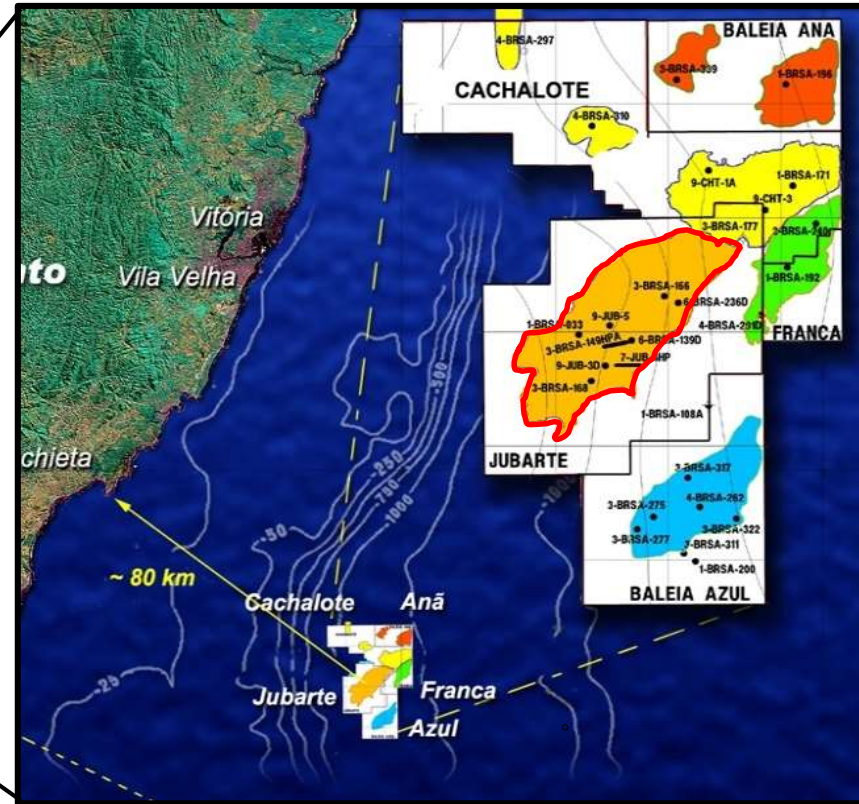
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Field & Data Overview



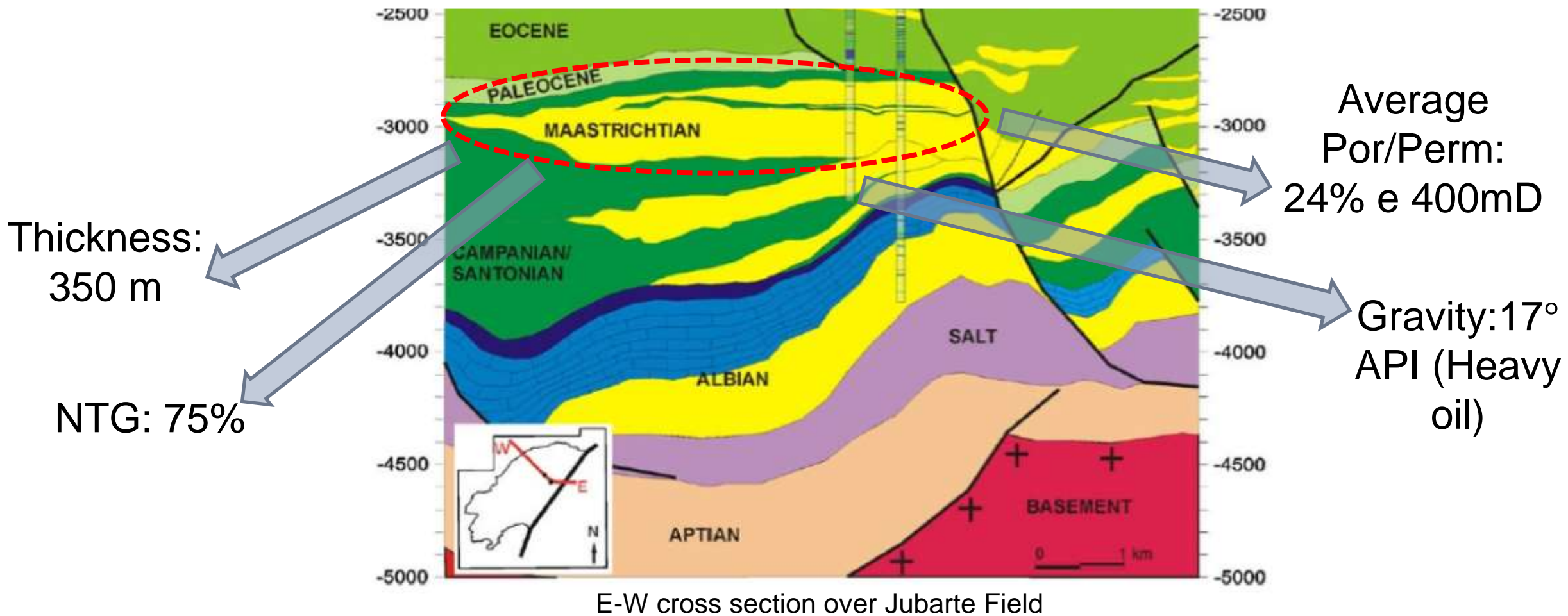
Brazilian Sedimentary Basins



Parque das Baleias location map, in the North of Campos Basin.

Field & Data Overview

Discovered in 2001, but production started in 2006

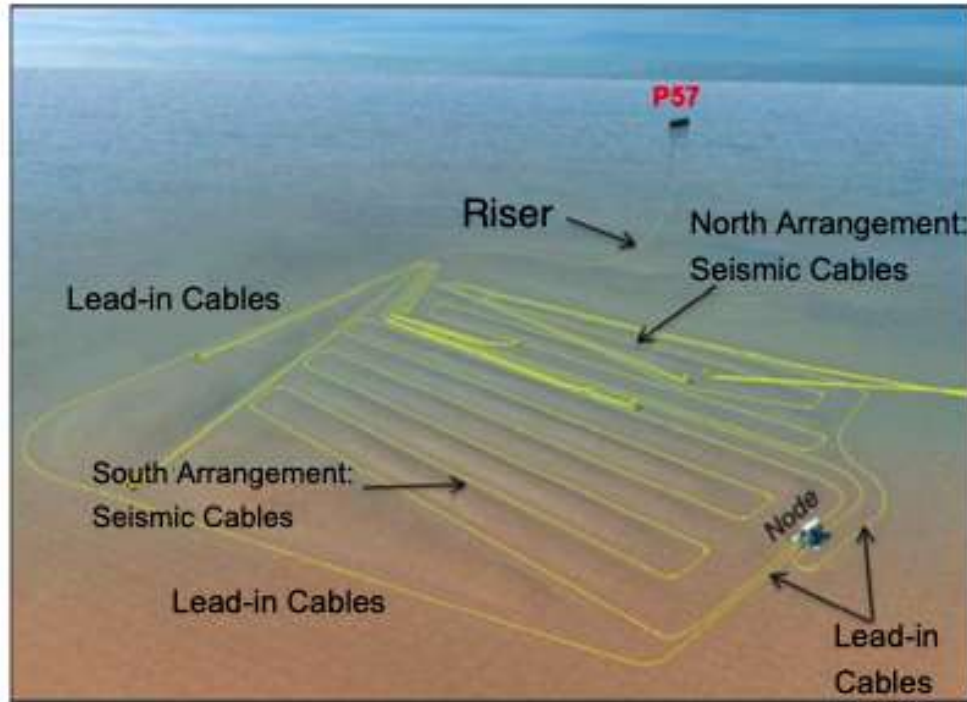


Field & Data Overview

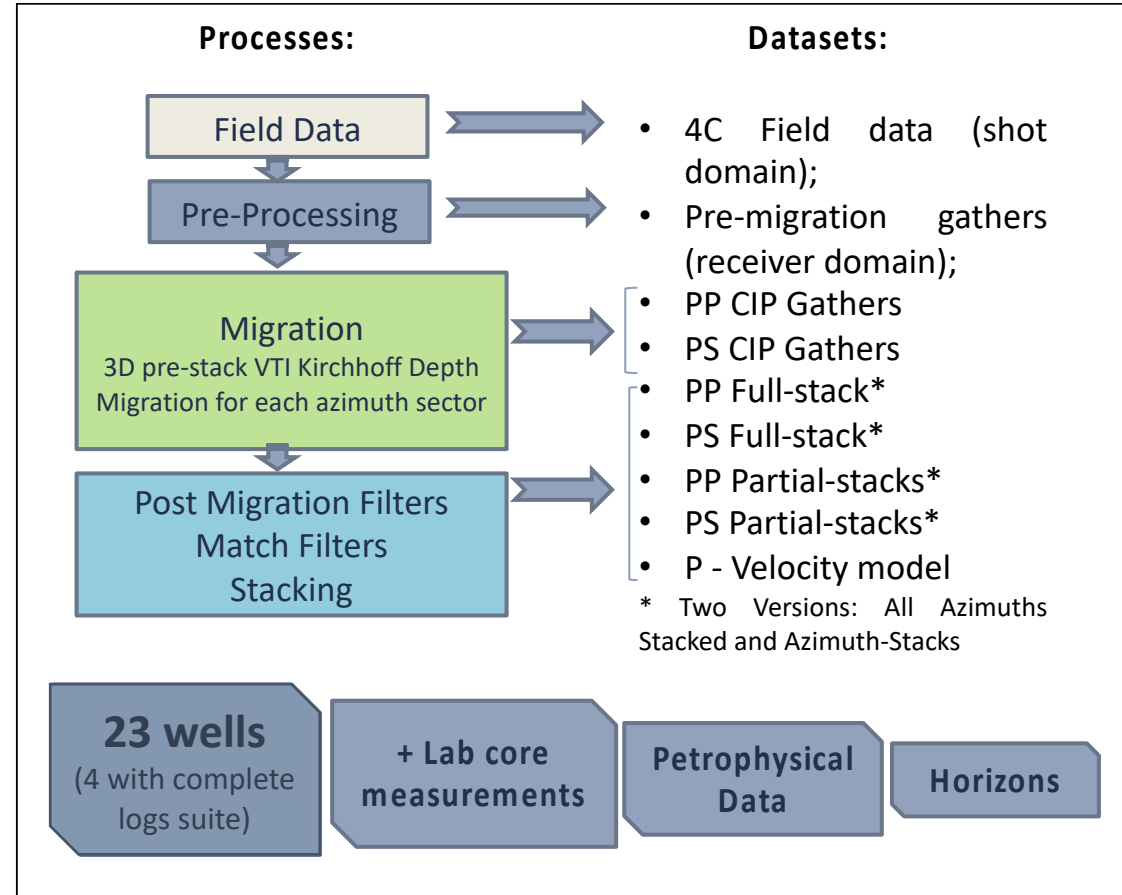
PRM Seismic Acquisition

Monitor 1
(2014)

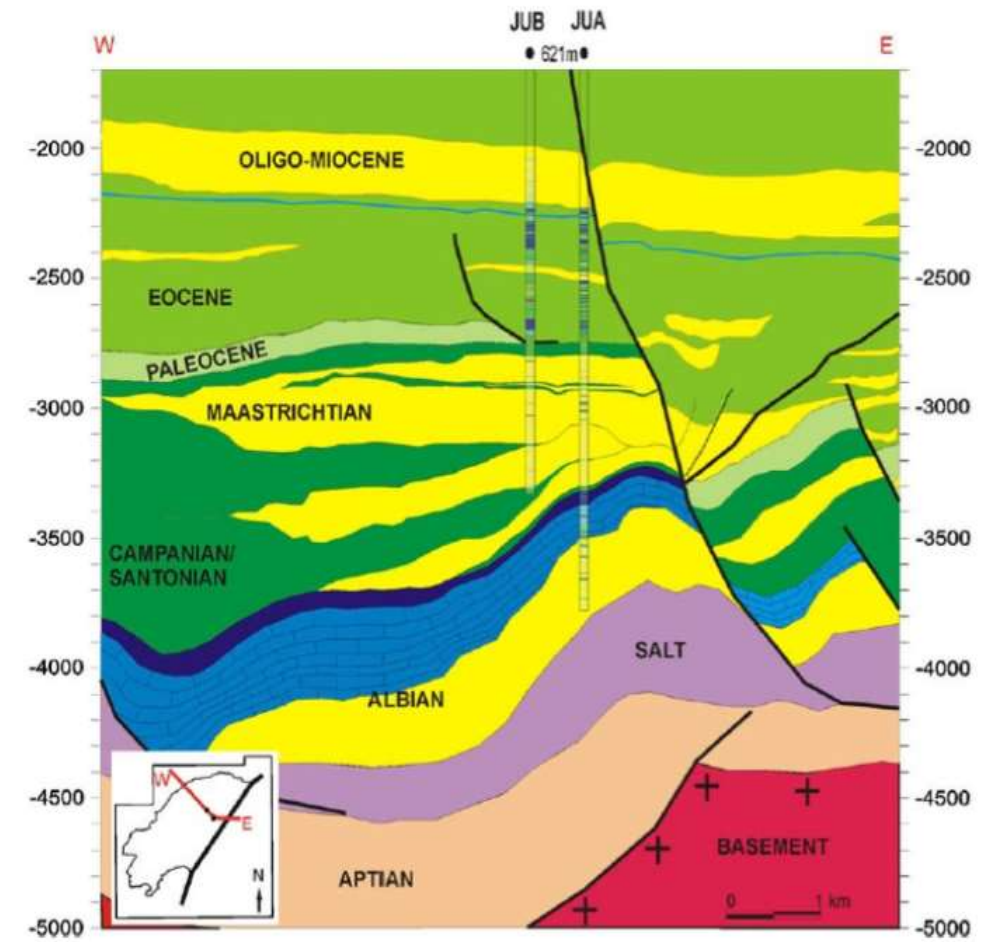
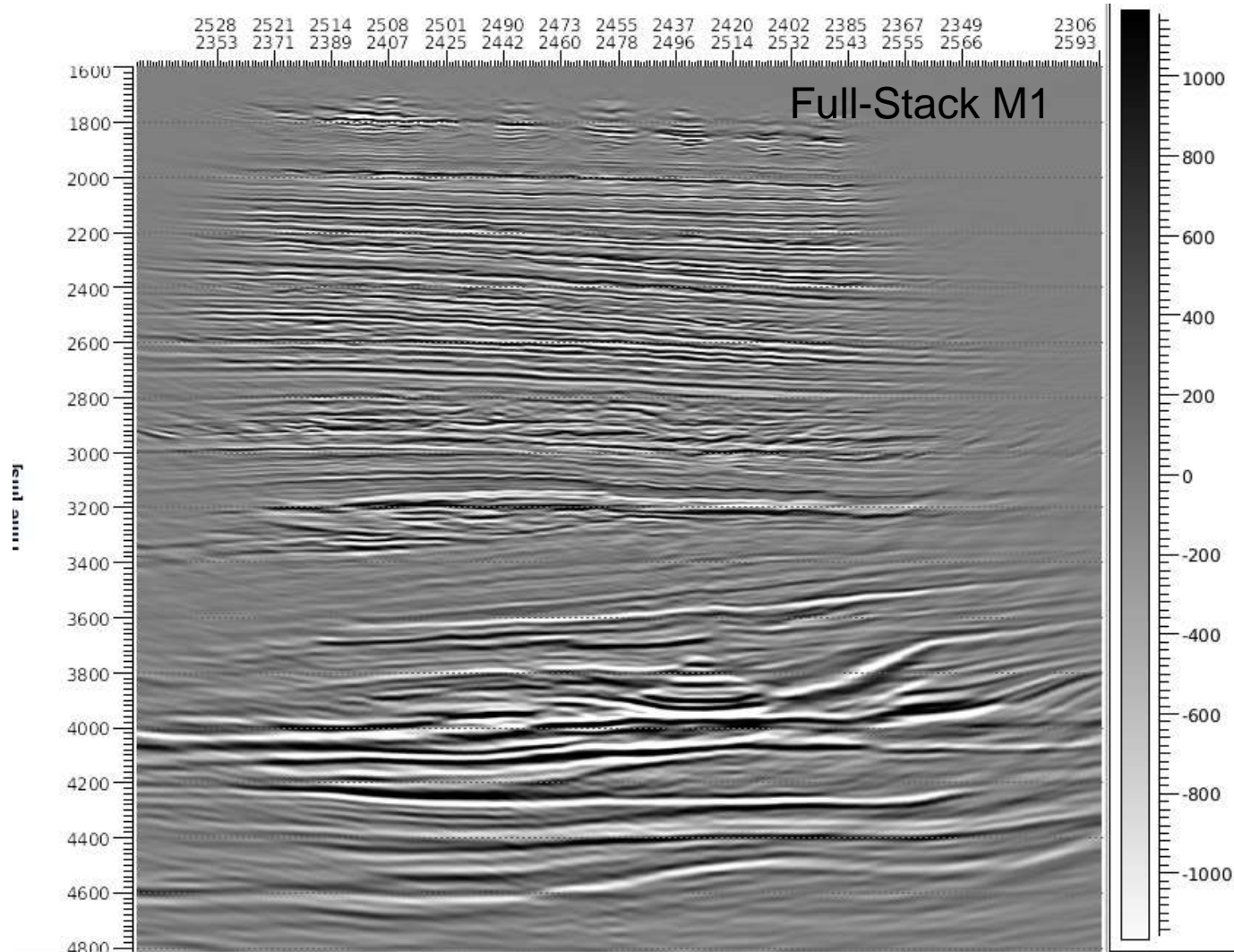
Monitor 2
(2015)



Seismic Project Design

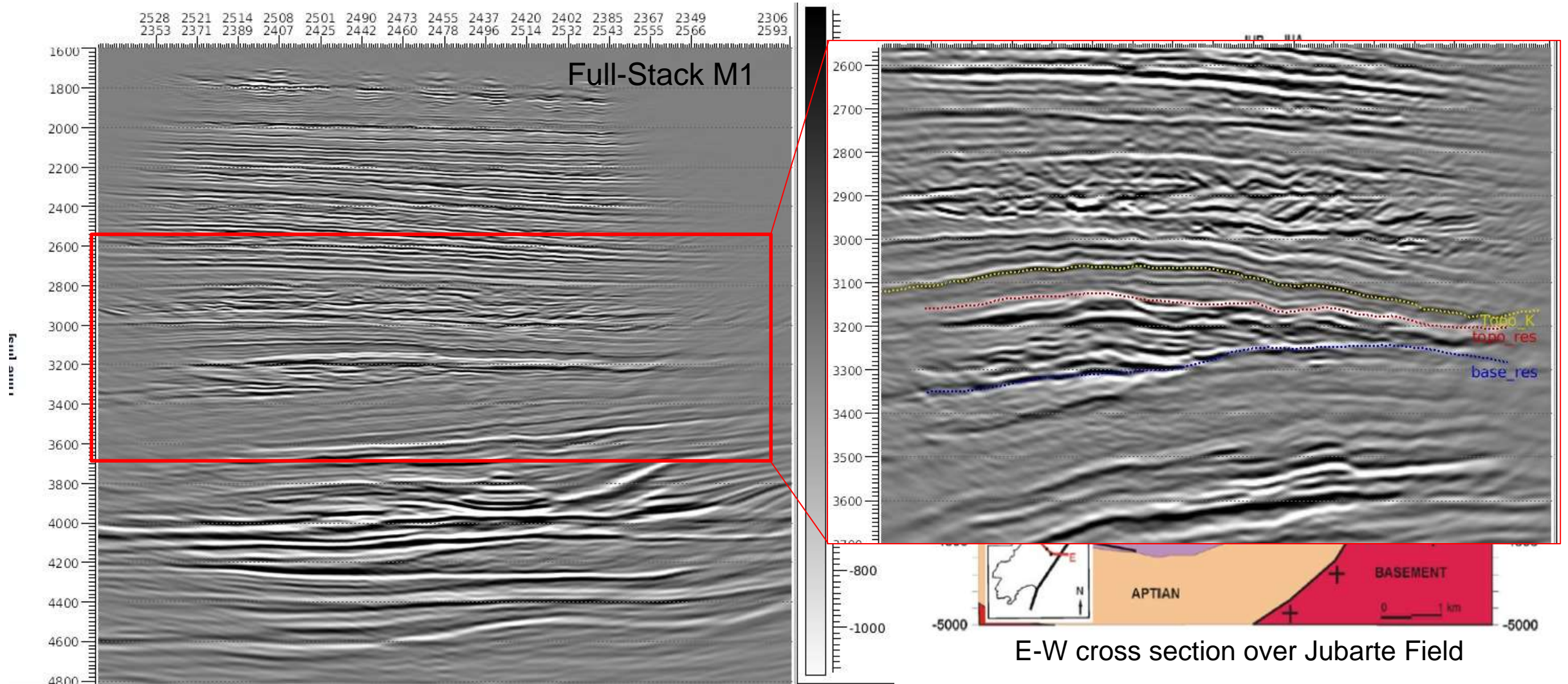


Field & Data Overview



E-W cross section over Jubarte Field

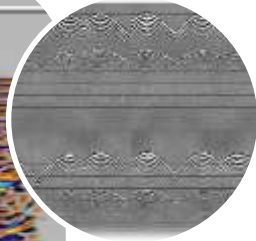
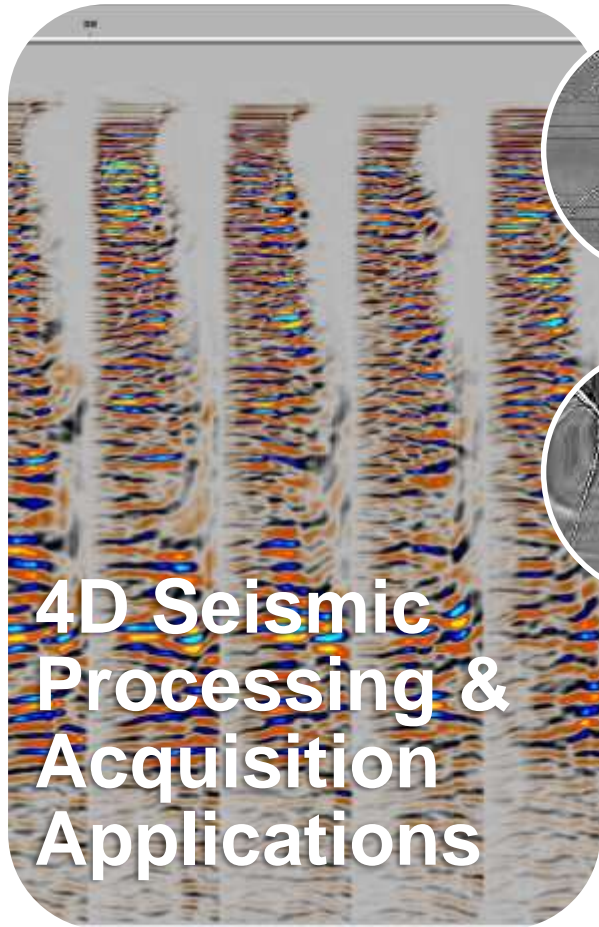
Field & Data Overview



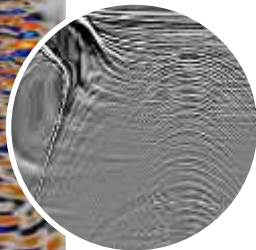
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- 🔹 Field & Data Overview
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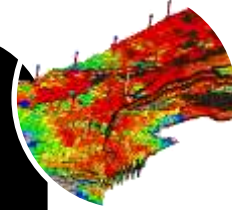
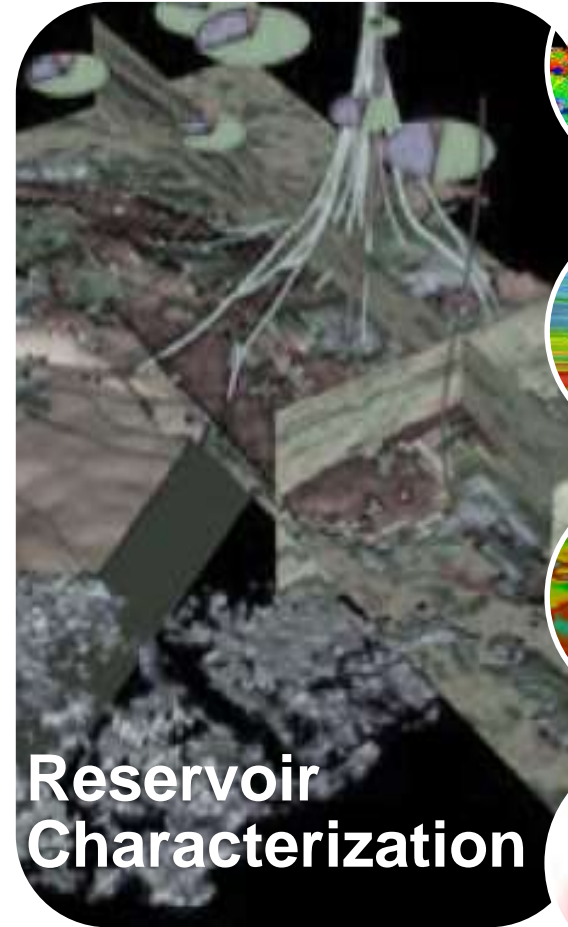
Project Research Topics Overview



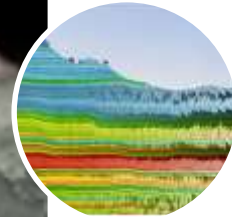
Seismic
Blending/Deblending
Techniques



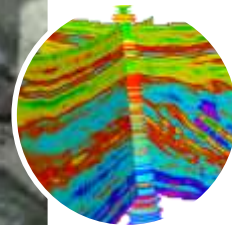
Advanced
Processing
Techniques



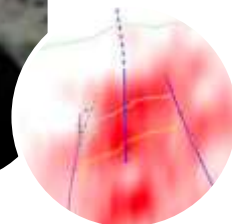
Production
Data



Rock
Physics



4D-
Seismic
Inversion



Time-shifts



Reservoir Characterization (Jubarte Field – Brazil)

Andrea Damasceno

Agenda

- 💧 Seismic Data Repeatability
- 💧 Sensitivity Analysis to Pore Pressure and Fluid Saturation changes
- 💧 4D Elastic Inversion – PP data
 - Workflow applied
 - Amplitude correction
 - Results Analysis
 - Preliminary 4D interpretation
- 💧 Final Remarks
- 💧 Next Steps

Agenda

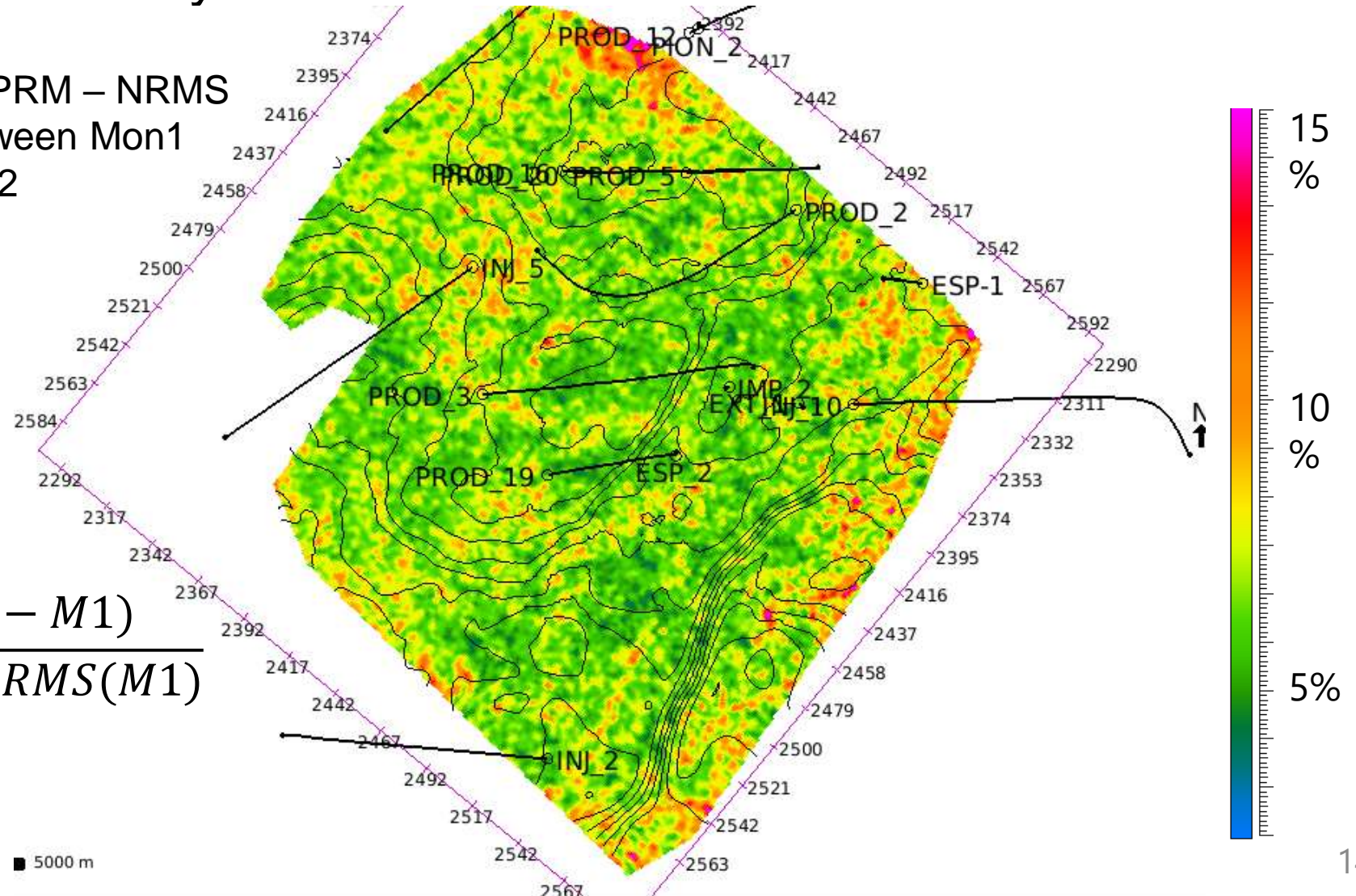
- 💧 **Seismic Data Repeatability**
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Jubarte Field Reservoir Characterization

Seismic Data Repeatability:

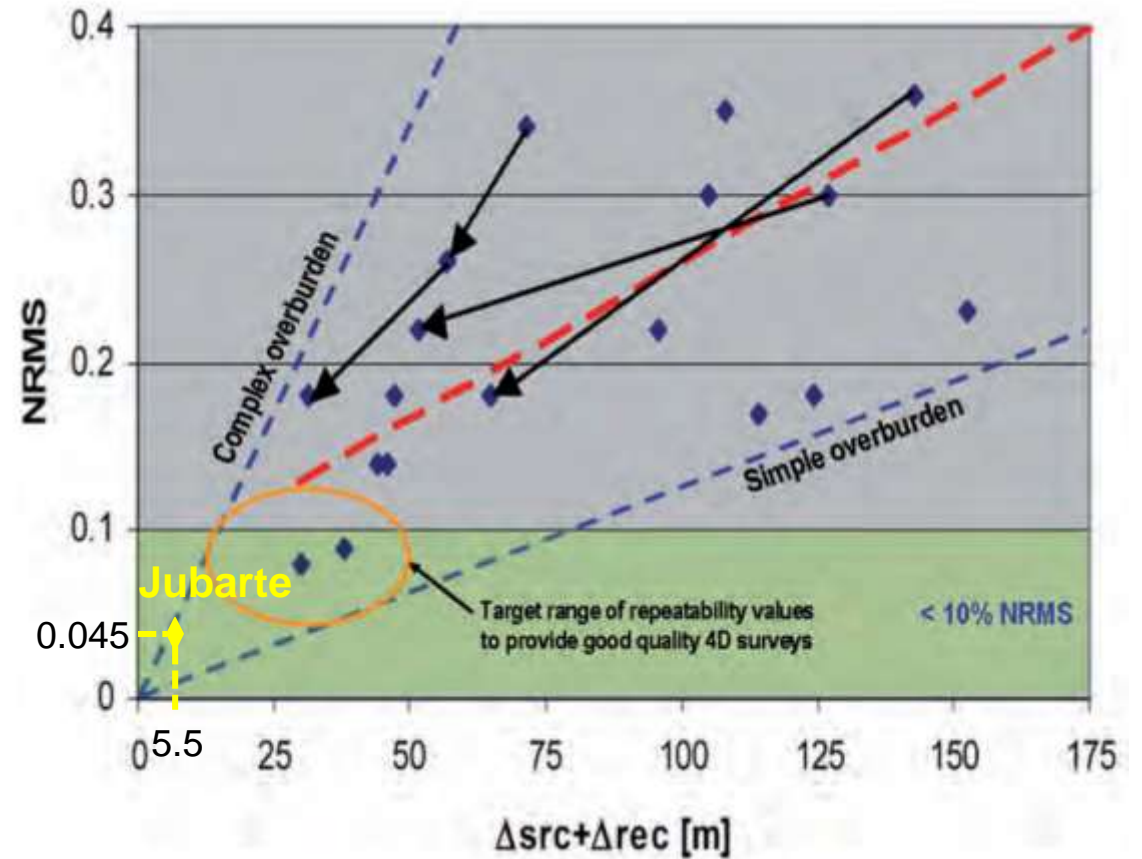
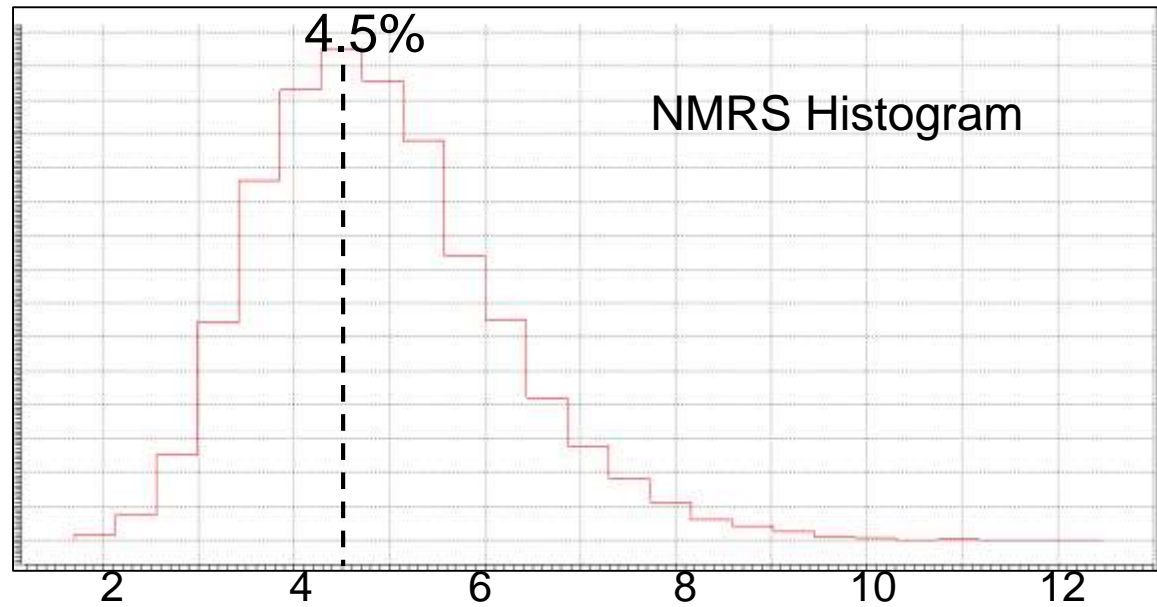
Jubarte PRM – NRMS map between Mon1 and Mon2

$$NRMS = 200 * \frac{RMS(M2 - M1)}{RMS(M2) + RMS(M1)}$$



Jubarte Field Reservoir Characterization

Seismic Data Repeatability:

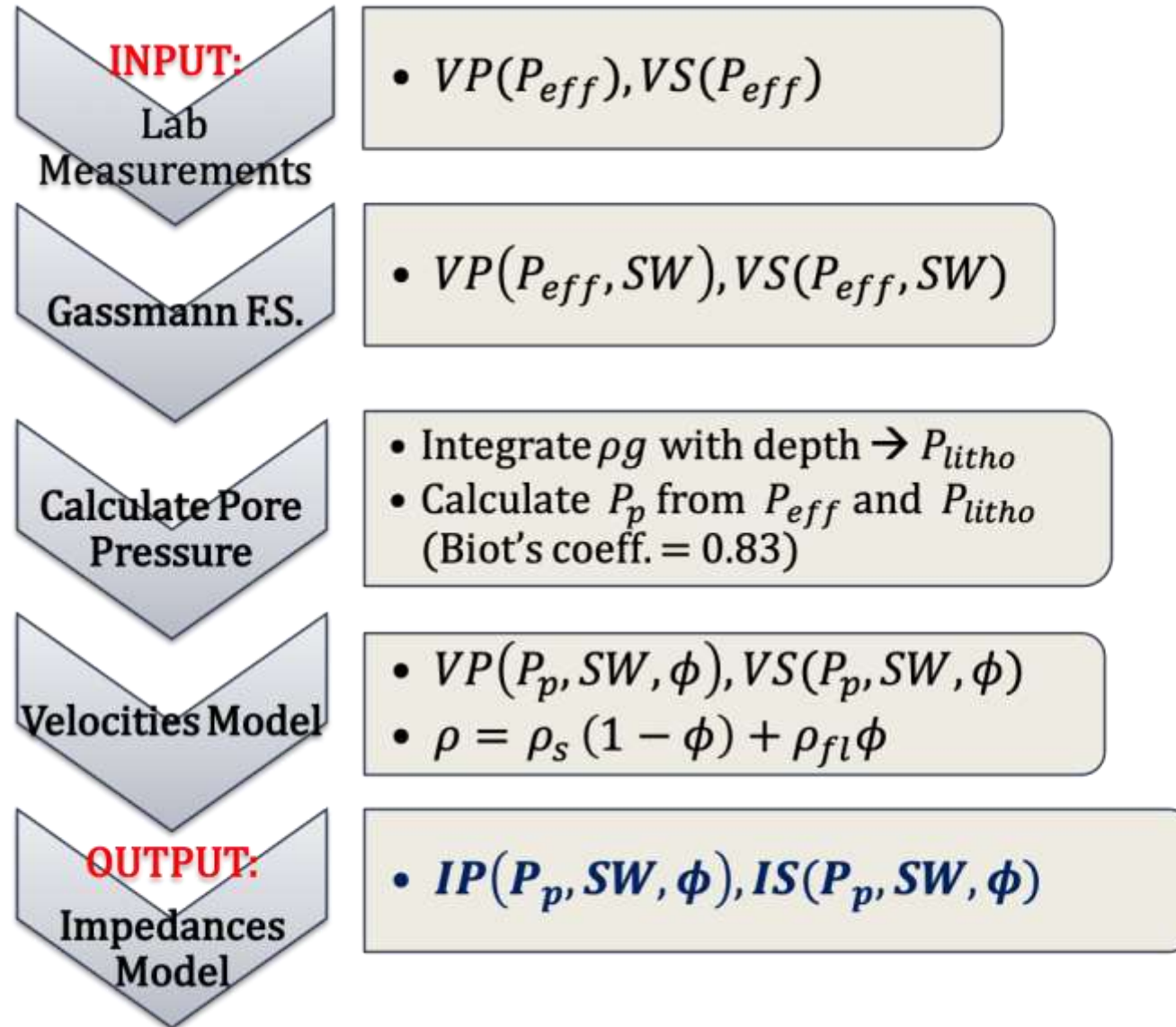


Brown and Paulsen (2011)

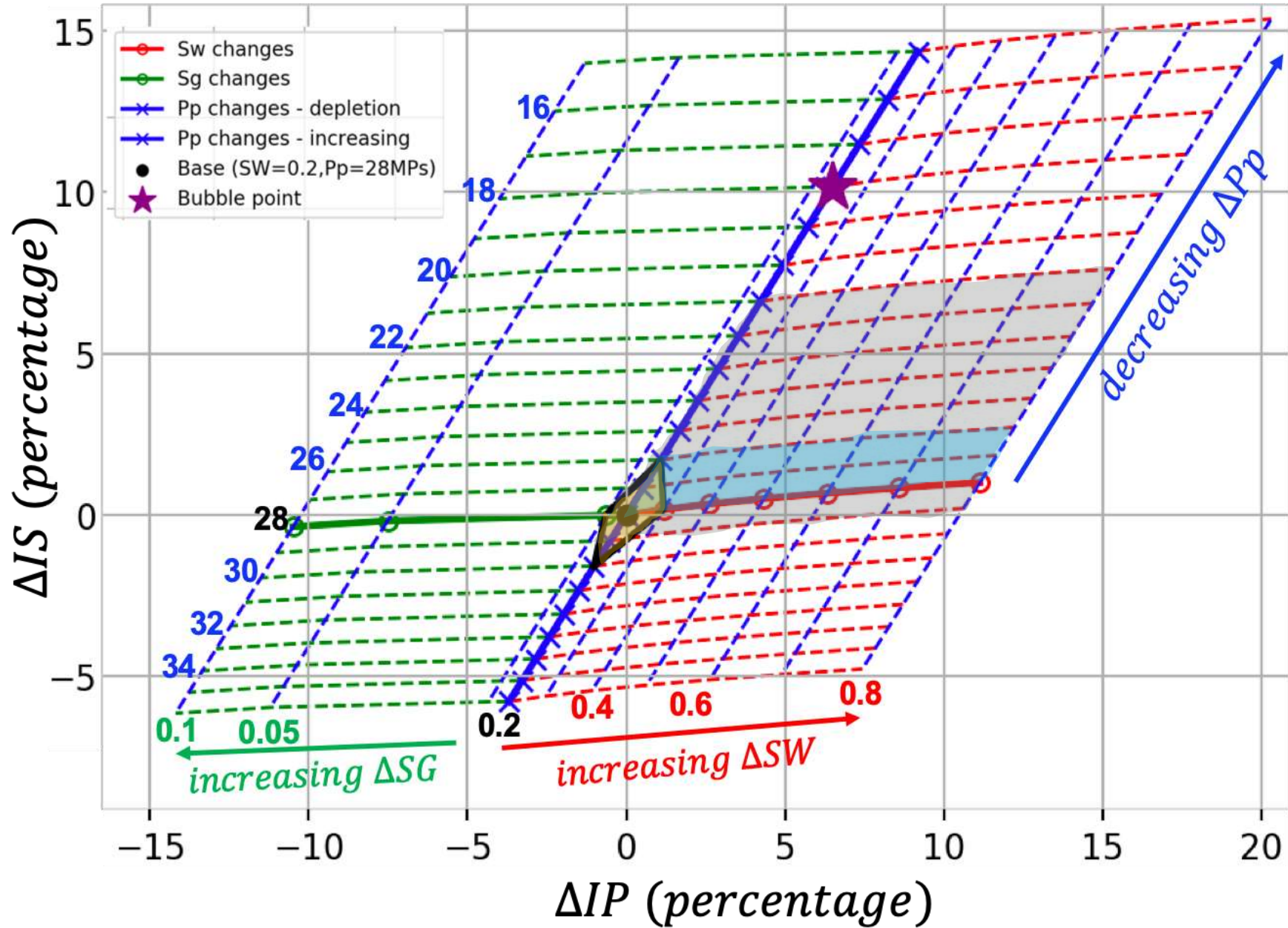
Agenda

- Seismic Data Repeatability
- **Sensitivity Analysis to Pore Pressure and Fluid Saturation changes**
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Sensitivity to Pore Pressure and Fluid Saturation changes



Sensitivity to Pore Pressure and Fluid Saturation changes



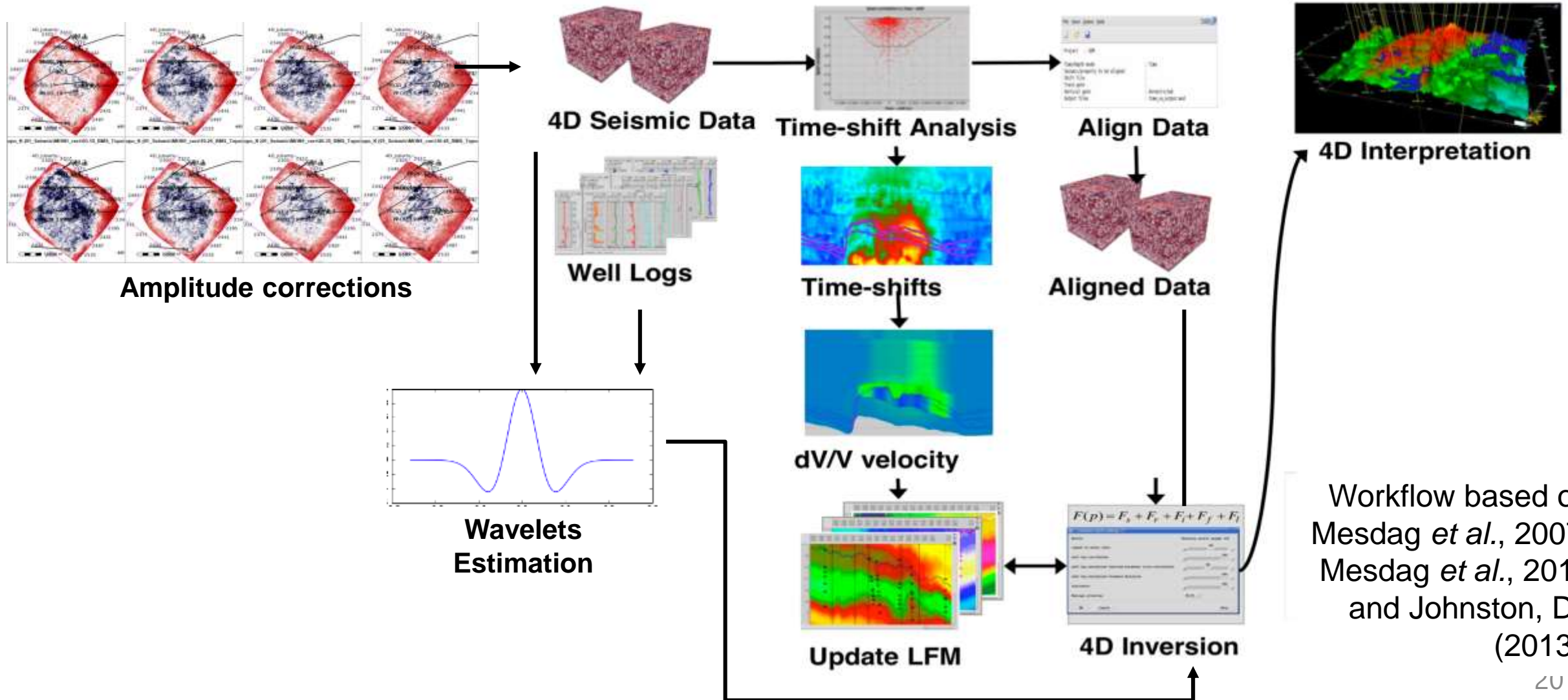
1 MPa = 145 Psi

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4D Elastic Inversion – PP data

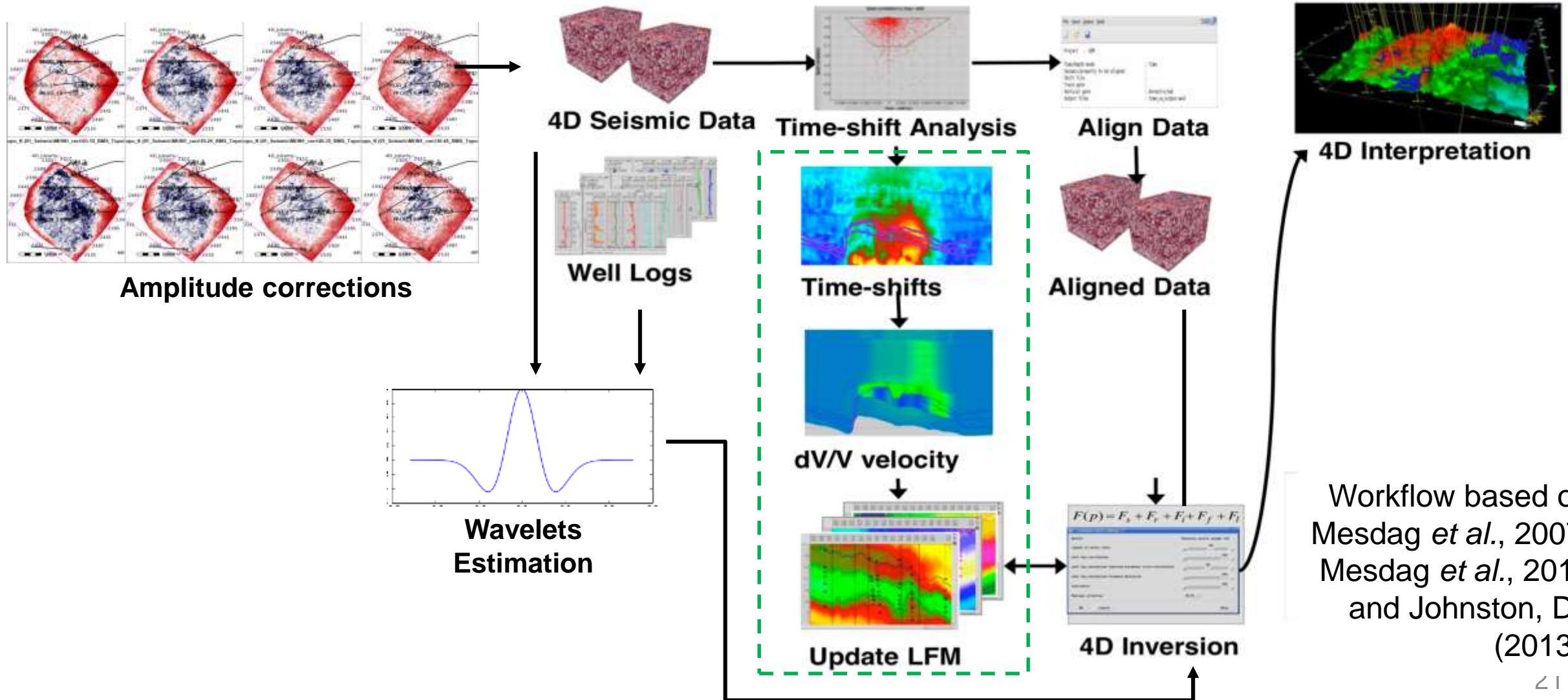
Workflow:



Workflow based on Mesdag *et al.*, 2007, Mesdag *et al.*, 2015 and Johnston, D., (2013).

4D Elastic Inversion – PP data

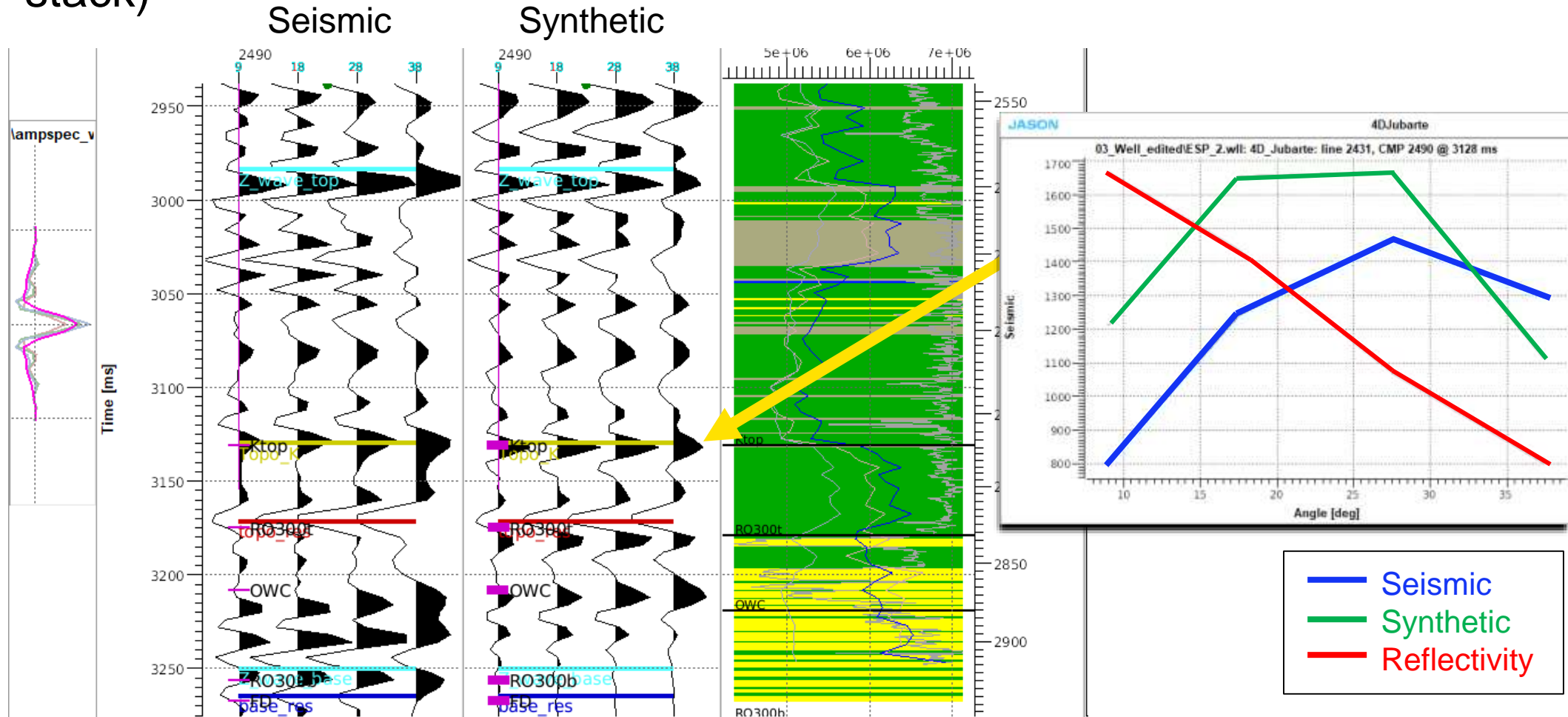
Workflow:



Workflow based on Mesdag *et al.*, 2007, Mesdag *et al.*, 2015 and Johnston, D., (2013).

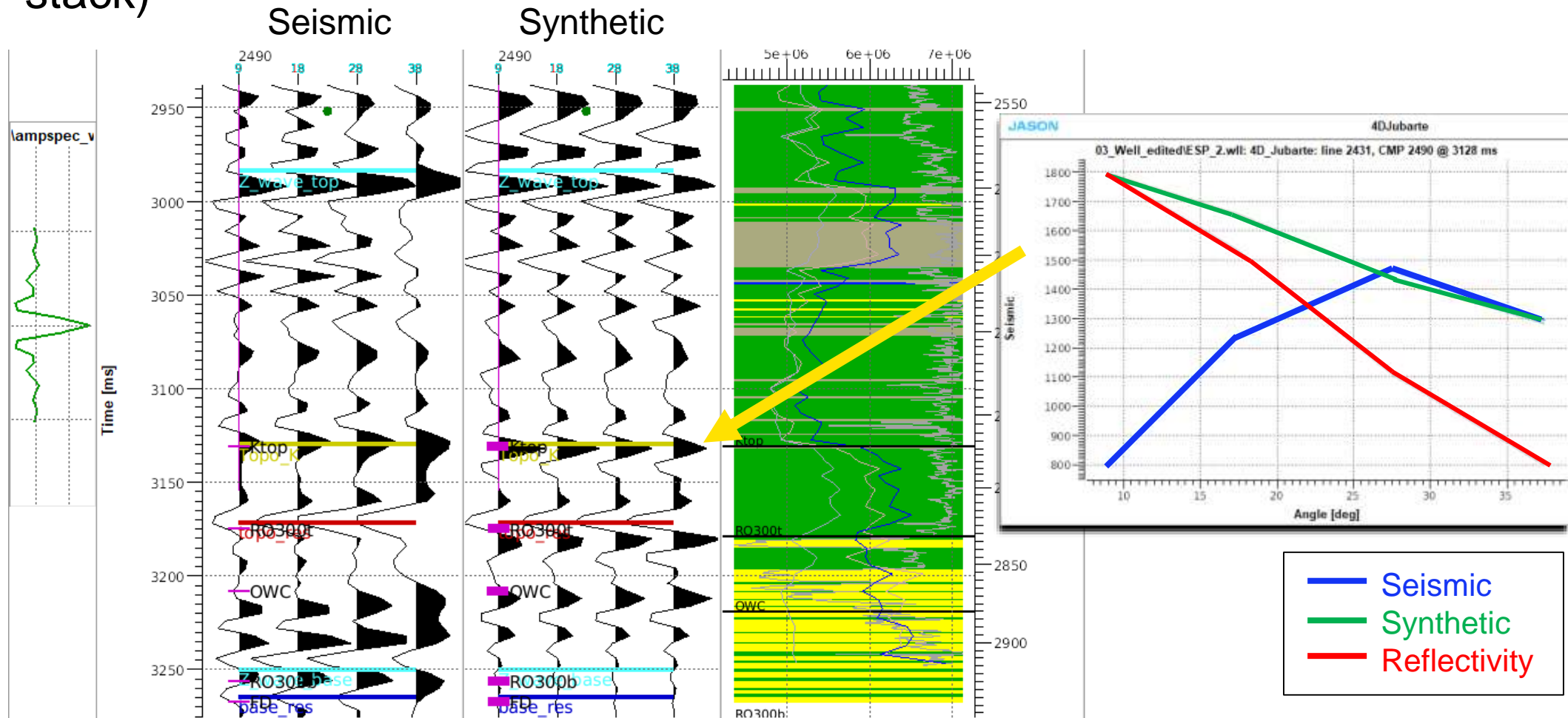
4D Elastic Inversion – PP data

- Seismic x Synthetic: AVO curves comparison – Well ESP-2 (wavelets from each stack)

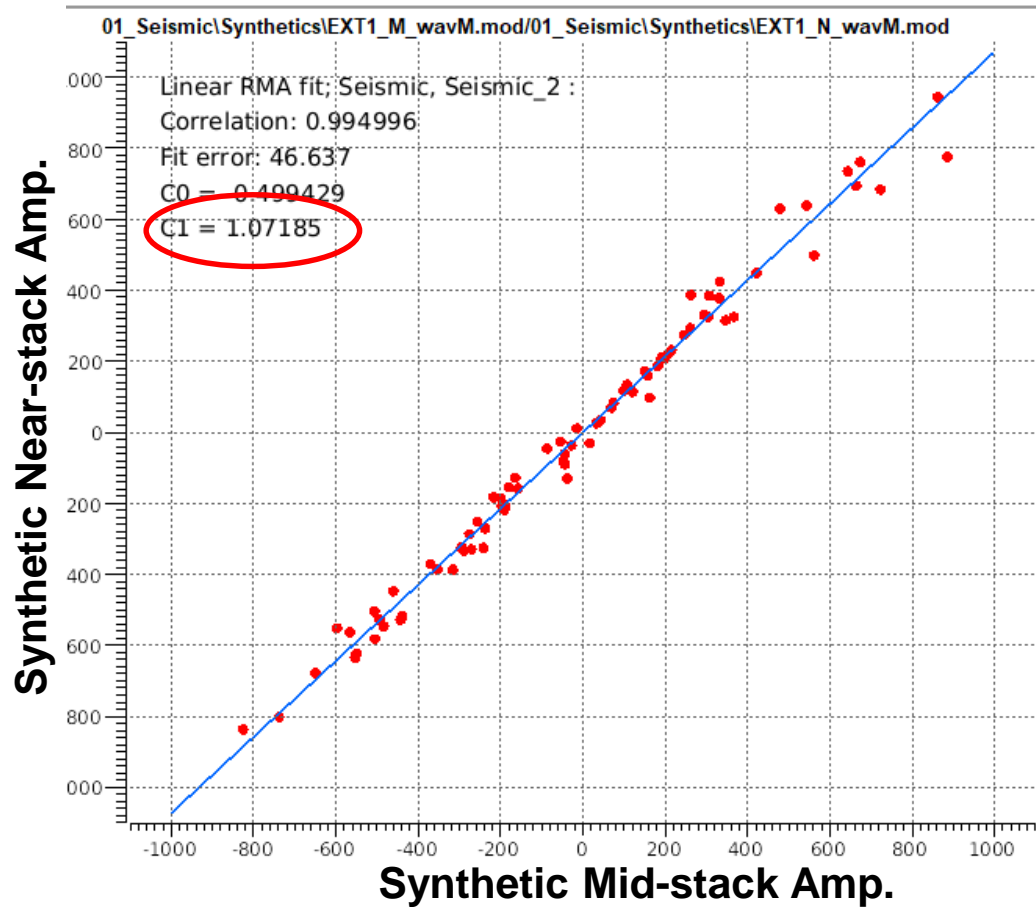


4D Elastic Inversion – PP data

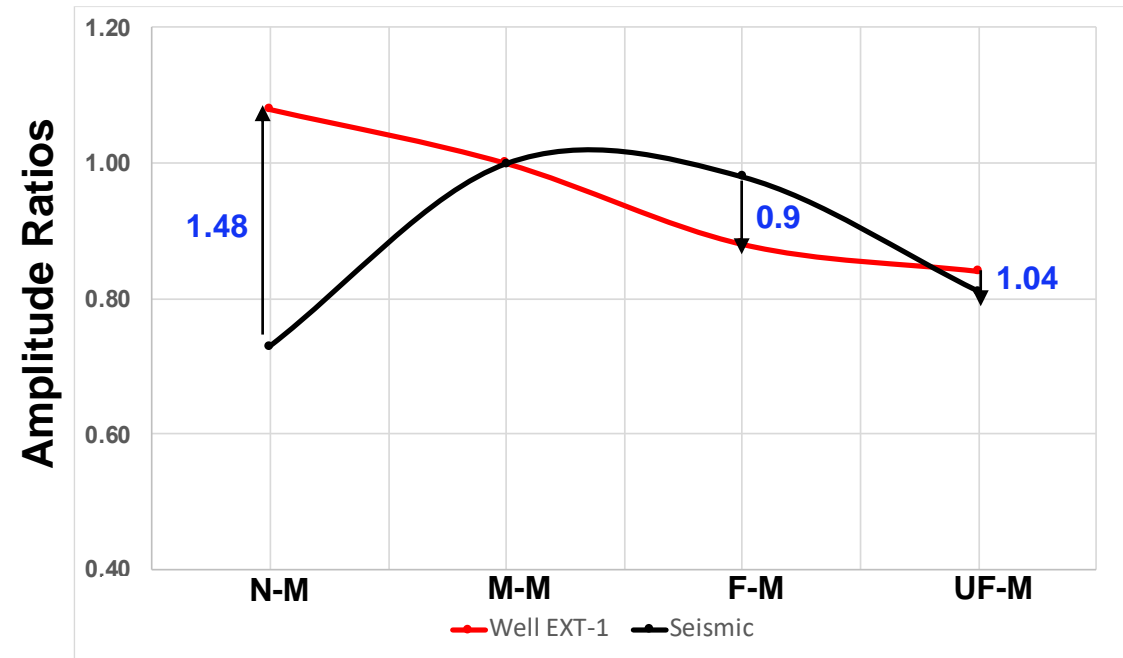
- Seismic x Synthetic: AVO curves comparison – Well ESP-2 (wavelets from MID stack)



4D Elastic Inversion – PP data



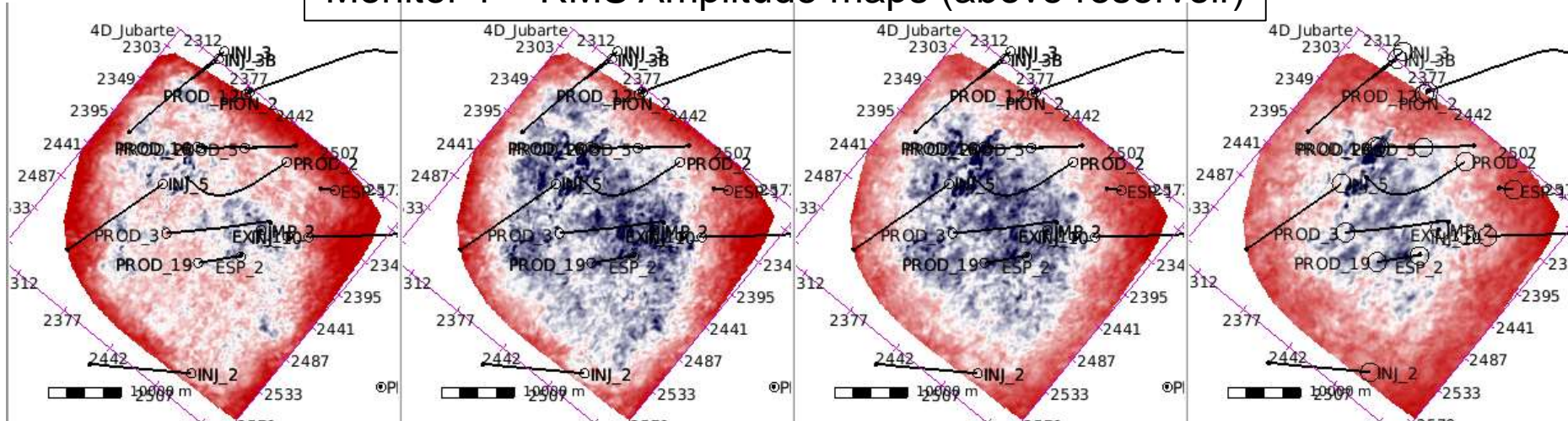
Wells	N-M	F-M	UF-M
EXT1	1.07	0.88	0.84
Seismic	0.73	0.98	0.81



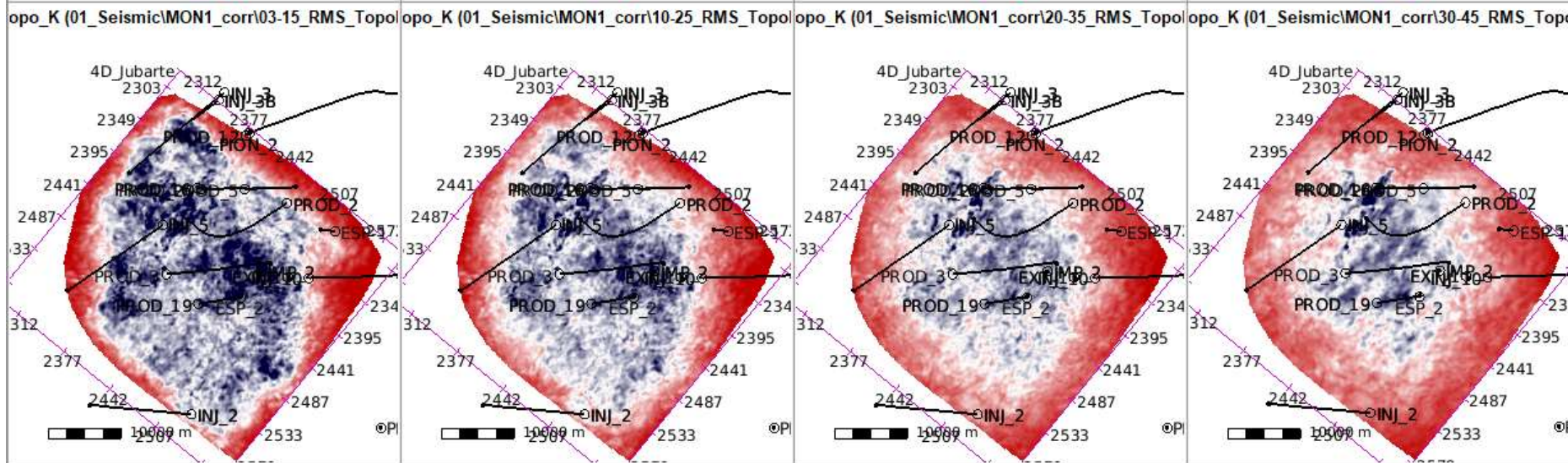
4D Elastic Inversion – PP data

Monitor 1 – RMS Amplitude maps (above reservoir)

Before correction



After correction



Near

Mid

Far

Ultra-Far

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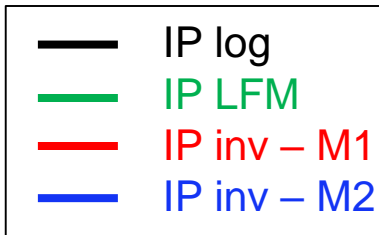
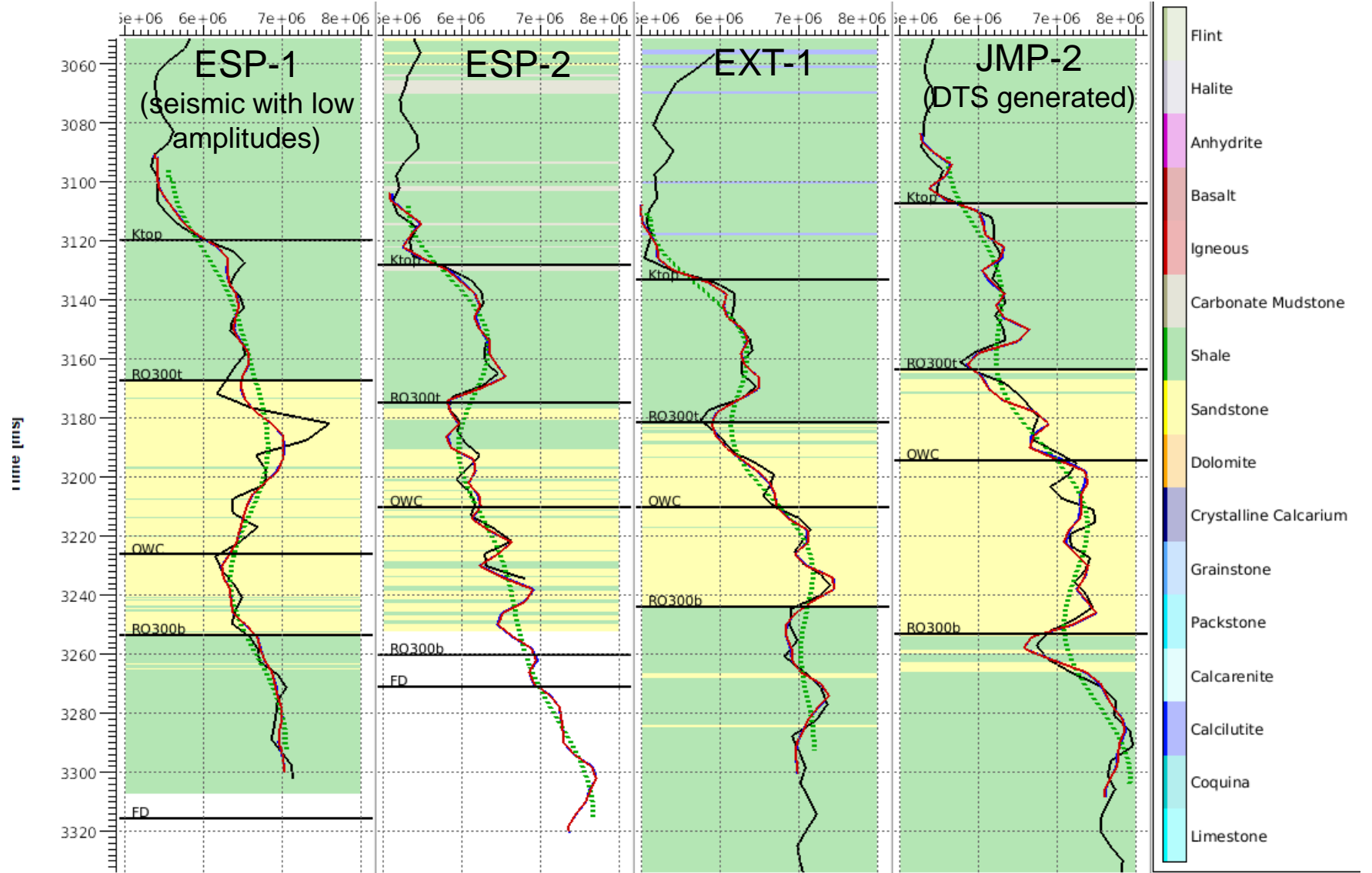
4D Elastic Inversion – PP data

Inversion:

- Jason – CGG
- Monitor 1 and Monitor 2 inverted separately, using the same parametrization → Rock Trace (3D algorithm)
- LFM:
 - Monitor 1: 3D LFM
 - Monitor 2: outputs from M1 inversion
- Wavelet extracted from M1 used for both inversions
- Merge frequency = 15 Hz
- Using lateral continuity constraints
- Using tight constraints outside the reservoir interval

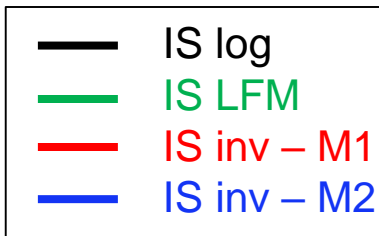
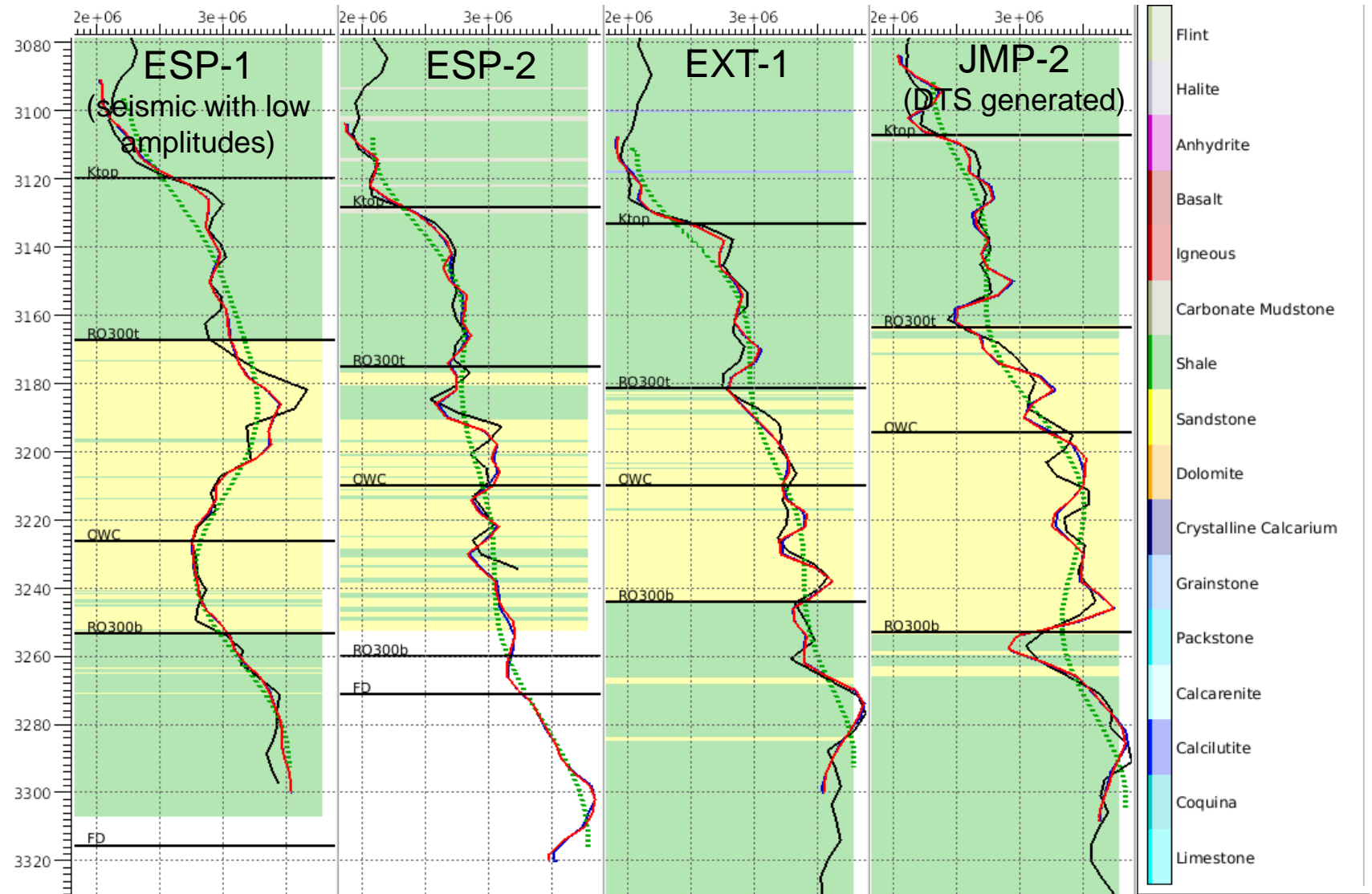
4D Elastic Inversion – PP data

🔹 Inversion
QC at well
positions: IP



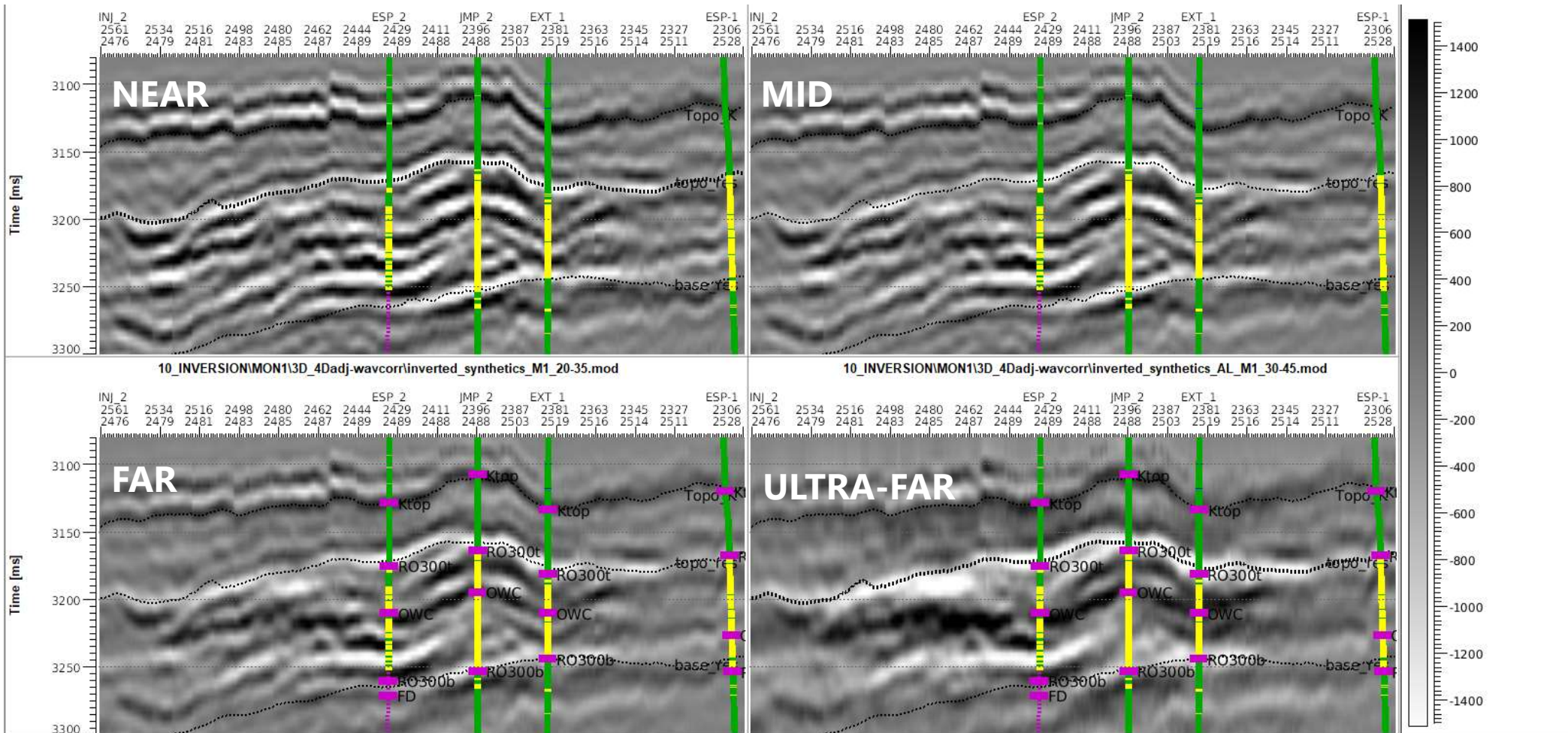
4D Elastic Inversion – PP data

🔹 Inversion
QC at well
positions: IS



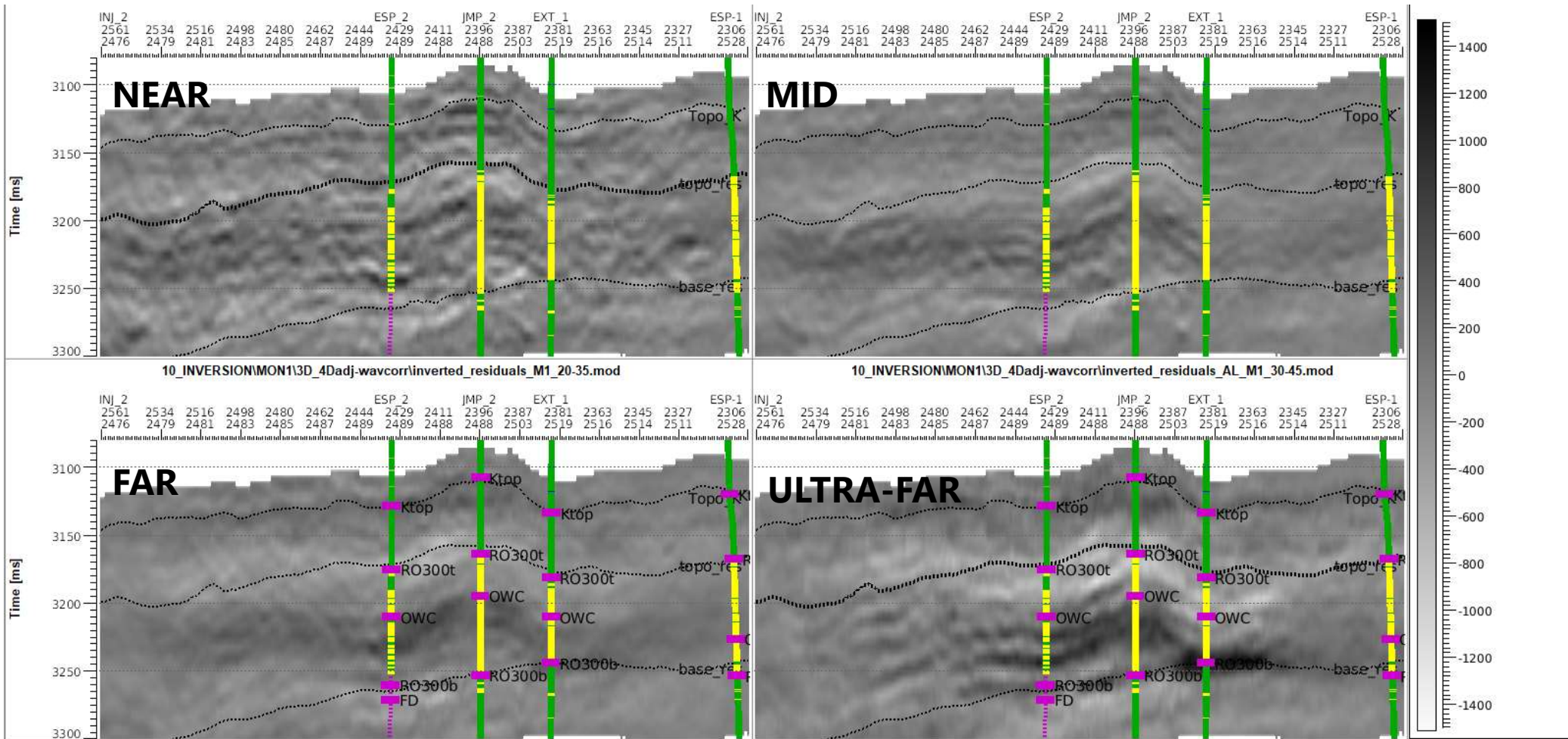
4D Elastic Inversion – PP data

Inversion input data



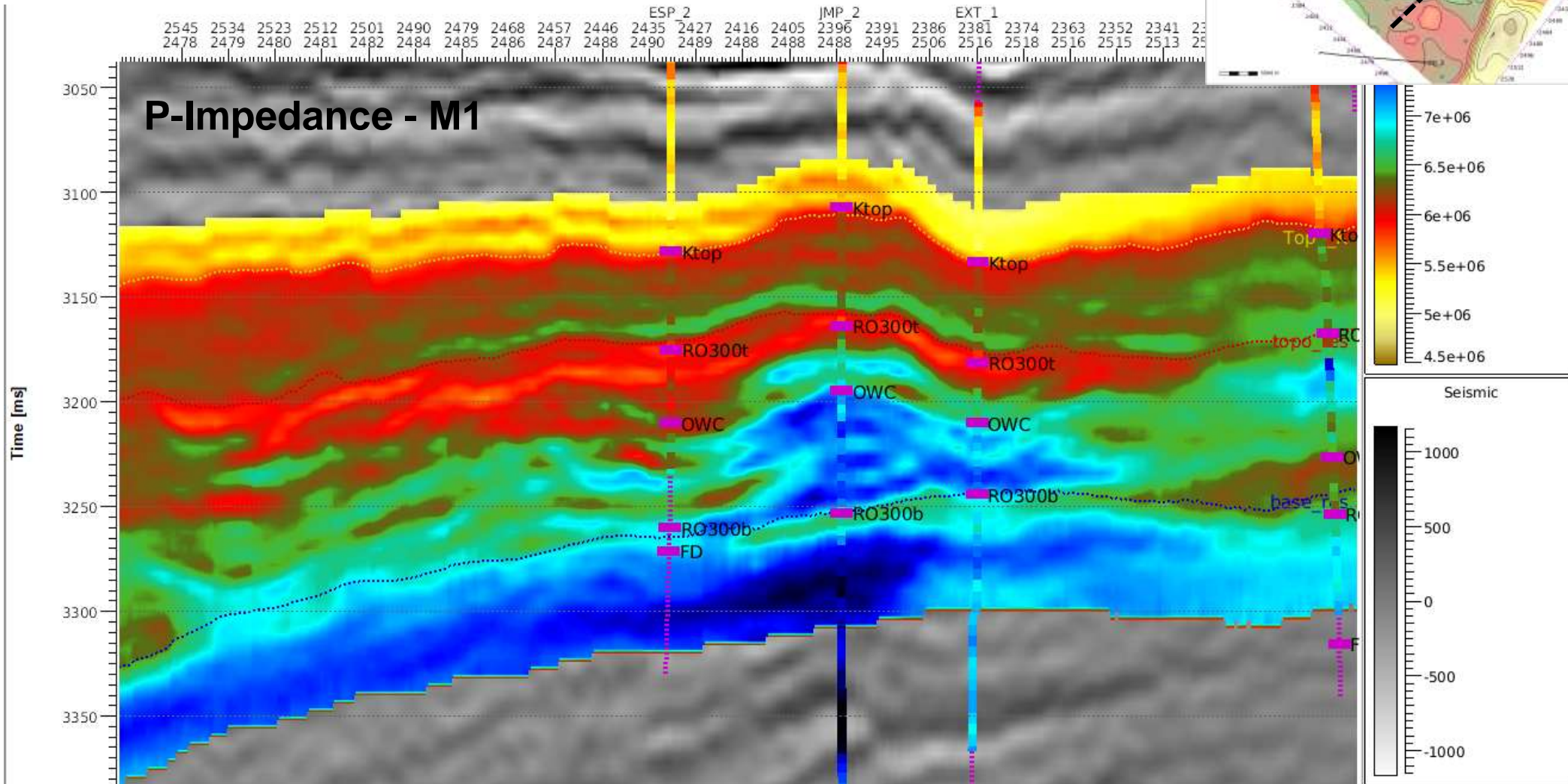
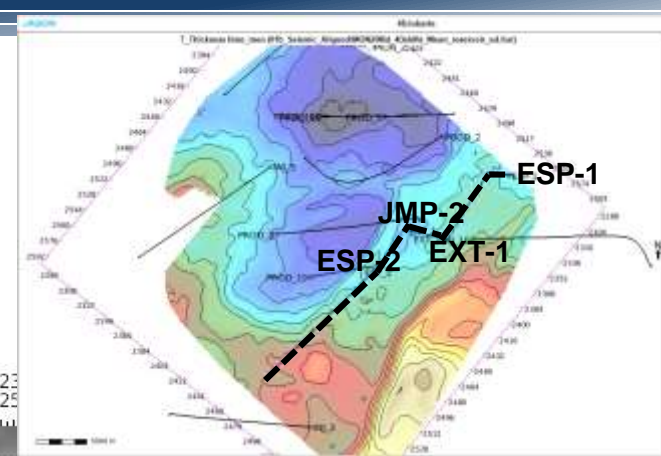
4D Elastic Inversion – PP data

Inversion residuals



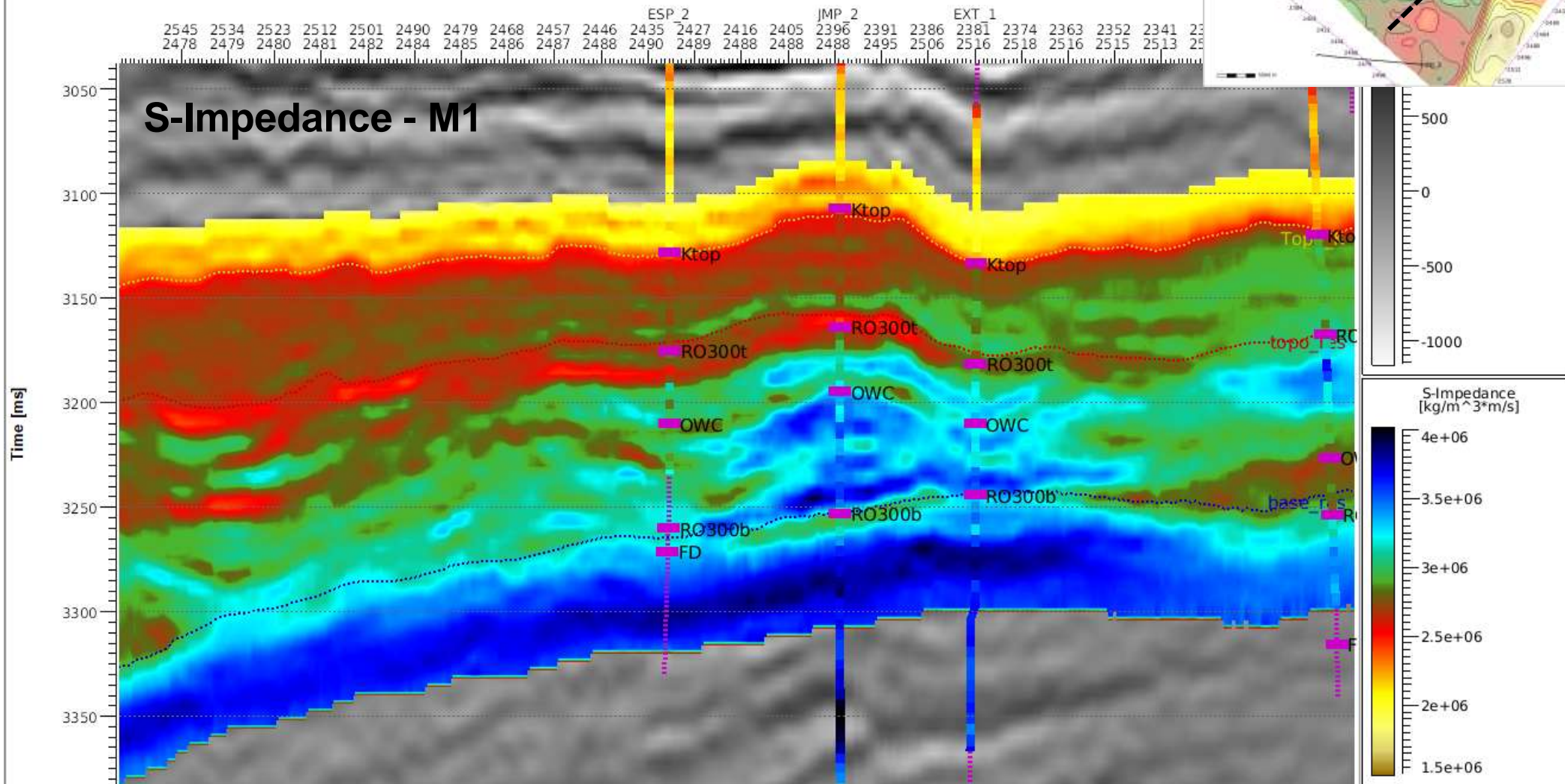
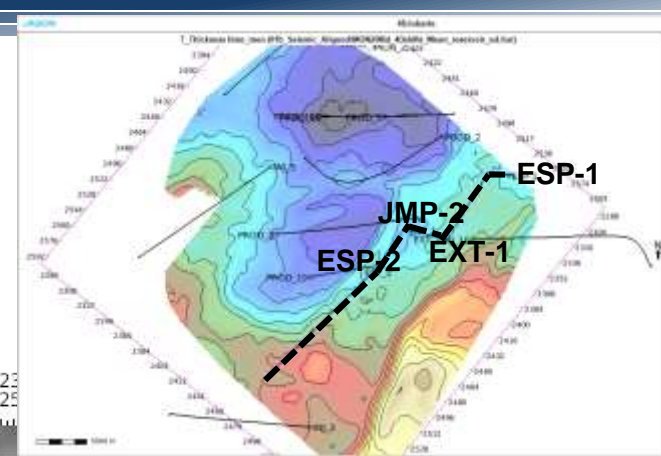
4D Elastic Inversion – PP data

🔹 Inversion QC in 2D lines



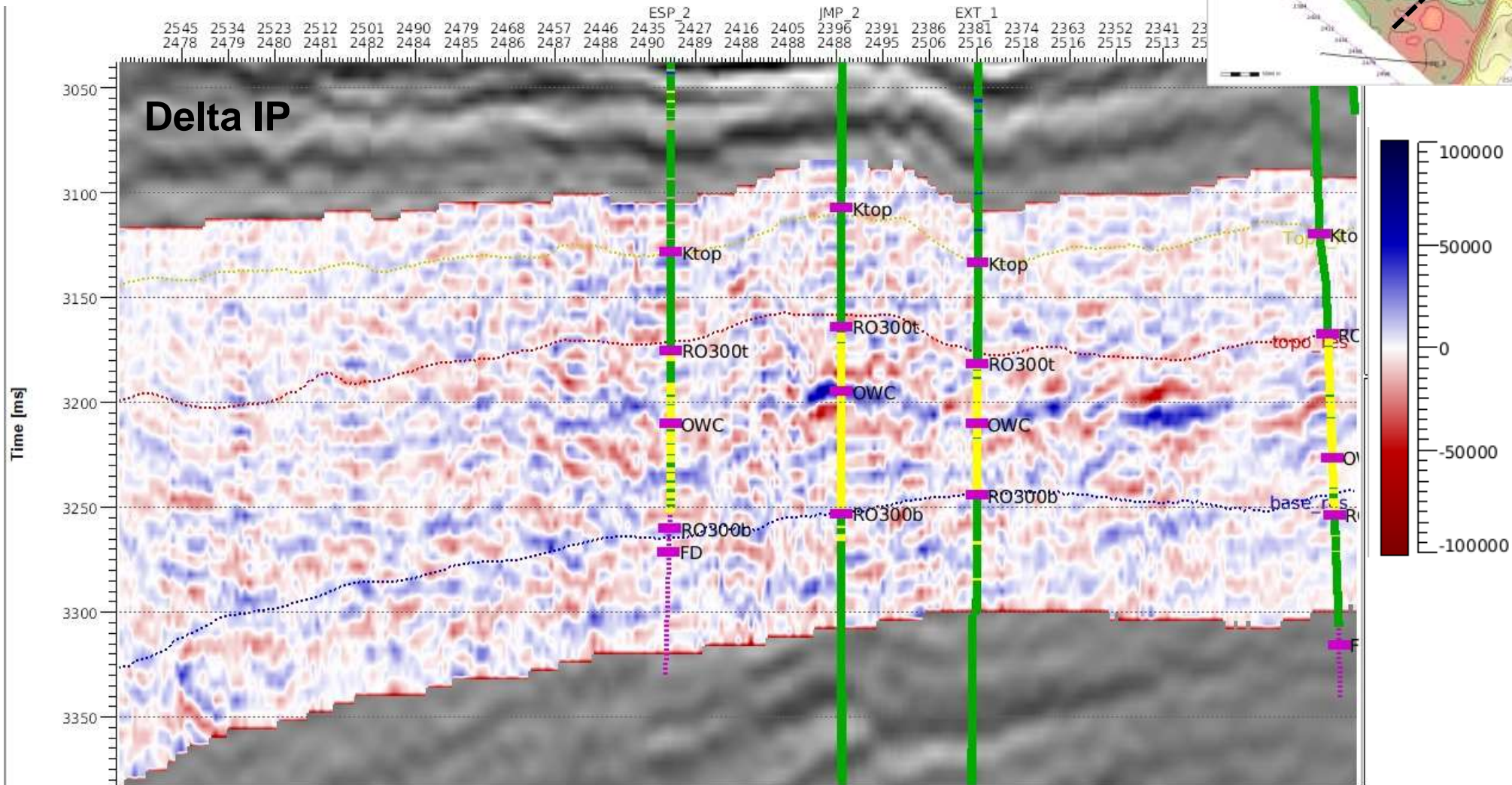
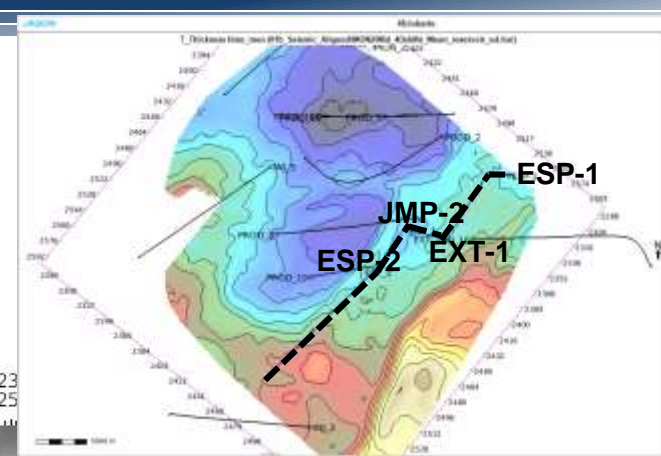
4D Elastic Inversion – PP data

🔹 Inversion QC in 2D lines



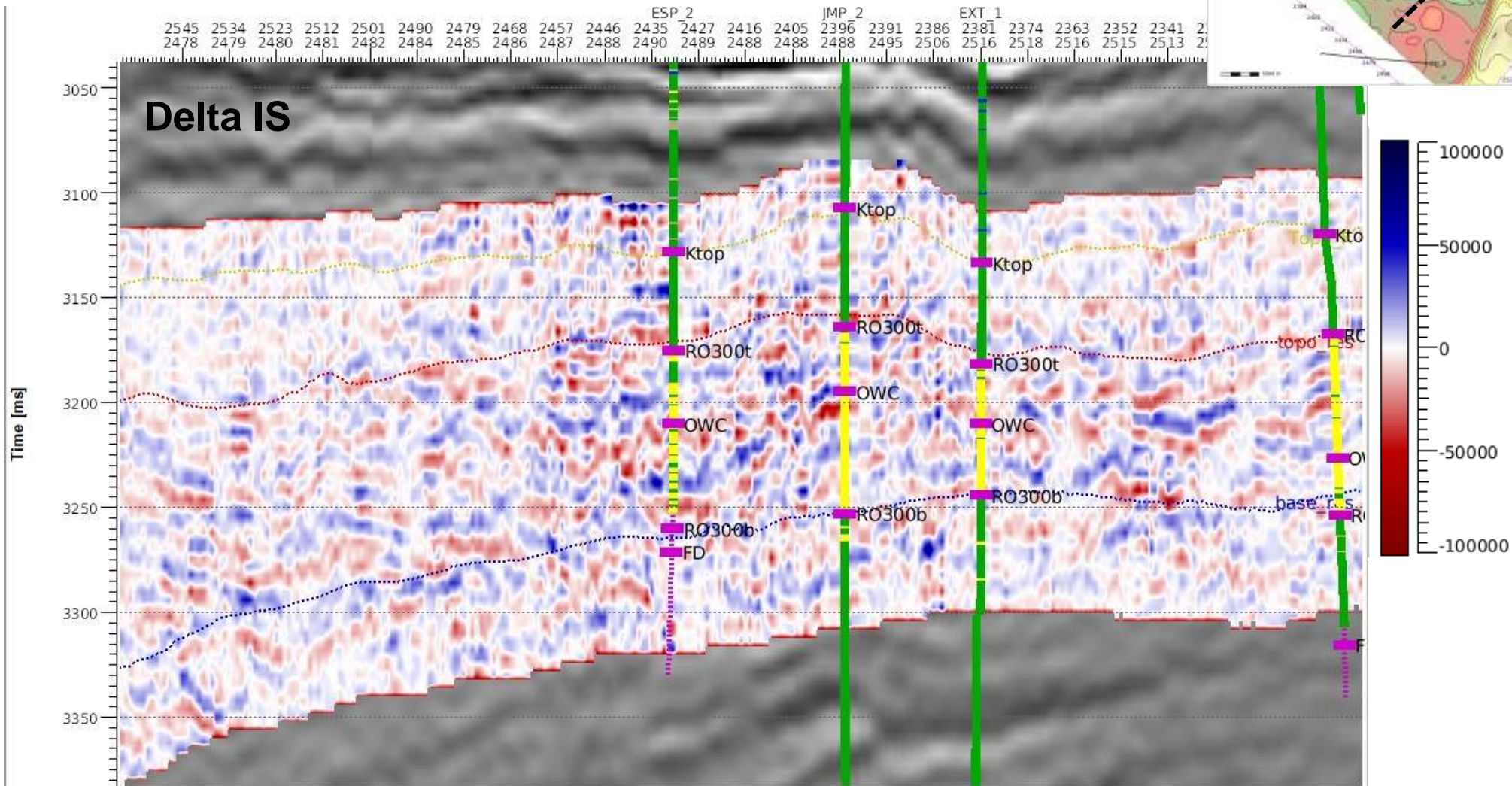
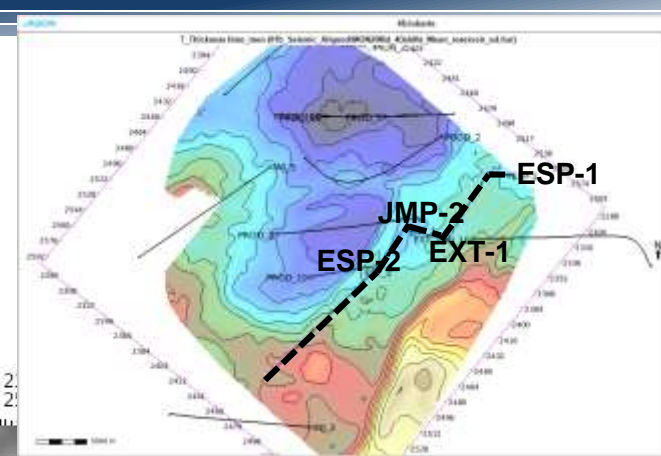
4D Elastic Inversion – PP data

🔹 Inversion QC in 2D lines



4D Elastic Inversion – PP data

🔹 Inversion QC in 2D lines

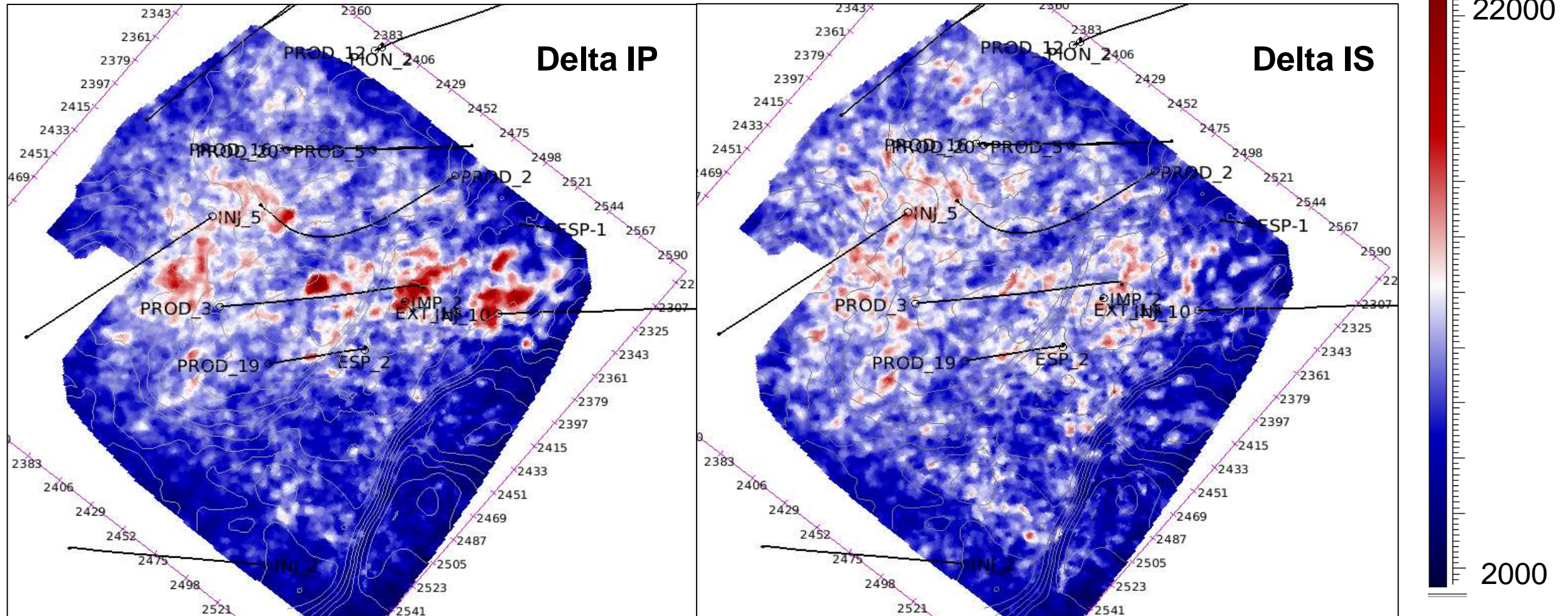


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4D Elastic Inversion – PP data

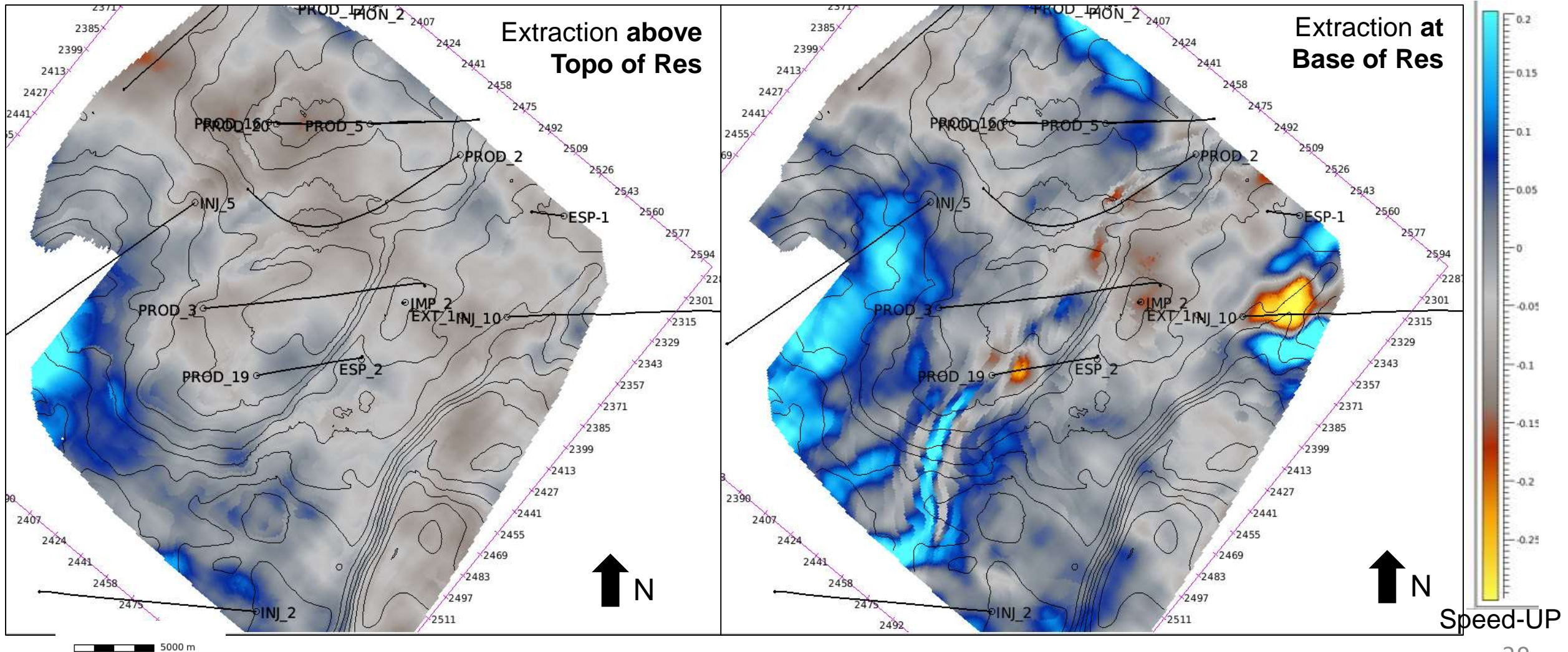
RMS maps - reservoir interval



4D Elastic Inversion – PP data

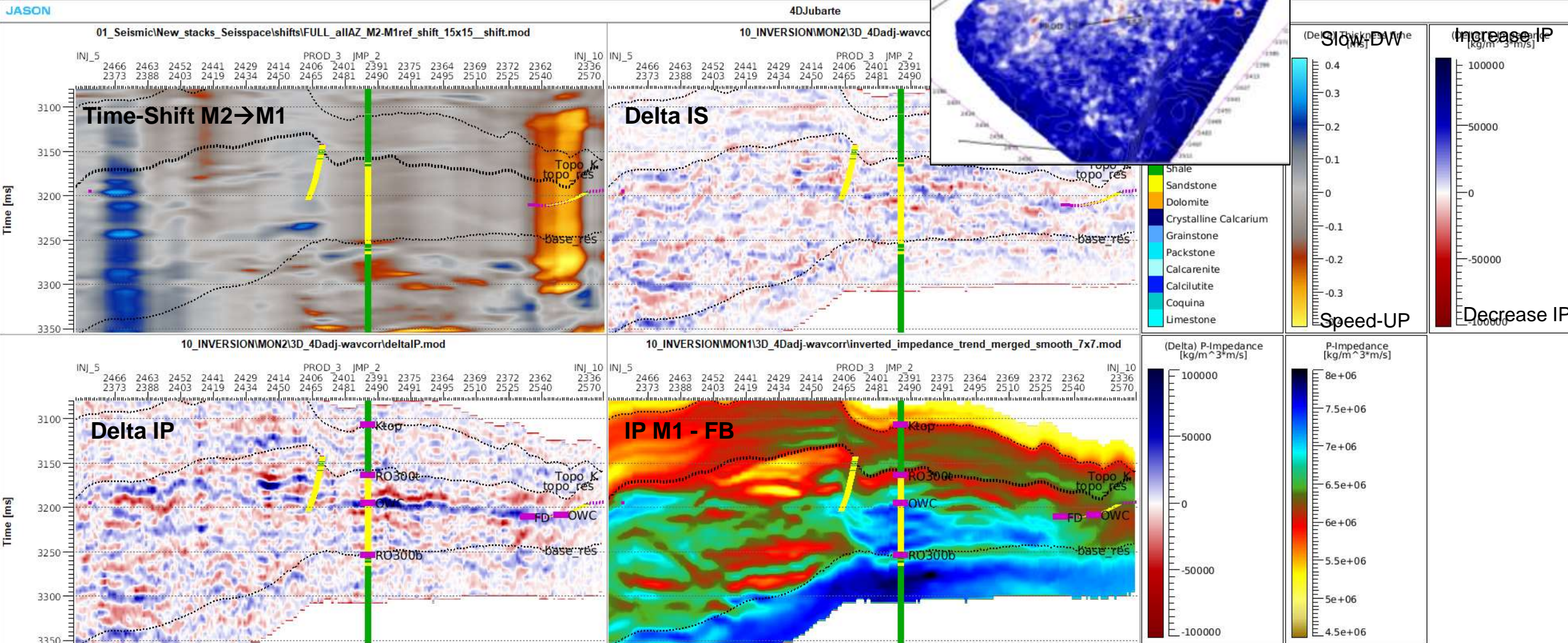
Time-Shifts – Full M2 → Full M1 (reference)

Slow-DW

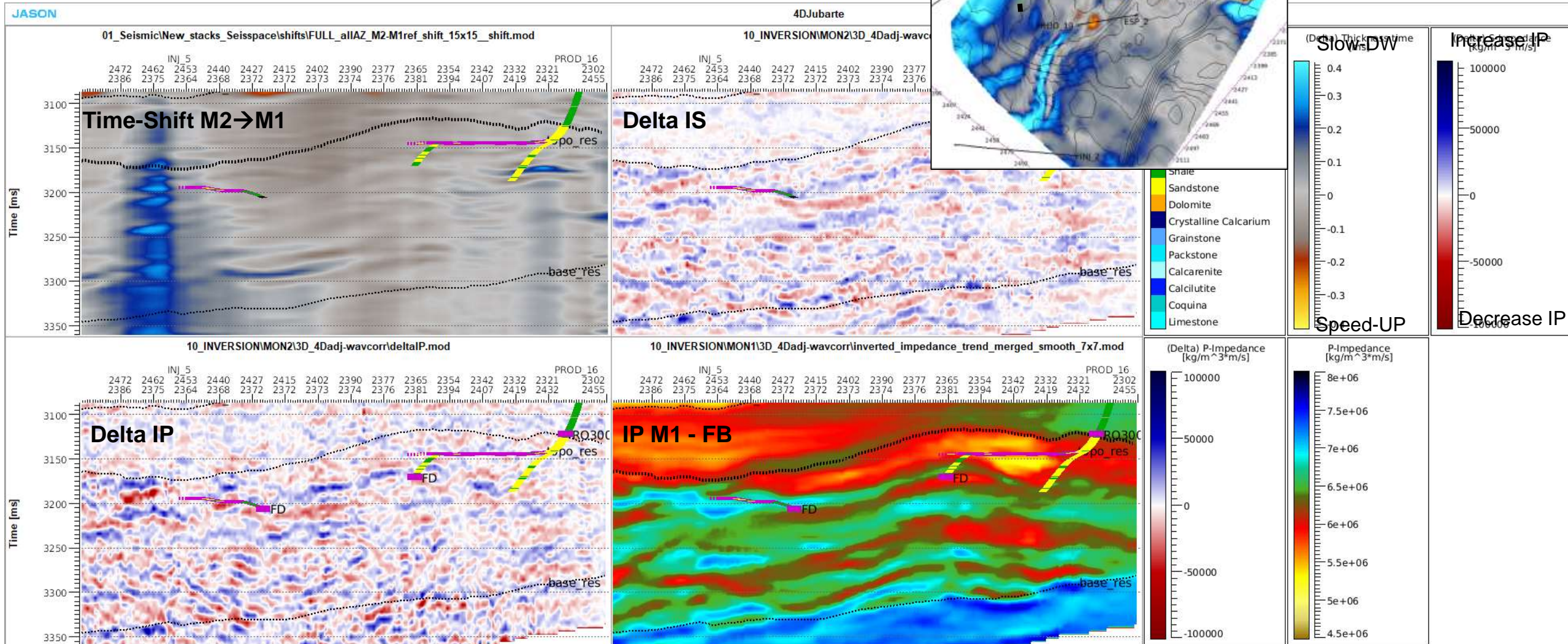


4D Elastic Inversion – PP data

JASON



4D Elastic Inversion – PP data



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Final Remarks

- As a multi-component OBC PRM, the input for 4D analysis is a high repeatable data with average NRMS level of 0.045 (4.5%).
- This high repeatability allows to observe the effects of the expected weak changes in pore pressure and fluid saturations (according to the presented sensitivity analysis).

Final Remarks

- It was performed an elastic 4D inversion using the PP data as an input. The 3D results of Monitor 1 and Monitor 2 looks very satisfactory when we analyze the main inversion quality controls.
- The 4D inversion results look coherent with the information we got from time-shifts, flow simulator, and production information.
- However, the S-impedance volumes are still noisy. Another problem is the residual side-lobes that are present in the 4D impedance differences. Those artifacts need to be minimized in order to make it possible to use these properties in a more quantitative way.

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Next Steps

- Incorporate the 4D effects in inversion LFM.
- Invert the PS data.
- Work more on the Rock-physics models.
- Integrate simulator and production data to time-shifts and inversion volumes in a more quantitative way.

