NEW CGG DATA TECHNOLOGY INITIATIVES – PSEUDO 3D TECHNOLOGY AND INTERPRETATION RESULTS FOR INDONESIA DATASETS

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- GEOLOGICAL SETTING
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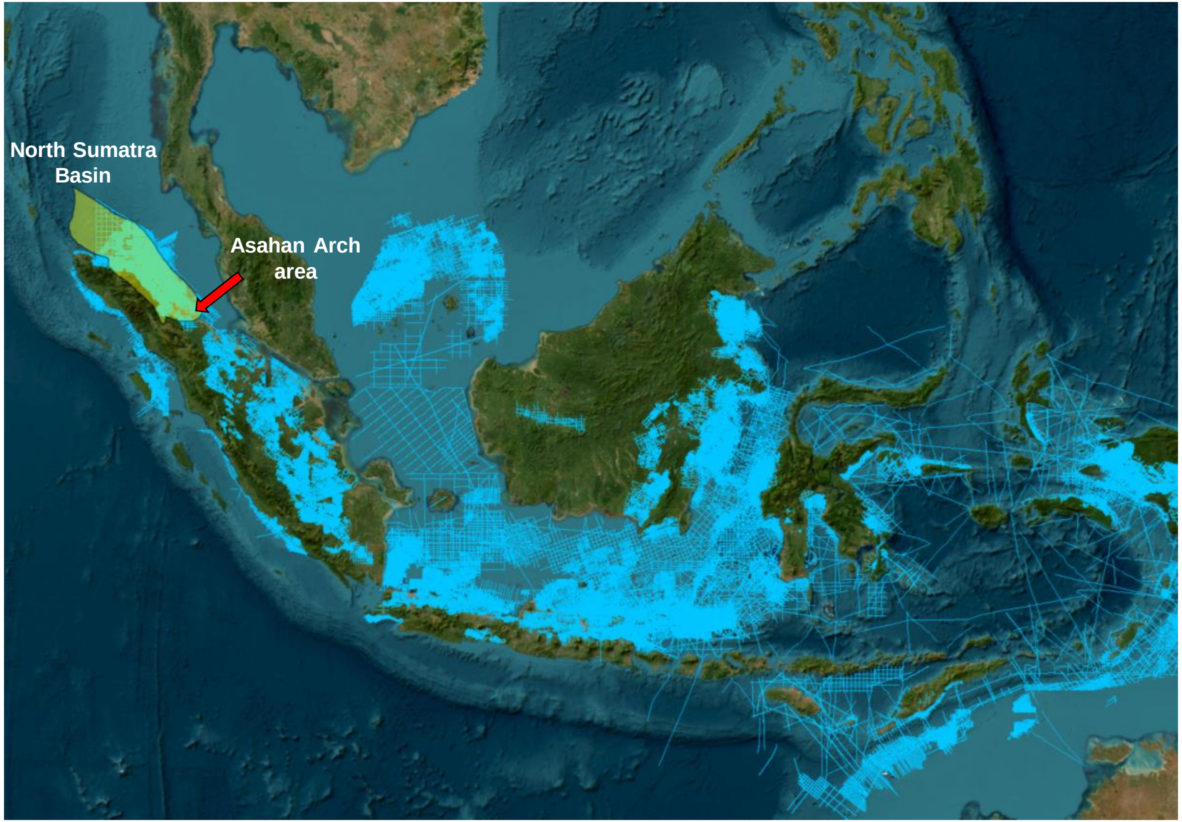
INTRODUCTION & PROJECT OVERVIEW

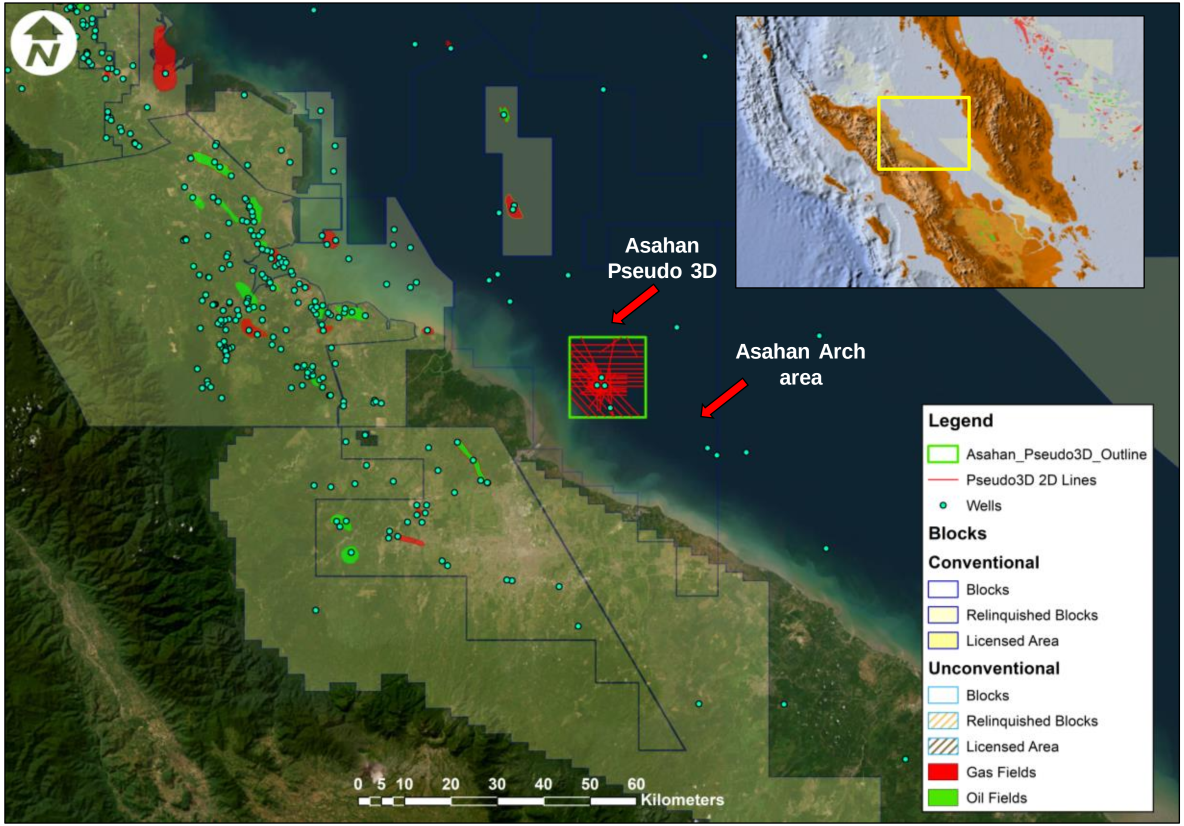
INTRODUCTION

- The availability and coverage of legacy seismic data within Indonesia, represents a key challenge for developing existing assets and pursuing new exploration initiatives
- CGG has undertaken a major global data collection initiative, with the objective of developing enhanced datasets through the application of high-end reprocessing technology and interpretation
- A key focus area is Indonesia, where advanced Pseudo 3D interpolation tests have been undertaken on legacy 2D data
- New Pseudo 3D volume generated from legacy 2D data within the Asahan Arch area (North Sumatra Basin)



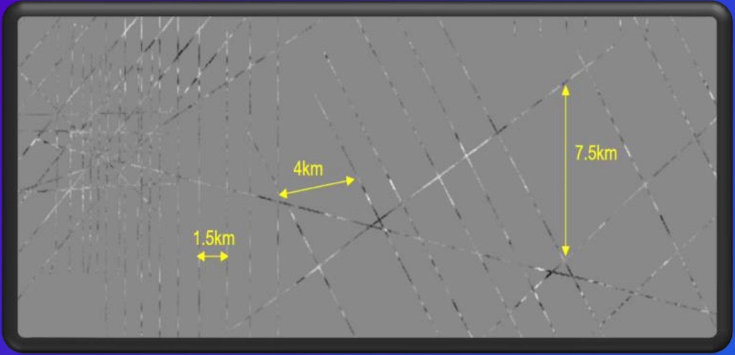
PROJECT AREA

- The project area is located approximately 15km from the east coast of Sumatra
- Project area is on the flank of the Asahan Arch, along the south-eastern extent of the North Sumatra Basin
- The Asahan Arch is a prominent structural high that represents the boundary between the North Sumatra and Central Sumatra Basins
- The dataset discussed comprises a 2D seismic grid of 53 lines with 540 line km of coverage, from which a new Pseudo 3D volume has been generated
- Interpretation was undertaken on the resulting dataset to evaluate enhanced interpretation capabilities

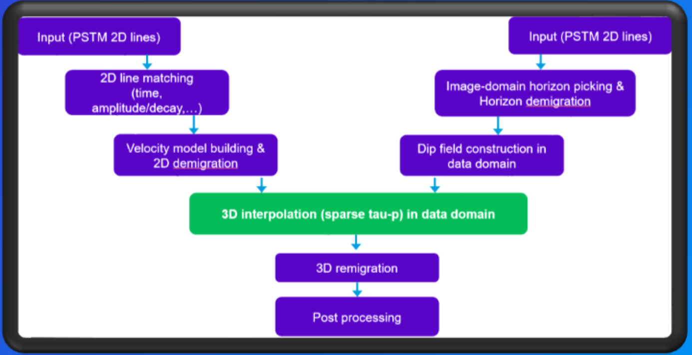


KEY OBJECTIVES (WORKFLOW)

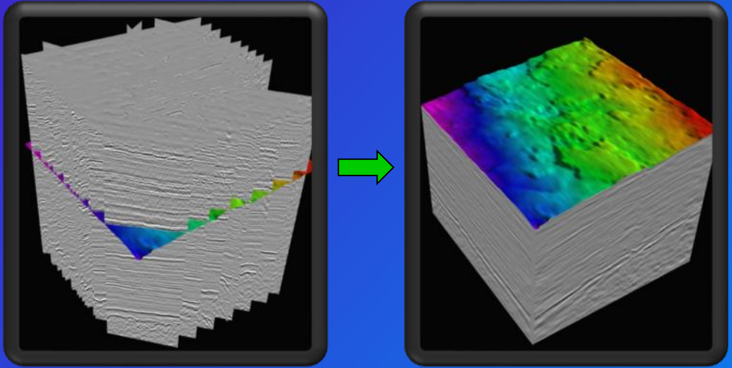
Data area identification and survey grid selection



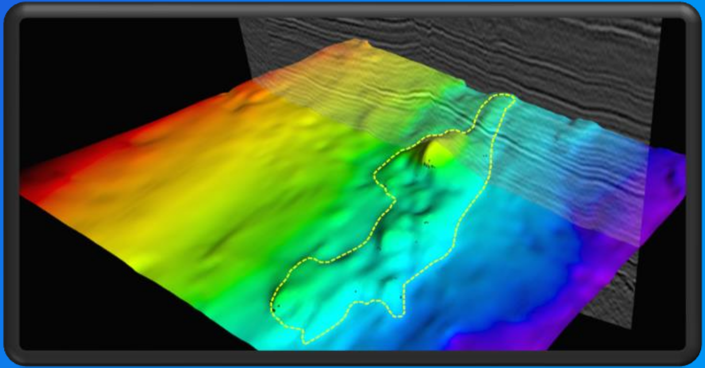
Data conditioning & Reprocessing (interpolation)



Pseudo 3D volume generation



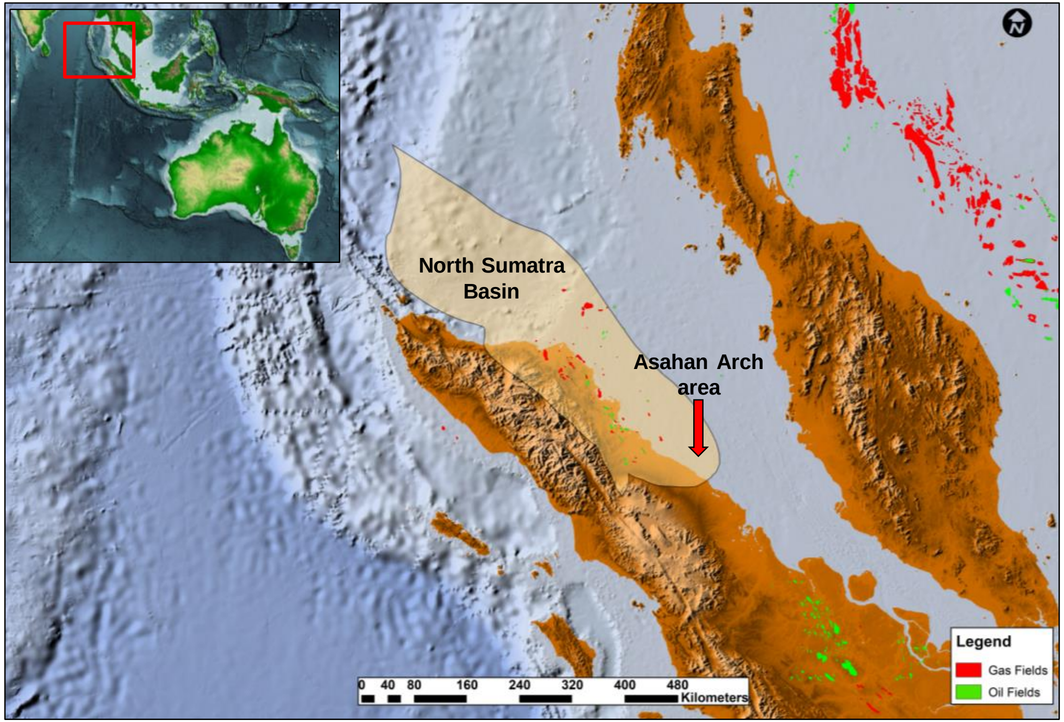
Volume-based interpretation

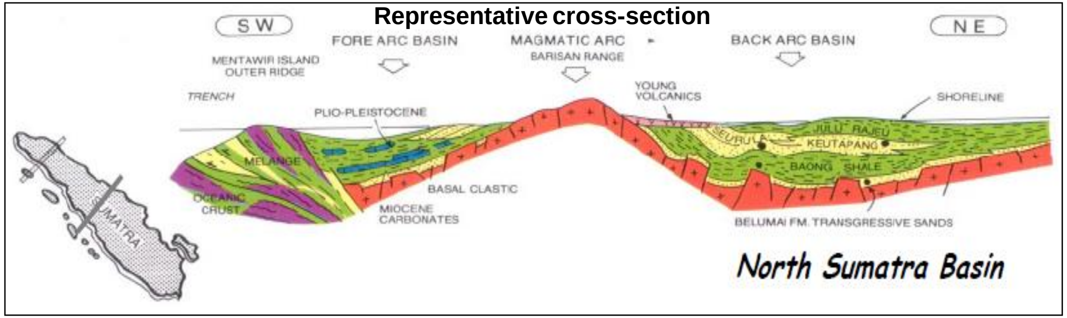


GEOLOGICAL SETTING

Basin Overview

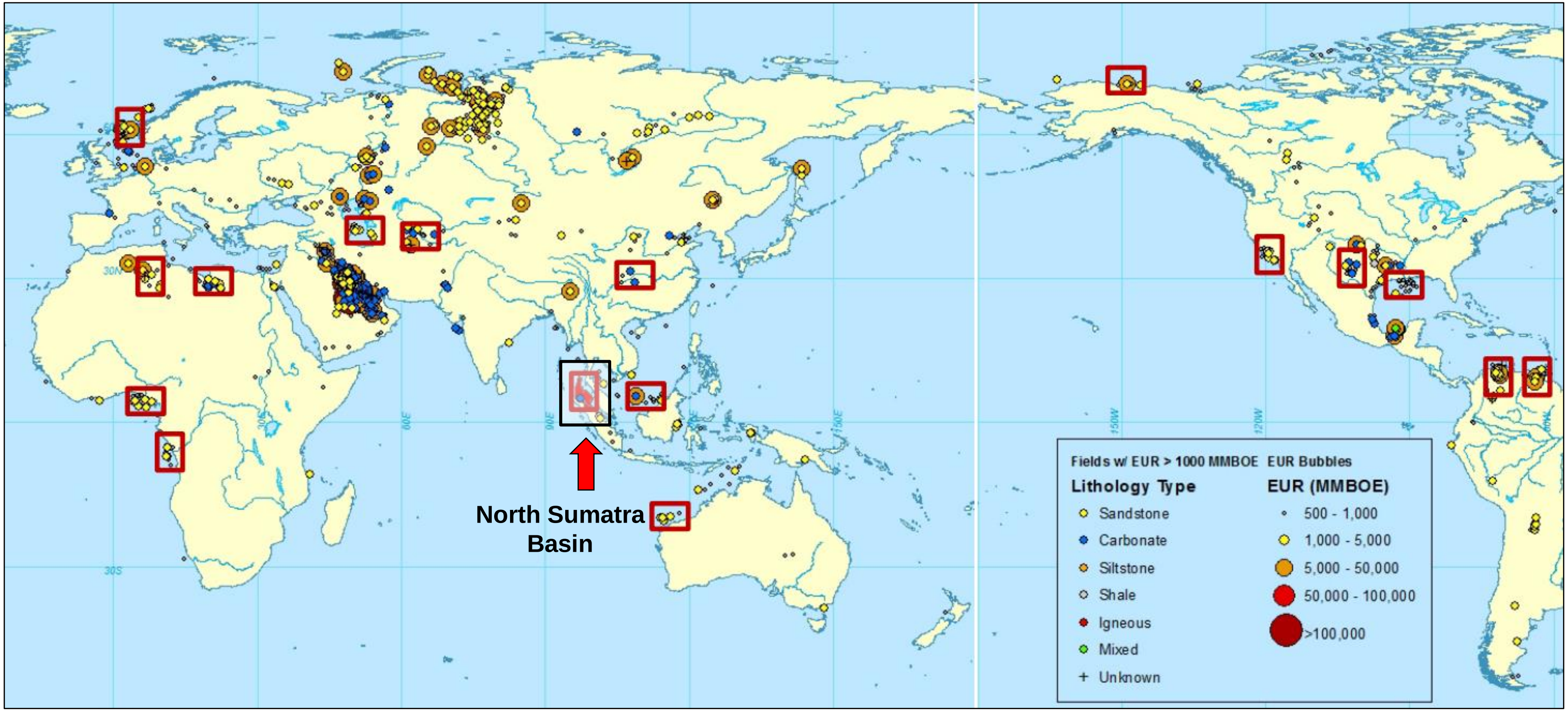
- The North Sumatra Basin covers approximately 60,000 sq km, both onshore and offshore
- Backarc basin, NE of the volcanic Sunda Arc, initiated in the late Eocene to early Oligocene time
- N-S basement lineaments, result of Palaeogene rifting and half-graben development (44–30 Ma), exert control on source rock & reservoir distribution
- Several phases of post-early Miocene NW-SE transcurrent faulting and folding
- 2–5 km Cenozoic sediments
- Early Tertiary rifting, Mid-Miocene inversion
- Widespread early Miocene carbonates, with local build-ups
- Basin prolific onshore, relatively unexplored in deeper water





Satyana, 2010

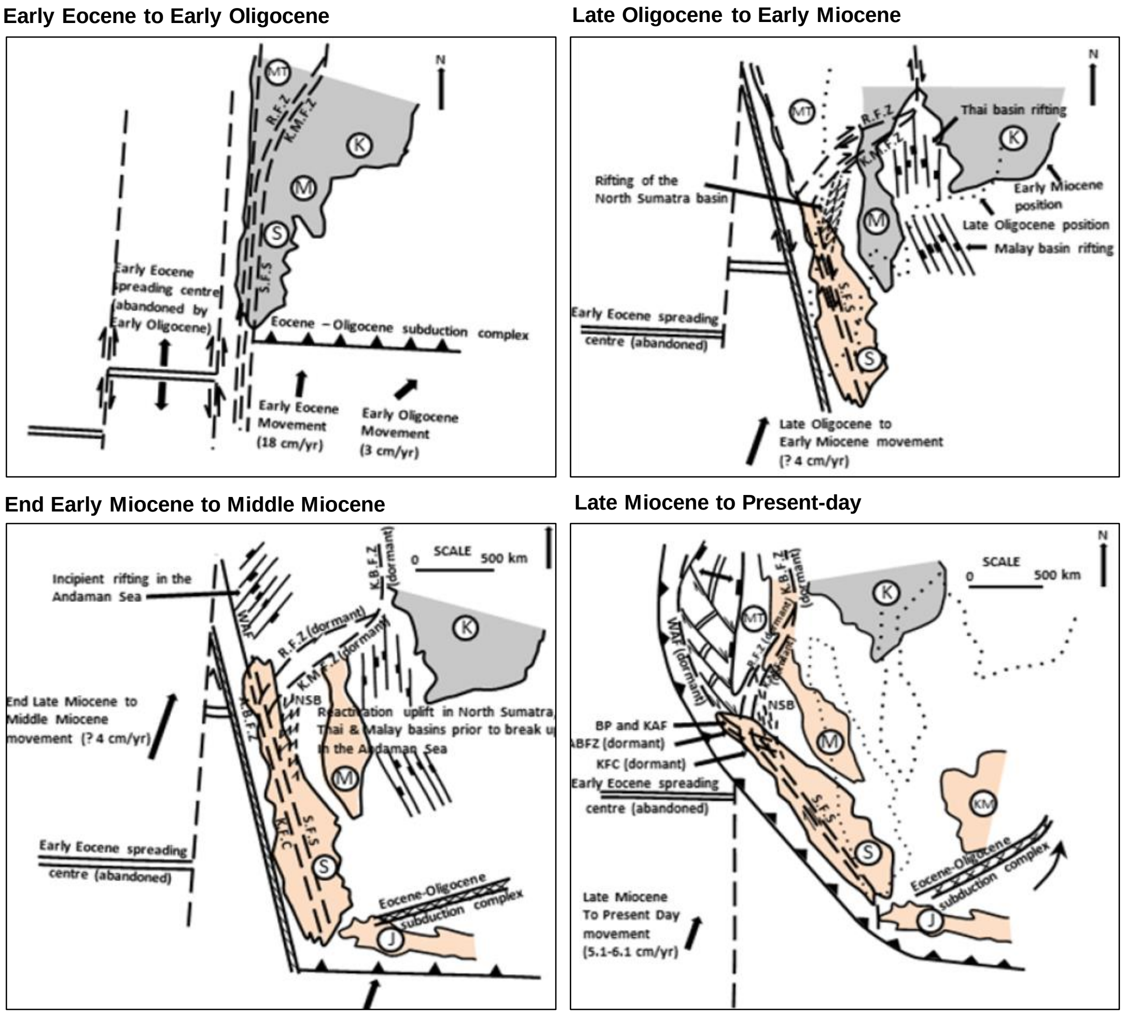
North Sumatra Basin – Exploration potential



(Meckel et al, 2012)

Basin Development

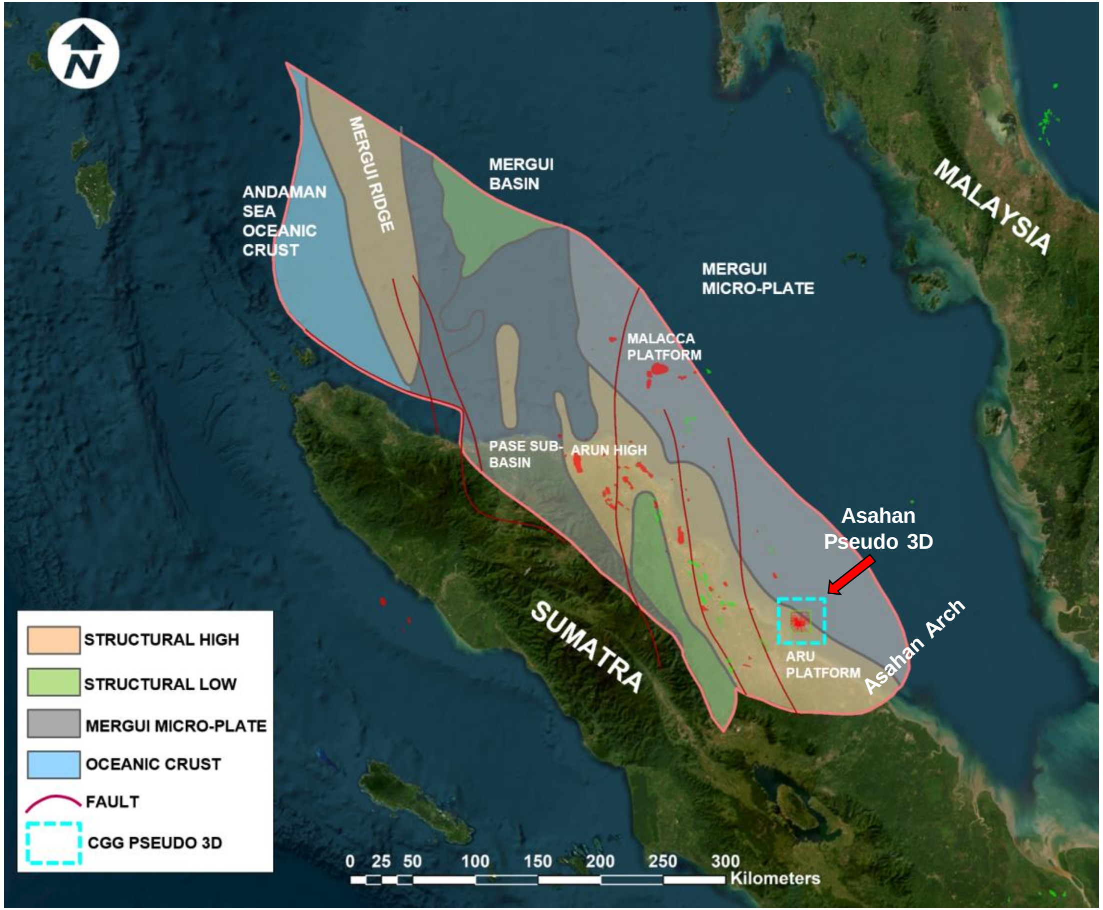
- The North Sumatra Basin developed throughout several phases of complex tectonic activity, occurring primarily from the Paleogene to the Neogene
- These cycles include Oligocene to Early Miocene extension and rifting; post-rift subsidence in the Middle Miocene; and dextral wrenching and compression from the Middle Miocene to the Pleistocene



(Davies 1984)

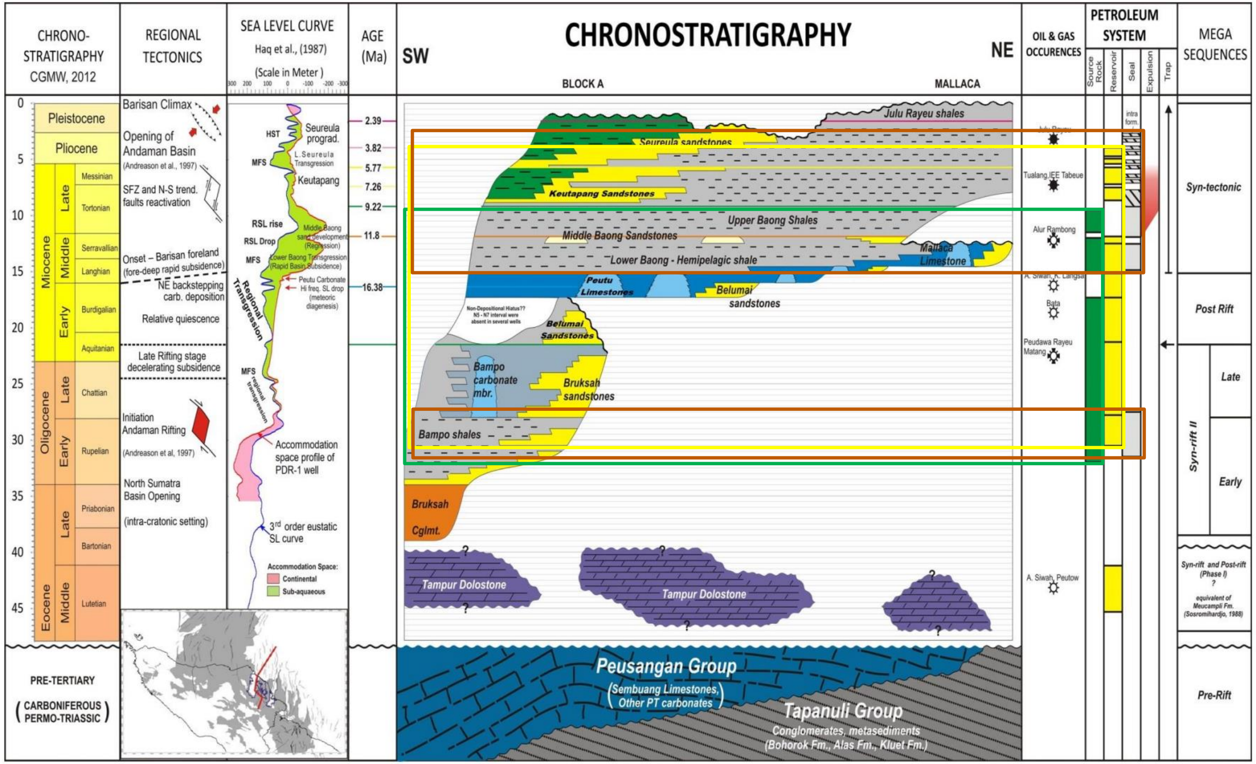
Structural configuration

- Several main structural components: Mergui Ridge, southern extent of the Mergui Basin, Pase Sub-basin, Malacca Platform, Arun High, and the Aru Platform
- Sedimentary fill of the basin is dominated by deep marine shales, open marine carbonates, and fluvio-deltaic to shallow marine sandstones
- SE offshore area, from the Arun High to the Asahan Arch - basin architecture is characterized by a series of large, north-south trending horst and graben structures
- Intra-basinal structures exert a significant control on the distribution and thickness of sediments

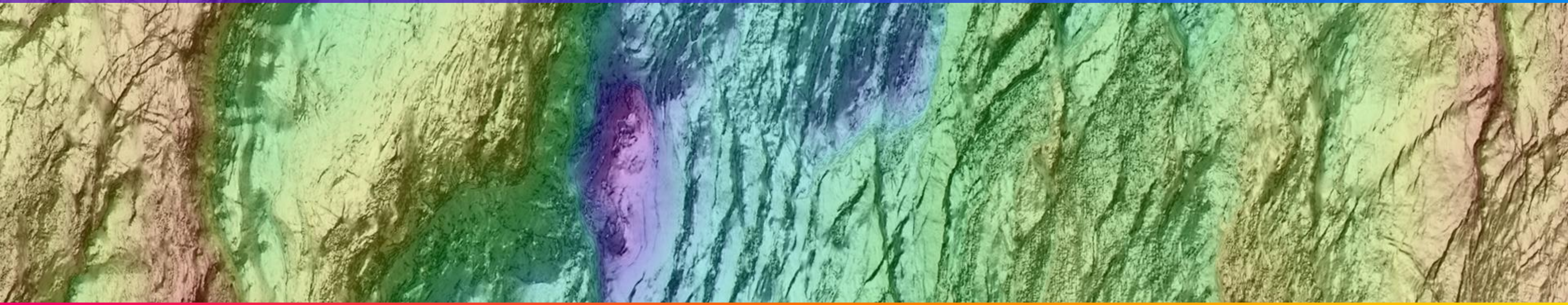


Stratigraphy & Petroleum Systems

- Paleogene lacustrine or shallow marine synrift source
- Oligocene - Miocene source rocks
- Oligocene, Miocene sands + Miocene reef buildups (potential reservoirs)
- Baong Formation & Bampo Fm shales form effective regional seal



(Syarifuddin & Ariyanto, 2018)



DATASET OVERVIEW & PSEUDO 3D TECHNOLOGY

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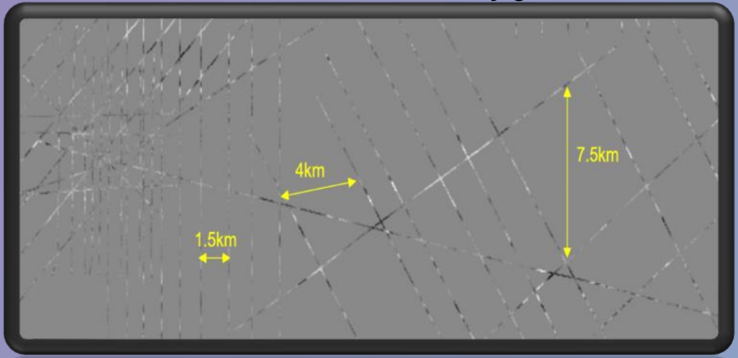
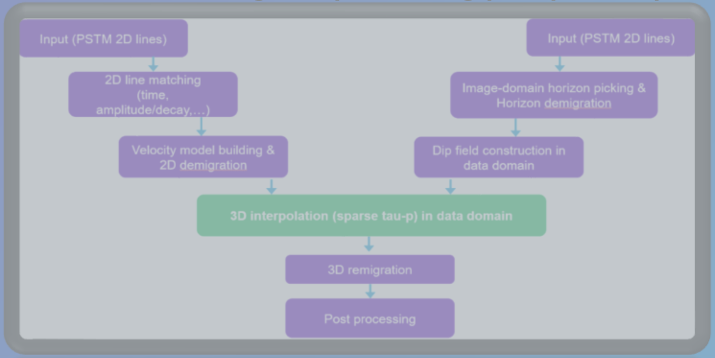
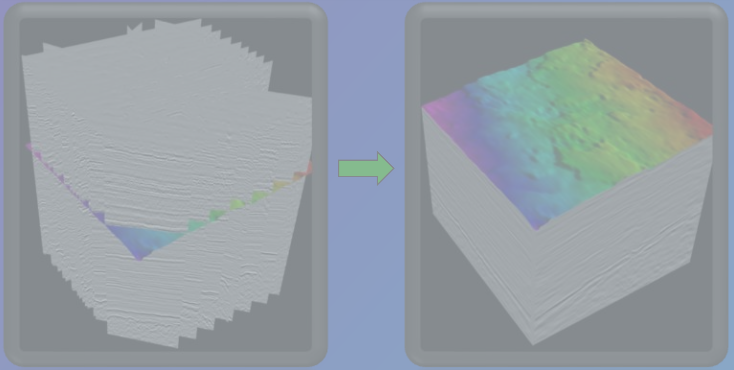


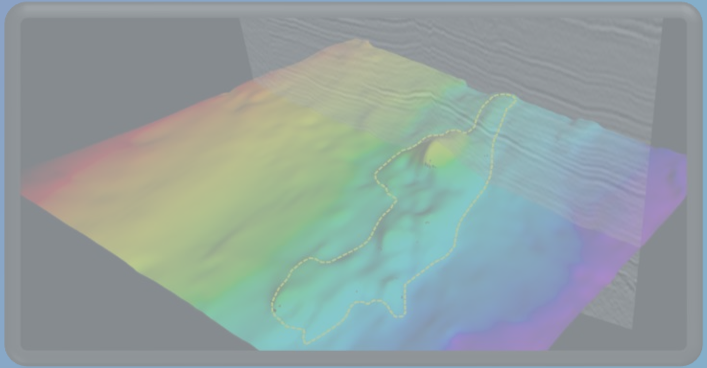
Data conditioning & Reprocessing (interpolation)



Pseudo 3D volume generation

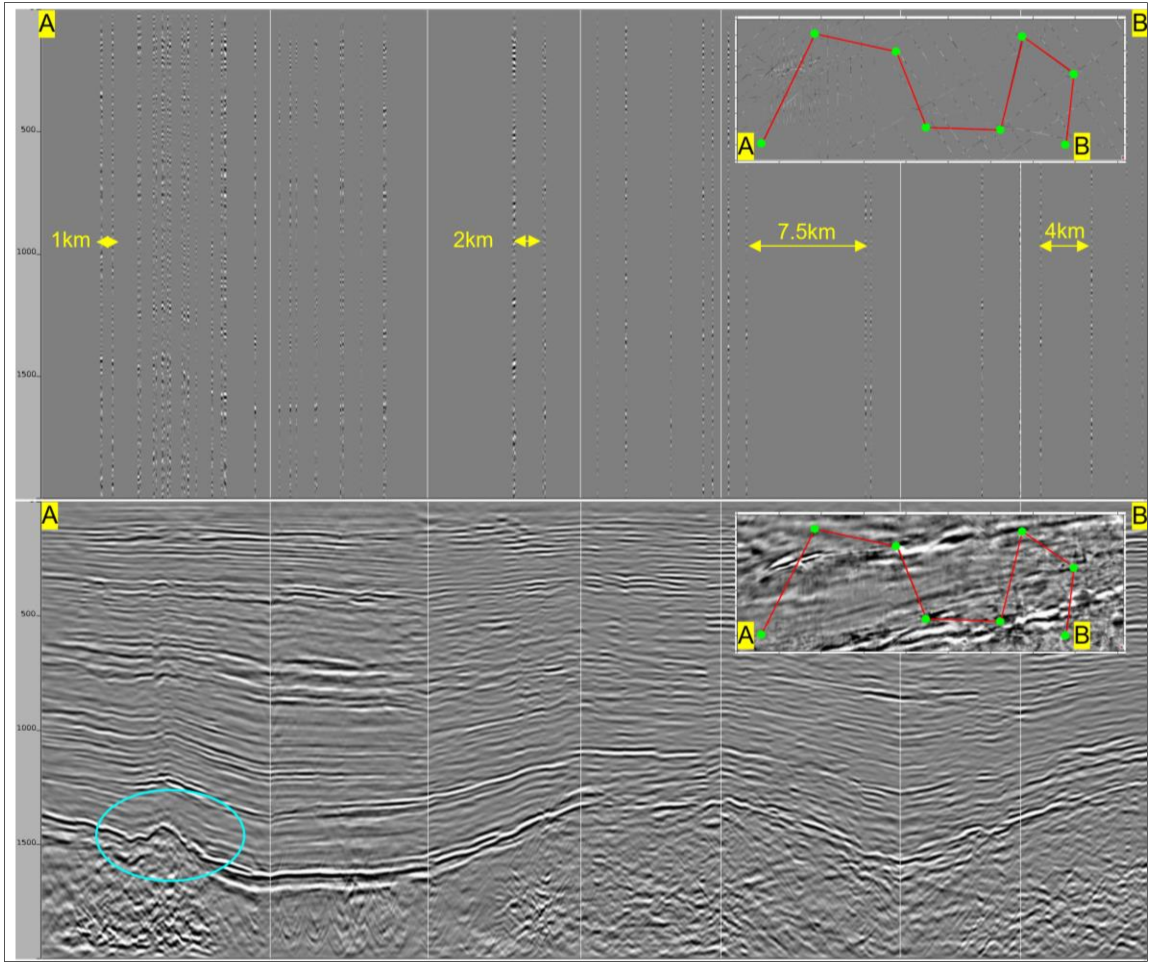


Volume-based interpretation

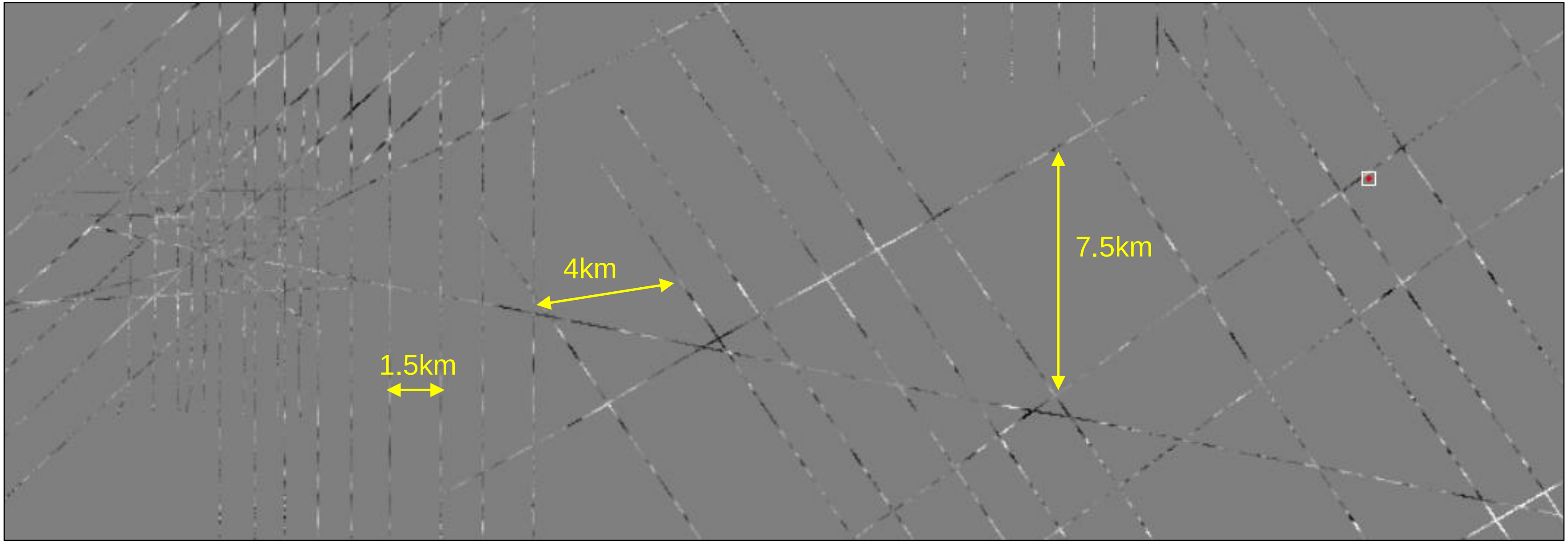


Asahan Area Pseudo 3D

- The Asahan Pseudo 3D project is located approximately 15km from the east coast of Sumatra
- The input dataset comprises 53 lines with a total of 540 km line coverage
- The Asahan 2D grid was selected on the basis of 2 key factors: viable spatial density, and data density variability
- Rigorous testing of the interpolation technology has shown that the optimal limit for line spacing for the Pseudo 3D volumes is in the range of 1-2km, however +5km can still achieve good results
- Highly dependant on input data and geological complexity



The testing area (from North Sumatra – Asahan area)



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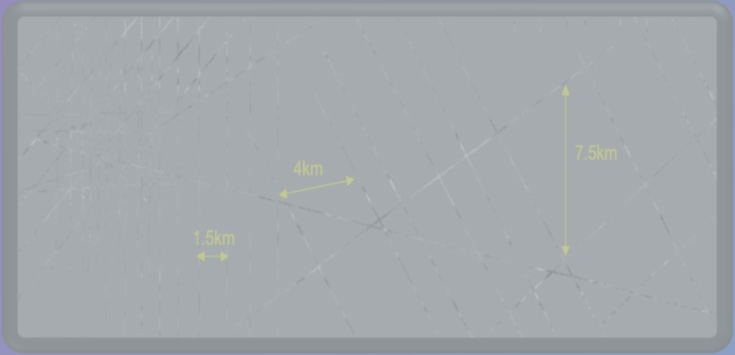

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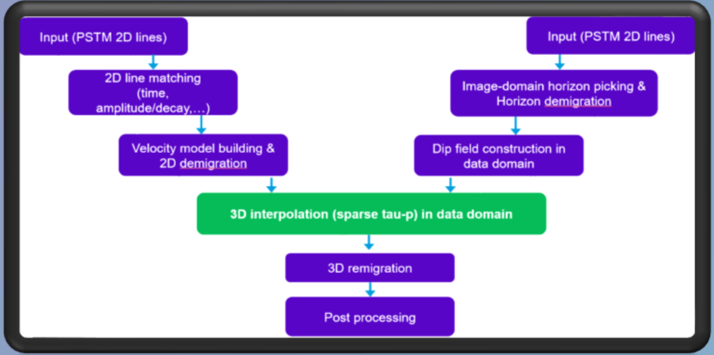

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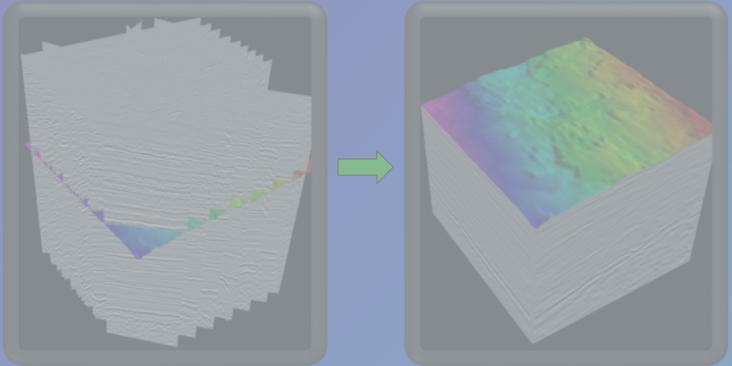
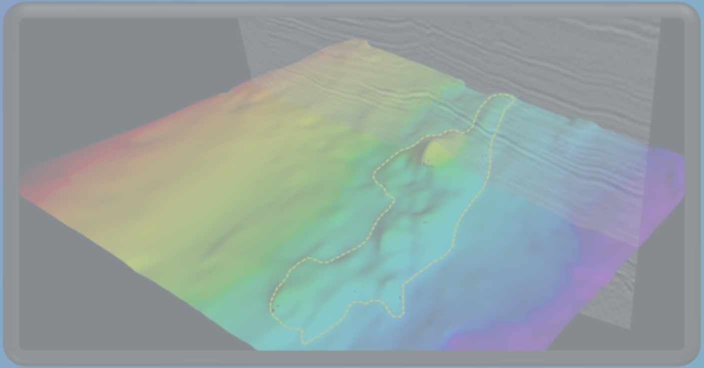
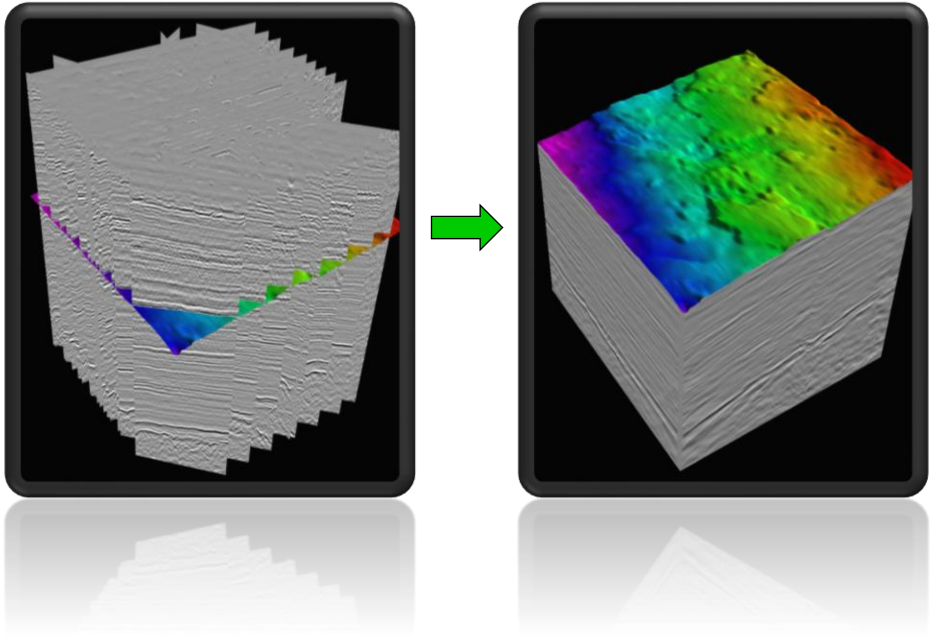


Volume-based interpretation



Pseudo 3D technology

- 3D data is very important in HC exploration. Superior to 2D, particularly for generating more robust, meaningful interpretations and models
- Pseudo 3D processing has been applied quite extensively for exploration programs for many years
- However, new technologies and processing techniques are constantly being improved
- The main concept involves applying an interpolation method to convert underlying input 2D data into a 3D volume



Interpolation flow: Pre-migration interpolation

Input (PSTM 2D lines)

2D line matching (time, amplitude/decay,…)

Velocity model building & 2D demigration

Input (PSTM 2D lines)

Image-domain horizon picking & Horizon demigration

Dip field construction in data domain

3D interpolation (sparse tau-p) in data domain

3D remigration

Post processing

Wang et al, 2014 proposed a sparse Tau-p transform algorithm for 2D data interpolation, which is effective for regularization of strongly spatially aliased seismic data.

Dip constraint functions are added which improves mitigation of aliasing effects. This algorithm was applied to effectively mitigate aliasing issues and improve overall data results.

KEY OBJECTIVES (WORKFLOW)

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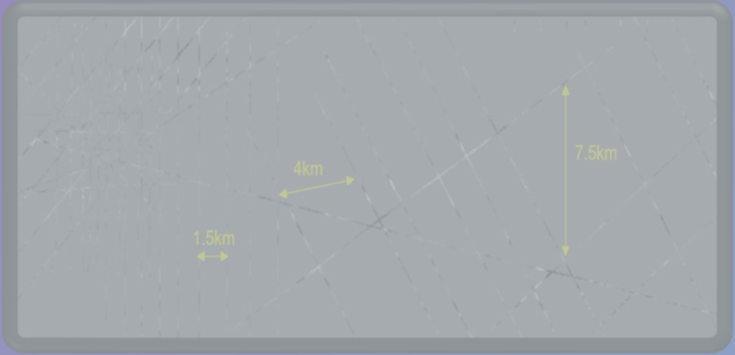

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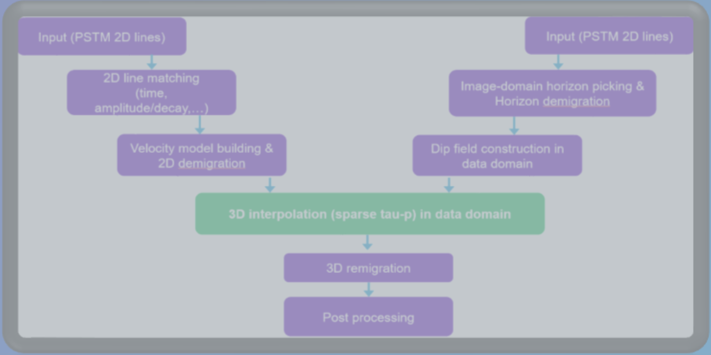

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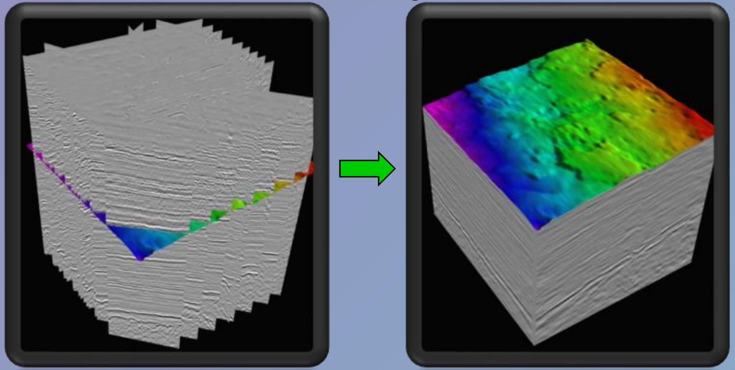

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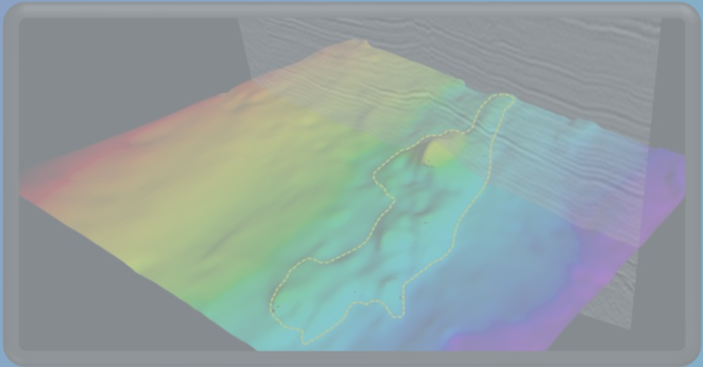
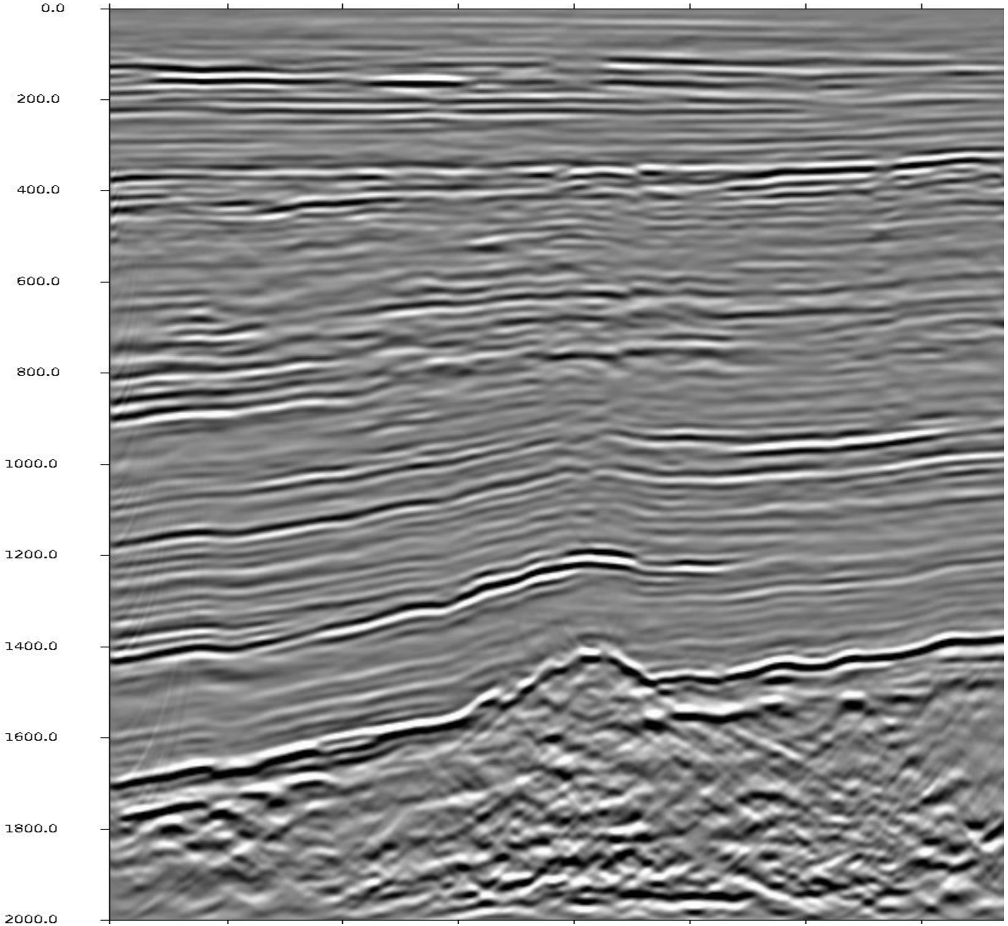
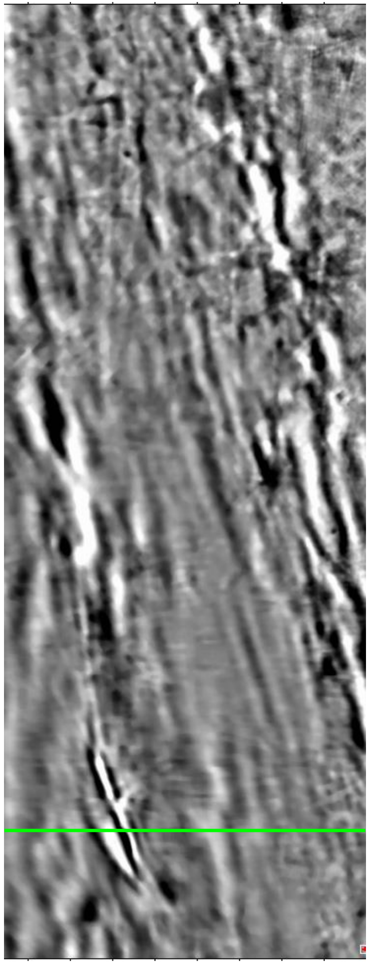
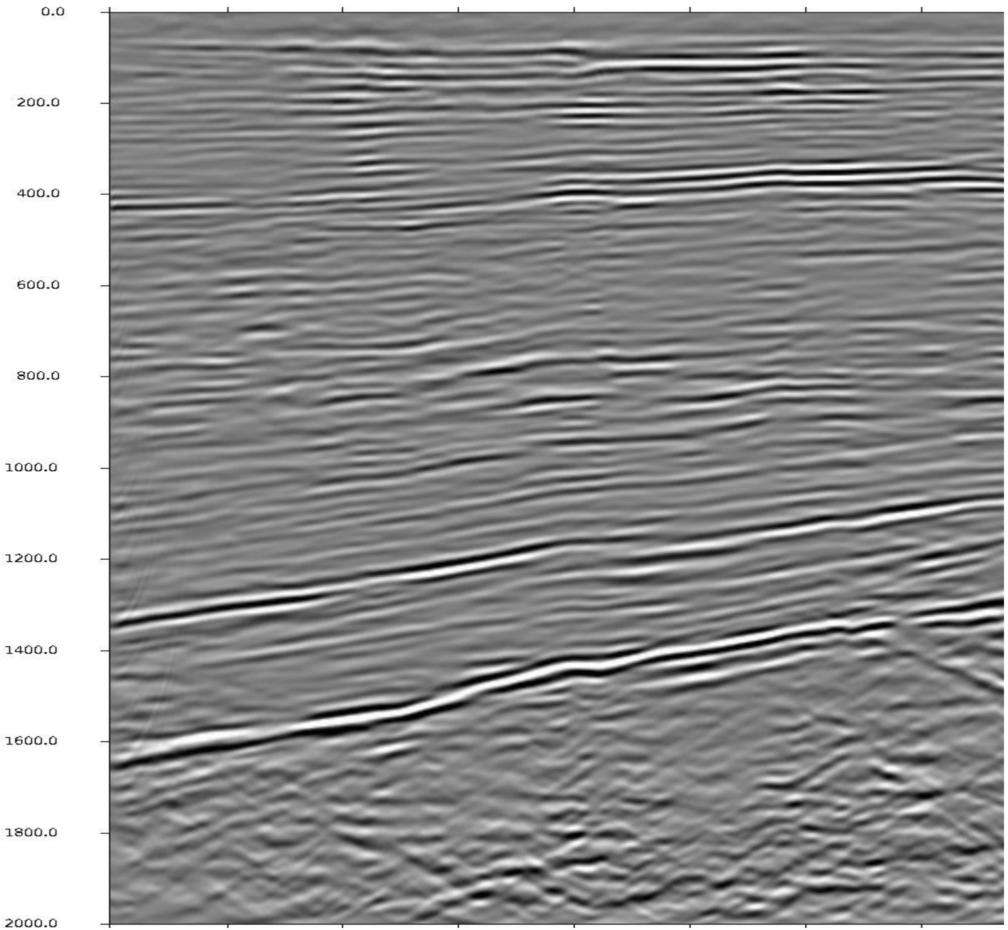


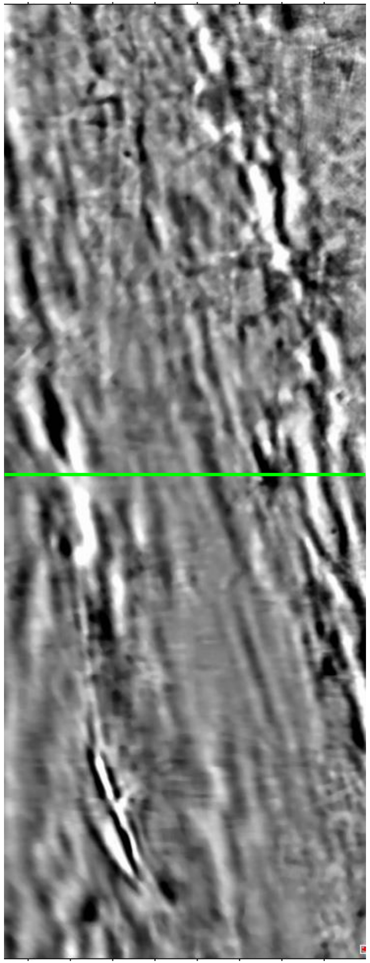
Subline A (line spacing~1km): before interpolation



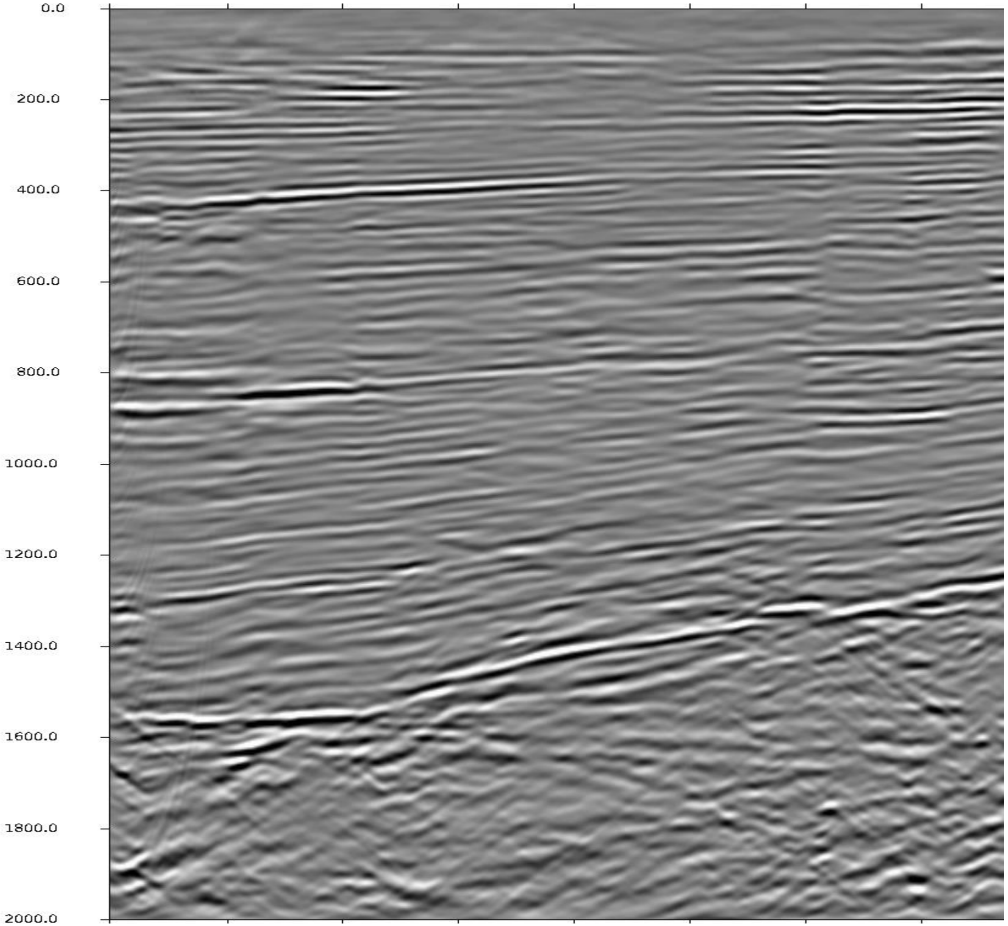


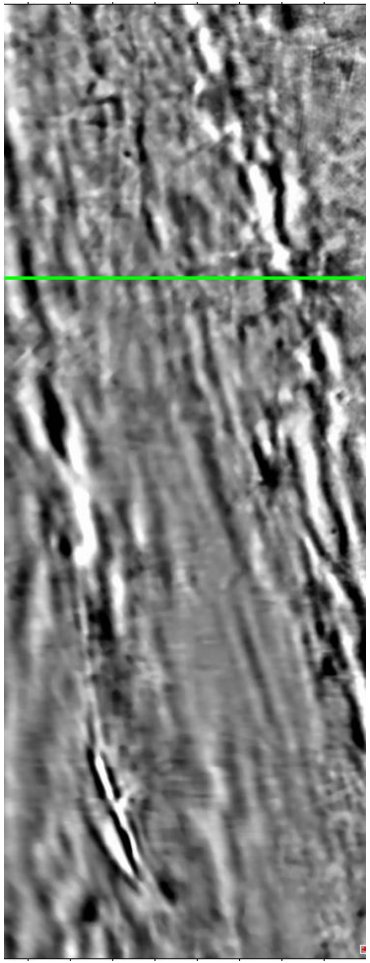
Subline 2 (line spacing ~2-4km): before interpolation





Subline 3 (line spacing ~6-8km): before interpolation





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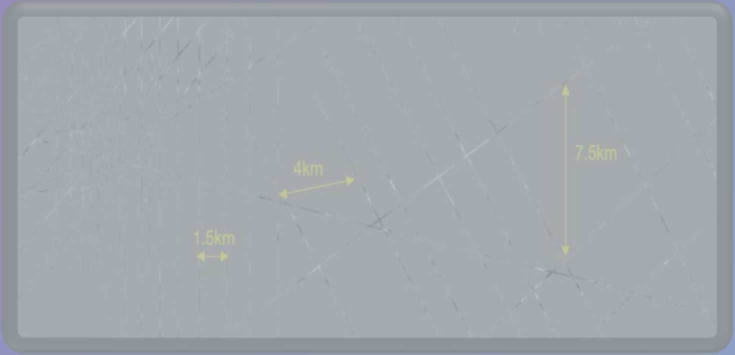

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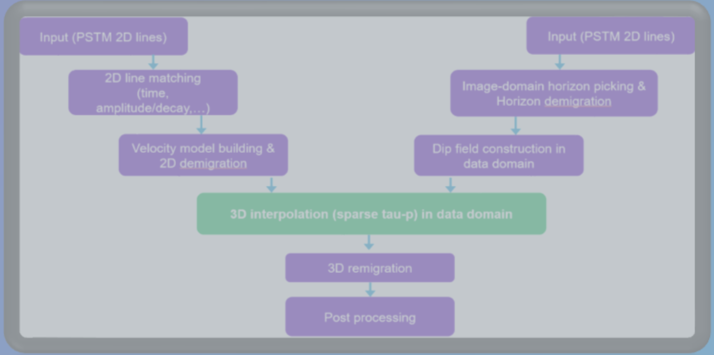

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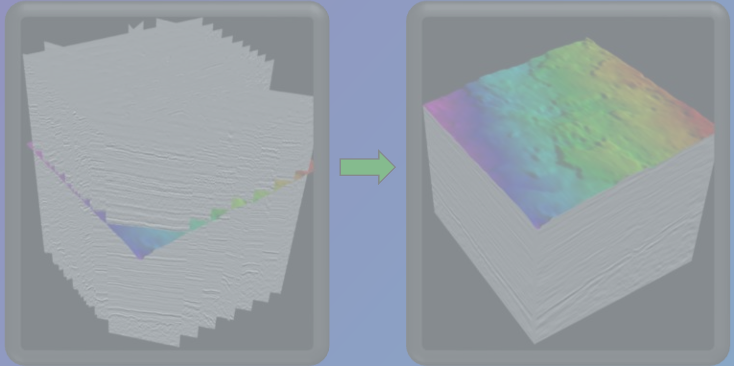
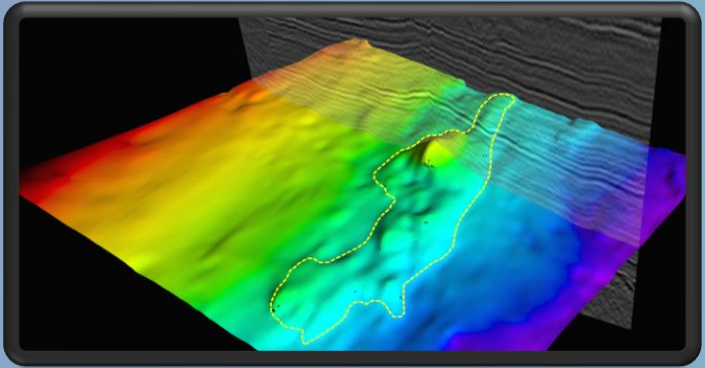


Volume-based interpretation



Interpretation – key objectives

Key objectives

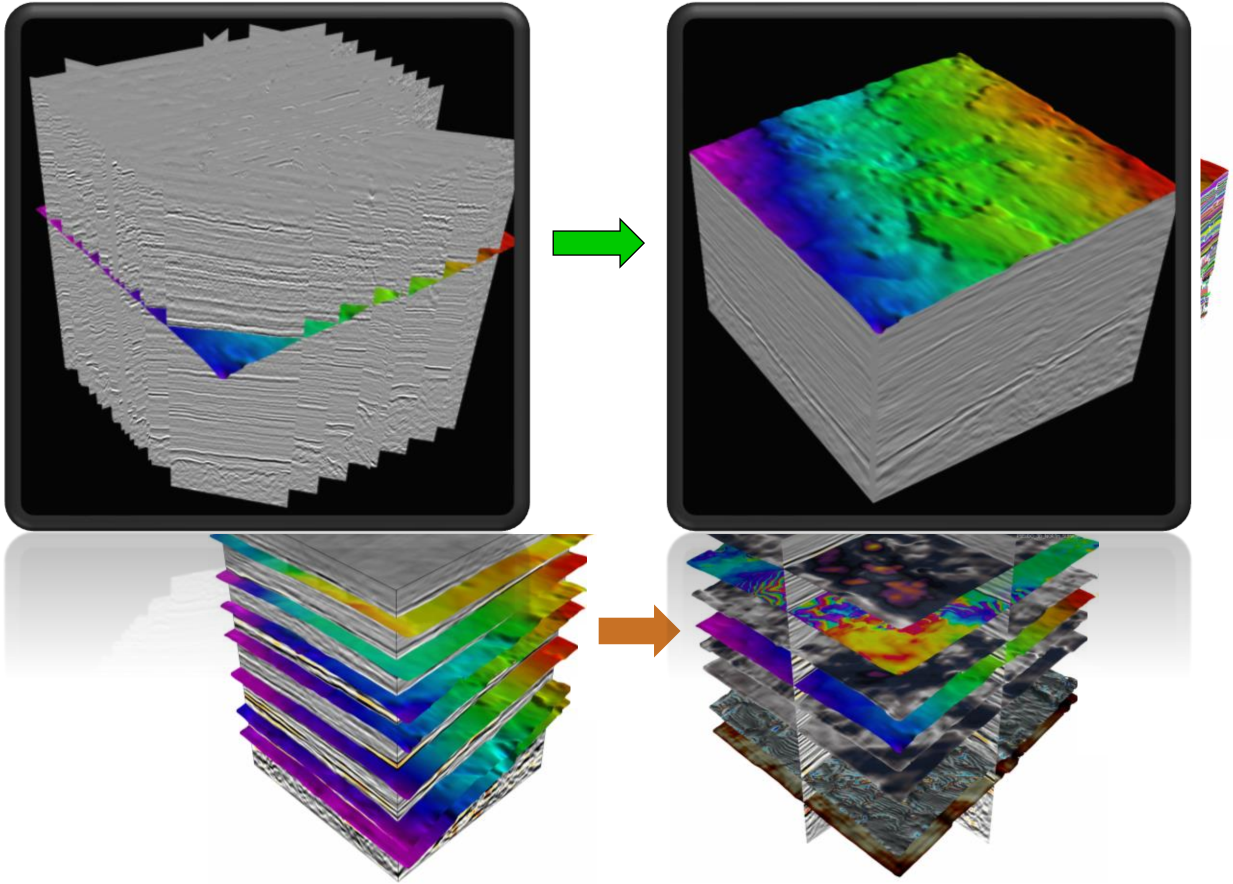
- Volume-based interpretation, including seismic attribute analysis was undertaken on a Pseudo 3D subset of the total 2D grid
- The subset, comprising 33 lines (393 line km), was selected as having optimal spatial density to test the enhanced interpretation capabilities of the Pseudo 3D volume
- Key objective of the interpretation phase was to demonstrate improved delineation of features, as compared to the legacy input 2D data
- A number of wells have been drilled throughout the project area. Importantly well data / results / key geological information was completely excluded from the Initial interpretation phase.
- The purpose of this was to demonstrate the interpretation capabilities in the absence of known geological information, and then to validate the results after interpretation carried out

Interpretation methodology

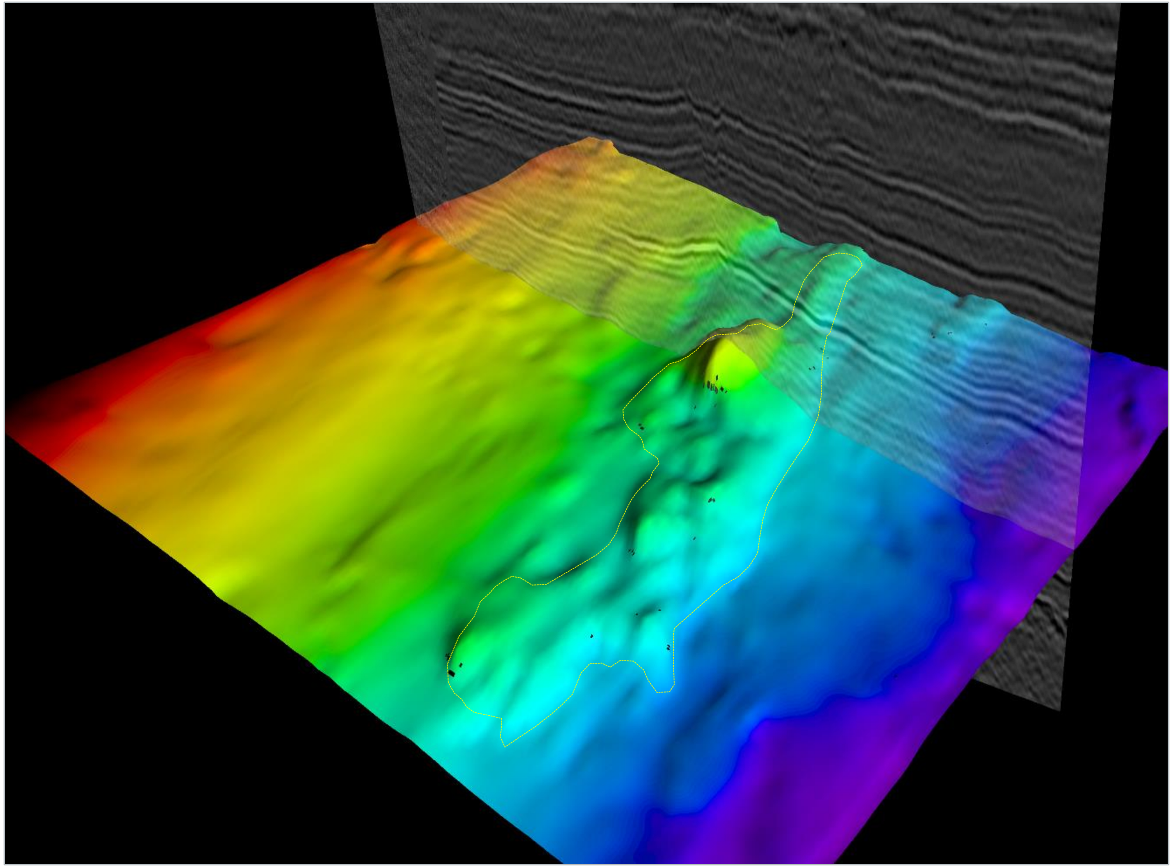
Asahan Pseudo 3D

Methodology (Paleoscan workflow)

1. Generate 3D model grid
2. Generate 3D Geomodel
3. Generate 3D horizon stack
4. Generate 3D attribute volumes
5. Correlate amplitude anomalies with potential depositional features

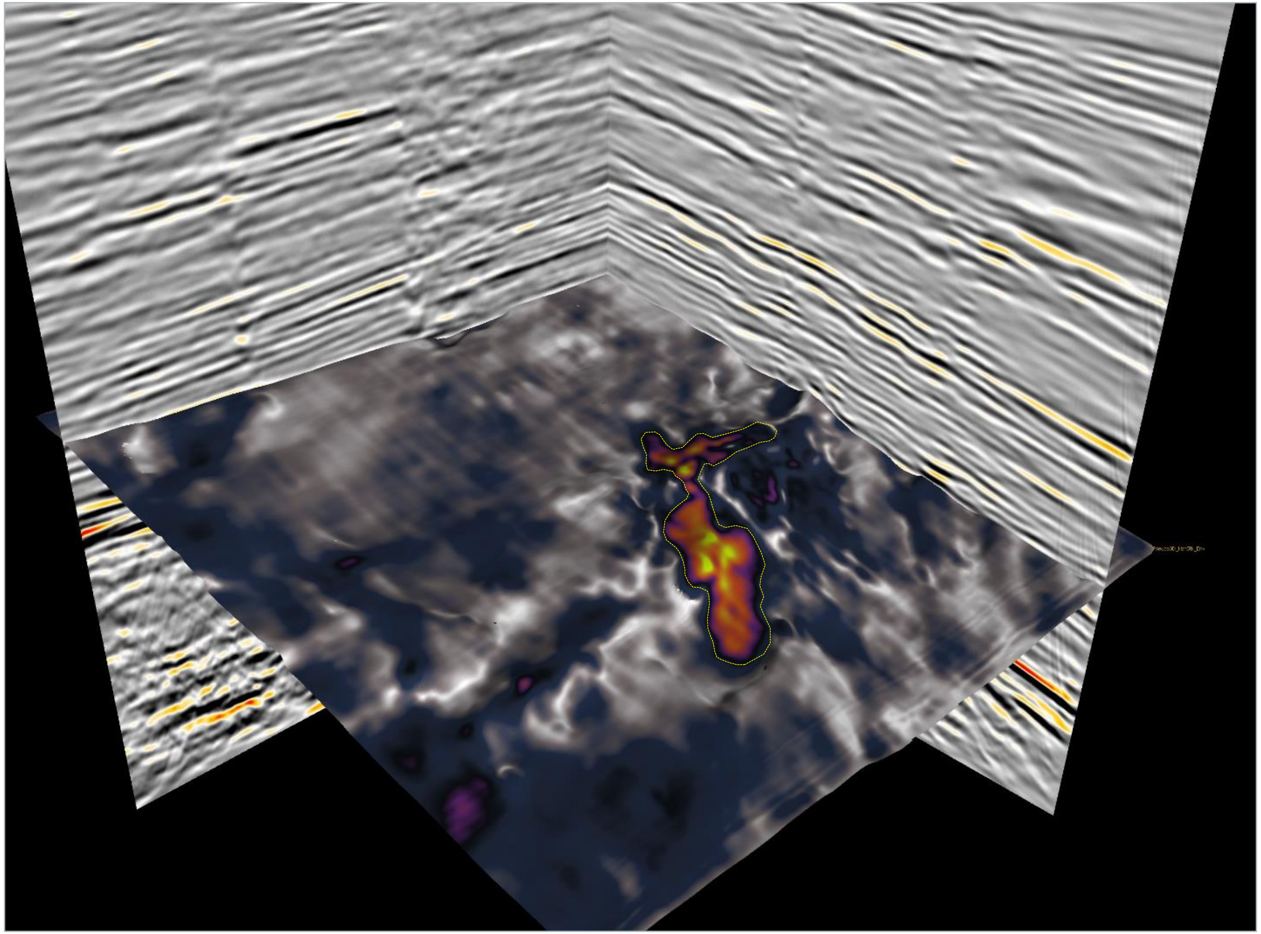


North Sumatra Pseudo 3D – Depositional features from auto horizon picking



- Hundreds of Horizon Stack surfaces can be generated from Pseudo 3D volume
- Demonstrates auto horizon surface generation capabilities
- Feature highlighted is a strong potential Carbonate buildup trend
- Possibly barrier / paleo-shelf edge reefal buildups. These represent important targets in this region

North Sumatra Pseudo 3D – Depositional features from seismic attribute volumes



- Envelope Attribute surface mapped to Horizon Stack surface
- Demonstrates auto horizon surface and attribute generation capabilities
- Feature highlighted is a potential distributary sand body with strong amplitude response

Interpretation – Further investigation

- Wells within the Asahan Pseudo 3D area were subsequently investigated after the initial phase of Pseudo 3D volume interpretation
- The features described were found to be consistent with well results, having been intersected during exploration drilling
- The results confirm that a coarse clastic sand of the Baong Formation was intersected beneath a Mid-Miocene unconformity which correlates with the feature described
- The sand body that was intersected exhibited excellent reservoir properties, and was found to host a sub-commercial wet gas accumulation
- The carbonate feature described was also found to be consistent with drilling results, having been intersected before the wells reached total depth in fractured Dolomitic carbonates. These results provide strong validation for the combined Pseudo 3D capabilities and interpretation methodology

SUMMARY & CONCLUSIONS

Summary & Conclusions

- In order to produce meaningful correlations and interpretation results, the quality, coverage and format of data is critical
- Having recognized the need for enhanced datasets within Indonesian offshore basins, CGG has undertaken a large-scale data collection and reprocessing initiative
- A key benefit of Pseudo 3D is the ability to undertake rapid, volume-based interpretation using modern software techniques, and to quickly identify and evaluate key depositional features
- These enhanced visualization capabilities have been demonstrated through automated horizon interpretation and 3D attribute analysis of the Asahan Pseudo 3D volume
- Importantly, the geometries and amplitude responses of depositional features can be observed and delineated within a very short timeframe, as compared to 2D data

Acknowledgements

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- SEAPEX conference organisers
- CGG Seismic Imaging team

THANK YOU

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