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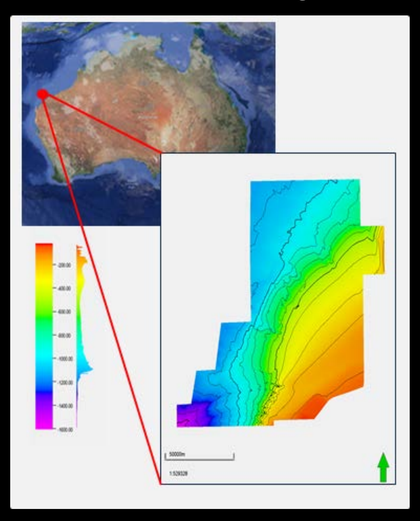
Summary

The Schlumberger Multiclient Exmouth 3D survey was acquired over the Exmouth Sub-basin, North West Shelf, Australia and covers 12,600 sq. kilometers. One of the primary objectives of the 3D survey was to produce a high image quality seismic volume with a wide coverage across the entire basin with advanced processing technology applied. The complexity of the overburden was one of the imaging challenges that impacted the structuration and image quality at the reservoir level. Unlike traditional full-waveform inversion (FWI) workflow, here, FWI was introduced early in the workflow in parallel with acquisition and preprocessing to produce a reliable near surface velocity model from a smooth starting model.

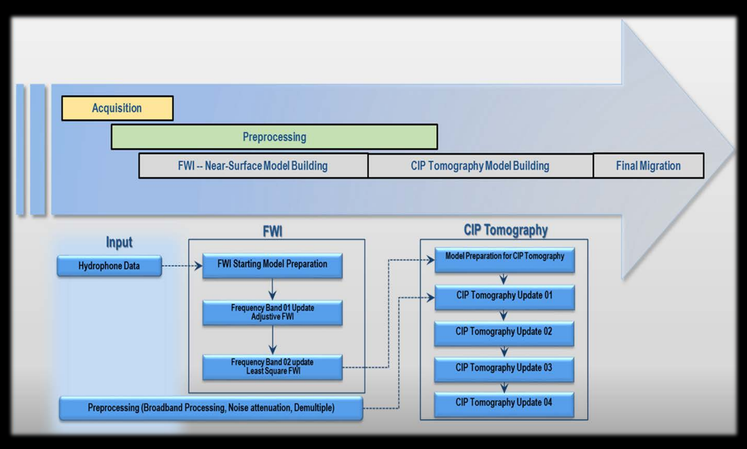
Introduction

The workflow was designed to allow the velocity model building and pre-processing to be performed in parallel in order to enhance the efficiency and effectiveness of project execution while utilizing the enhancements FWI brings to the model building process.



Model Building Strategy

- Near surface model building started in parallel with acquisition and pre-processing
- CIP tomography started with resolved near surface model
- Project timeline was shortened by approximately 30% compared to a traditional workflow

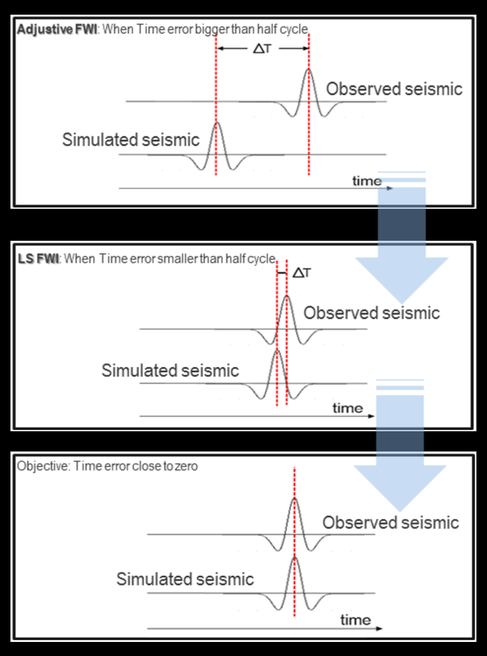


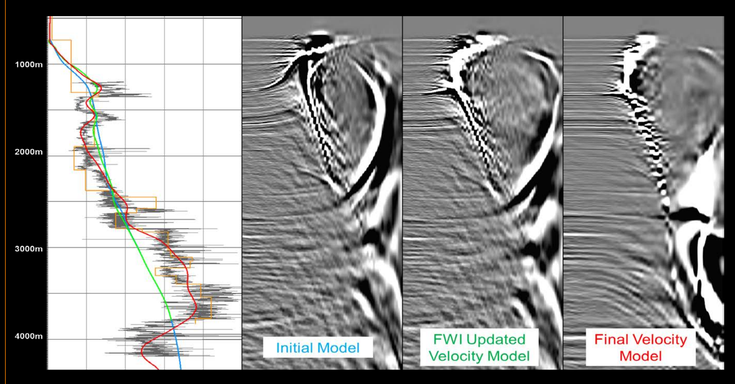
Imaging Challenges

- Resolving the velocity contrast in the complex overburden
- Maintaining a geologically conformable model to improve the imaging at the reservoir level.

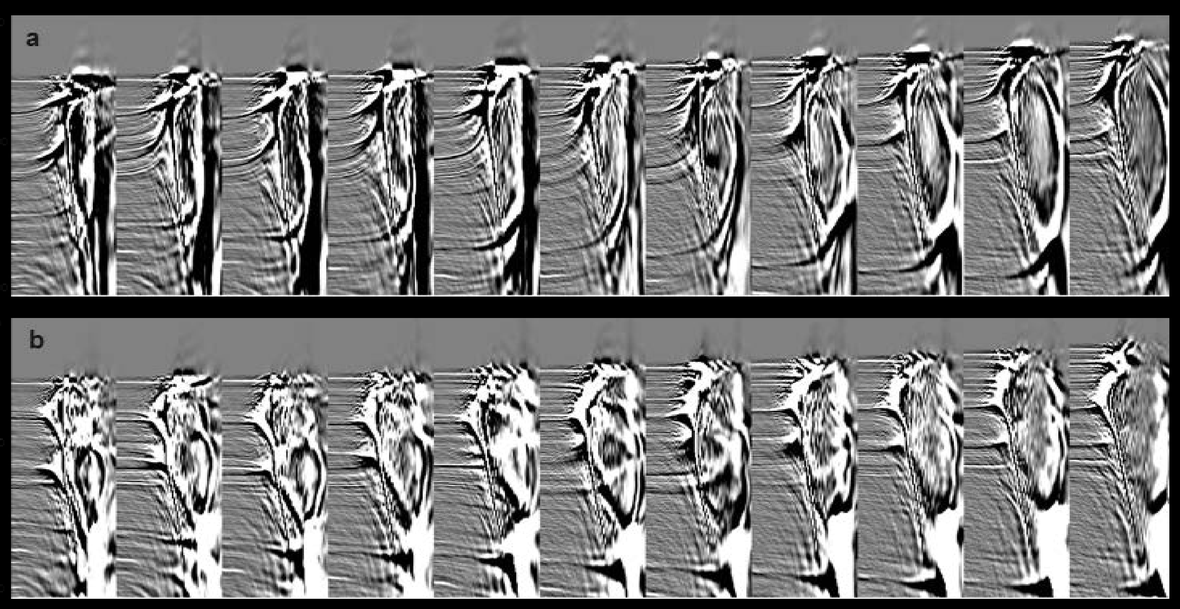
Near surface model building

- Two frequency bands of FWI updates with inner sub-iterations were performed for this project prior to reflection CIP tomography.
- The first frequency band update using Adjustive FWI aimed to correct the low wavenumber large-scale velocity errors in the model.
- The second FWI update is enabled to use least-square objective function at a relatively higher frequency band with the aim of correcting relatively small-scale velocity errors and delineating the near surface velocity contrast.
- Figures below showed the illustration and objectives of Adjustive FWI and LS FWI.





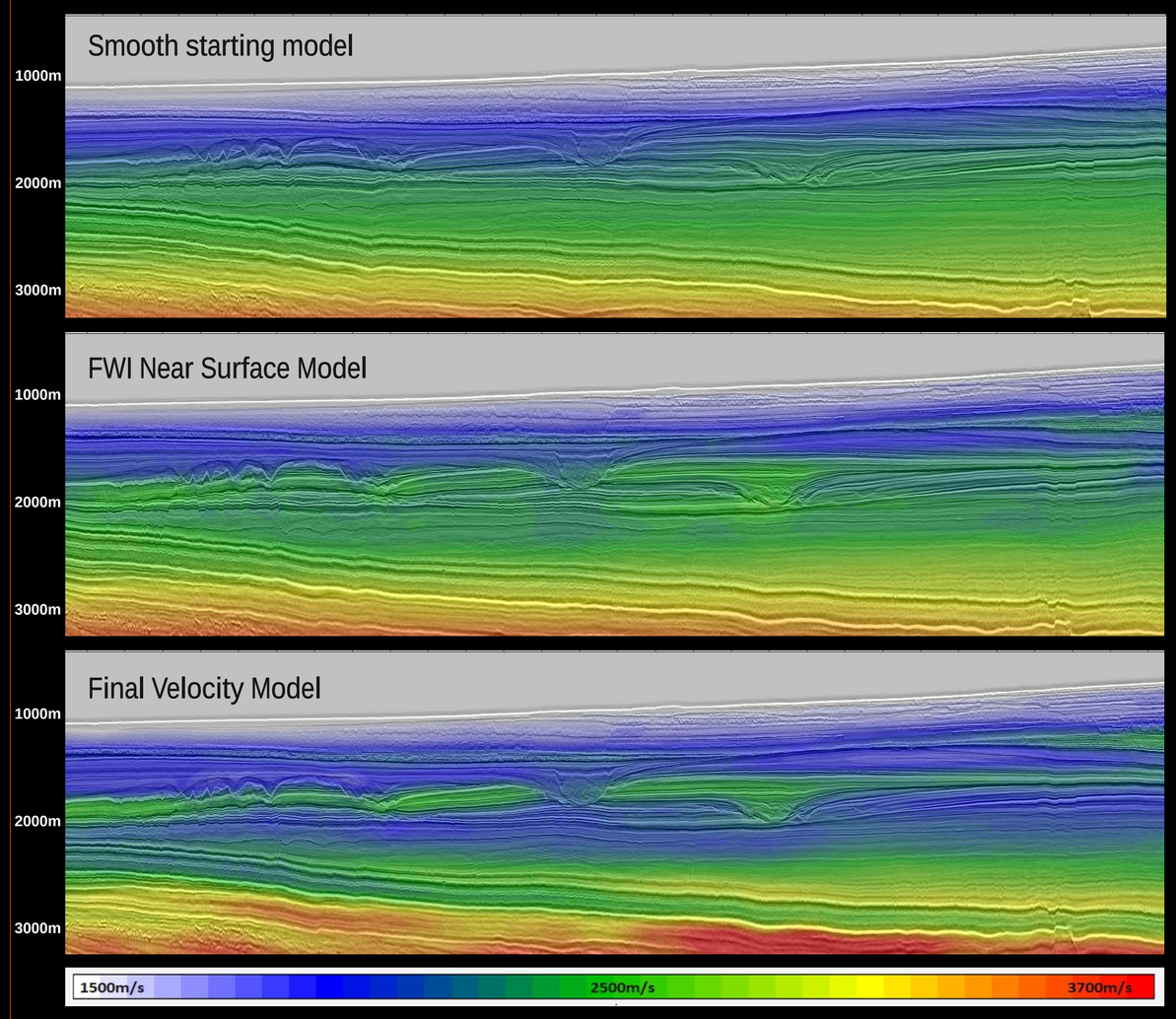
Velocity profile extracted from initial model, FWI model and final model to compare with well checkshot and sonic to illustrate FWI resolved the short scale length velocity contrast in the overburden. The final model correlate well with the well profile.



3D Kirchhoff Pre-Stack Depth Migrated CIP gathers using (a) the smooth starting model, (b) the FWI updated model. FWI velocity model captured the velocity variation in the overburden and improved the residual moveout of the CIP gathers.

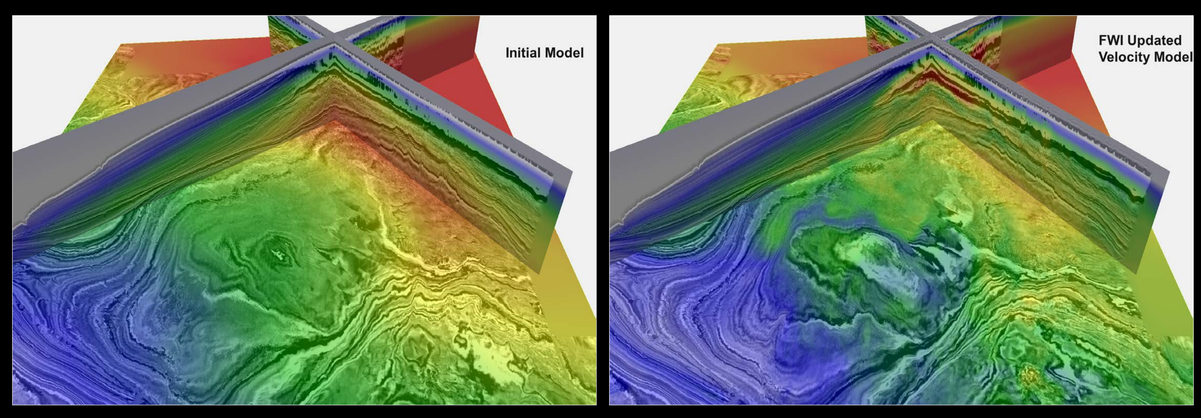
Velocity Model

The model displayed below shows how the complex overburden at the near surface has been resolved, in particular within highly amalgamated shallow channel systems.



Imaging

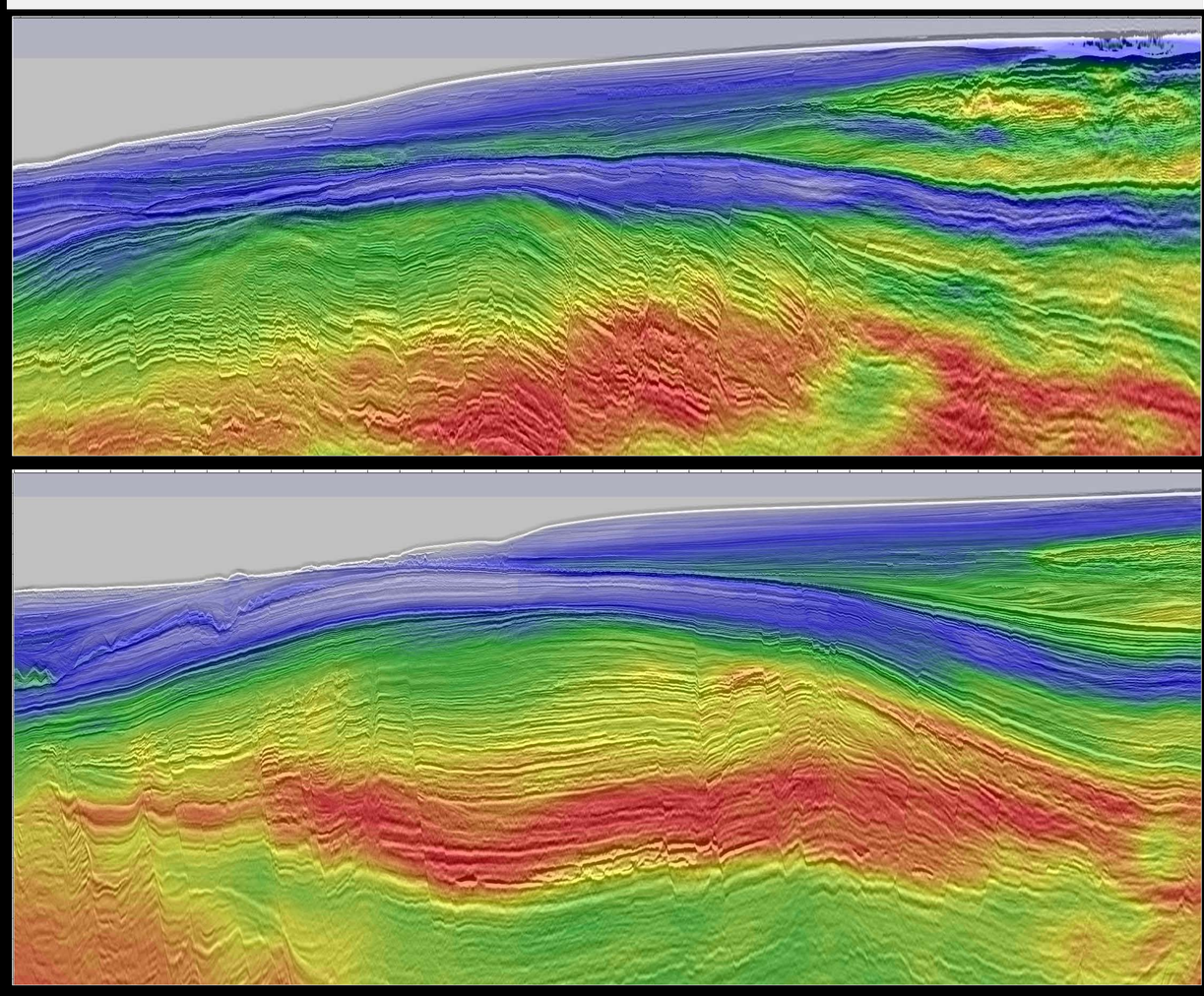
The figures below demonstrate the improvement in imaging from the smooth starting model compared to the FWI updated velocity. Image quality, event continuity and overall image sharpness benefitted largely from the improvements made to the shallow part velocity model after FWI generating a much more accurate image of the subsurface.



Conclusions

FWI has successfully corrected the background velocity trend and captured the shallow velocity variations in the complex overburden. This allowed a more accurate starting model for subsequent CIP tomography, resulting in a better velocity model from the near surface and ultimately delivering a superior depth imaging product, all within in a faster turn around time. The enhanced subsurface image has resulted in an improved geological interpretation and thus a superior product to investigate the hydrocarbon potential within the Exmouth sub-basin.

KIRCHHOFF PSDM IMAGE WITH VELOCITY OVERLAID



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