SEISMIC IMAGE PROCESSING

eGWM wave equation high frequency gathers to validate FWI models in gas cloud

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Full waveform inversion

- FWI is industry standard velocity model for final migration. Problems at high frequency.
- Kirchhoff migration is ray-based travel time calculation often fails due to caustics when a velocity model is complex in gas clouds, Salt or other sharp boundaries such as Chalk/Basalt interfaces.
- A compromise is smooth the velocity model, but this may cause loss of model details which results in inaccuracy of the travel times for high resolution imaging.
- **eGWM wave equation full offset gathers easily to 100Hz practical for FWI QC.**

FWI workflow - Tommeliten Alpha

OBC survey 2005

Tommeliten Alpha is a gas and condensate field found at a depth of approximately 3,000m in the chalk layers of the Palaeocene Ekofisk and Upper Cretaceous Tor formations

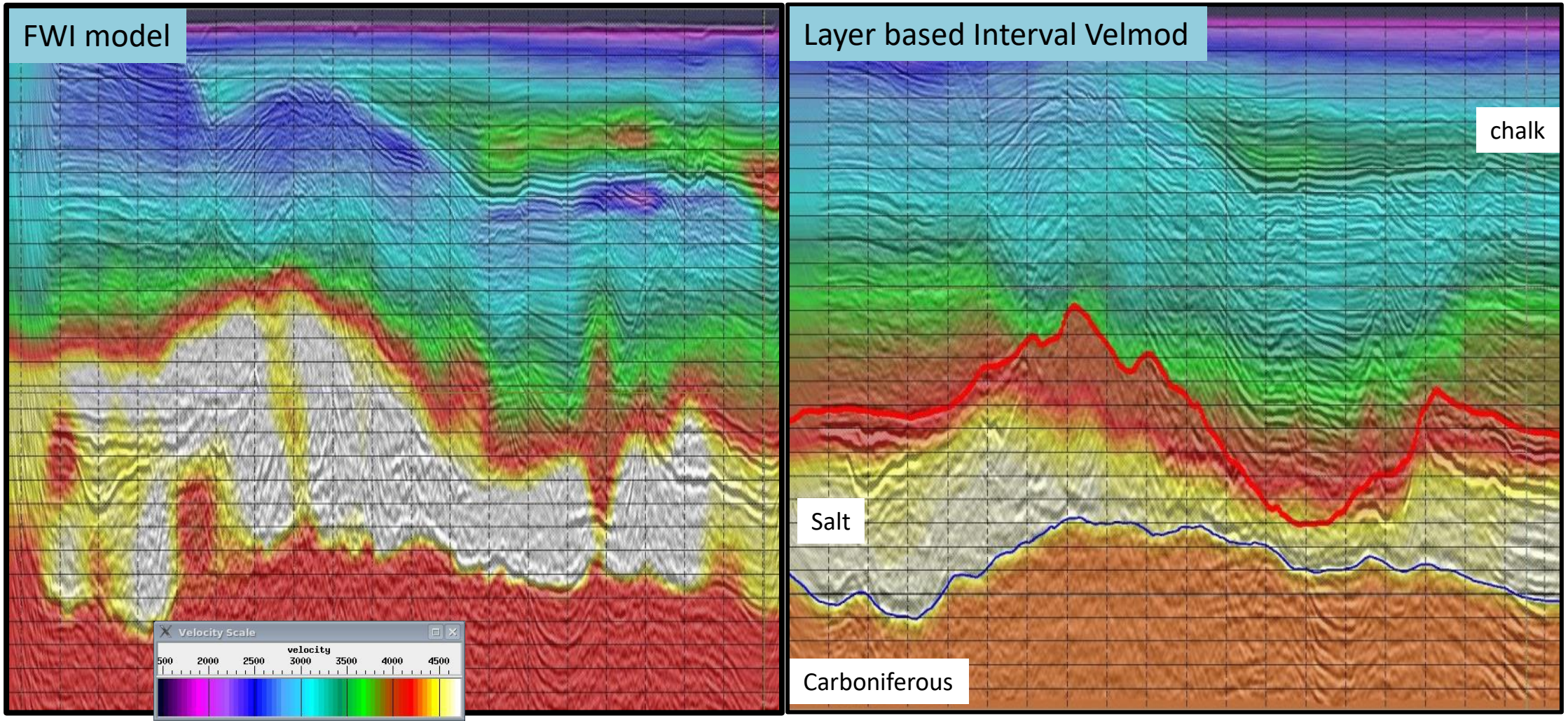
FWI Velocity model

Refraction FWI 22Hz (3km) + Reflection Tomography

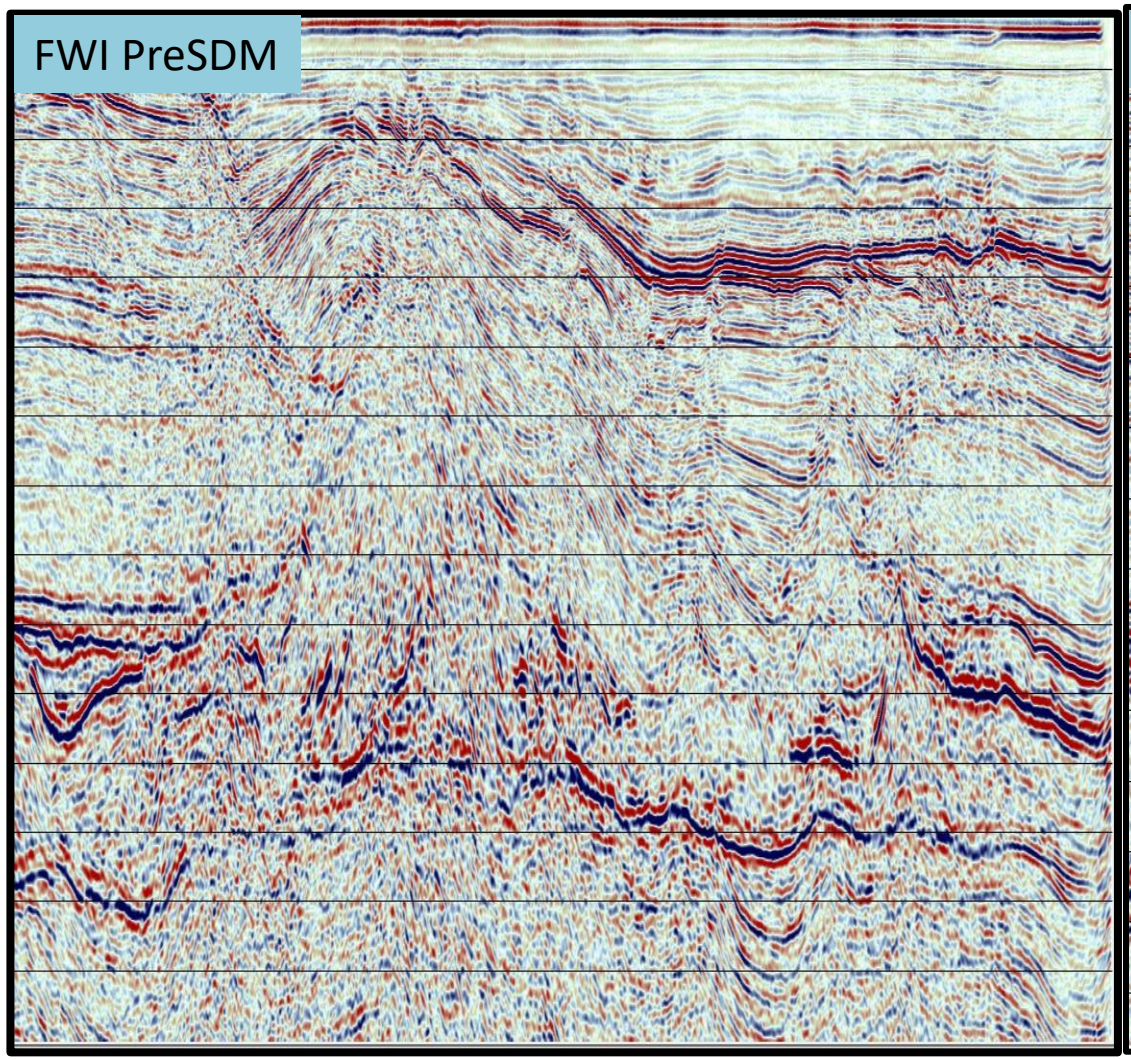
Beam Tomo Velocity Model

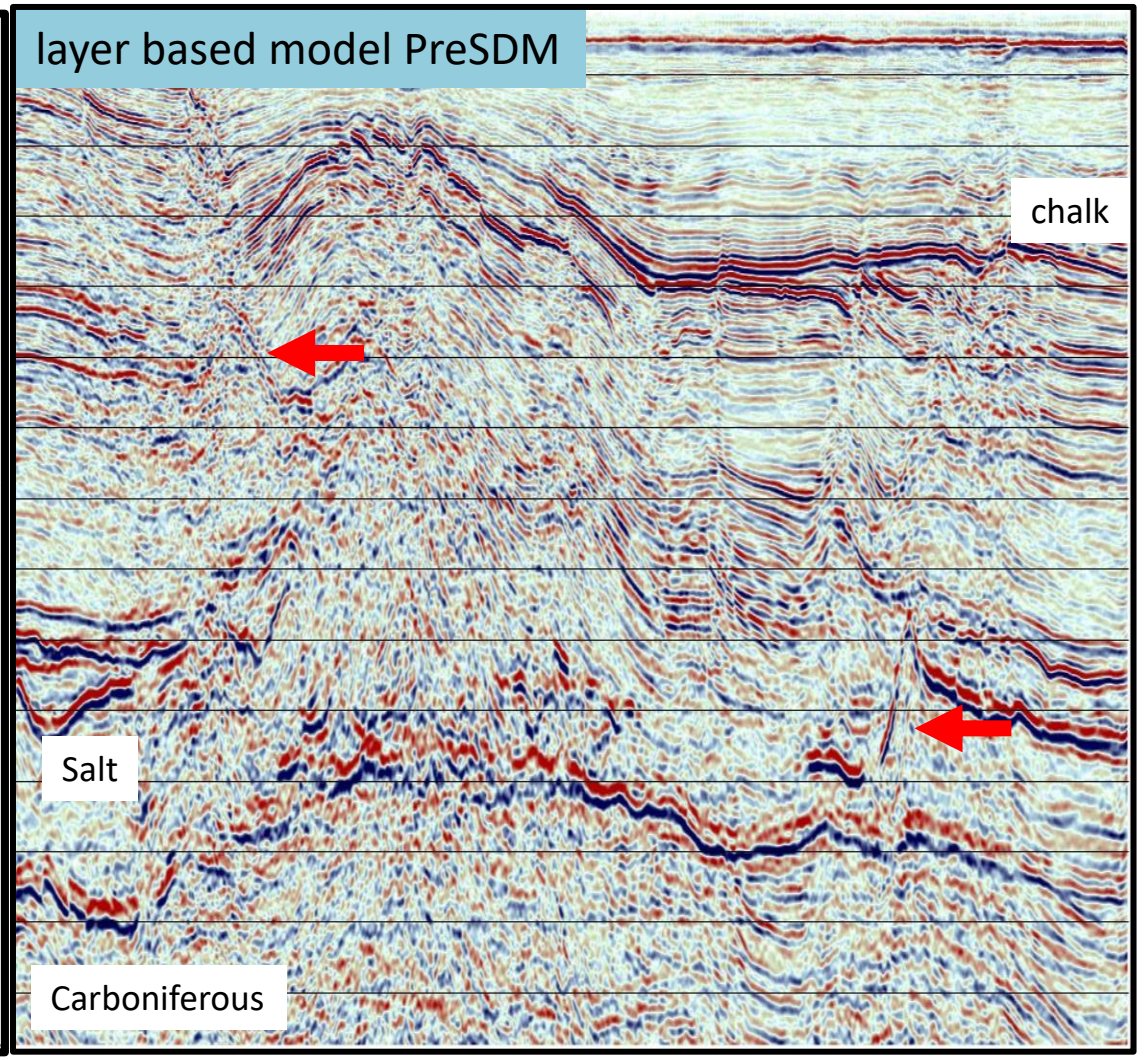
Smooth FWI and input to Beam tomography = FWI in image space (high resolution)

Velocity model comparison



Kirchhoff PSDM stacks
Simpler velocity model superior PSDM

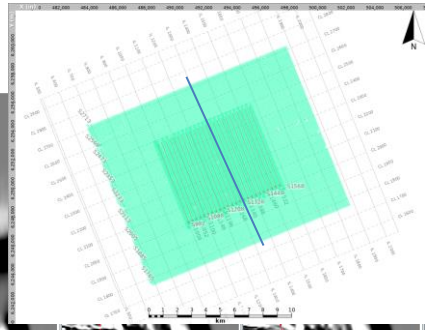




Kirchhoff PSDM stack

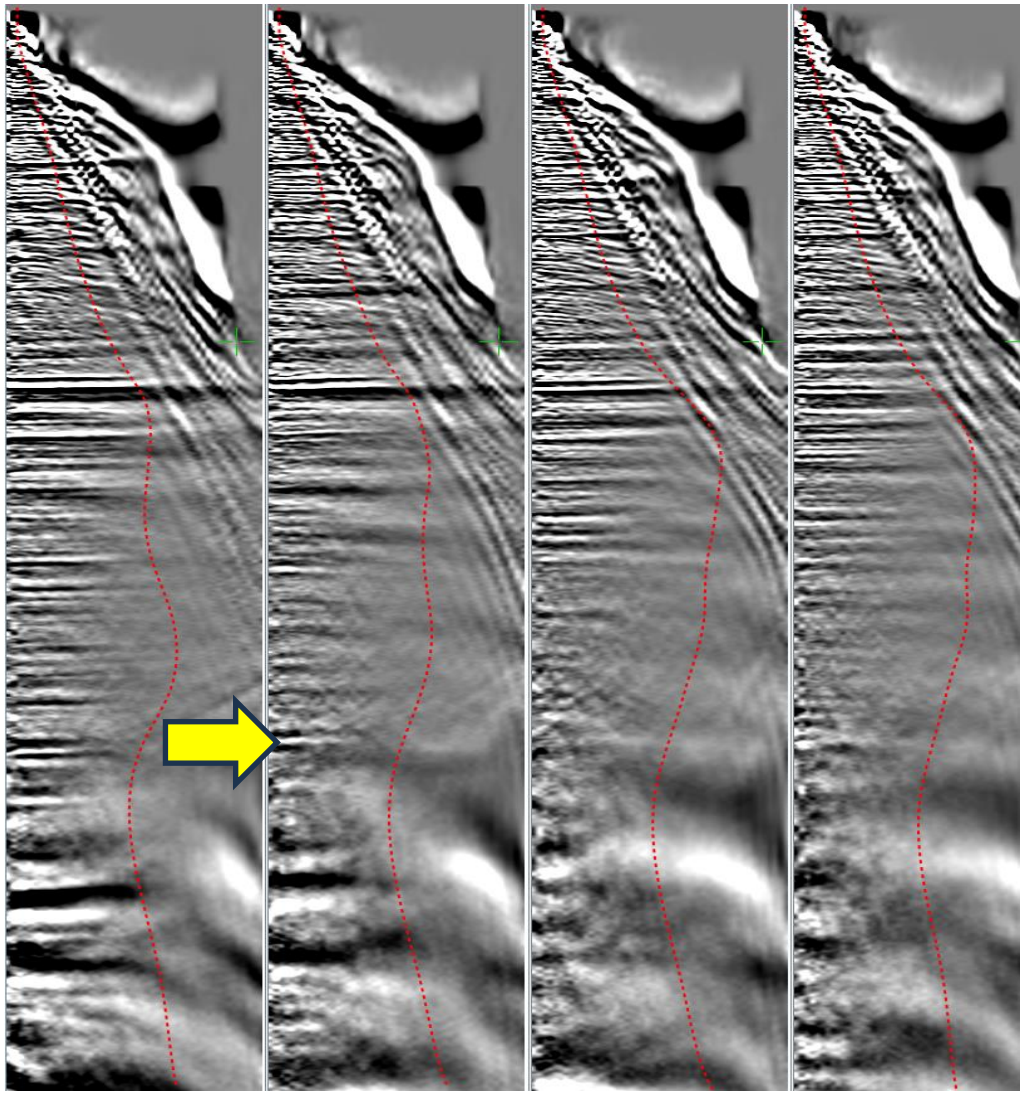
N->S

Kirchhoff PSDM gathers

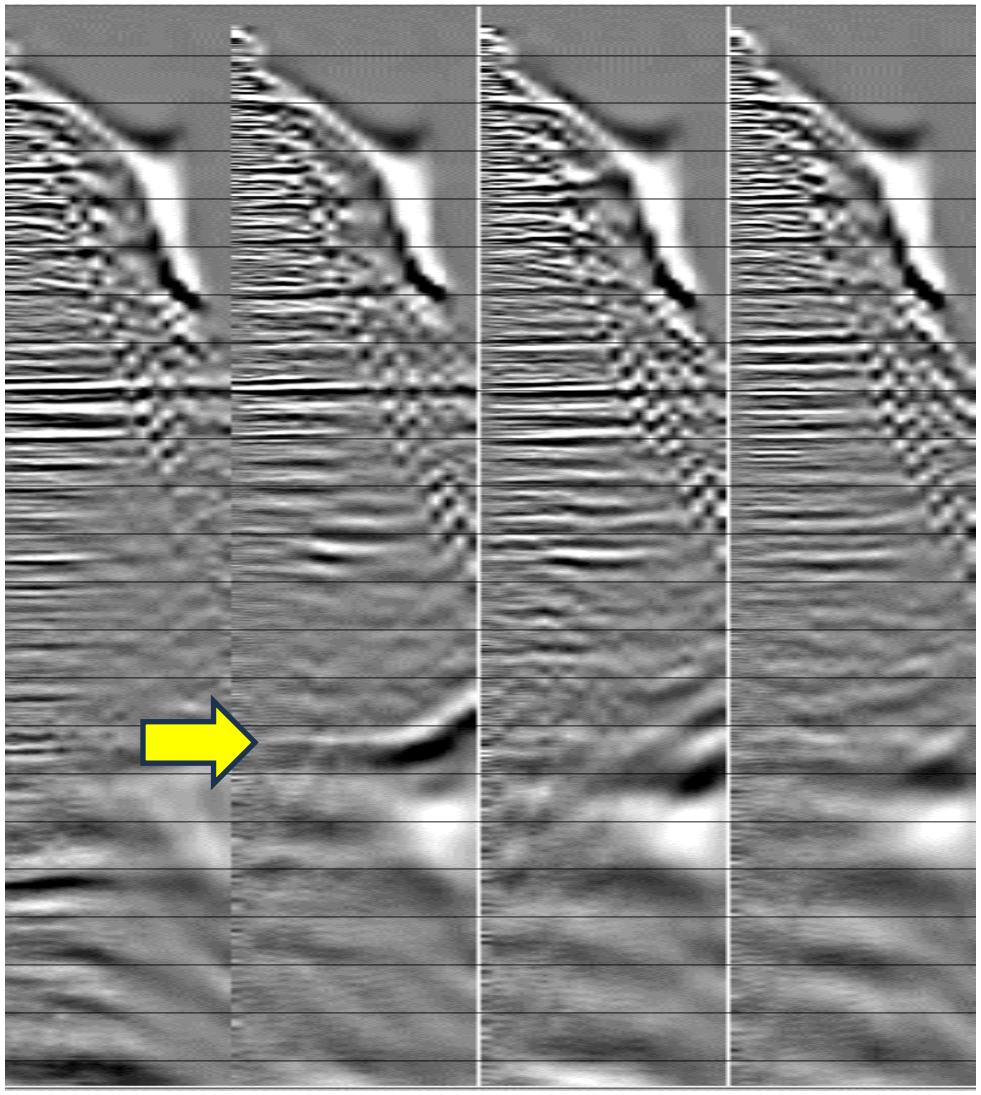


KPSDM no moveout visibility around gas cloud for RMO

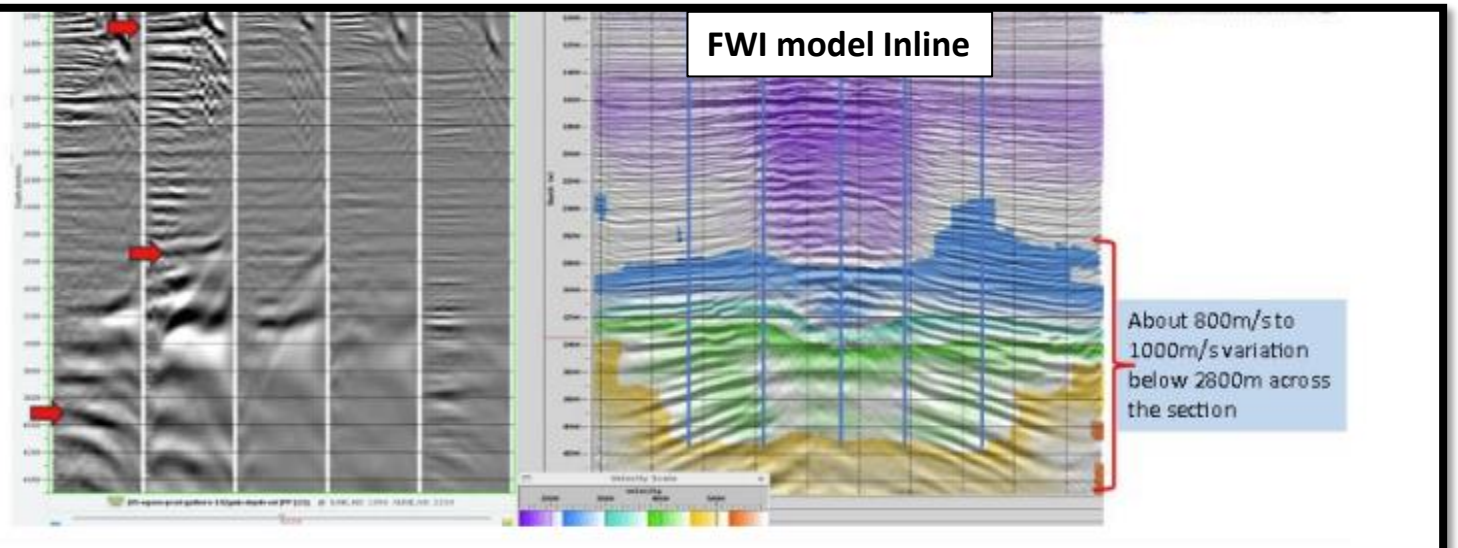
Kirchhoff PSDM gathers



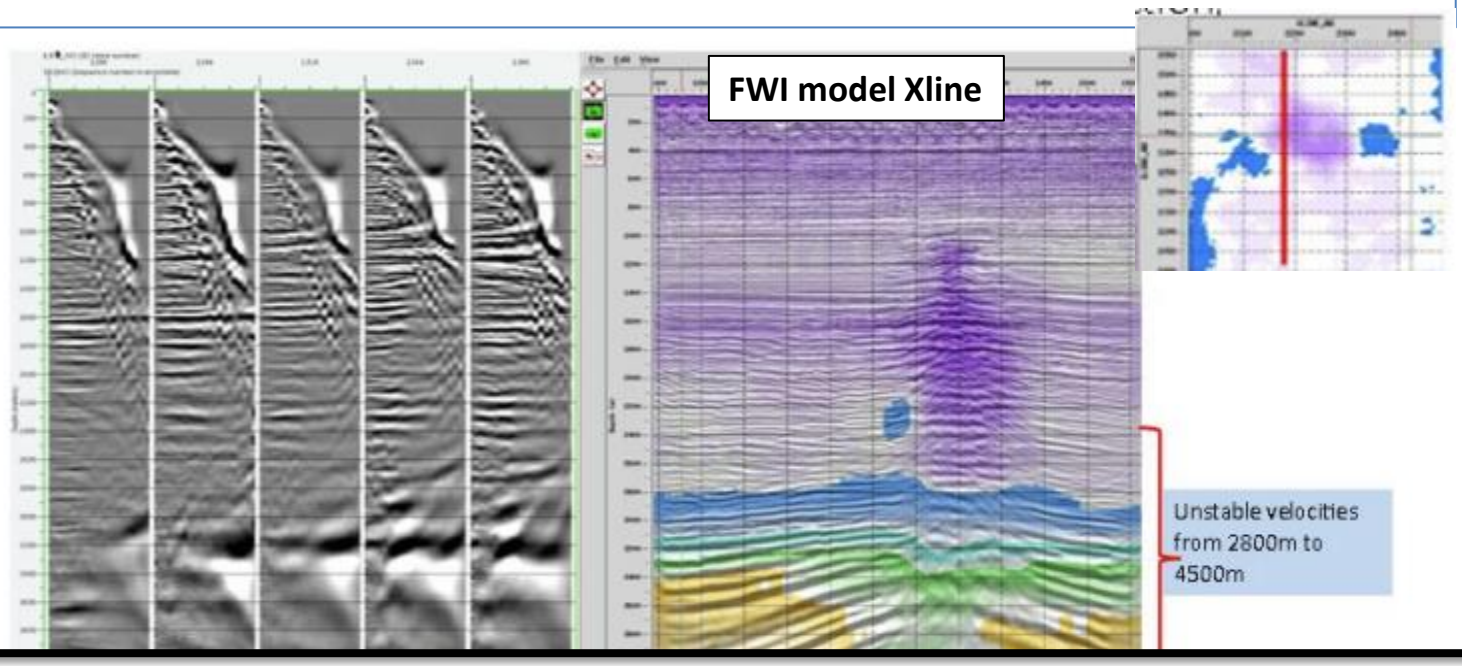
eGWM Gathers



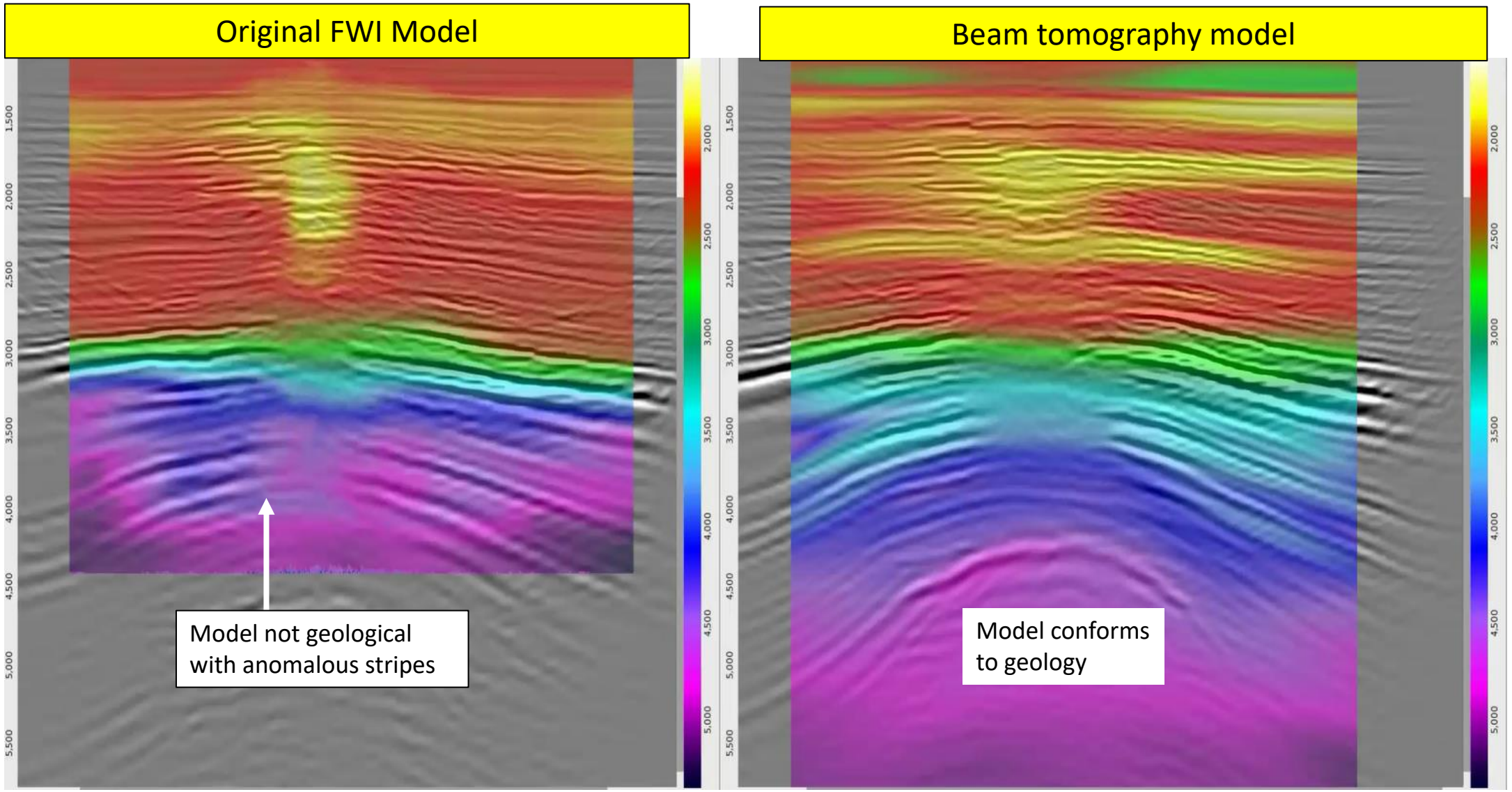
Moveout on eGWM gathers is useable RMO in tomography updates. Kirchhoff has lot of noise and no NMO to pick. Critical energy & anisotropy are visible on eGWM.



eGWM gathers show problems in the FWI velocity model rapid changes high & low values. Inverse theory non-uniqueness needs constraints. Kirchhoff could not image far offsets.



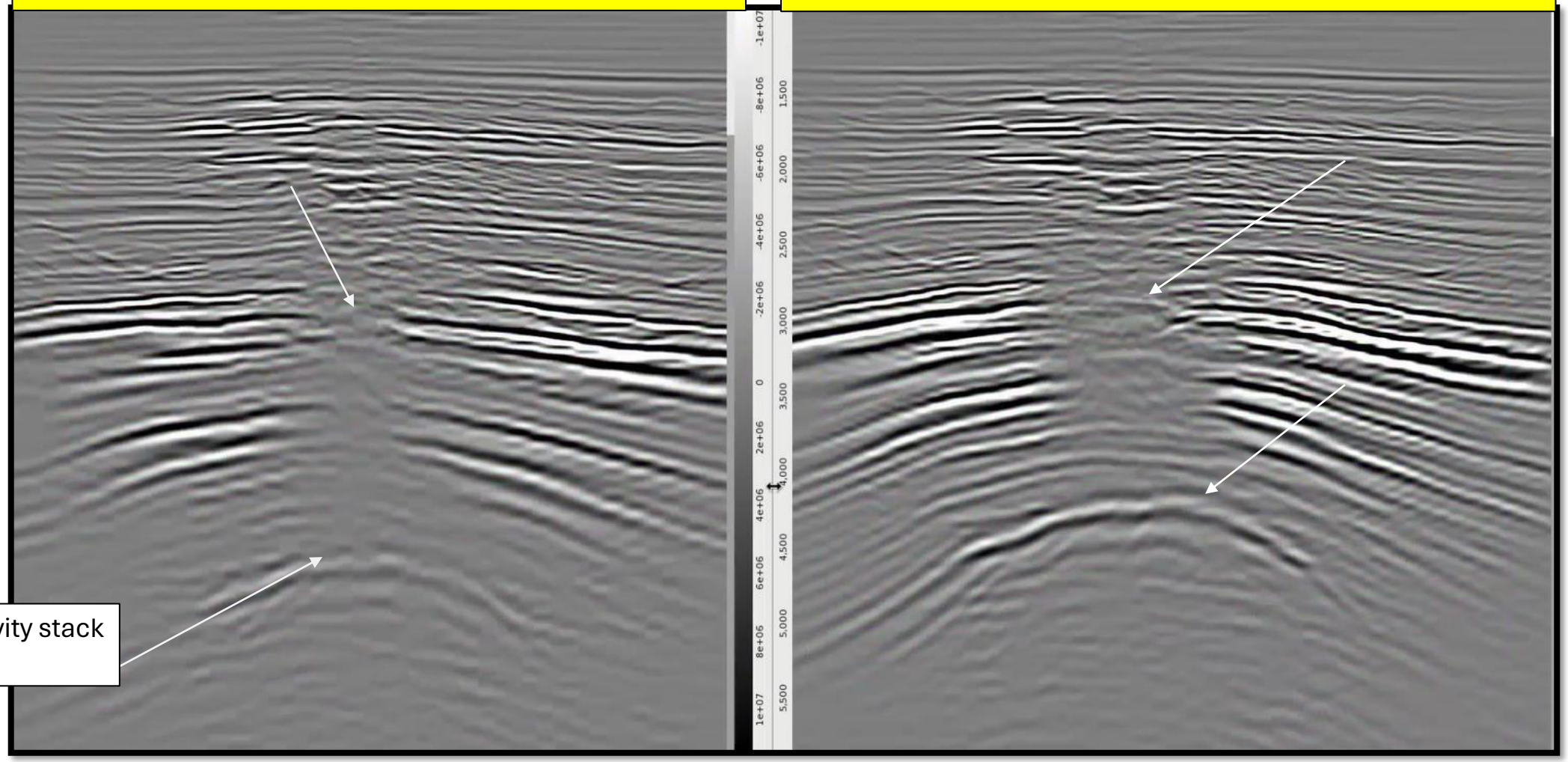
RTM stack


Original FWI Model
Beam tomography model
Model not geological with anomalous stripes
Model conforms to geology

RTM raw stack

FWI Model

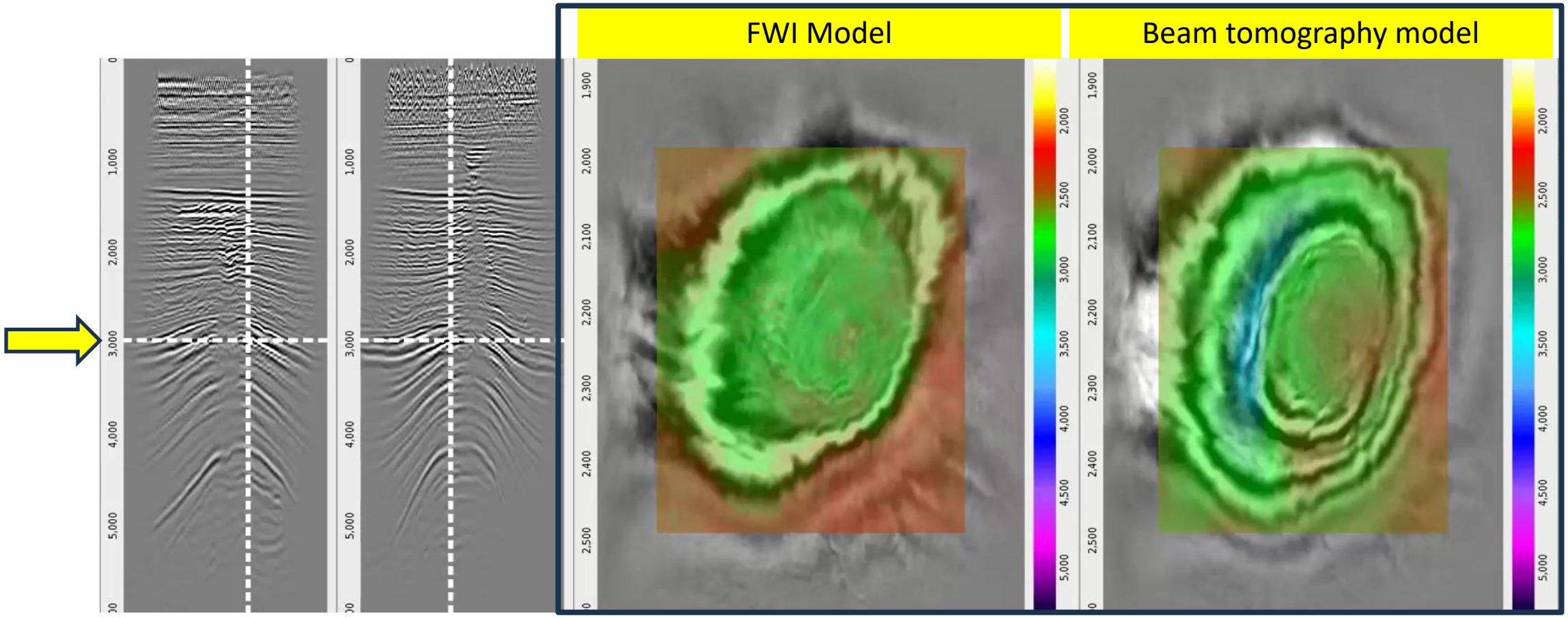
Beam tomography model



Reflectivity stack
Is poor

Structural resolution has improved across the seismic profile by using beam tomography model

Depth 3000m – big improvement below gas cloud



Conclusion

- High frequency FWI can often give a poor image with ray-based migration
- eGWM gathers extract true value of FWI. First industry 100Hz Wave Equation and no Post Migration processing required.
- Available to all on the AWS cloud and 1000 x faster (Frequency) than RTM

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