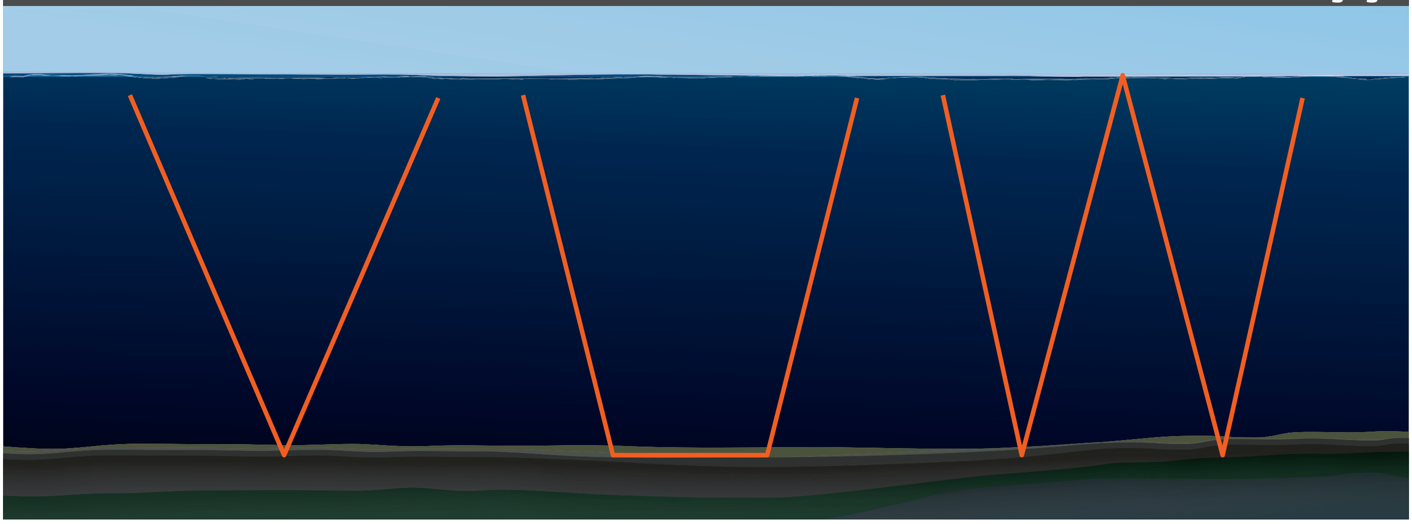


Complete Wavefield Imaging

PGS Complete Wavefield Imaging (CWI) is a processing flow developed by PGS which integrates advanced technology for high-resolution velocity model building and depth imaging using reflections, refractions and multiples.

PGS CWI is ideally suited for shallow-water environments and in areas with a complex geological overburden. It includes the following key technologies:

- Reflection Tomography using primary reflections (P-UP)
- Full Waveform Inversion (FWI) using reflections and refractions (H-RAW)
- PGS SWIM® (Separated Wavefield Imaging) using sea-surface reflections (P-UP and P-DWN)

By combining reflection tomography, full waveform inversion and separated wavefield imaging we are able to produce high-resolution velocity models that are ideally suited for imaging broadband GeoStreamer® data. Leveraging dual-sensor streamer technology and the wavefield separation that comes with it we use up- and down-going wavefields for imaging and tomography to dramatically improve resolution and illumination. This ensures a much better understanding of the target at reservoir level.

By towing the streamer deep we preserve the low frequencies that are important for the success of full waveform inversion without sacrificing a broadband signal that is vital for producing high-resolution reflection images of both the shallow overburden and deep reservoir sections.

Reflection Tomography

The first step of the CWI workflow utilizes reflection tomography to construct a globally consistent background velocity model. At this stage, primary reflections are used to resolve the long wavelength velocity trend and shallow gradients, providing a suitable initial model for any subsequent FWI iteration.

KEY BENEFITS

- More accurate modeling and imaging of the entire substrata from the seabed to the reservoir
- Improved accuracy of reservoir characterization
- Better detection of potential shallow hazard threats

FWI

In the CWI workflow, the velocity models produced using reflection tomography are introduced to FWI for further refinement. FWI is successful in resolving small scale velocity features; in particular, in shallow-water environments where reflection based tomographic methods are limited.

PGS

By making use of reflections, refractions and diving waves the restrictions posed by conventional reflection tomography are overcome, leading to highly accurate high-resolution velocity models.

In FWI, the velocity model is iteratively refined by matching modeled and recorded data. The frequency content is subsequently increased to add spatial resolution to the updates. To ensure convergence of the model and avoid cycle skipping, FWI starts with the lowest frequencies in the data which contain coherent energy. The deep towed dual-sensor streamer enables these crucial low frequencies to be recorded.

PGS SWIM

Due to the lack of angular illumination in areas of very shallow water depth, conventional depth migrated gathers and stacks are not suitable for the validation of the shallow overburden model provided by FWI. The CWI workflow relies on the capability of SWIM to create high-resolution stack images and well sampled angle gathers by using sea-surface reflections to complement primary imaging. By using the separated up- and down-going wavefield, uniquely recorded by GeoStreamer, SWIM provides enhanced subsurface illumination and highly increased angular coverage for shallow targets.

Repeat Reflection Tomography

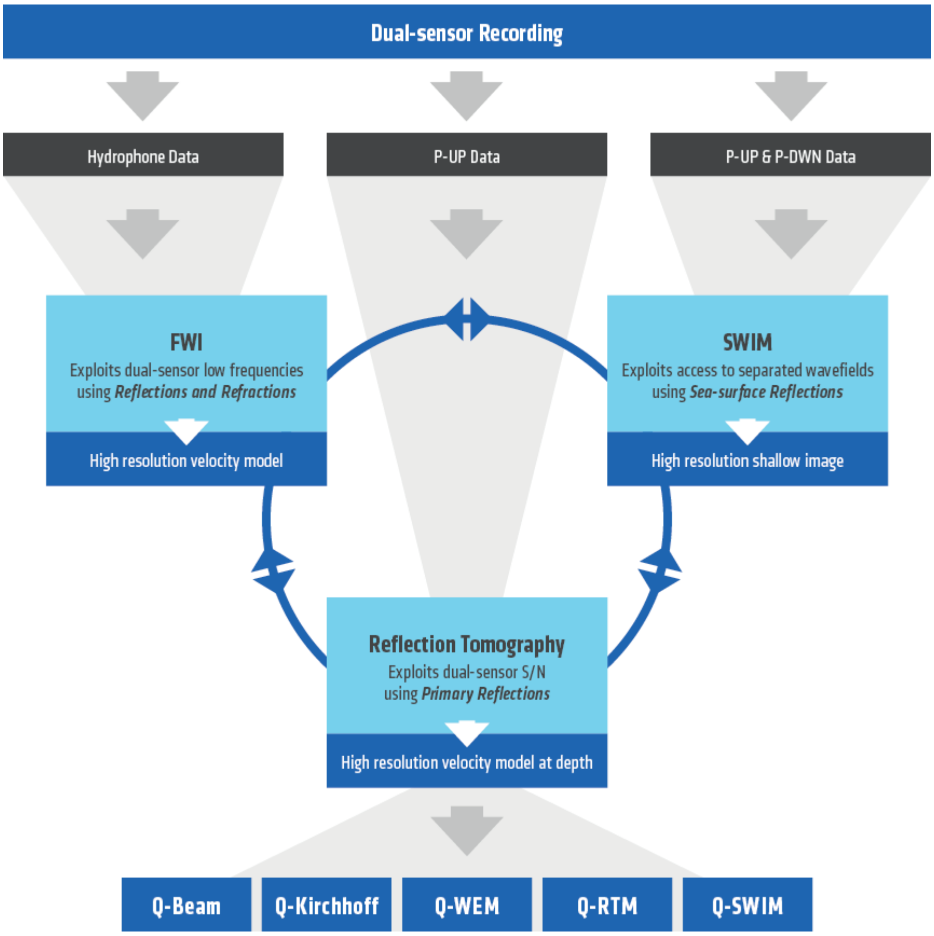
The workflow is completed by applying reflection tomography again but this time for deeper model building once the shallow overburden has been resolved.

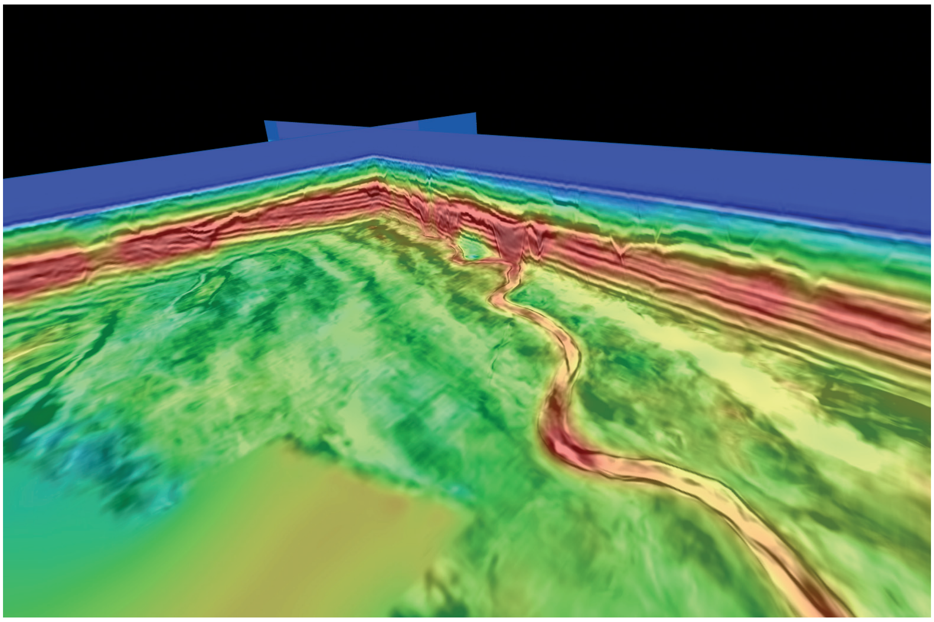
Conclusions

CWI provides more accurate and robust velocity models leading to superior imaging results.

The high resolution CWI model is used as input for our suite of advanced imaging algorithms ranging from ray-based Kirchhoff and Beam migrations to wave equation based migrations such as one-way Wave Equation (WEM) and Reverse Time Migration (RTM).

Anisotropy and Q are handled consistently





High-resolution CWI near-surface velocity model showing a palaeochannel with high-velocity sediment infill

in all our model building and imaging tools, ensuring the delivery of accurate images.