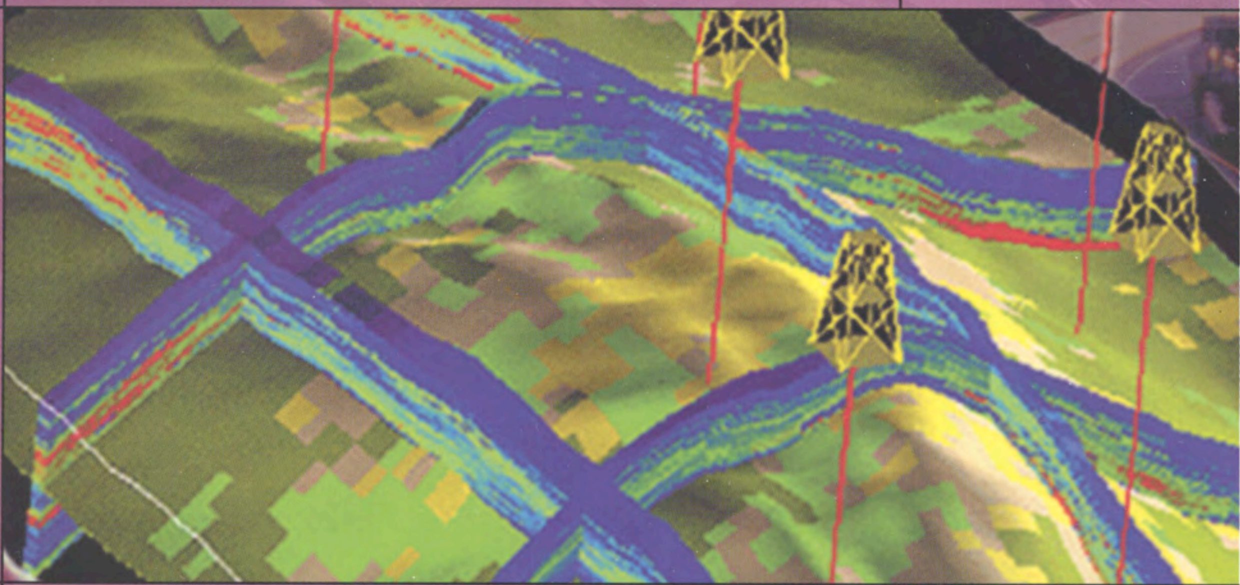
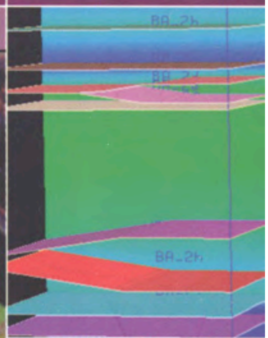
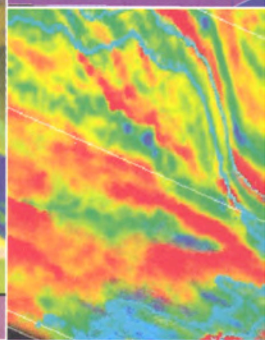
StrataVista

Reservoir Characterisation Services







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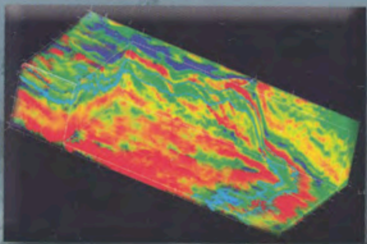
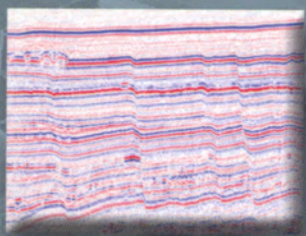
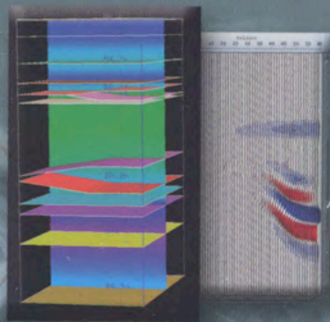


Seismic Inversion

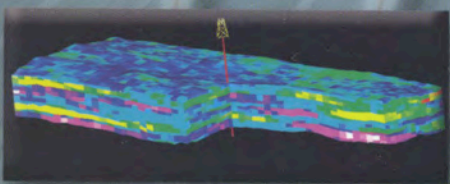


GeoHazard Analysis

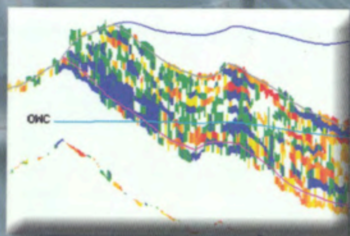


4D Feasibility

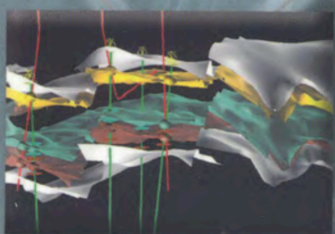
Reservoir Characterisation Services



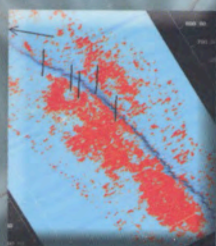
Reservoir Modelling



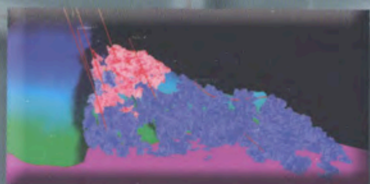
4D Elastic Inversion



Depthing

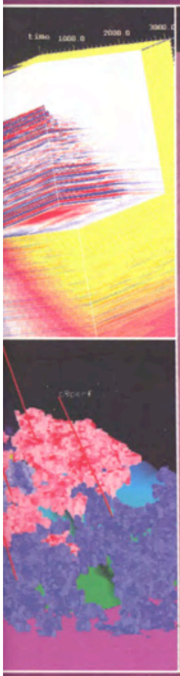


Fluid and Rock Properties



4D Interpretation

Integrated seismic processing and inversion workflows for
reservoir characterisation



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StrataVista

Relative Inversion for automated interpretation

An automated method for complex geology and very large blocks

CGG's relative inversion method has the speed and ease of application required to address large-scale exploration programs typical of deepwater areas as well as renewed exploration efforts in mature basins. The interpretation workflow provides a high-resolution stratigraphic image, resolving subtle weak and gradational impedance contrasts. Moreover, since the microlayers are optimally aligned with the impedance boundaries by the TDROV inversion engine, much of the conventional interpretation picking can simply be extracted from the final microlayer model. With its StrataVista inversion platform, CGG combines both software and methodology to bring the next generation of interpretation technology.

- **Rapidly and accurately interpret large and complex volumes**
- **Assist fault interpretation and stratigraphic correlation across faults**
- **Aid a less experienced workforce with an easy-to-use interpretation tool**

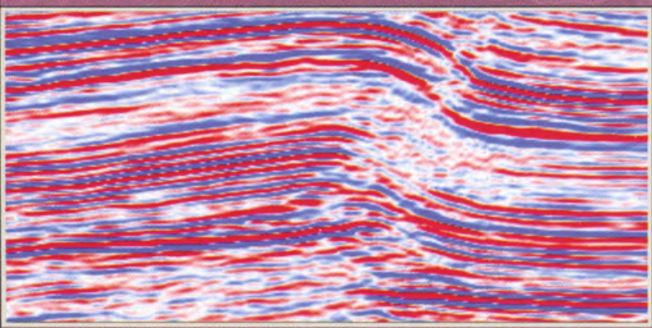


Figure 1: Seismic

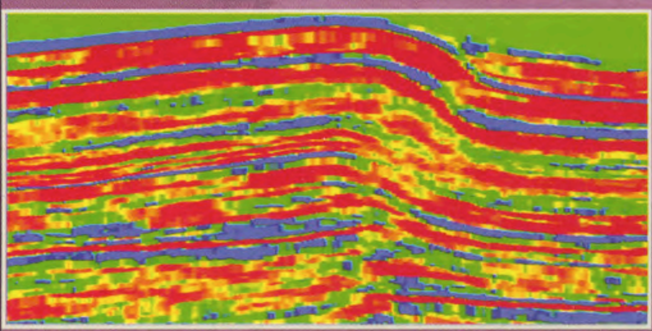
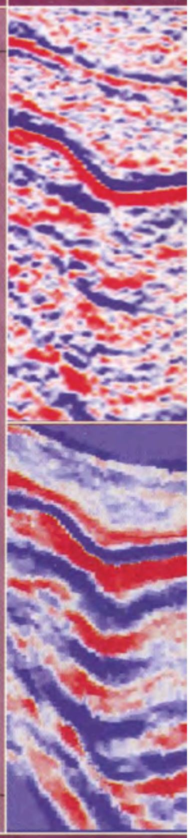


Figure 2: Inversion

Figure 1 displays the seismic image from a faulted reservoir zone requiring interpretation. Figure 2 shows the layers resulting from the relative inversion, which are accurately modeled by entering a geometric pick that follows the dip regime without reference to faults. Thus this image was made without the need for a complex model. Compared to the seismic in Figure 1, the enhanced fault imaging is clearly seen. As a result, fault interpretation is greatly simplified because the impedance image allows a better correlation across the faults than the seismic image. The microlayers from the inversion can then be extracted to build the interpretation. The enhanced imaging and export of microlayers allow the TDROV 3D engine to greatly aid the interpretation workflow.



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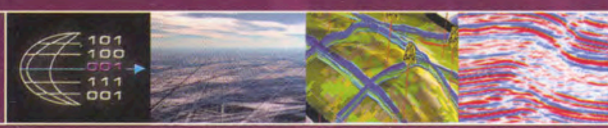

StrataVista

Relative Inversion for automated interpretation

Methodology for use in large deepwater blocks with no well control

Methodology for complex areas

- *Determine Wavelet*
- *Geometric model*
- *Acoustic impedance (AI) inversion*
- *Automated picks on the AI inversion*
- *Choose patches of micro-layers*
- *Construct interpretation from layering system*
- *Final AI or EI as per client requirements*

Methodology for areas with No Wells

- *Automated model based on dip regime*
- *Determine Wavelet from seismic*
- *AI or EI inversion as required by the client.*

Unlike a "typical" inversion project in a mature area with many wells, the wavelet in a true exploration project is determined from the seismic. The pre-inversion processing is therefore very important, and CGG's Geocluster software meets this need. In our exploration workflow, a 3D microlayer model with a constant impedance background is input into the TDROV inversion engine. TDROV exploits the fact that impedance distributions naturally follow the local dip regime of the seismic, which is represented by the initial model.

Figure 3: Seismic

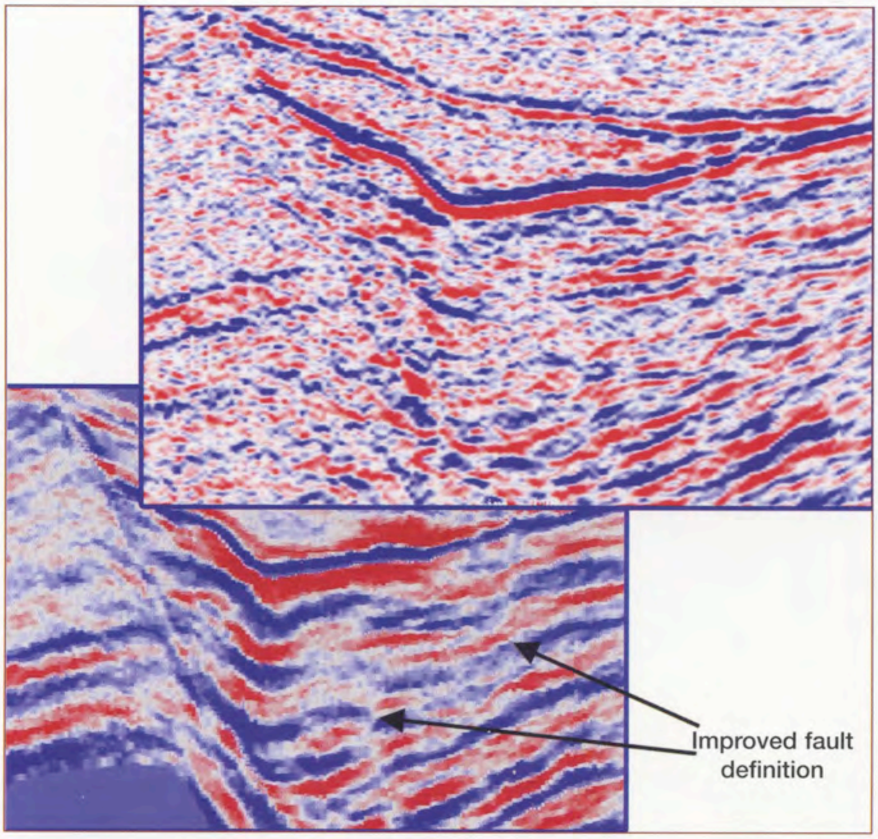

Figure 4: Inversion

Figures 3 and 4 are taken from a large North Sea block in an area characterised by subtle impedance contrasts and clearly show the enhanced resolution achieved by the relative inversion. Note that the improved stratigraphic definition also helps the definition of the smaller faults on the hanging wall as well as the large fault. The enhanced imaging provided by this inversion greatly simplifies the interpreter's task.

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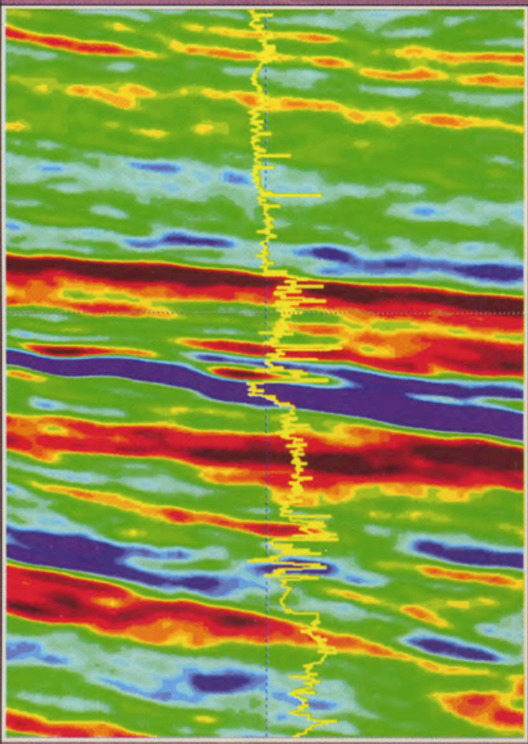
StrataVista

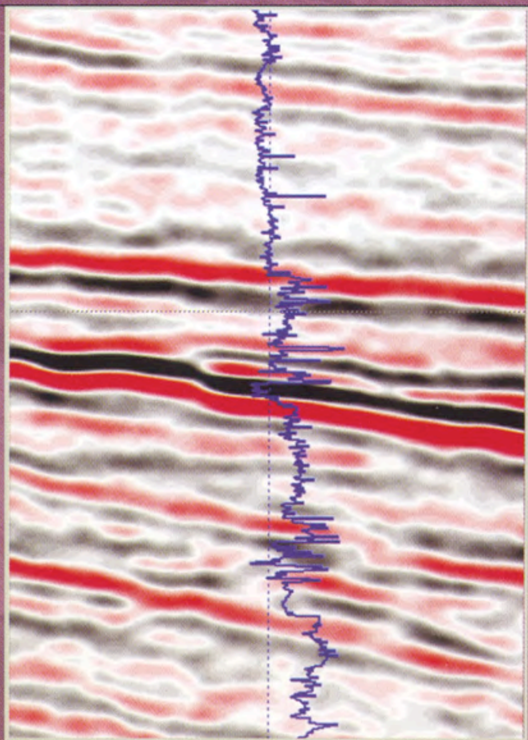
Coloured Deconvolution

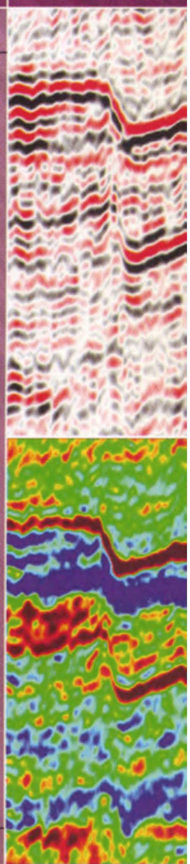
Reliable and affordable impedance attributes in real time

Coloured deconvolution can be applied to full or partial offset stacks to obtain relative acoustic or elastic impedance attributes. The combination of CGG's patented signal-enhancing processing technology with an impedance log-calibrated operator improves signal-to-noise ratio and increases resolution. In this way impedance can be used on a routine basis to enhance the analysis and interpetation of seismic data.

- Fast turnaround
- Improved understanding of stratigraphy
- Horizons and geological model not needed
- Provides a strong guide for initial interpretation


Coloured inversion result and impedance log


Seismic data used in the inversion



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Coloured Deconvolution

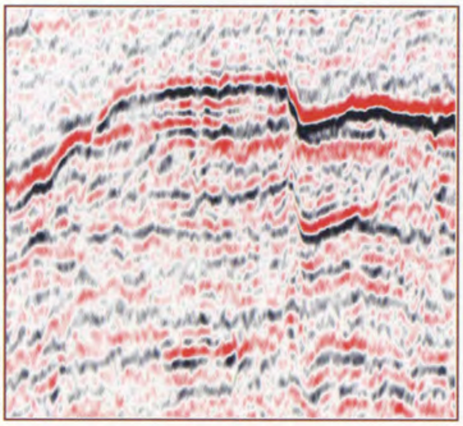
A seismic data processing approach to understanding impedance

Workflow

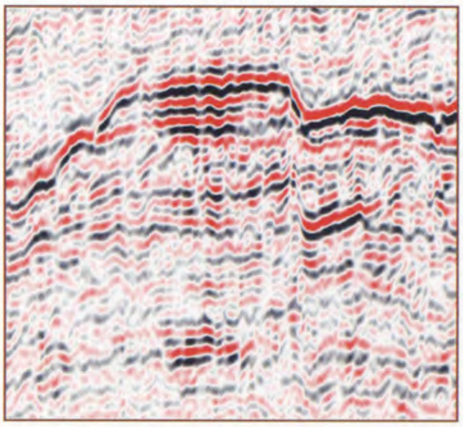
- Attenuate random noise (optional) to improve S/N ratio for high frequencies
- Enhance S/N ratio for low frequencies
- Zero phase the data (statistical or well-based)
- Apply coloured deconvolution operator.

Operator Design

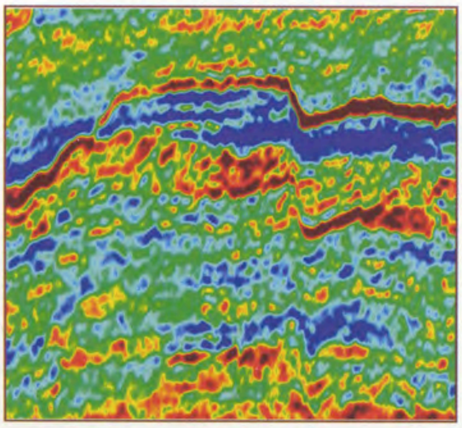
- Compute the amplitude spectrum of one or several representative impedance well logs
- Analyse the amplitude spectrum of the well logs
- Compute the average amplitude spectrum of the seismic
- Design the colouring operator based on the above.



Input seismic



After pre-processing



Coloured deconvolution

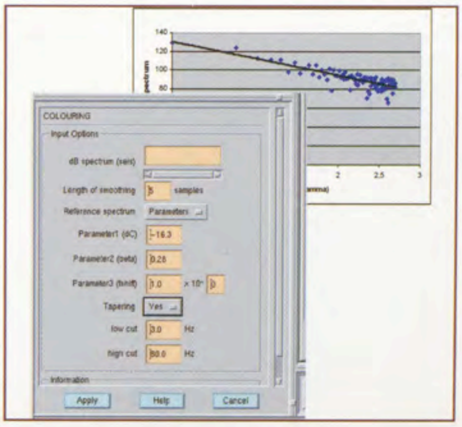
Why and How

Since 1996 CGG has offered advanced inversion solutions for detailed reservoir characterization based on its TDROV inversion engine. Coloured deconvolution is a new, reliable and fast impedance attribute available with StrataVista, that can be applied on large data volumes without detailed geological knowledge. Coloured deconvolution can be delivered as an additional processing product without increasing project turnaround time.

The only input required is one representative impedance log from a well either inside or outside the seismic cube. An inversion operator is carefully designed based on the provided well log and the seismic data. CGG's patented pre-processing technology is vital in order to improve the S/N ratio and avoid low-frequency "striping" in the inversion result. The illustrations on the left show the input seismic before and after pre-processing followed by the coloured deconvolution result.

The Best Tools

The purpose-built ColourCalc tool helps the processing geophysicist to design the coloured deconvolution operator efficiently and reliably.



Reference: Steve Lancaster and David Whitcombe: Fast-track "coloured" inversion. SEG 2000 Expanded Abstracts.

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The TDROV inversion engine

A true 3D inversion for any size data volume

Today's asset teams work with high-resolution 3D data, except when inverted data is used to determine rock properties. ONLY a true 3D algorithm can harness the true potential of acoustic impedance, elastic impedance, 4D inversion, or even prestack inversion. Simply put, for an accurate stratigraphic interpretation, and the volumetric calculations that follow, 3D will give far superior results to 1D every time. Whether for prospective purposes or drilling decisions this level of detail is required!

- Geostatistics for rock properties
- 3D method gives highest resolution possible in reservoir
- Detect interconnected bodies
- Link seismic to rock properties
- Direct layer output
- Voxel volume output
- Layers or times can be held constant for 4D workflow
- Elastic Impedance workflow available

The TDROV inversion uses a 3D simulated annealing algorithm. This algorithm allows for an optimal solution avoiding local minima. The initial model is perturbed to produce an updated set of micro-layers. Both time and/or impedance values may differ from the initial model. This update is driven by user-defined geological constraints, such as the impedance corridor, to ensure that the end result is consistent with *a priori* knowledge of the field. The two-way time perturbations associated with the layered structure of the model achieve an optimal detuning/deconvolution process. This allows the seismic bandwidth to be fully utilized. The TDROV engine exploits the fundamental 3D nature of the seismic stratigraphic problem: impedances are distributed in a parallel or sub-parallel direction to the seismic dips. This means that TDROV is able to image weak and gradational impedance contrasts, which is simply not possible with single-trace inversion methods. As the well impedances are not input in the *a priori* model, they can be used for an effective QC of the results.

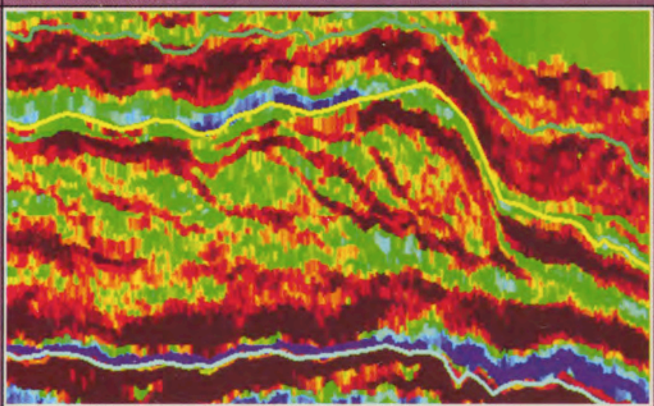
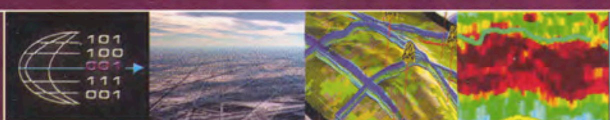


Figure 1 shows an acoustic impedance inversion from Quad 9 in the North Sea. The prograding delta front units are clearly imaged. When compared with the seismic, the inversion gives much more information, both about the structure and the lithology. This shows the advanced interpretive features of the basic inversion that is part of the CGG StrataVista service.



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The TDROV inversion engine

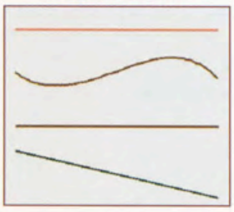
Reliable data in, reliable rock properties out

Workflow

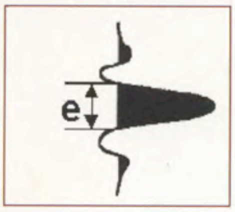
This series of figures shows the key elements of the StrataVista inversion process.

A macro model is built using the key sequence boundaries. Based on the seismic wavelet and the stratigraphy, the initial microlayer model is built and input into the TDROV engine.

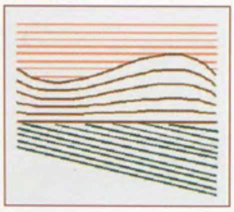
Macro Model



Wavelet



Micro Model



Simulated annealing

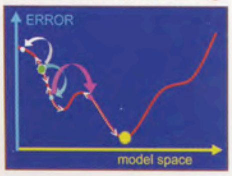


Figure 2: QC at well locations.

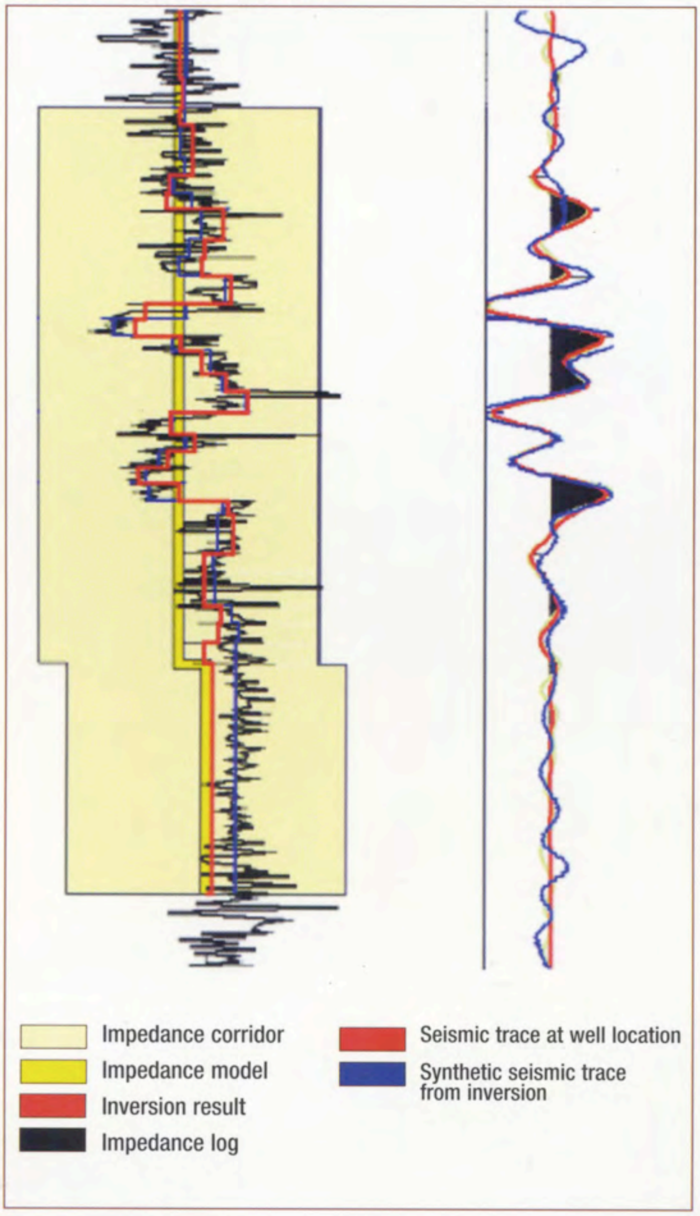


Figure 2 is a typical QC plot from the QCINV module in StrataVista. This plot shows the comparison of the well log (in black) with the modeled impedance from the inversion (in red).

Also displayed are the input impedance corridor (inversion constraint) and initial model (in yellow). Note that the well log is never input into the inversion.

This means that the tie at the well is a reliable indicator of the effectiveness of the inversion. The actual seismic trace and the resulting model trace are shown on the right of this diagram and they are also a good indicator of the inversion quality.

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Elastic Inversion: a complete workflow @ CGG

Elastic attributes combined with full 3D PSTM

The definition of rock properties plays a key role in exploration, delineation and development projects. Elastic attributes derived from elastic impedance (EI) are rapidly replacing conventional AVO products. CGG has developed an EI workflow to accurately define reservoir properties, which are computed by starting with high-quality PreSTM data which is then used as input to the TDROV EI workflow.

- **Combined high-resolution imaging of structural and elastic properties**
- **True 3D inversion**
- **True 3D migration**

CGG proposes a phased workflow to condition prestack seismic data for reservoir property estimation. Critically, the first phase should be conducted in conjunction with pre-stack time migration processing to ensure that the processed seismic is optimal for reservoir characterisation and to speed up delivery of the final results. The migrated angle gathers are input to StrataVista for calculation of elastic impedance. This EI result is used to derive elastic attributes which can then be correlated to the desired reservoir properties.

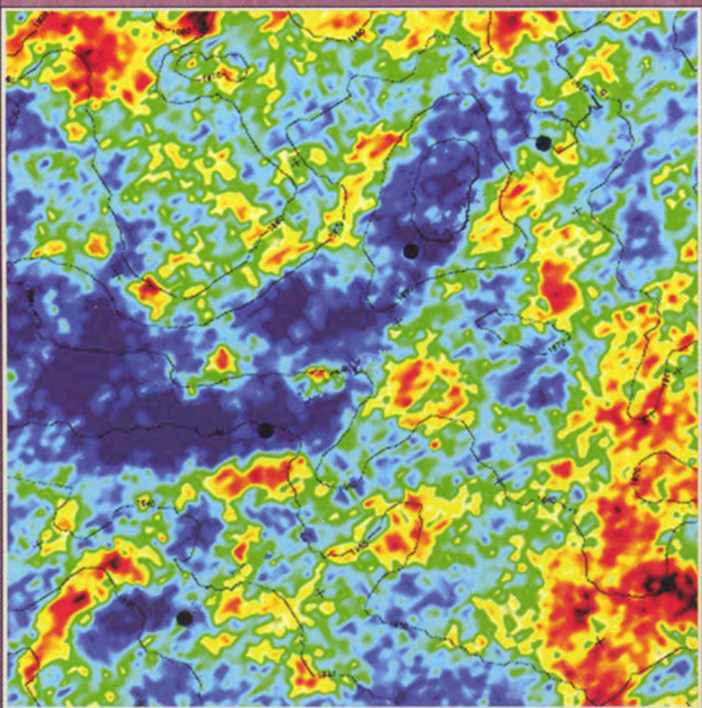
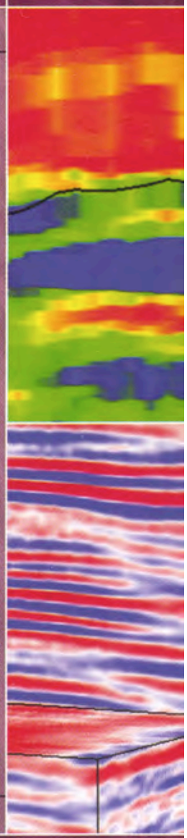


Figure 1: Horizon slice

*Figure 1 shows a Lambda*Rho horizon slice of a turbidite reservoir. The data were processed using CGG's full 3D PSTM Kirchhoff migration, TIKIM, followed by elastic impedance inversion. The geometry of the sand channel in the oil zone is clearly shown by the dark blue low impedance areas. After the full pre-stack time migration, the angle stacks are output to give geophysicists full insight into their data. The integrated VXOUT tool gives the output gathers in industry-standard voxel format.*



StrataVista

Elastic Inversion: a complete workflow @ CGG

CGG 3D PSTM and Elastic Attribute Workflow

Workflow: Calibration

CGG has a phased approach to elastic inversion:

- ***Model** the elastic impedance response using well data.*
- ***Estimate** the wavelet.*
- ***Compare** synthetic gathers to real data gathers.*
- ***Compute** relevant elastic properties from well data.*
- ***Correlate** well elastic properties to lithologies and fluids.*
- ***Determine** the angle ranges of interest.*
- ***Compute** elastic properties on well tie lines.*
- ***Determine** optimal angle ranges for angle stacks.*

Workflow: Processing

- ***Adjust** the residual wavelet.*
- ***Compute** angle stacks.*
- ***Construct** the TDROV model.*
- ***Run** the elastic impedance inversion of angle stacks.*
- ***Compute** the elastic properties from elastic impedances on entire volume.*

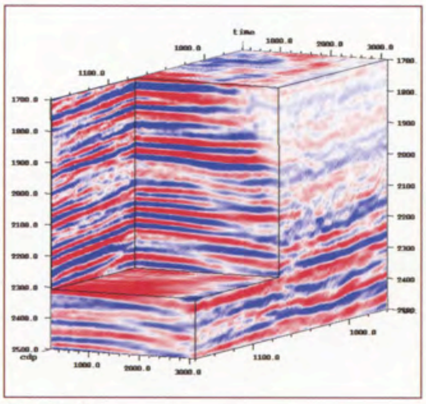


Figure 2

Figure 2 shows a pre-stack well tie line which has been fully migrated using TIKIM full 3D prestack Kirchhoff migration.

In *figure 3*, the incidence angles have been overlaid in colour. The processing sequence includes high-resolution Radon demultiple and 3D noise attenuation. The net result of this high-resolution sequence is that the geology is clearly visible on individual offset planes, and hence narrow angle stacks. The well tie line is used to pilot determination of the rock properties.

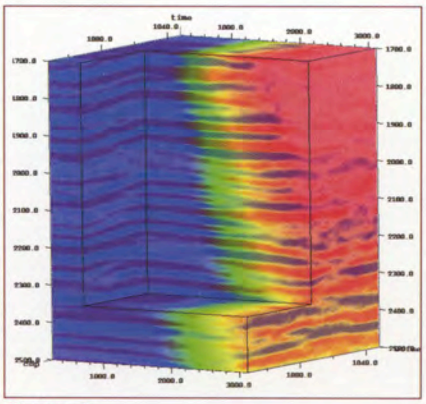


Figure 3

In CGG's elastic attribute workflow, angle stacks are inverted using a coupled earth model provided by the TDROV micro-layer system. The inverted angle stacks play an important quality control role; meaningful rock properties cannot be obtained if the elastic impedance response is incorrect. Given the imaging of subtle EI contrasts by TDROV, the inverted angle stacks also serve as a valuable interpretation tool. *Figure 4* shows the top of the reservoir in black, the higher impedance shale facies in green and the lower impedance sands in blue. It also clearly shows the sands from an ancient channel system.

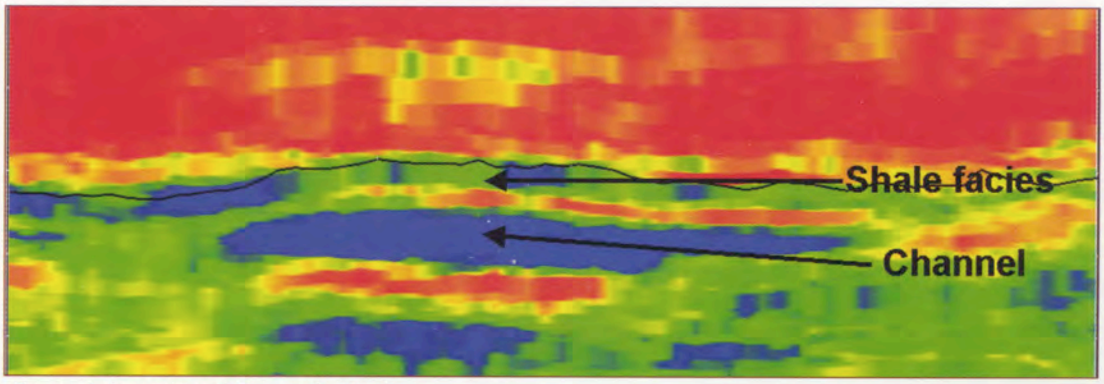


Figure 4: Inversion of Far angle stack

The same workflow is used to produce the Lambda*Rho sections which offer an understanding of the fluid properties in the corresponding lithology, as we saw in *figure 1*.

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StrataVista

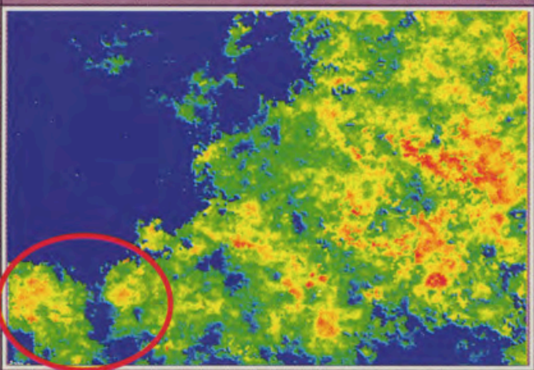
4D Inversion to track production effects

Measuring fluid movement using seismic

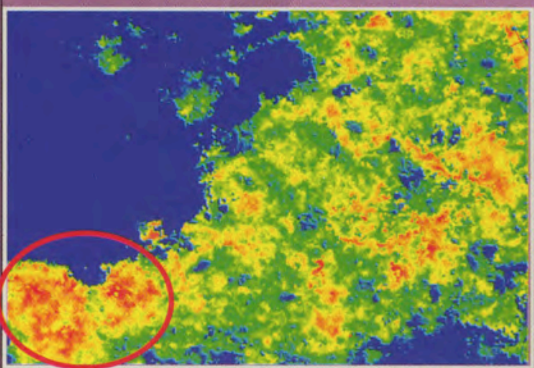
Geophysicists and reservoir engineers can measure both fluid properties and movements in a reservoir with CGG's 4D inversion expertise. This process is a true 4D methodology where the layering is fixed during a multi-volume inversion. By applying the simulated annealing technique within TDROV and our unique methodology, CGG gives our clients the full benefit of all the information that can be extracted from 4D seismic data. This expanded data is delivered in engineering scaled units rather than in seismic amplitudes, so that the reservoir asset team can directly apply the output data.

Use CGG's processing technology and competence:

- **Maximum repeatability - reliable amplitudes**
- **Controlled Wavelet phase with offset - key issue for EI and AVO**
- **High-resolution Radon anti-multiple - patented technology**
- **High-order NMO and Anisotropic PSTM operators - analysis and correction of RMO**
- **Output in industry-standard Voxel format**



Baseline survey: far offset impedance



Monitor survey: far offset impedance

Key advantages of 4D inversion:

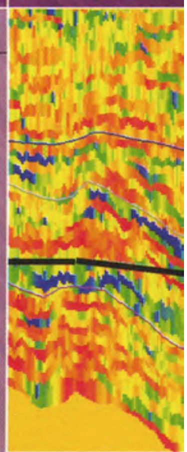
• Focuses the 4D effect into the correct stratigraphic interval/flow unit by removing the wavelet signature and by reducing interference effects.

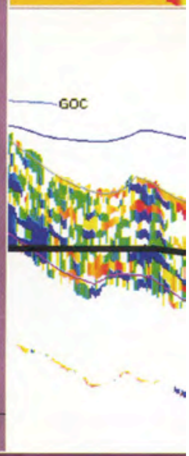
• Provides both an estimate of and changes in the rock properties. These results are more easily integrated into reservoir models (both static and dynamic) and can be more easily understood than seismic amplitudes by specialists from other disciplines (e.g. engineers, geologists).

• Production-related changes in seismic amplitudes are translated and quantified into production-related changes in rock properties. This is the first step in the estimation of saturation and pressure changes.

• 4D AVO effects are translated into changes in elastic parameters. These are easier to interpret - e.g. an increase in Poisson's ratio is water flooding whereas a decrease is gas flooding.

The 4D effect is clearly seen within the red circles. The impedance change within the reservoir is caused by the water flood performed to enhance oil production.





Processing & Reservoir

StrataVista

StrataVista is a trademark of CGG

4D Inversion to track production effects

Calculated attributes for accurate fluid type determination

Methodology

- *Develop sparse macro layers*
- *Define micro-layer system*
- *Determine wavelet*
- *Invert the near-offset Baseline Survey. Times and impedance allowed to vary*
- *Invert near-offset Monitor survey at the reservoir level. The layer times are fixed, impedance values are allowed to vary*
- *Invert far-offset Baseline Survey. The layers are held fixed, only the impedance varies*
- *Invert far-offset Monitor survey at the reservoir level. The layer times and impedance are allowed to vary.*

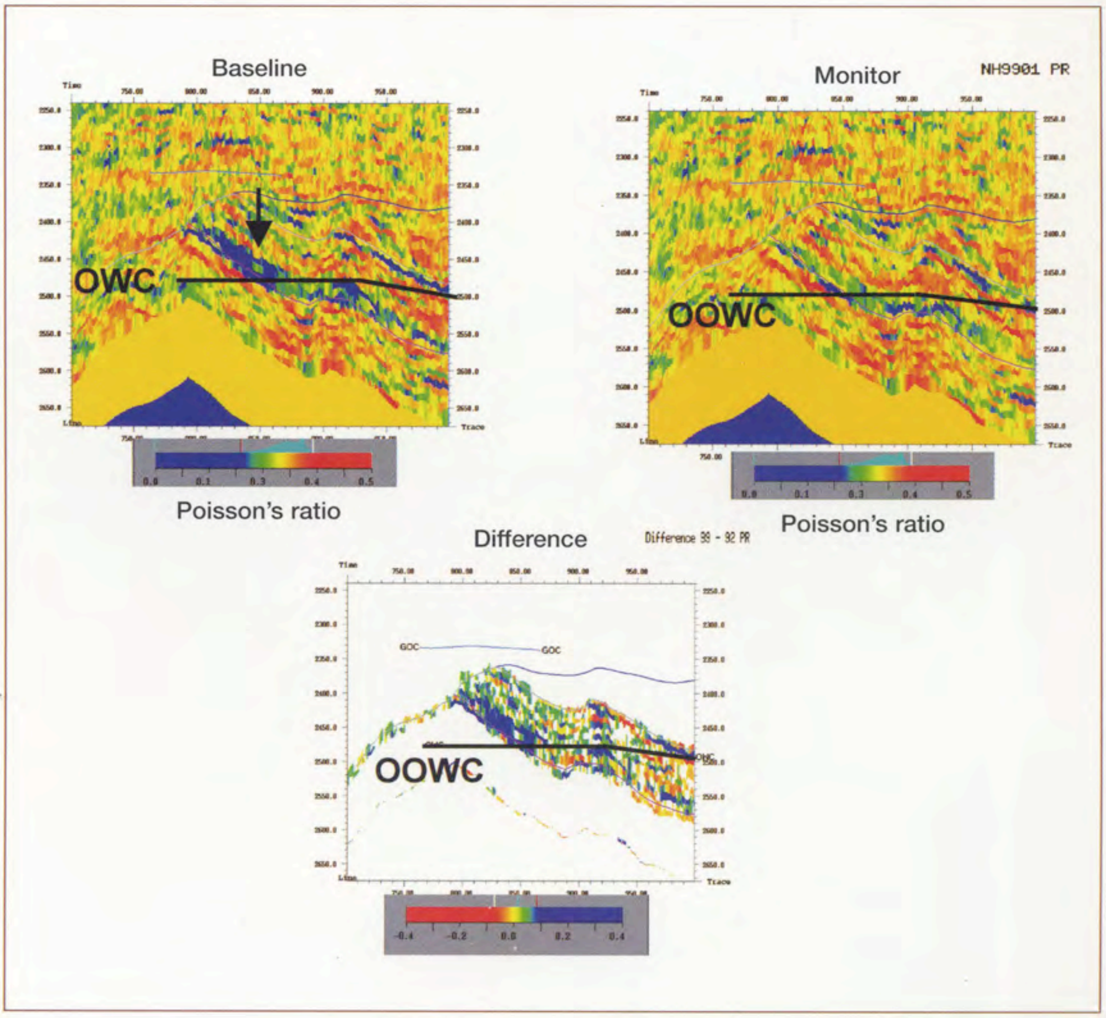
Unique Technology

This unique methodology honors the geology since the inversion is implemented with a layered approach.

The layers can then be held fixed, allowing the different vintages to be analyzed with the same model.

Parameters that can be estimated are:

Ratio between P- and S-wave velocity, Shear impedance, lambda*rho, mhu*rho and Poisson's Ratio.



On the baseline inversion, there is an interval of low Poisson's ratio above the oil-water contact (marked by the black arrow). This is the oil-filled zone and below the contact, the Poisson's ratio is higher, indicating water-filled reservoir. After seven years of production, the monitor survey shows the interval that was originally oil-filled now has a response similar to the water zone. This indicates that the reservoir has been flushed by water. The difference section clearly shows the dramatic change in Poisson's ratio and thus locations of oil production.

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Prestack visualization

The first step in prestack interpretation

CGG has a strong commitment to prestack interpretation technology. Our capabilities include full 3D prestack time migration, elastic impedance, AVO, and specialized time-lapse processing. To support asset teams in prestack workflows, CGG outputs volumes from Geocluster and the StrataVista inversion platform in industry-standard format. Clients can plug our results directly into their workstations, eliminating costly data-loading bottlenecks. Advanced visualization can be used upstream in initial processing steps and downstream in the reservoir characterisation workflow.

- Track fluid contacts
- Define 4D effects
- Understand your Vp/Vs ratio
- See difficult-to-detect AVO effects
- QC migration velocity fields
- Investigate anomalies
- Run advanced volume detection
- Direct input to visualization centres
- No need to re-enter or reformat existing interpretation data

Prestack interpretation means loading and manipulating multiple volumes of data. Whether you prefer to work with Magic Earth/Geoprobe® or VoxelGeo/Reservoir Navigator®, CGG can provide your data in a true voxel volume format for fast and easy loading. Any volume, including prestack shot gathers, full-offset line volumes, angle volumes, or offset cubes can be output. These can then provide a new way of looking at and interpreting seismic data, giving interpreters the ability to understand and QC the images with which they are working.

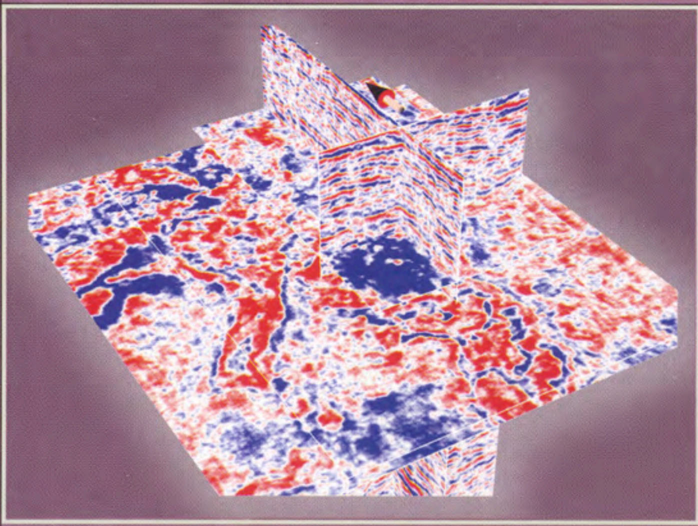

Figure 1 shows a single-offset cube, with seismic data from a North Sea 3D block. A state-of-the-art CGG processing sequence with our patented high-resolution Radon de-multiple and prestack time migration has been used. Fine structural details that had previously been smeared in the stack can be interpreted using Voxel-based tools.

StrataVista

StrataVista and Geocluster are trademarks of CGG

Prestack visualization

The Geocluster voxel output tool: VXOUT

The unique feature of VXOUT is that there are no limits on the output axis types. The three diagrams below illustrate the basic theme that the 4th dimension is represented by multiple volumes, yielding a true 4D volume loaded into memory. This is then very easy to navigate.

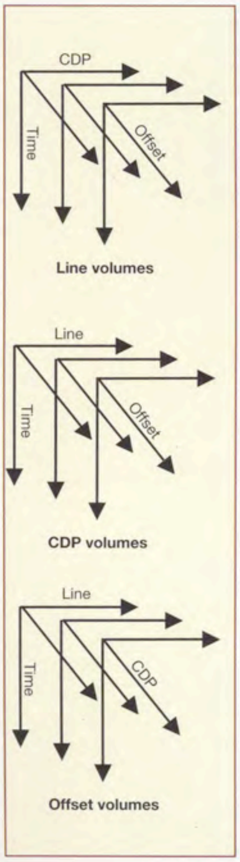

Figure 2 shows a cube of data composed of prestack traces. The Y axis represents a cdp line, while the X axis represents offset. The volume is therefore a set of CDP gathers, along a single in-line, arranged side by side, with the seismic amplitudes represented using the red positive, blue negative scheme. The blue to yellow overlay represents the incidence angle. When the same volume is generated for all the in-lines in a project, (or every nth in-line) and then loaded into computer memory, a 4D space is created. By viewing this space in conjunction with a 3D AVO or Elastic Impedance volume, a geophysicist can use the prestack data as a tool to investigate and fully understand anomalies.

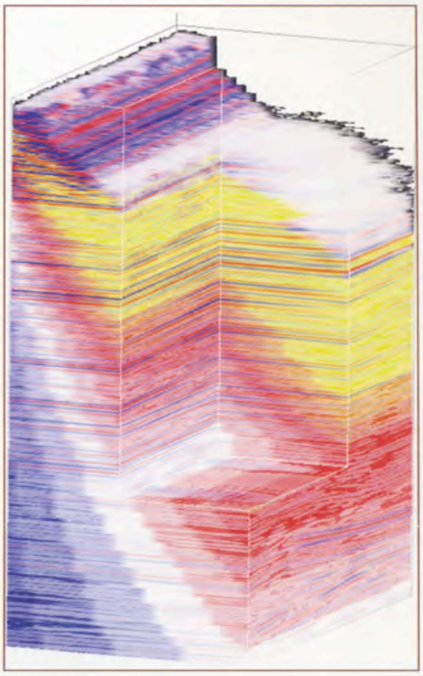

Figure 2

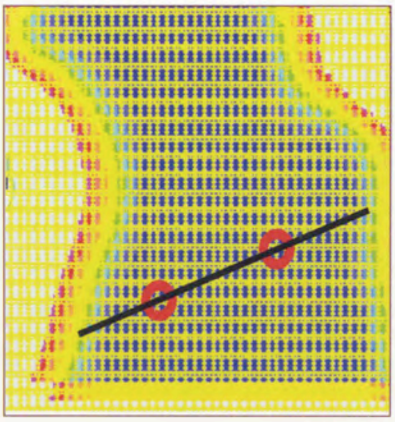

Figure 3

A powerful feature of VXOUT is that the output is not constrained to follow straight in-lines or cross-lines. It can output along any random lines in the survey space as shown in *Figure 3*. The volume in *Figure 4* represents the offset-sorted CMP gathers between two wells. This gives the interpreter an unprecedented understanding of how the geology varies between wells.

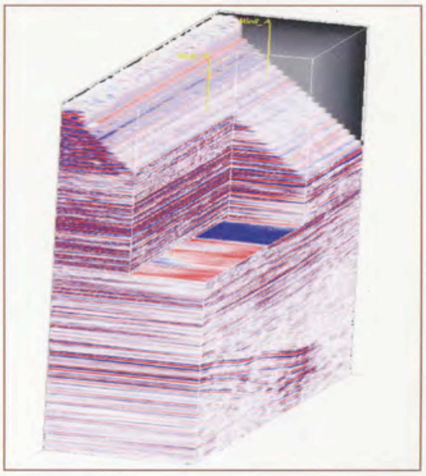

Figure 4

*VoxelGeo and GeoProbe by Paradigm; MagicEarth and Reservoir Navigator by Halliburton are the trademarks of their respective owners.

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StrataVista

A parallel solution for deepwater challenges

3D acoustic inversion or elastic attributes for large deepwater blocks

Today's interest in deepwater exploration sets many challenges, typified by large-volume seismic surveys, tight time constraints, and high drilling costs. CGG has addressed the need to apply advanced seismic reservoir characterization workflows in these deepwater blocks by porting our successful TDROV stratigraphic inversion engine, a part of StrataVista, to the massively parallel computing environment.

Parallel TDROV high-resolution inversion allows you to:

- Invert for fast-track 3D and 4D projects
- Use mega 3D Acoustic Inversion (AI) or Elastic Inversion (EI) for licensing rounds
- Address entire core acreage positions
- Derive regional pre-stack elastic attributes
- Run high-resolution AVO analysis

The computing horsepower previously reserved for pre-stack processing is now available for seismic reservoir characterization. This is a major new capability with wide applicability to exploration of deep waters and mature basins. The superior reservoir definition provided by TDROV now offers a critical competitive edge in exploration and development on a very large scale. The TDROV layered model-based approach is the cornerstone of a new generation of interpretation technology. It provides a highly scaleable interpretation framework for 4D and elastic attributes as well as large-scale exploration reconnaissance.

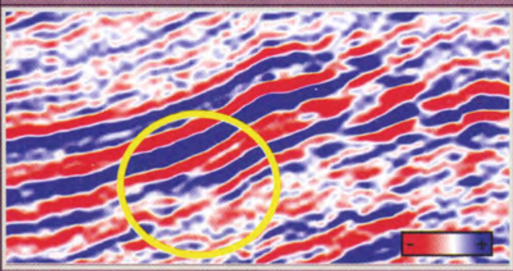


Figure 1: Input seismic

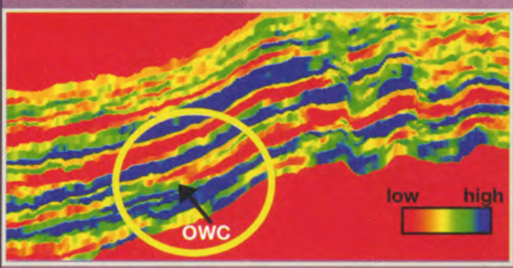
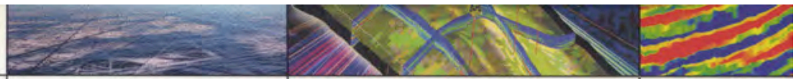


Figure 2: Inverted angle stack

The Atlantic Margin deepwater data on the left shows the power of the true 3D algorithm used in our TDROV inversion engine. Figure 1 shows the input seismic while Figure 2 shows an inverted angle stack from the deep water volume. The custom application of parallel processors can give our clients the ability to invert volumes of up to 4000 sq km. In the inversion data, the low impedance reservoir sands (red) are clearly imaged along with intervening shale barriers (dark blue) and low net/gross zones (green). Note the definition of the oil/water contact in the lower sand; as expected the TDROV engine gives excellent overall stratigraphic resolution.



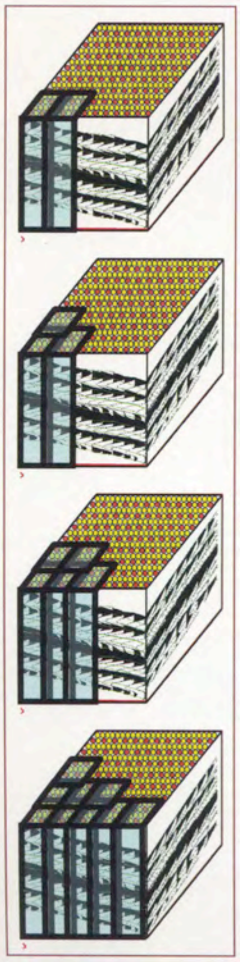
StrataVista

A parallel solution for deepwater challenges

Best-in-class inversion now suitable for large surveys

Workflow

Propagating through the block, much like a wavefront, the inversion grows from one CPU to two, then three, up to a specified number. The overlapping 3D operators exploit the stratigraphic symmetry to allow multi-CPU inversions. This is just one example of the expert data processing experience that CGG applies to inversion projects via Geocluster.



Advantages of the parallel TDROV inversion engine:

- 3D algorithm for stratigraphic resolution
- Global solution avoids local minima
- Imaging of weak and gradational contrasts
- Independence from well data provides reliable QC
- Applicability to large-scale exploration with sparse well data
- Automated initial model building
- Common layered model for elastic inversion

The parallel algorithm exploits multiple CPUs

With the new parallel algorithm, our clients can process huge data volumes quickly with the TDROV high-resolution inversion engine. Now any deepwater block, no matter how large, can have a best-in-class inversion applied by CGG's specialist teams. The graph in *Figure 3* shows how the parallel inversion engine takes advantage of CPU power. With multiple CPU's, turnaround is cut by a factor of 12. As survey size increases, more and more processors can be used. The algorithm has been developed in such a way that there is actually more acceleration on larger blocks. All of this computer science is of direct benefit to our clients; elastic inversion, 4D inversion, prospect-wide inversion, rock properties derived from seismic over the entire prospect, are now all available. To apply this new algorithm, and our advanced imaging sequences, CGG has increased its computing power 70 times in the last year. This is shown in the graph in *Figure 4*; note the scale is LOGARITHMIC!

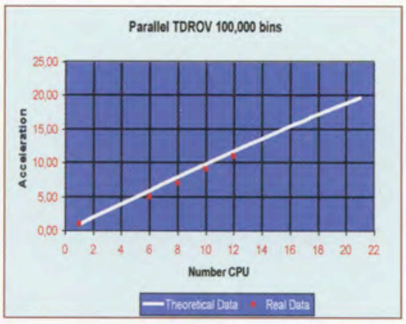


Figure 3

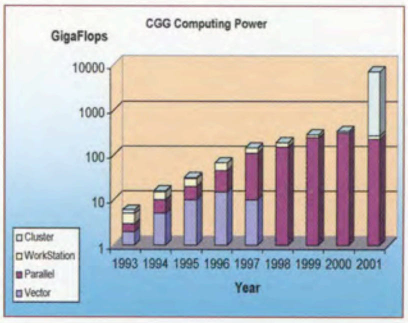


Figure 4

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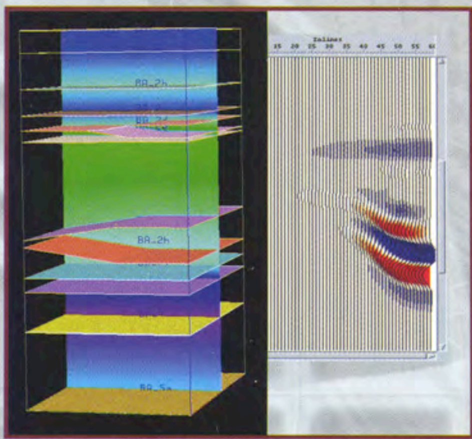
Integrated seismic processing and reservoir characterisation services

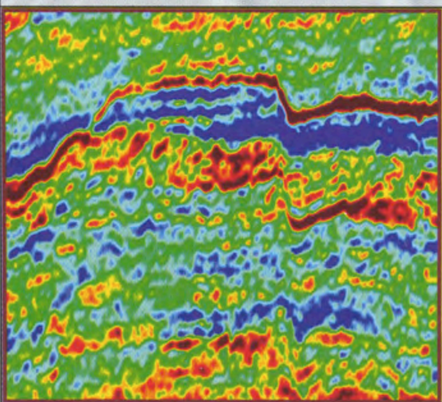
StrataVista is a range of reservoir-oriented products which bring added value from seismic data to help solve the reservoir problem. The new workflows take the seismic data through an optimised processing sequence ensuring that it is properly prepared for the stratigraphic reservoir characterisation phase. The best result is obtained through close collaboration between CGG's processing and reservoir experts working in parallel to address the reservoir objectives.

Feasibility studies

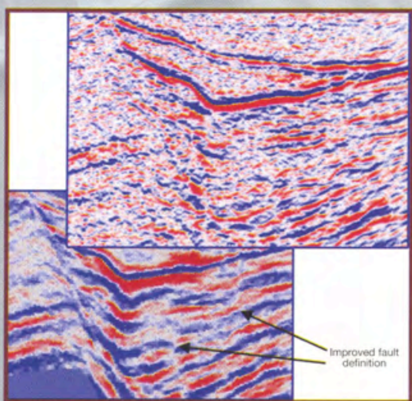
- Analysis and cross-plotting of well data to investigate the relationship between seismic and rock parameters
- Petrophysical modelling
- Fluid substitution modelling and modelling of 4D effects
- Study and documentation of various scenarios (e.g. brine sand, gas sand, etc.)

All these modelling exercises can be complemented with seismic modelling to check the synthetic versus real response.

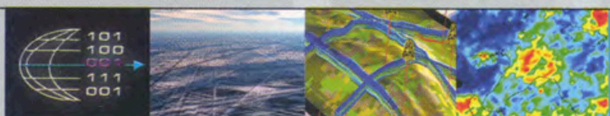




Coloured deconvolution is a quick way to obtain impedance attributes from seismic data through the application of an operator. This operator is derived on a case-by-case basis using seismic and well data. Attributes include: Acoustic Impedance, Elastic Impedance and Vp/Vs ratio. The Vp/Vs ratio is obtained through an innovative and proprietary workflow which includes technologies from 4D processing.

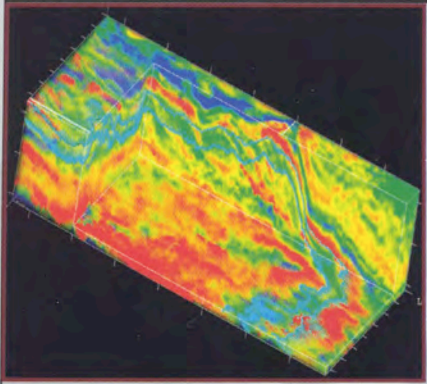


Relative inversion for automated interpretation - The method has the speed and ease required to address large-scale exploration programs as well as renewed exploration in mature basins. The interpretation workflow provides a high-resolution image resolving subtle impedance contrasts and yields a microlayer model from which the conventional interpretation picking can simply be extracted.



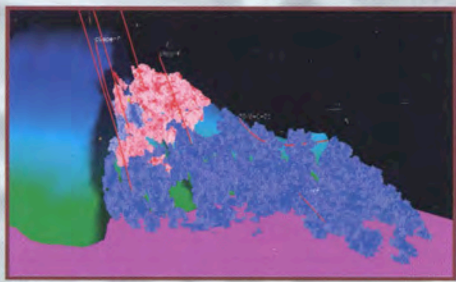
StrataVista

Integrated seismic processing and reservoir characterisation services

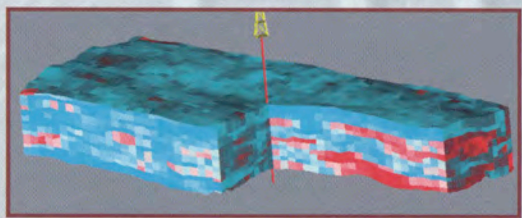


Stratigraphic inversion is a high-end product which gives an estimate of the elastic parameters in a stratigraphic (layer-based) framework for both exploration and production environments. The parameters that can be estimated include: P and S Impedance, Vp/Vs, Poisson's ratio, Lambda*Rho, Lambda*Mu. The quality of the input seismic is of the greatest importance and processing is optimised to preserve amplitude, attenuate multiples, avoid residual moveout and wavelet (resolution) variation with offset, and to enhance S/N ratio.

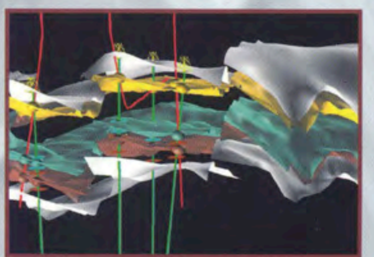
4D stratigraphic inversion and interpretation estimates the change in elastic parameters due to production. In the interpretation step, these changes can be analysed and related to pore pressure and saturation changes using a petrophysical model. The layer-based approach allows us to optimally constrain the 4D change within the reservoir interval.



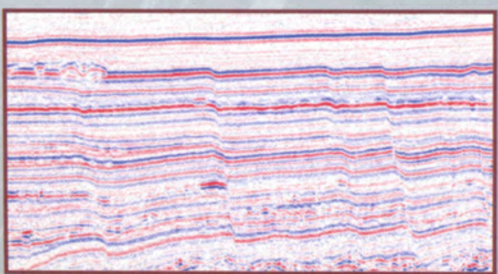
Modelling of reservoir parameters takes the stratigraphic inversion result one step further. The stratigraphic inversion result is first calibrated to wells using a proprietary geostatistical technique. In a next step, rock parameter(s) are modelled using a statistical relationship between elastic and rock parameters. This relationship is established at seismic resolution by analysis of well data.



Depthing. Seismic and reservoir parameters can be converted from time to depth using well data and CGG's proprietary HD Seismic Velocity cube. The velocity cube is based on dense (25m x 25m) and automatic velocity picking combined with powerful geostatistical filtering techniques to obtain seismic interval velocities.



GeoHazard processing and interpretation.



Standard seismic data is taken through an optimized processing flow in order to enhance resolution in the very shallow part. This is followed by stratigraphic inversion, attribute analysis and seismic interpretation in order to identify possible drilling hazards. Results are documented in a report.

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