GTC 2015 - S5329
How Schlumberger Leverages NVIDIA GPUs using the Open Inventor® toolkit

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Agenda

- Data acquistion

  → What is ‘seismic data’?

- Visualization

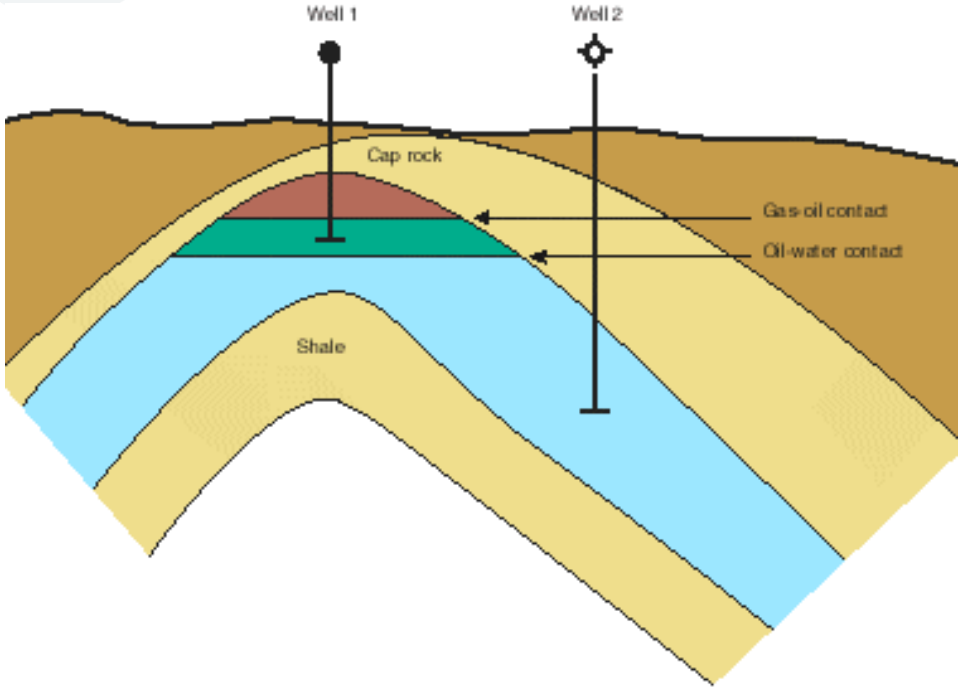
  → How do we use the GPU?

- Use of the technology

  → What do end-users do with it?

Data acquisition

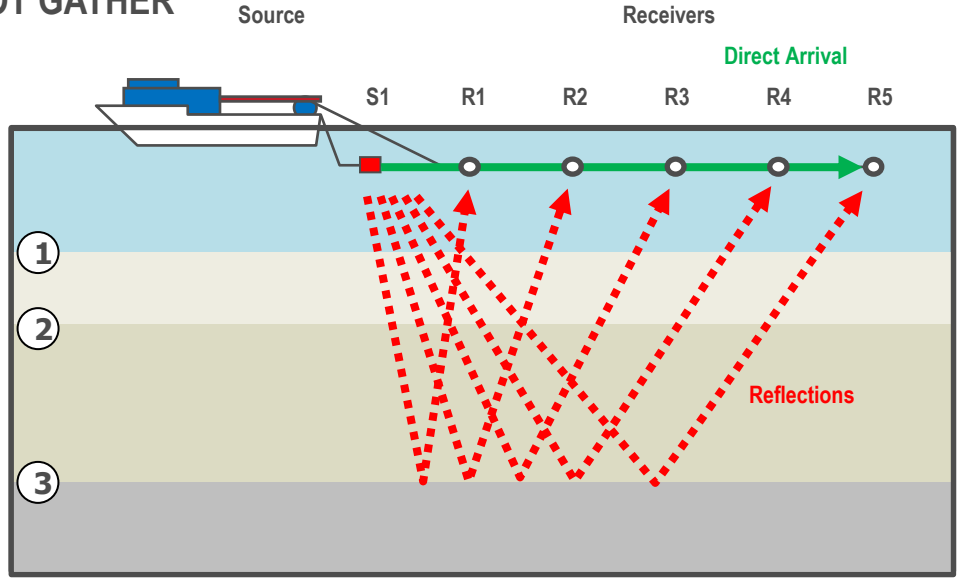
Oil Exploration



- Locate reservoir
- Understand structure
- Big $$$

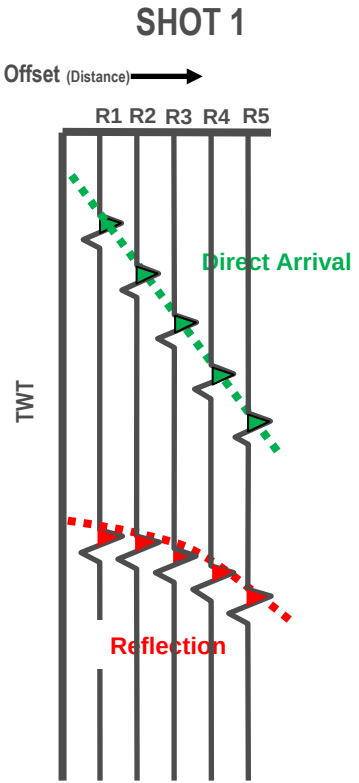
Acquisition (1)

SEISMIC – SHOT GATHER

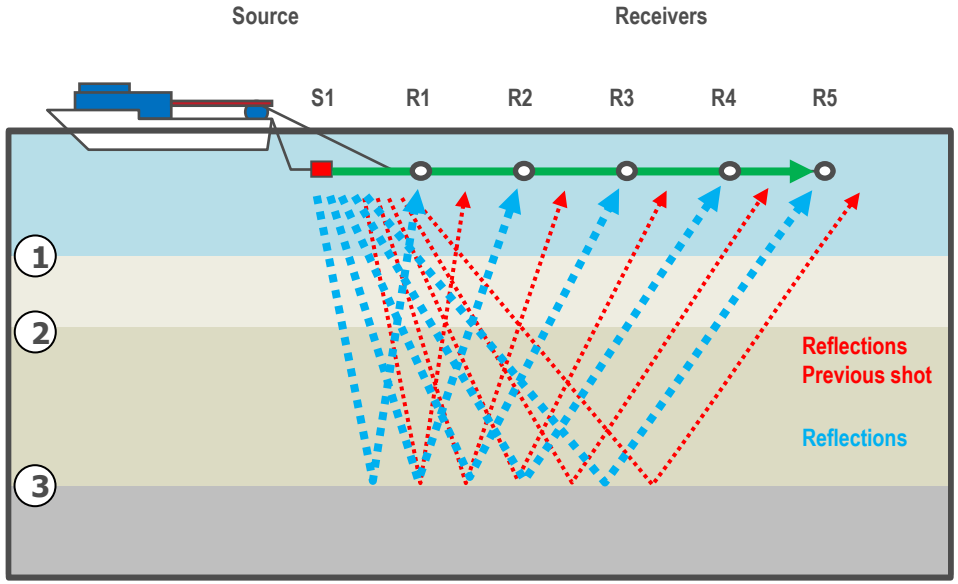


For each shot, reflections are recorded in 5 receivers

There are 5 'bounce' points along interface 3

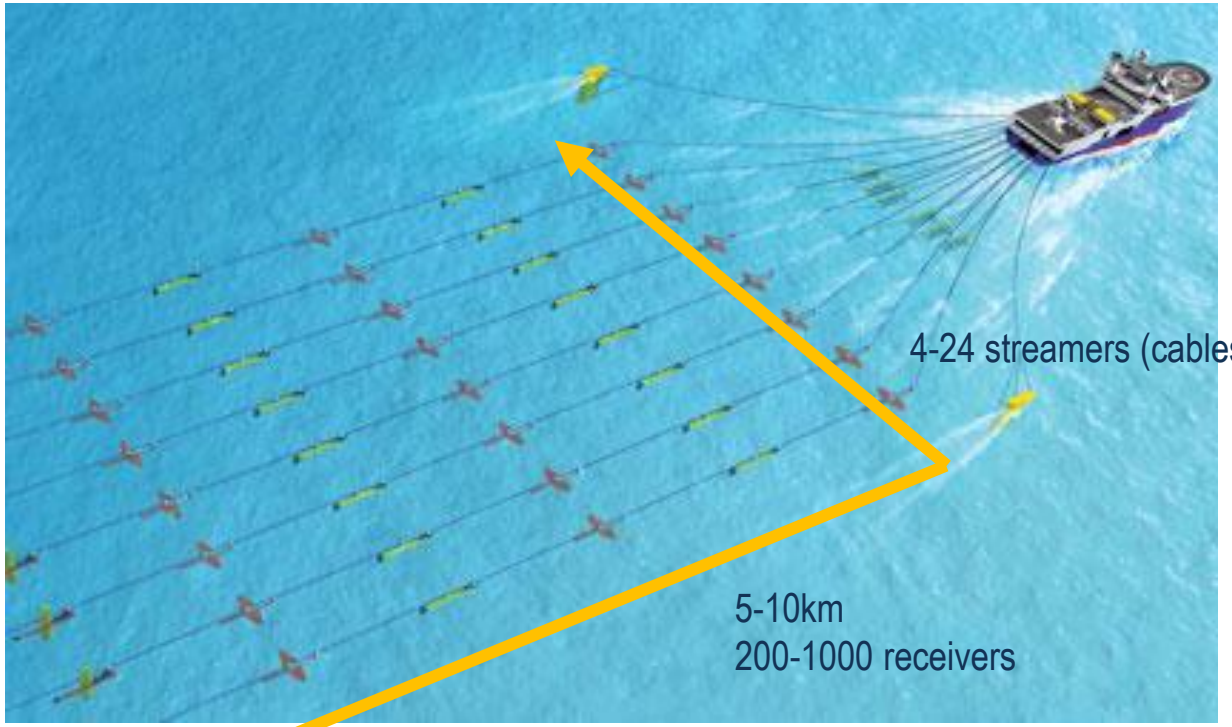


Acquisition (2)

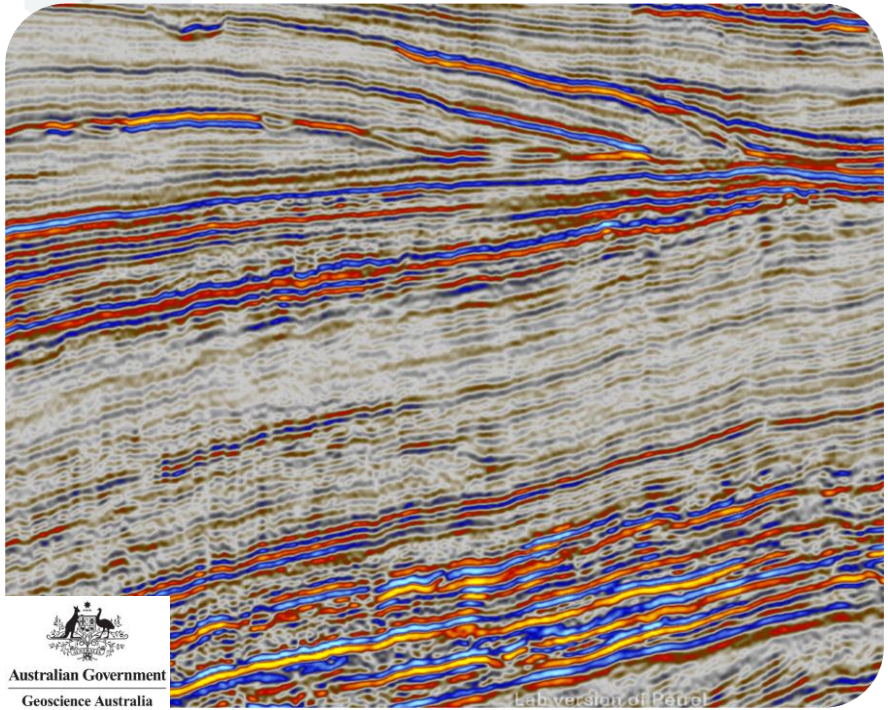


Source is moved
Same point in underground «illuminated»
from different direction

Acquisition in the real world



Seismic reflections vs real rock



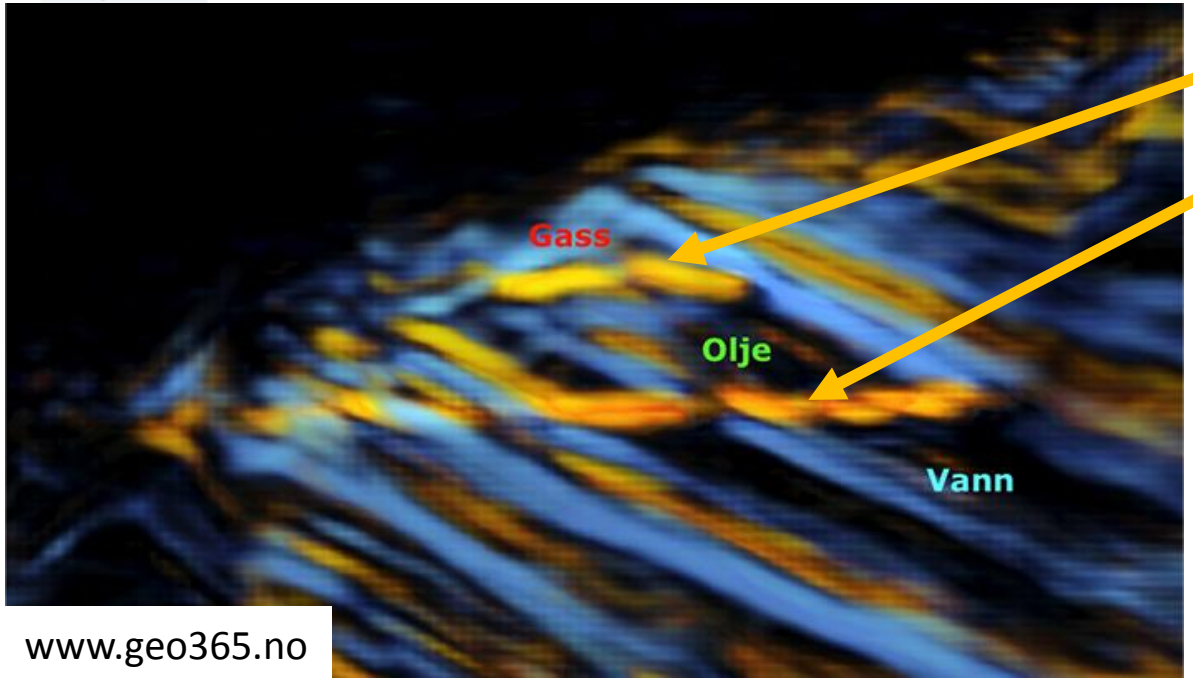
Australian Government
Geoscience Australia

Explore. Discover. Resolve.

Schlumberger

FEI™

Sedimentary and Oil/Water Contact

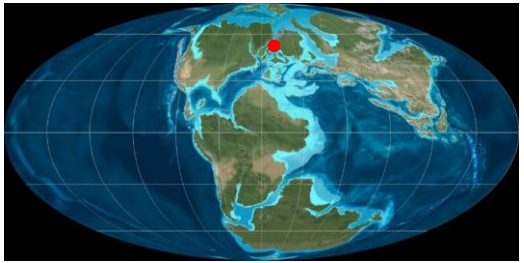


www.geo365.no

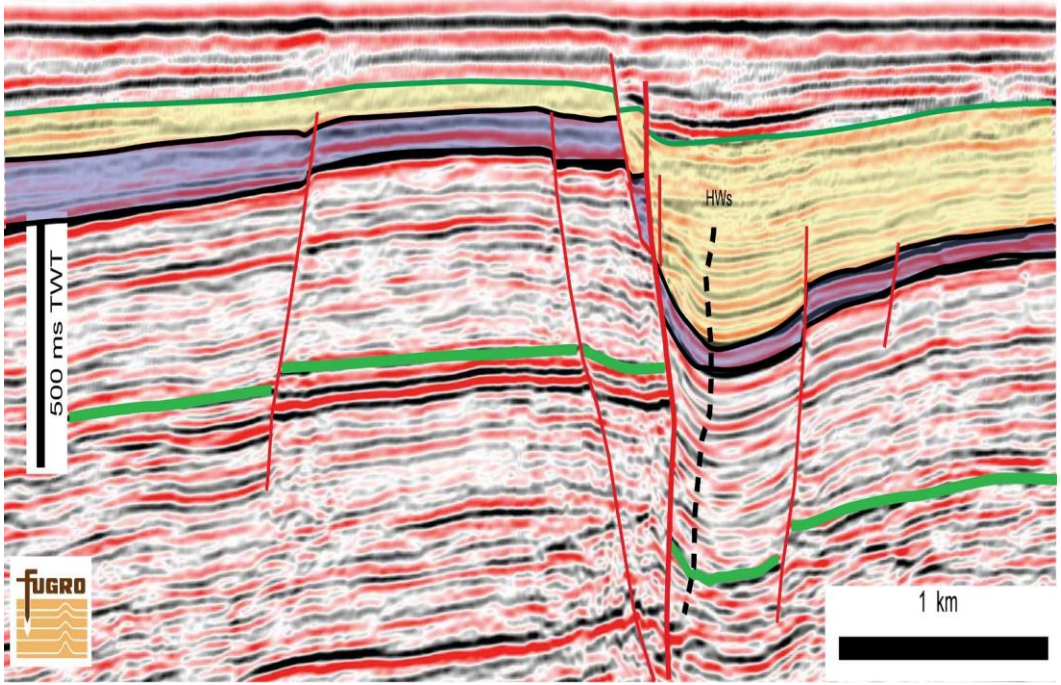
Gas/Oil contact

Oil/Water contact

1700m depth (ca 1 mile)
Jurassic period, ca 150-200My

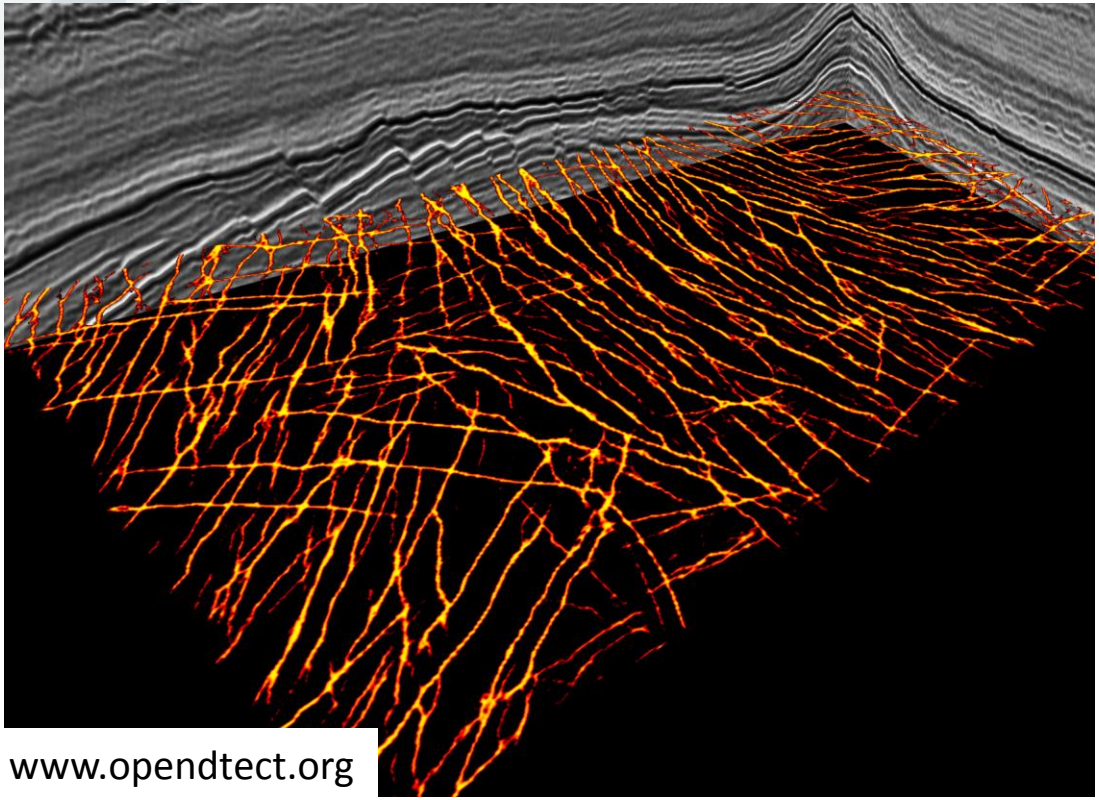


Faulting



San Andreas fault, California

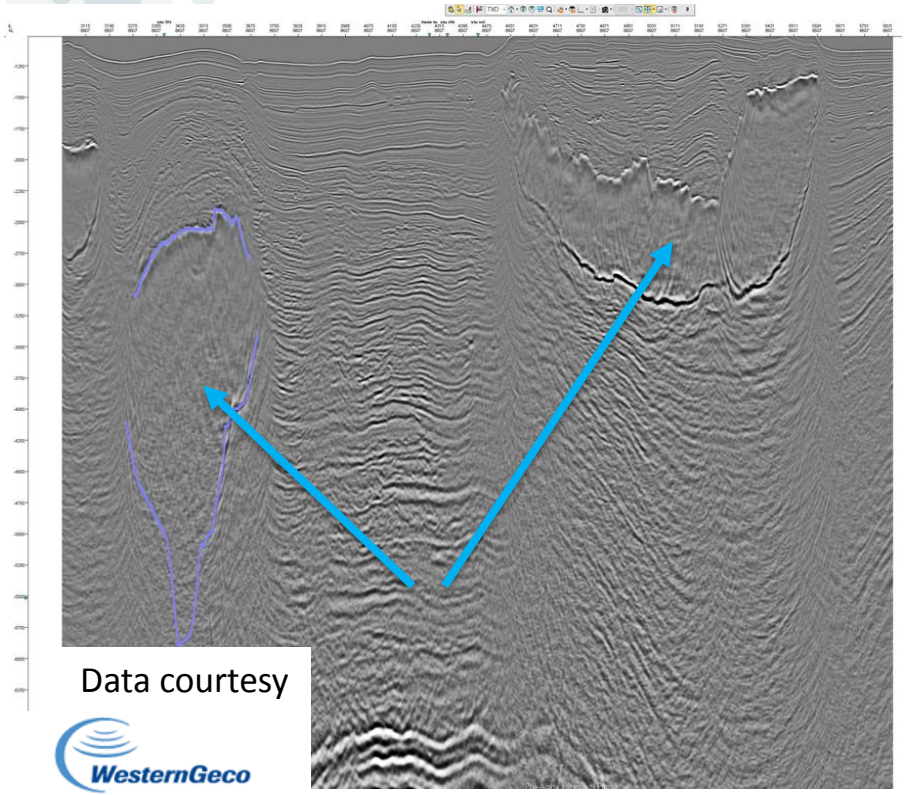
Example complex fault system



www.opendtect.org

- Drilling hazards
- Avoid reservoir leakage
- Drill through fractures for optimal draining

Salt example

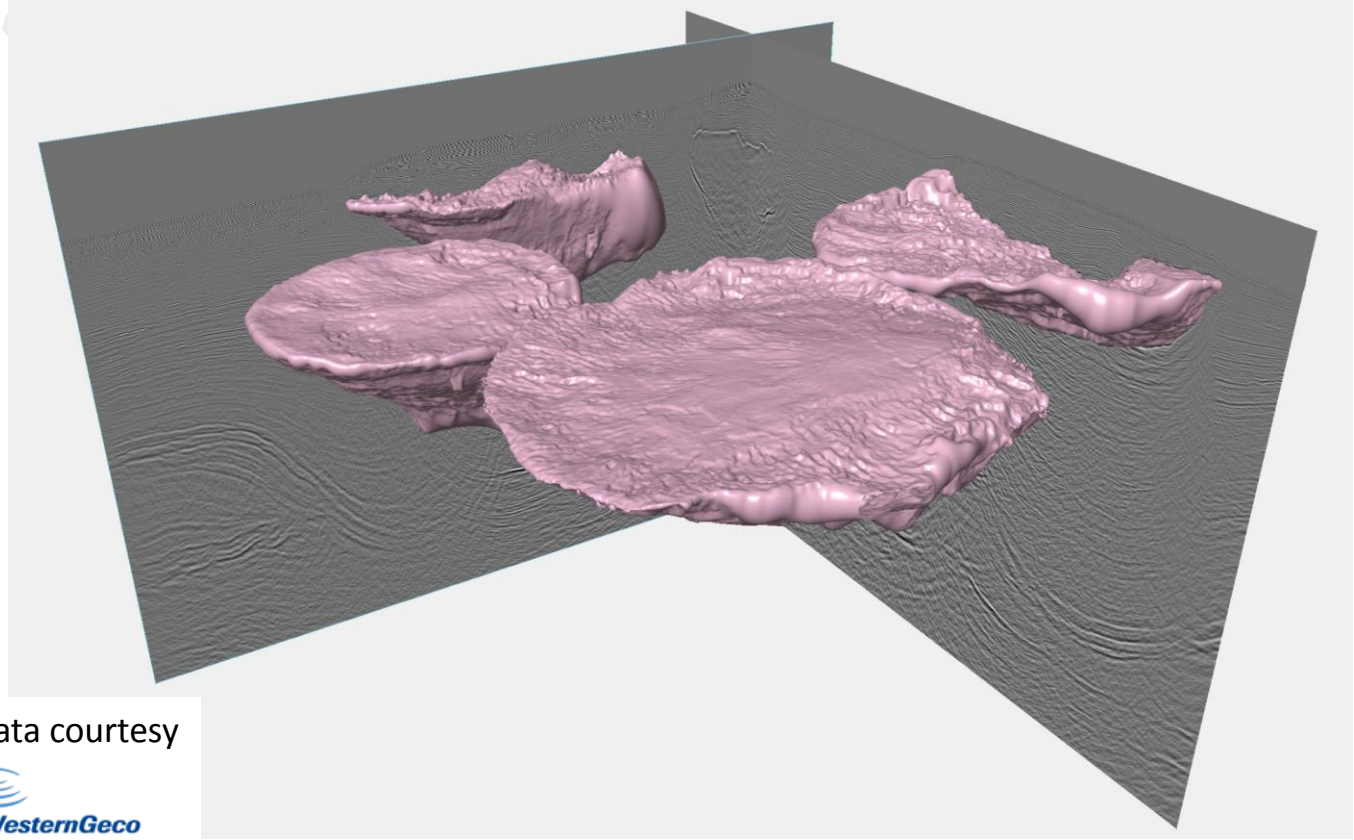


Data courtesy

WesternGeco

Zagros Mountains, Fars province, Iran

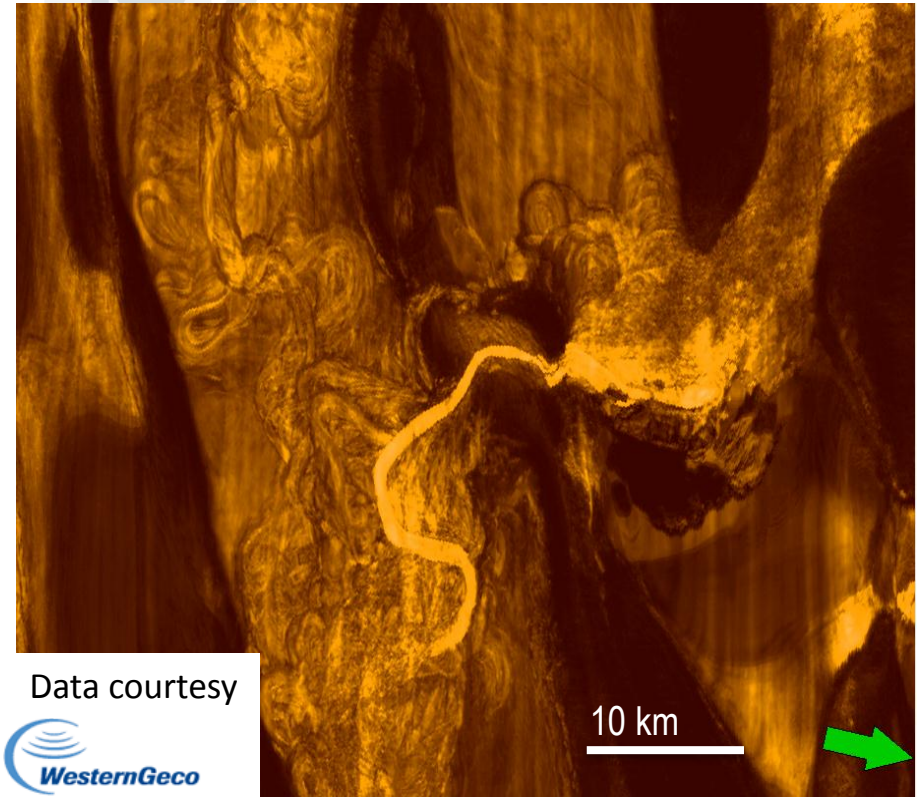
Salt bodies



Data courtesy

WesternGeco

Meandering river



Data courtesy

WesternGeco

Rio Negro, Argentina

High Quality Acquistion

Data courtesy

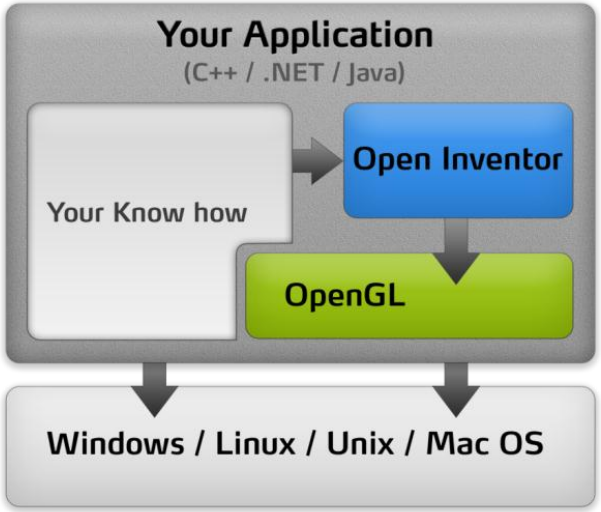
THOMBO petroleum

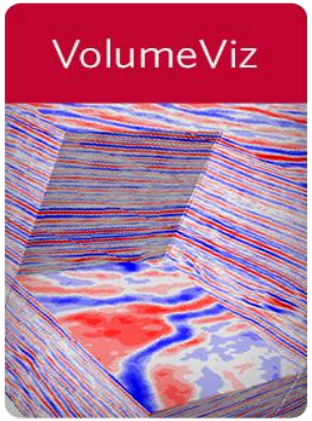
Visualization

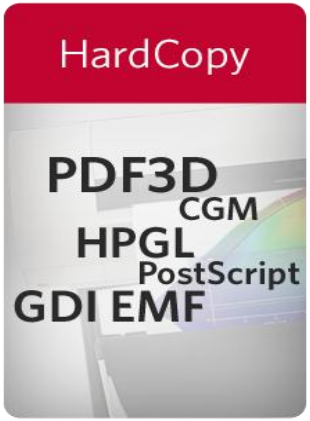
Open Inventor® + Extensions

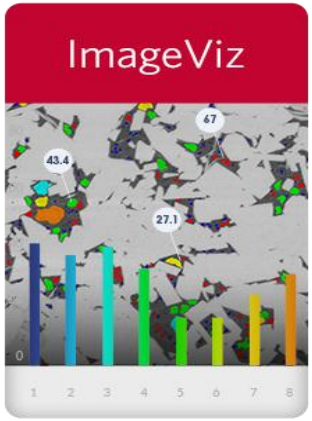
Much more than just a 3D geometry toolkit!

Open Inventor extensions provide powerful tools for specific data types (mesh, volume, image) as well as cloud rendering and publication.







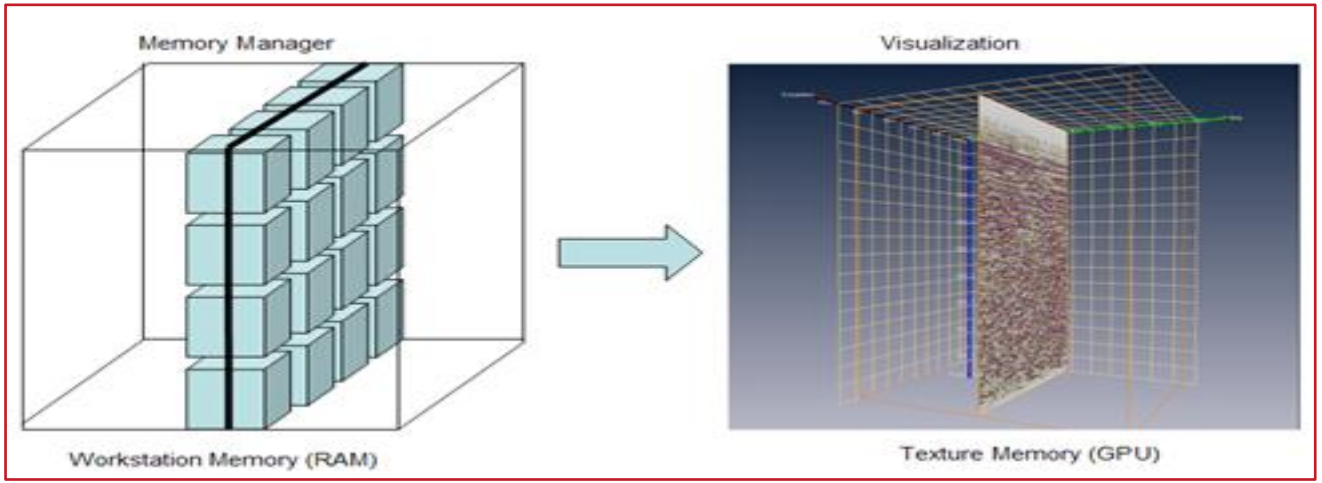


Open Inventor / VolumeViz Technology

- **Large data management**
  - Scaleable performance (just add hardware)
  - Interactive with 200+ GB data sets on your desktop
- **High quality rendering**
  - Direct volume rendering using ray-casting on GPU
  - Lighting/rendering effects, clipping, co-blending, …
- **Extensible shader framework**
  - Override specific shader functions in render pipeline
  - Virtual volume available to shader functions on GPU

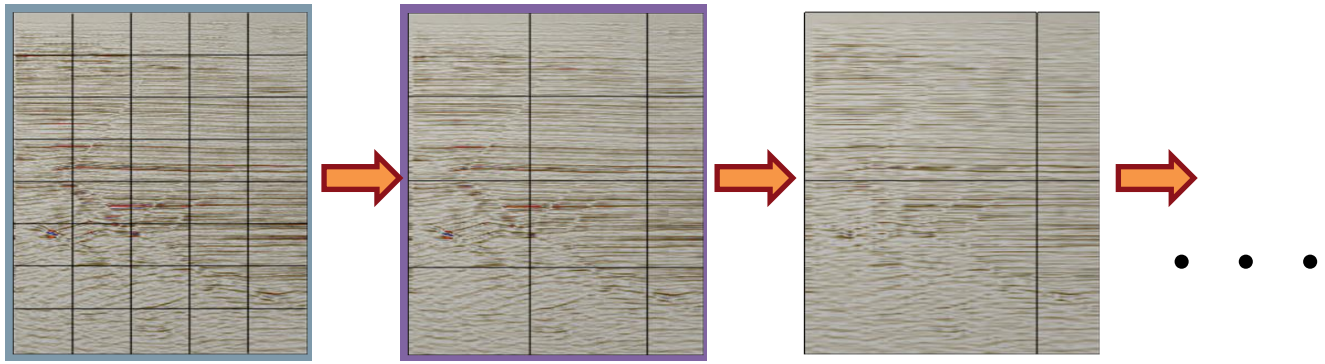
Manage data 1: Divide and conquer

- **Divide volume into “tiles”**
  - Allows “random access” to data
  - Load only what you need (by ROI, primitive, clipping, …)
  - Keep tile meta-data (min/max, has uniform value, …)

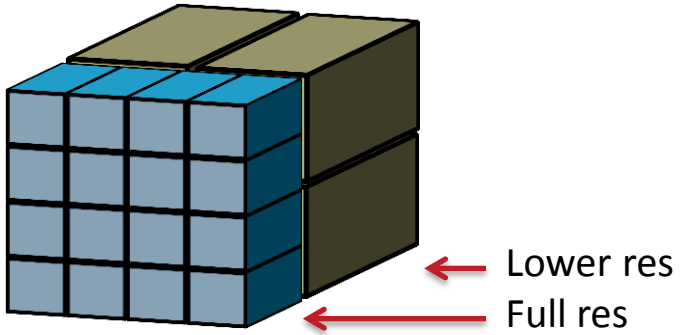


Manage data 2: Multi-resolution

- **Create an octree-like hierarchy of resolutions**
  - Level N □ Level N+1: 1/8 number of tiles

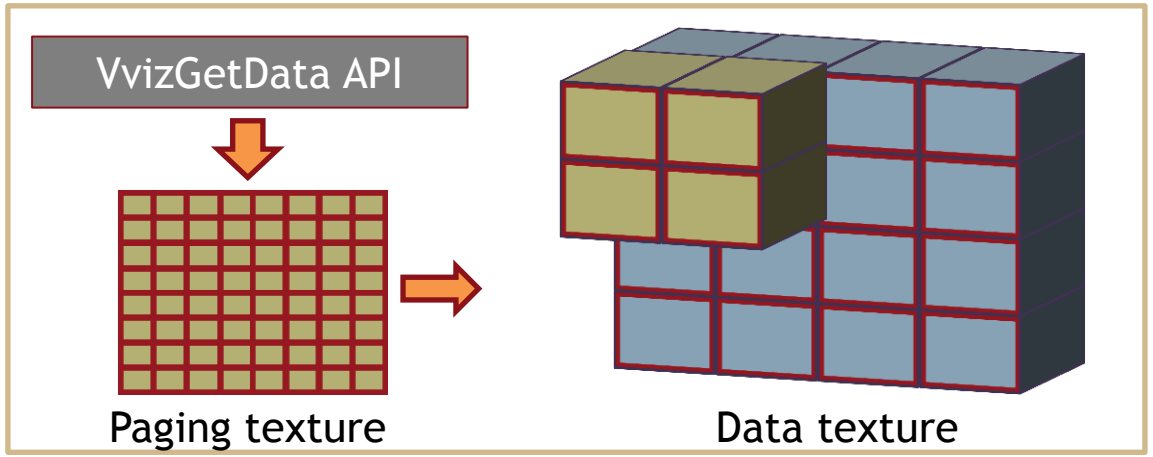


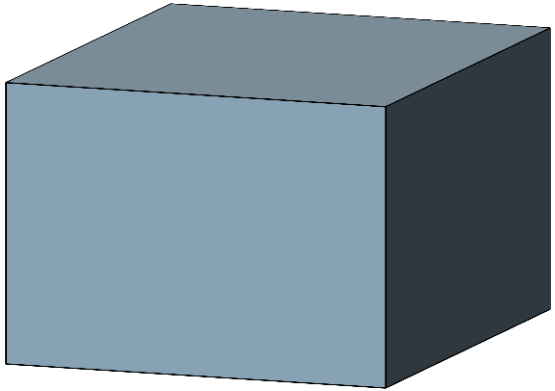
- **Choose "best" set of tiles to represent volume in available/allowed memory**
  - By assigned priority
  - By distance from camera
  - By ratio of voxels to pixels (etc)



Manage data 3: “Virtual volume” on GPU

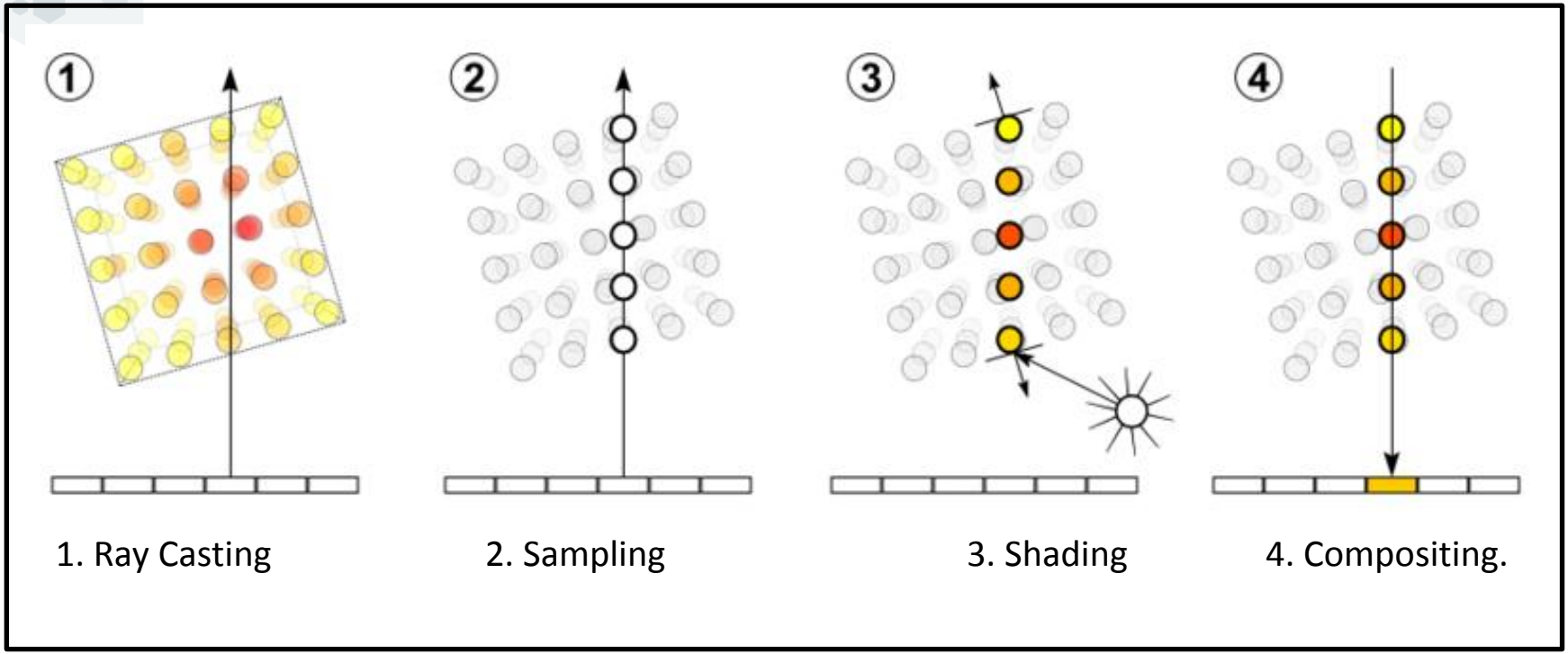
- **Physical: Actual data tiles packed into data texture**
- **Virtual : Shaders always see a complete volume (0..1)**
  - Rendering: access neighbor voxels for blending, gradient, . . .
  - Computing: access any voxel in volume, e.g. along trace
  - No need for overlapping tiles





Shader’s view of volume
(uniform & continuous)

Direct Volume Rendering using Ray Casting

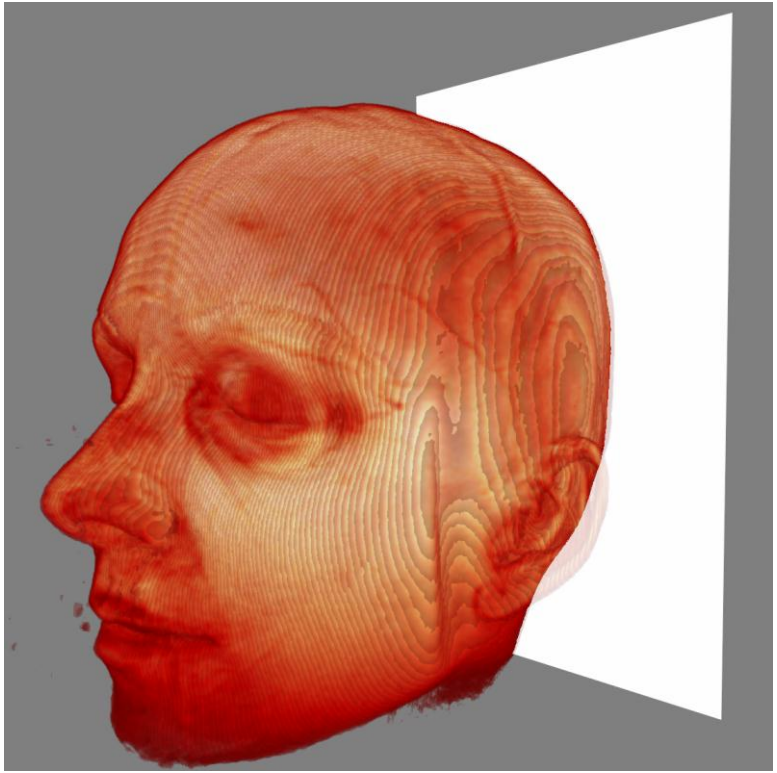


Source: Wikipedia

Open Inventor – Evolution of Volume Rendering

Open Inventor 7.x
(2000's)

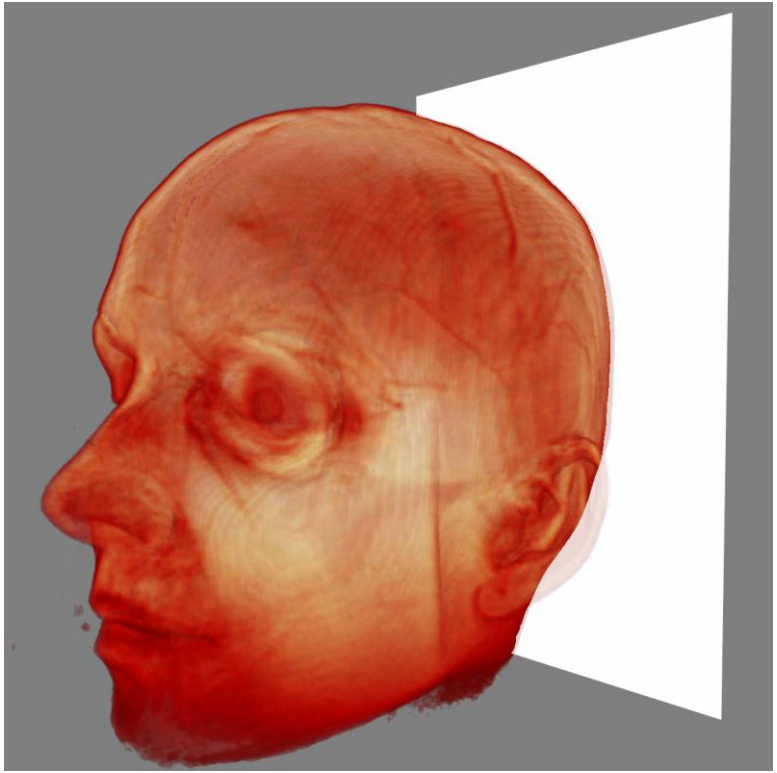
- Slice based
- Data aligned slices



Open Inventor – Evolution of Volume Rendering

Open Inventor 8.x
(2000's)

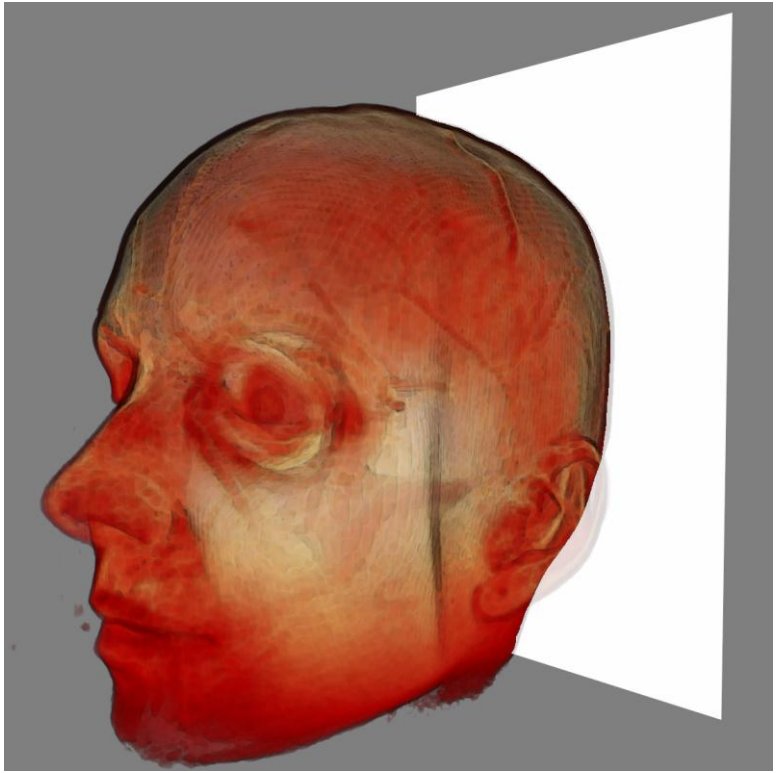
- Slice based
- Camera aligned slices
- Pre-integration



Open Inventor – Evolution of Volume Rendering

Open Inventor 8.x
(2000's)

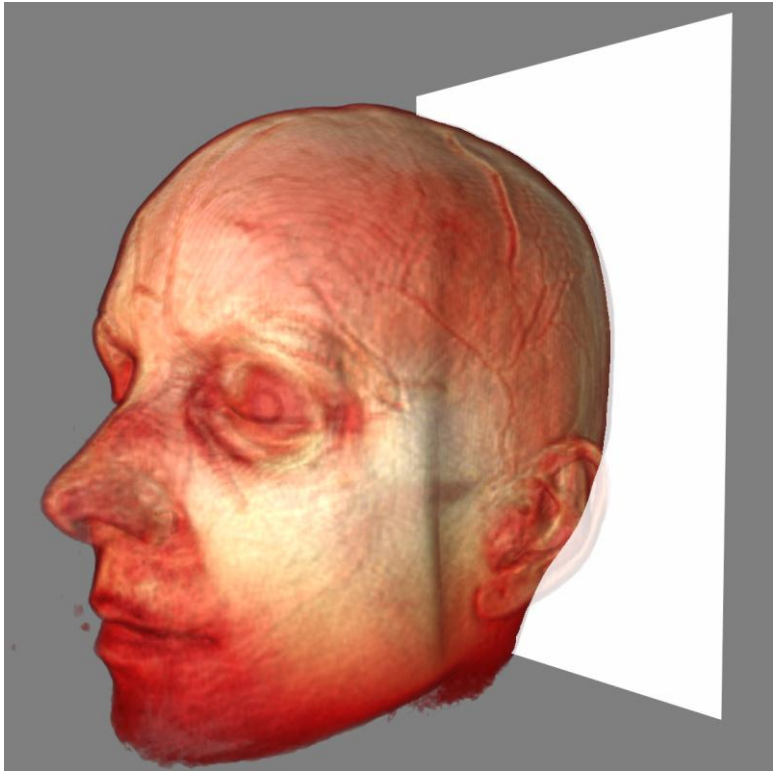
- Slice based
- Camera aligned slices
- Pre-integration
- Edge 2D detection
- Edge Colouring



Open Inventor – Evolution of Volume Rendering

Open Inventor 8.x
(2000's)

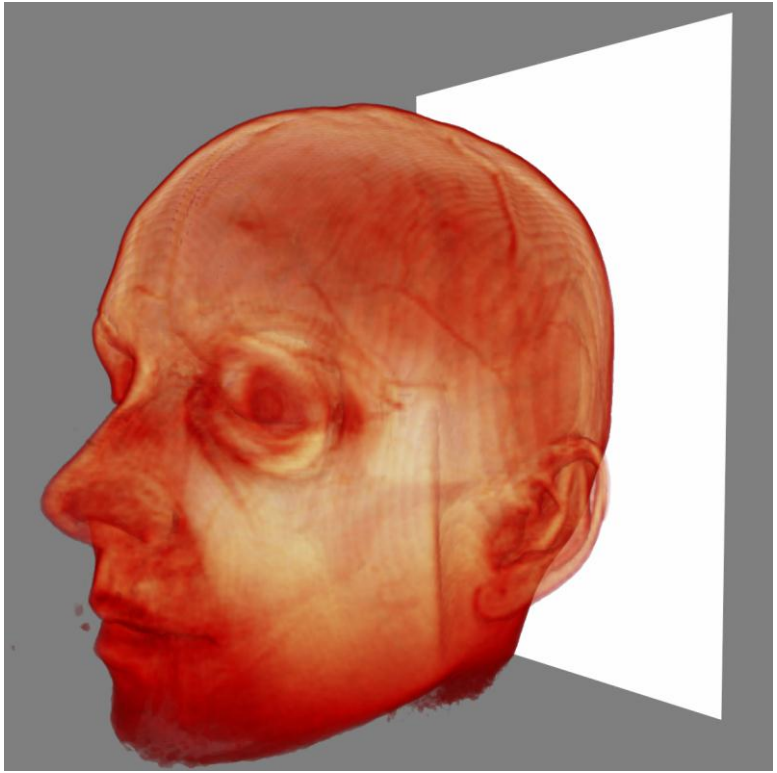
- Slice based
- Camera aligned slices
- Pre-integration
- Lighting



Open Inventor – Evolution of Volume Rendering

Open Inventor 9.x
(2010's)

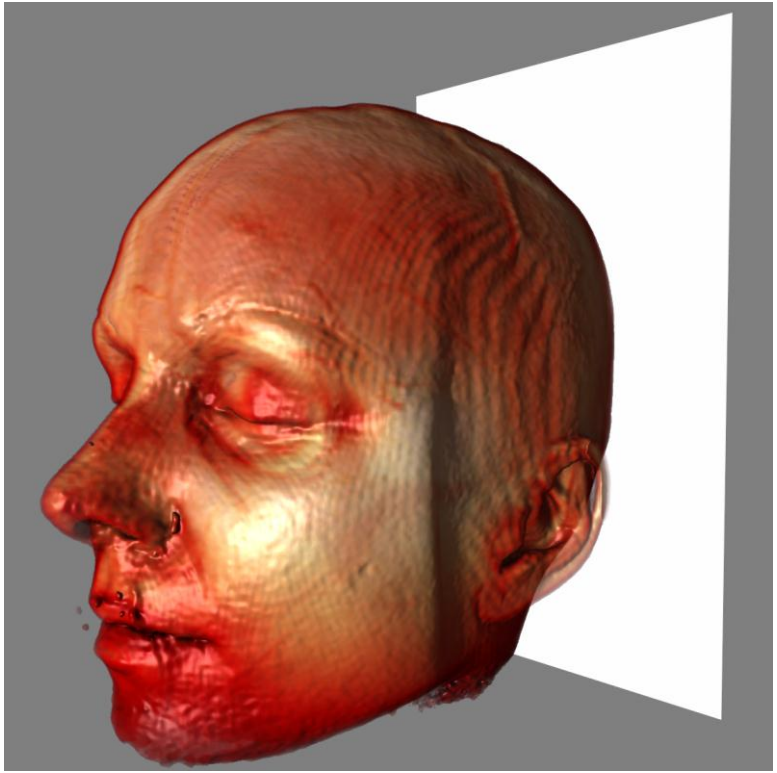
- Ray-Casting!
- Pre-integration



Open Inventor – Evolution of Volume Rendering

Open Inventor 9.x
(2010's)

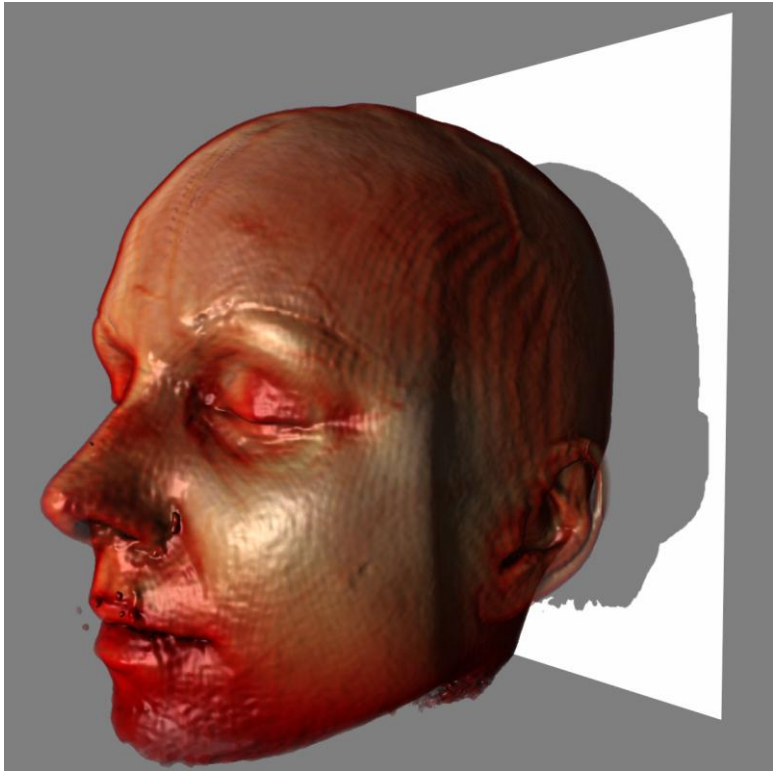
- Ray-Casting
- Pre-integration
- Smooth Boundary
- Deferred Lighting
- Ambient Occlusion



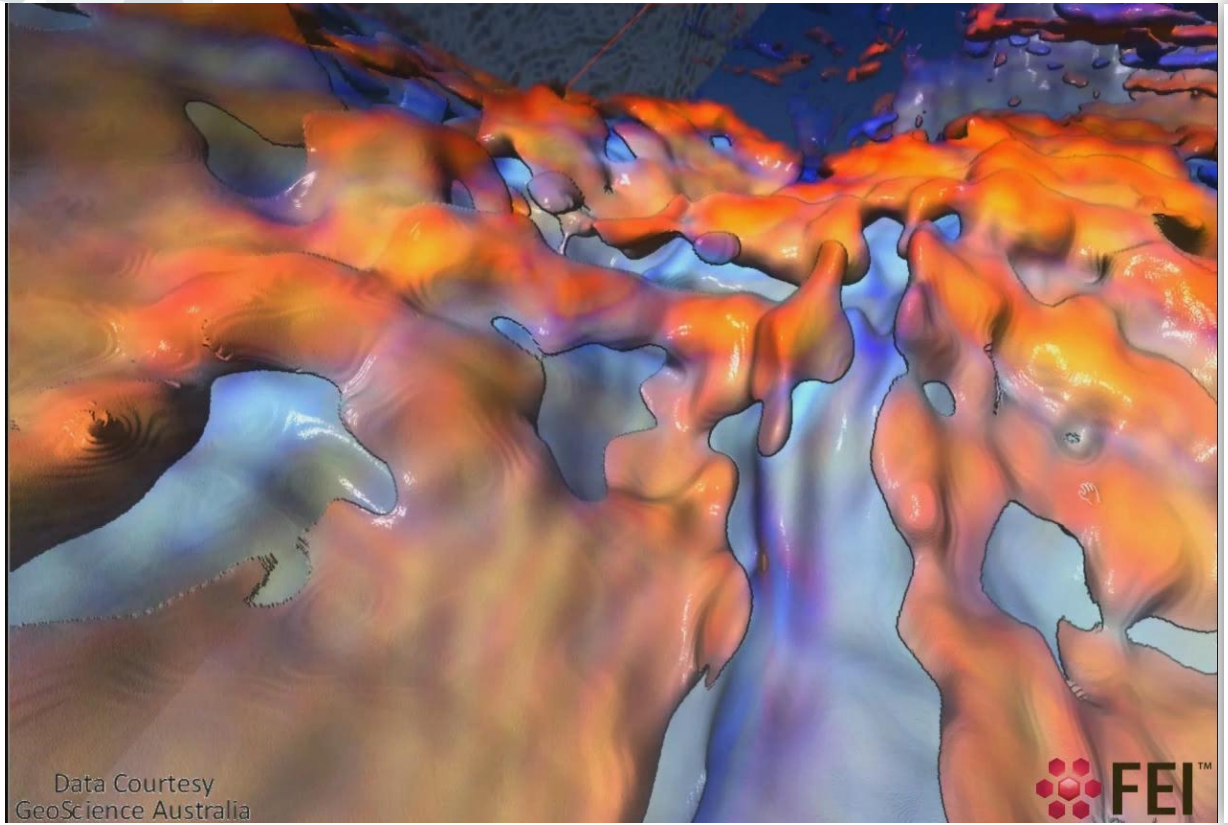
Open Inventor – Evolution of Volume Rendering

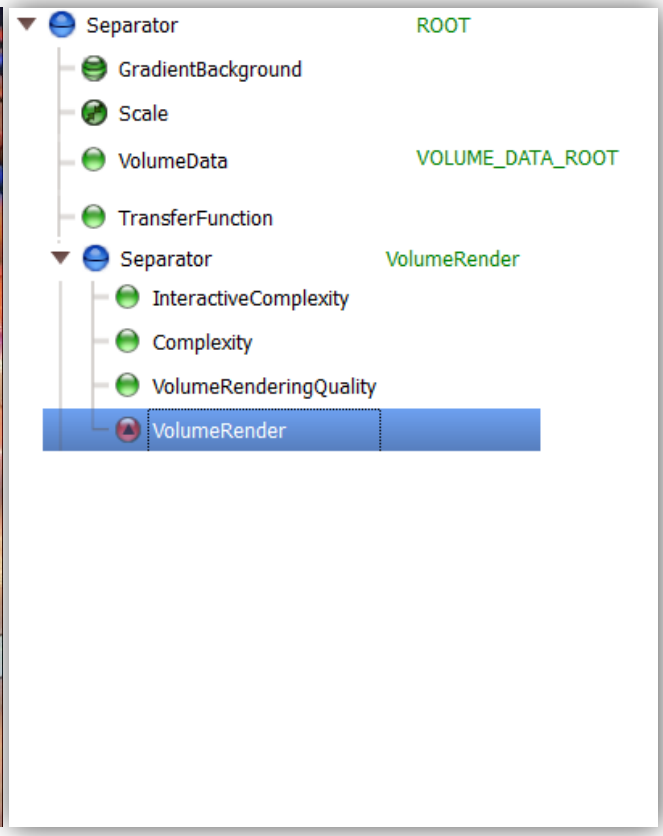
Open Inventor 9.x
(2010's)

- Ray-Casting
- Pre-integration
- Smooth Boundary
- Deferred Lighting
- Ambient Occlusion
- Shadow Casting

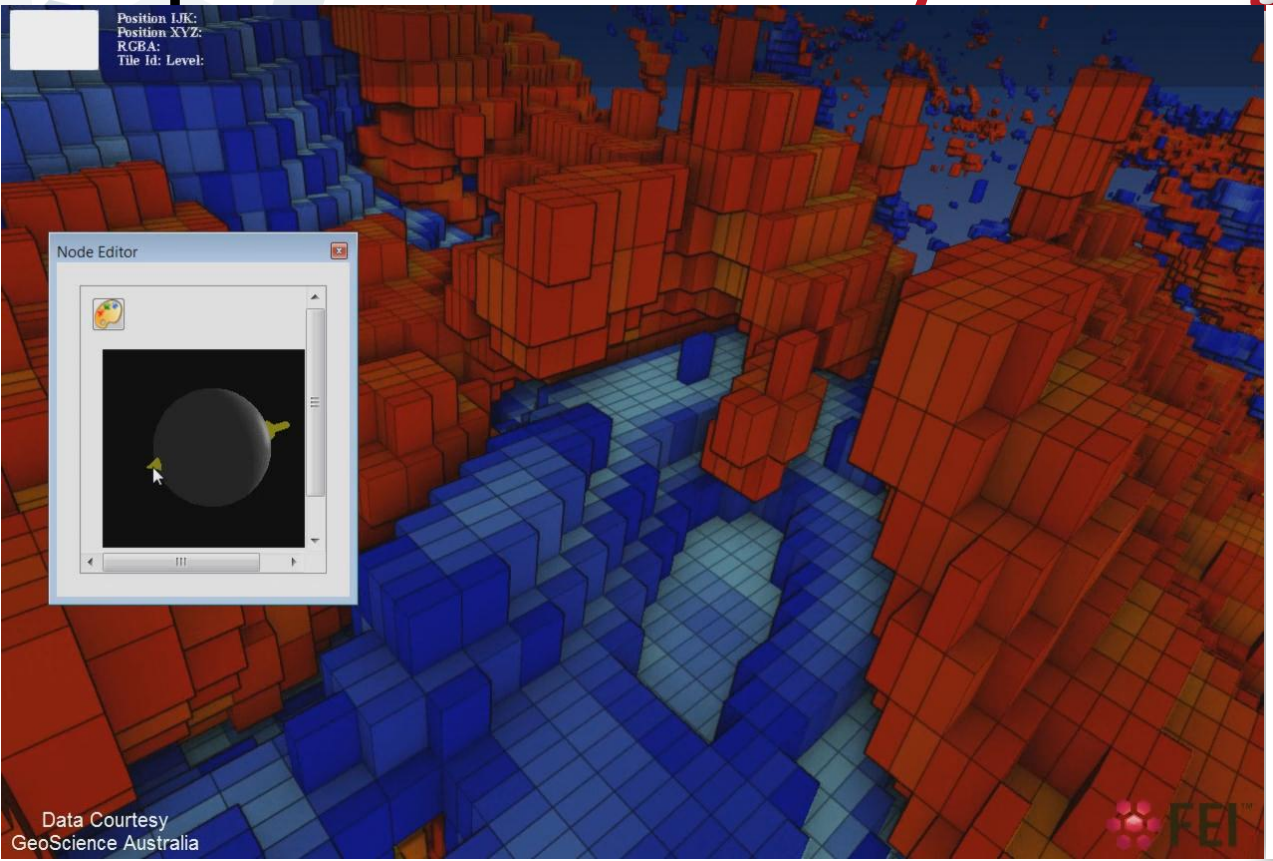


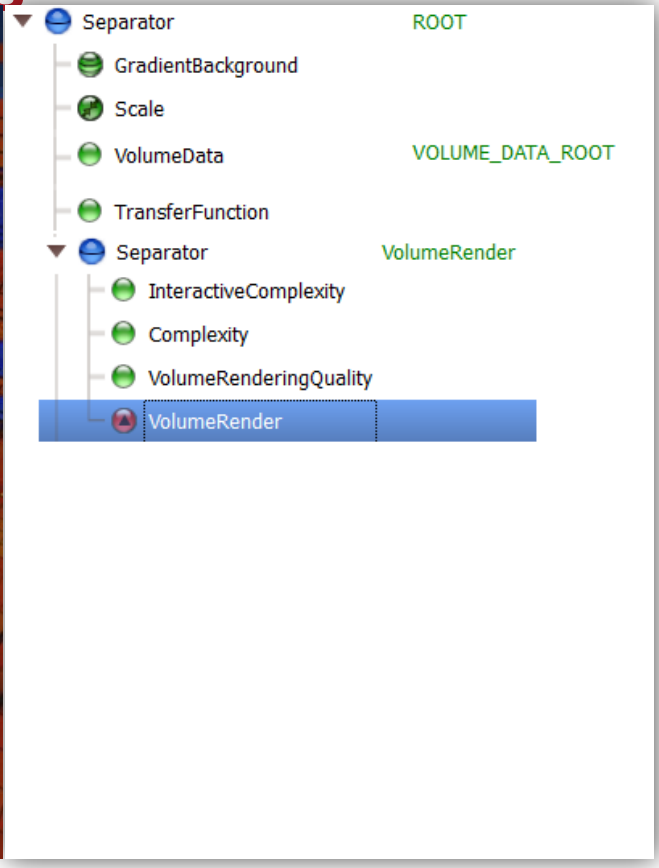
Open Inventor – Ray Casting Rendering



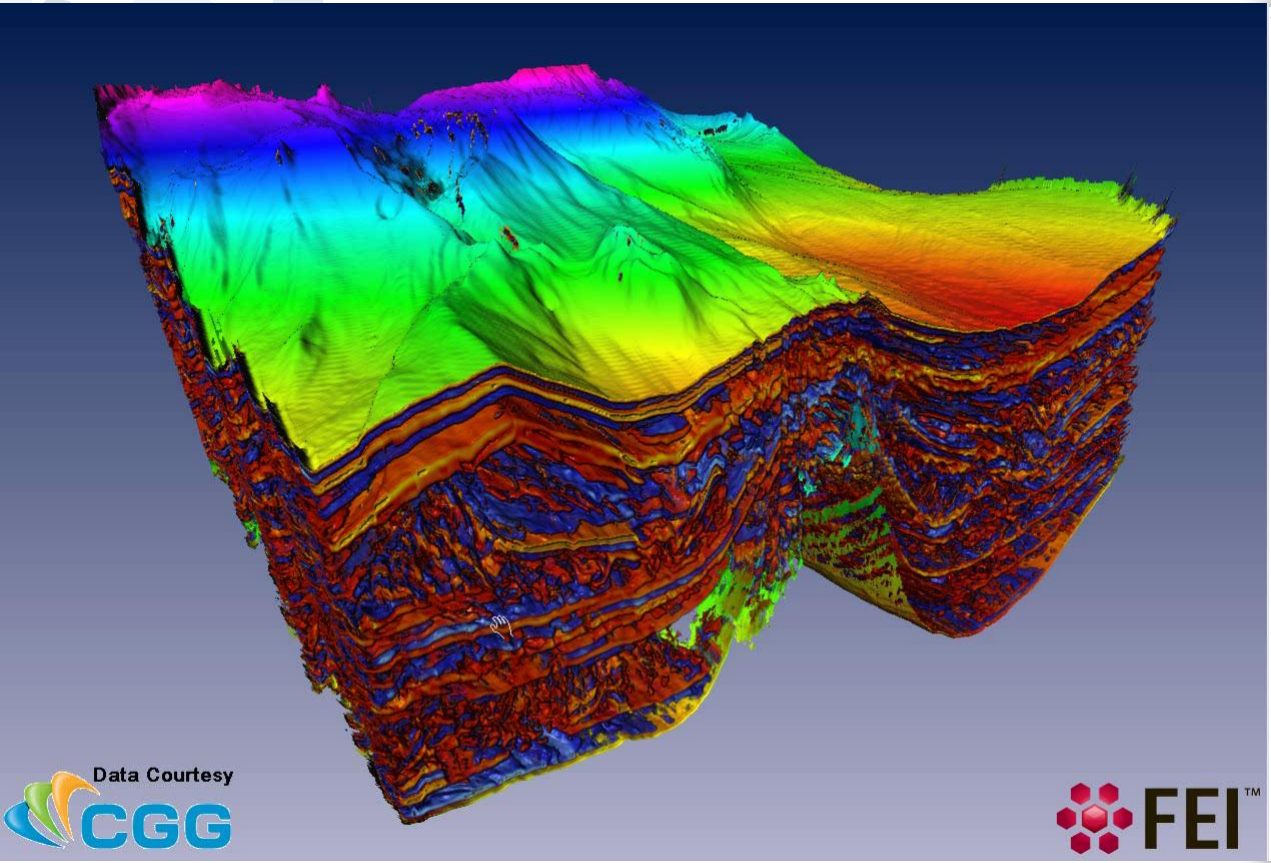


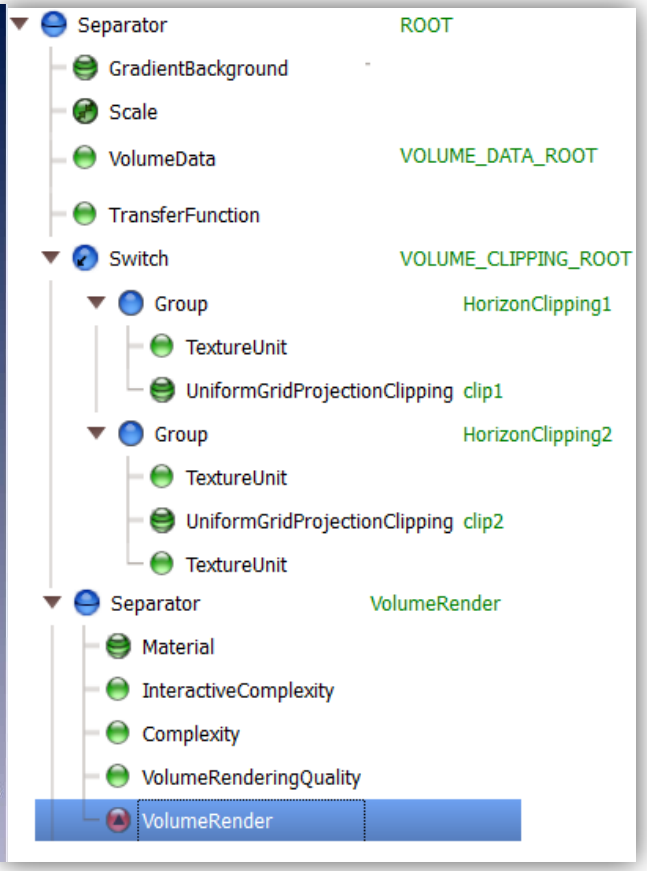
Open Inventor – Geobody Rendering



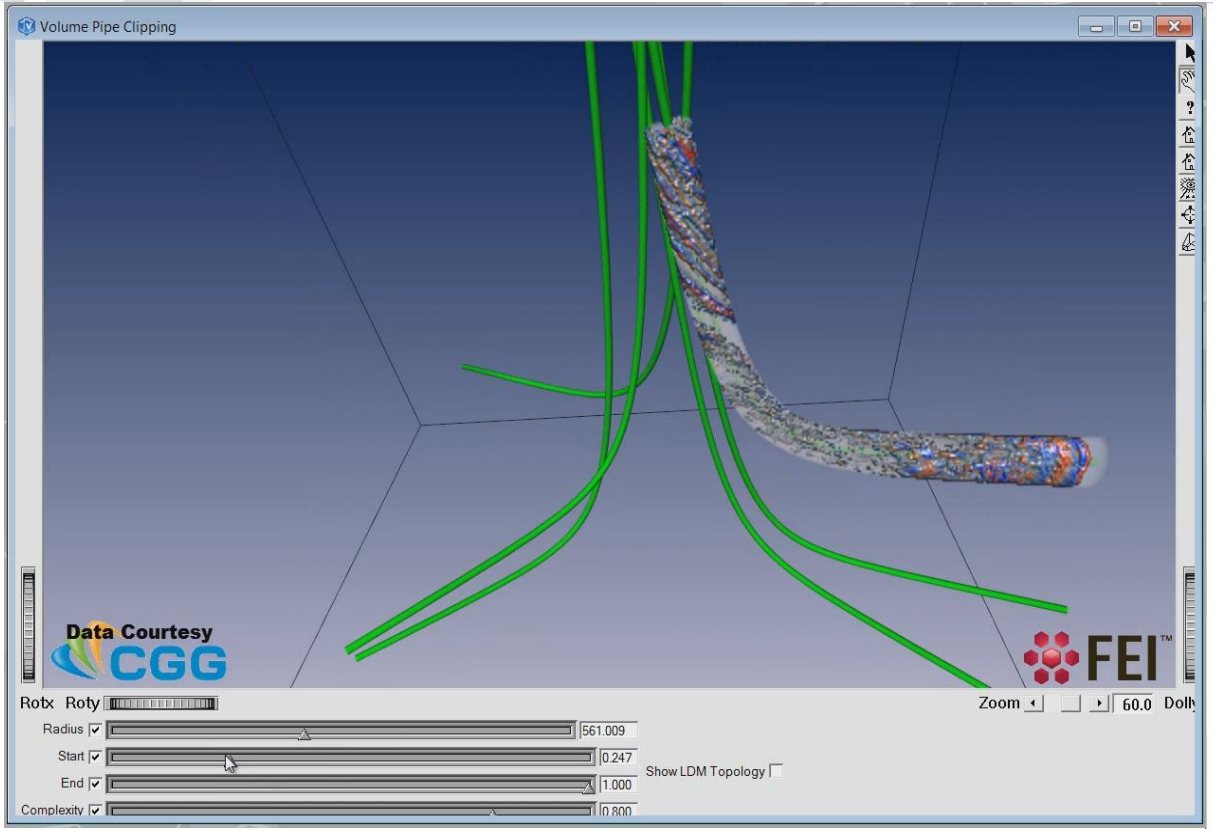


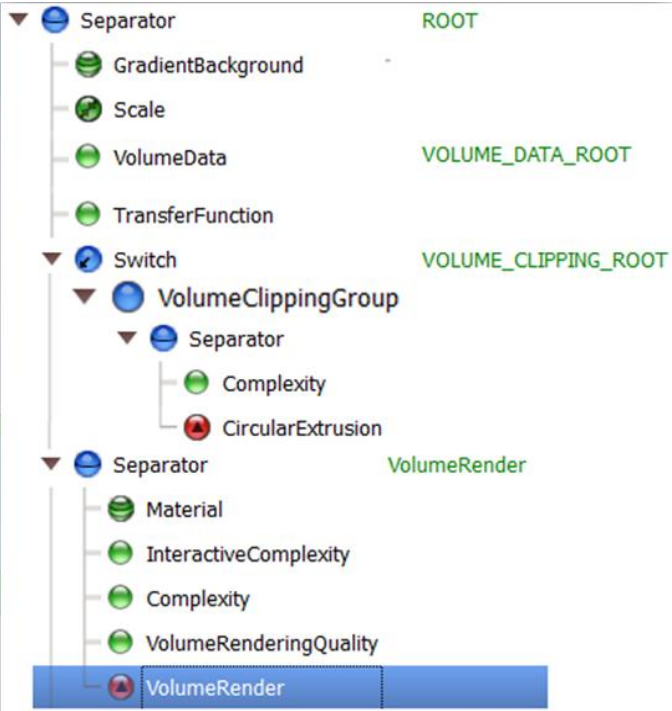
Open Inventor – Clipping by Horizons



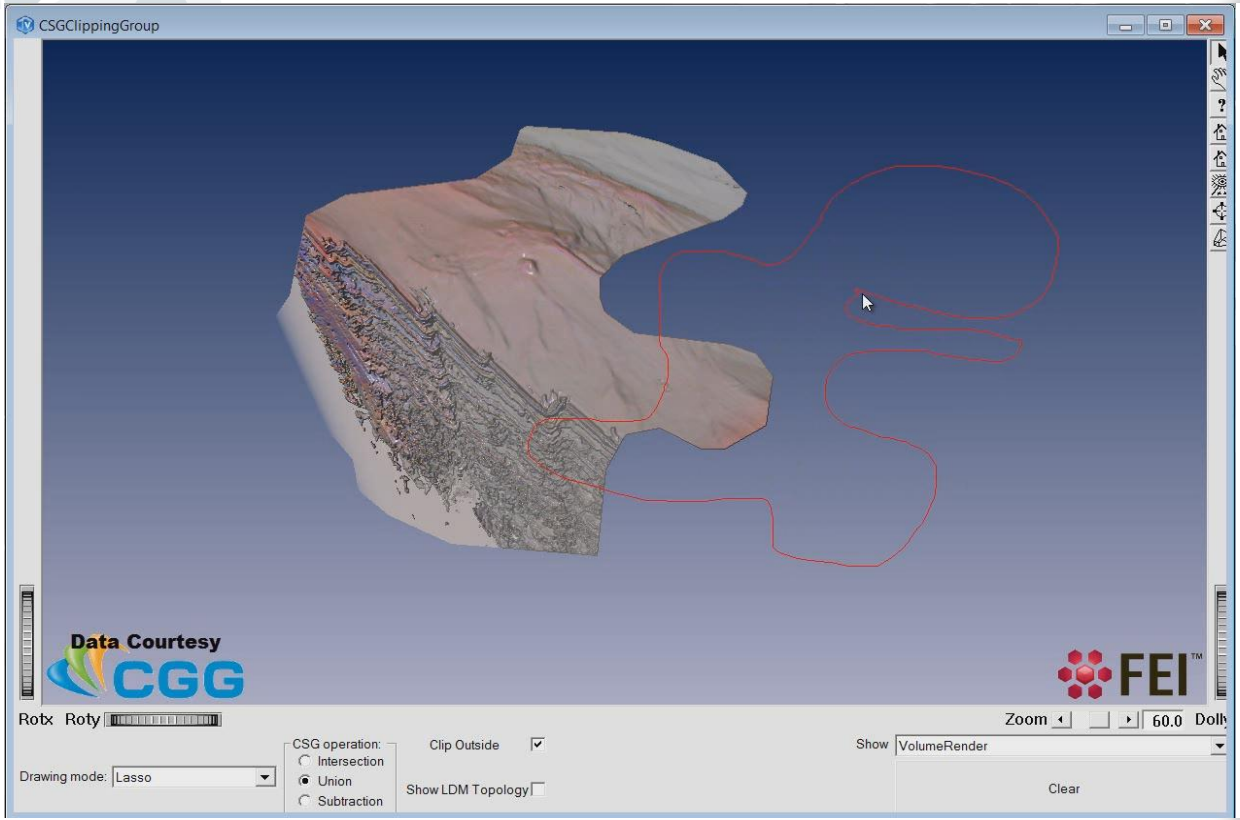


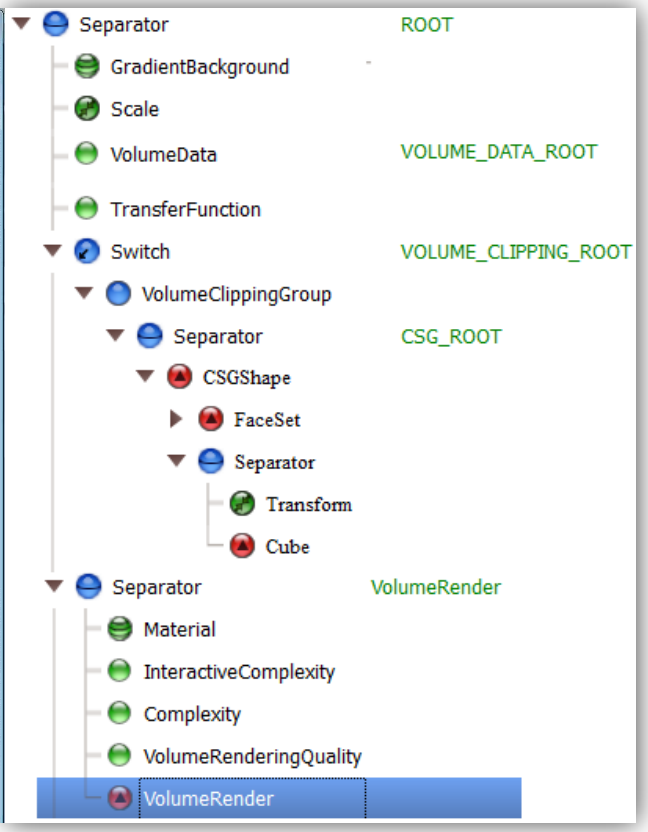
Open Inventor – Clipping by Well Path



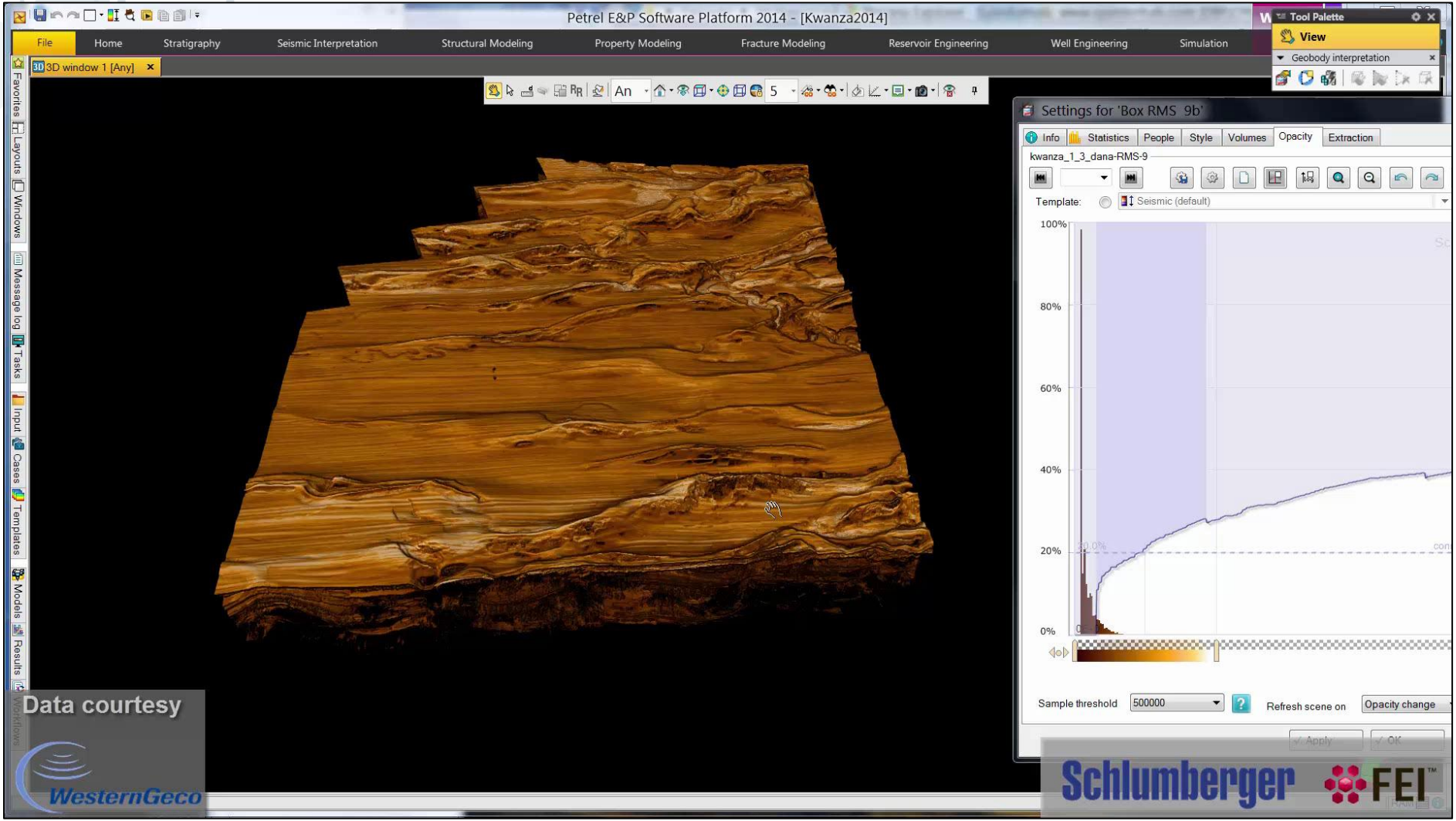


Open Inventor – Clipping by CSG Boolean Operation





Using the technology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Seismic Interpretation
Structural Modeling
Property Modeling
Fracture Modeling
Reservoir Engineering
Well Engineering
Simulation
3D window 1 [Any]
Tool Palette
View
Geobody interpretation
Settings for 'Box RMS 9b'
Info
Statistics
People
Style
Volumes
Opacity
Extraction
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100%
80%
60%
40%
20%
0%
Sample threshold
500000
Refresh scene on
Opacity change
Apply
OK
Favorites
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Layouts
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Data courtesy
WesternGeco
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FEI

Closing remarks

- Visualization is key in oil & gas exploration.
- Using a standard 3rd party graphics toolkit is effective.
- Volume visualizing large datasets possible on desktop
  - Level of detail is essential for scalability
  - Scalable performance (interactive with 220 GVoxel volume)
- GPUs continue to improve interactivity and display quality
  - These examples shown on a K6000 with 25 GVoxel volumes.
  - K6000 is approximately 2x faster than K5000 with same software.

Acknowledgements:

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Federico Gamba, FEI Visualization Sciences Group

Thank you for attending!

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