IESE
Institute of
Earth Science
and Engineering
Aotearoa

CITR, Department of Computer Science,
University of Auckland, October 2011

Visualizing 3D Geophysical Data

Scientific Data Visualization

John Rugis

Outline

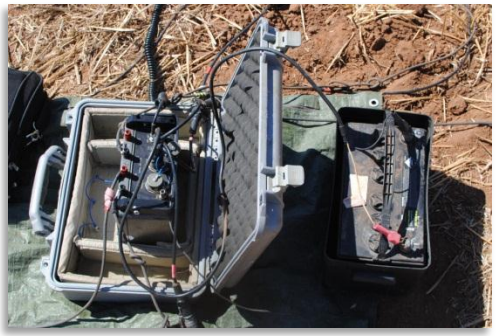
- Overall Theme: *3D graphics visualization used to leverage the power of the human visual pattern recognition system*
- Geophysical field data collection and processing
- Visualization results
- Discussion and future direction

IESE Borehole and Surface Seismic Networks

- Standard data analysis and interpretation
  - *Earthquake locations*
  - *Simple velocity models*
  - *Special data analysis and interpretation.*
  - *Seismic velocity and velocity–ratio tomography*
  - *Fracture density and orientation*

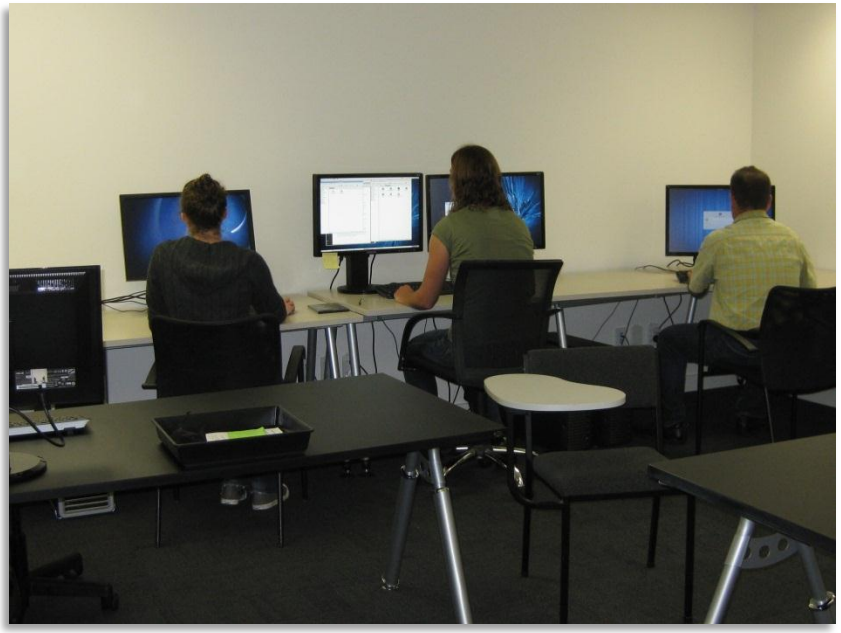
IESE Magnetotelluric Surveys

- Standard data analysis and interpretation
  - *Resistivity and polarization profiles*
  - *Reservoir characterization*
  - *Geothermal site surveys*



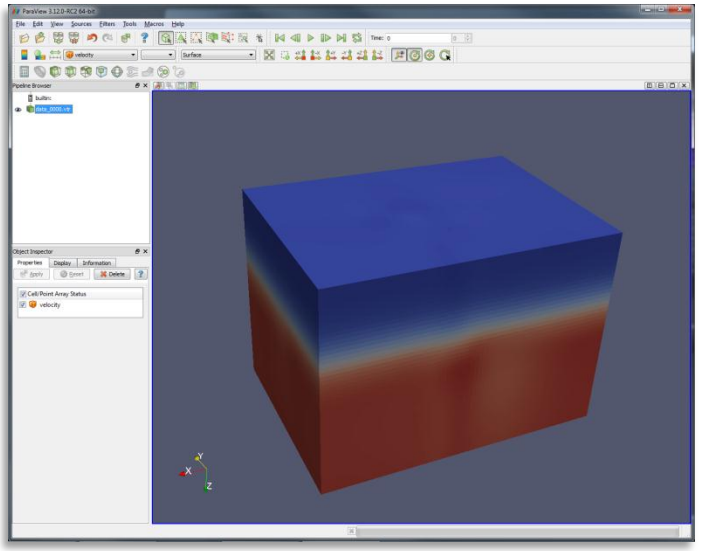
IESE Scientific Data Visualisation

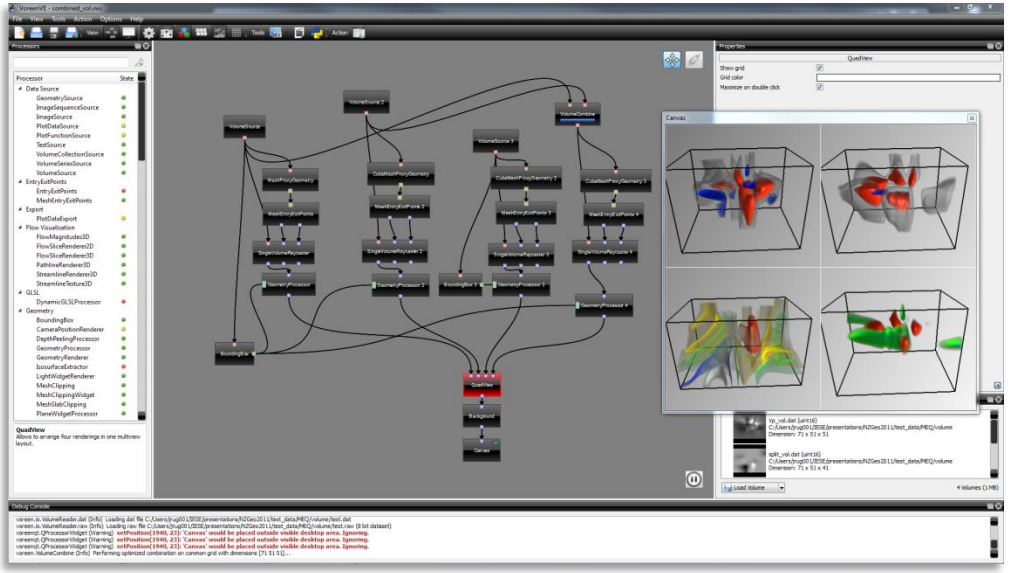
- Goal of scientific visualization: *Informed data exploration*
- IESE Visualization Centre
- “Interactive Graphics”
  - *Viewing parameters under user control*
  - *Performance: Real-time response*
  - *Stereoscopic viewing options*
  - *New technology developments…*



IESE Scientific Data Visualisation

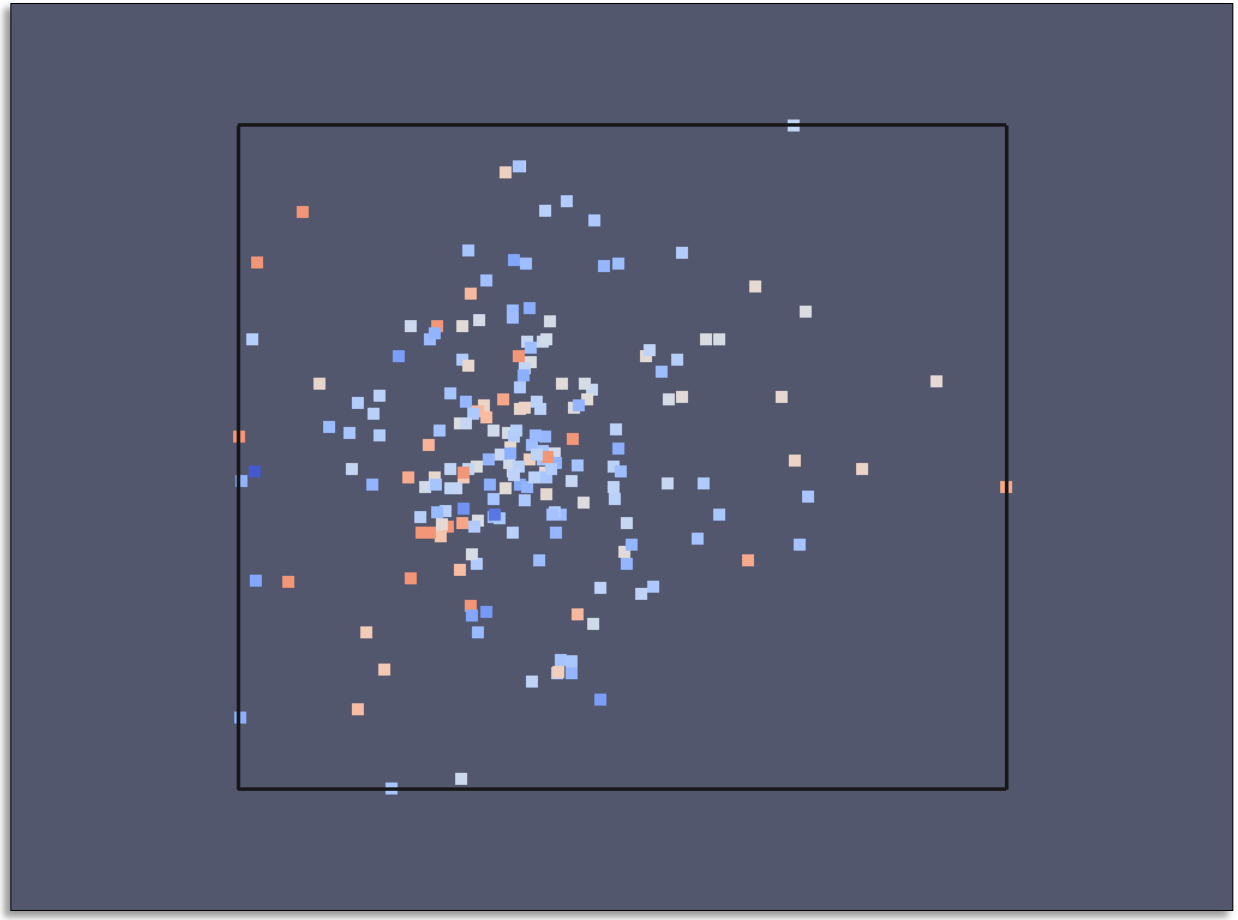
- Micro-seismic event locations
- Fracture and porosity distributions
- Seismic wave speed distributions
- Fracture density distribution
- Magnetotelluric resistivity distribution





Micro-seismic event locations

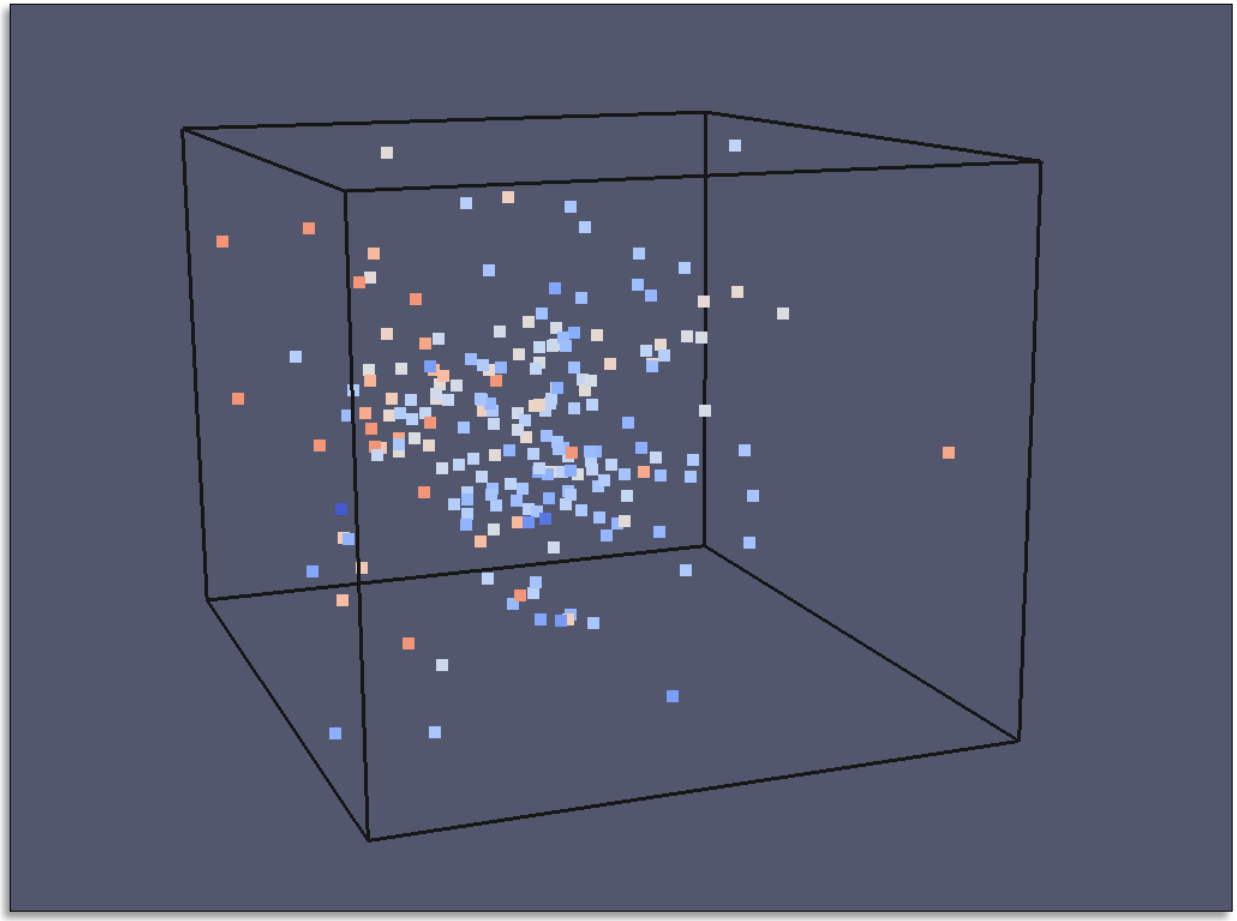
Spatial clustering & magnitudes



Points: Orthographic plan projection (seismic event location)

Micro-seismic event locations

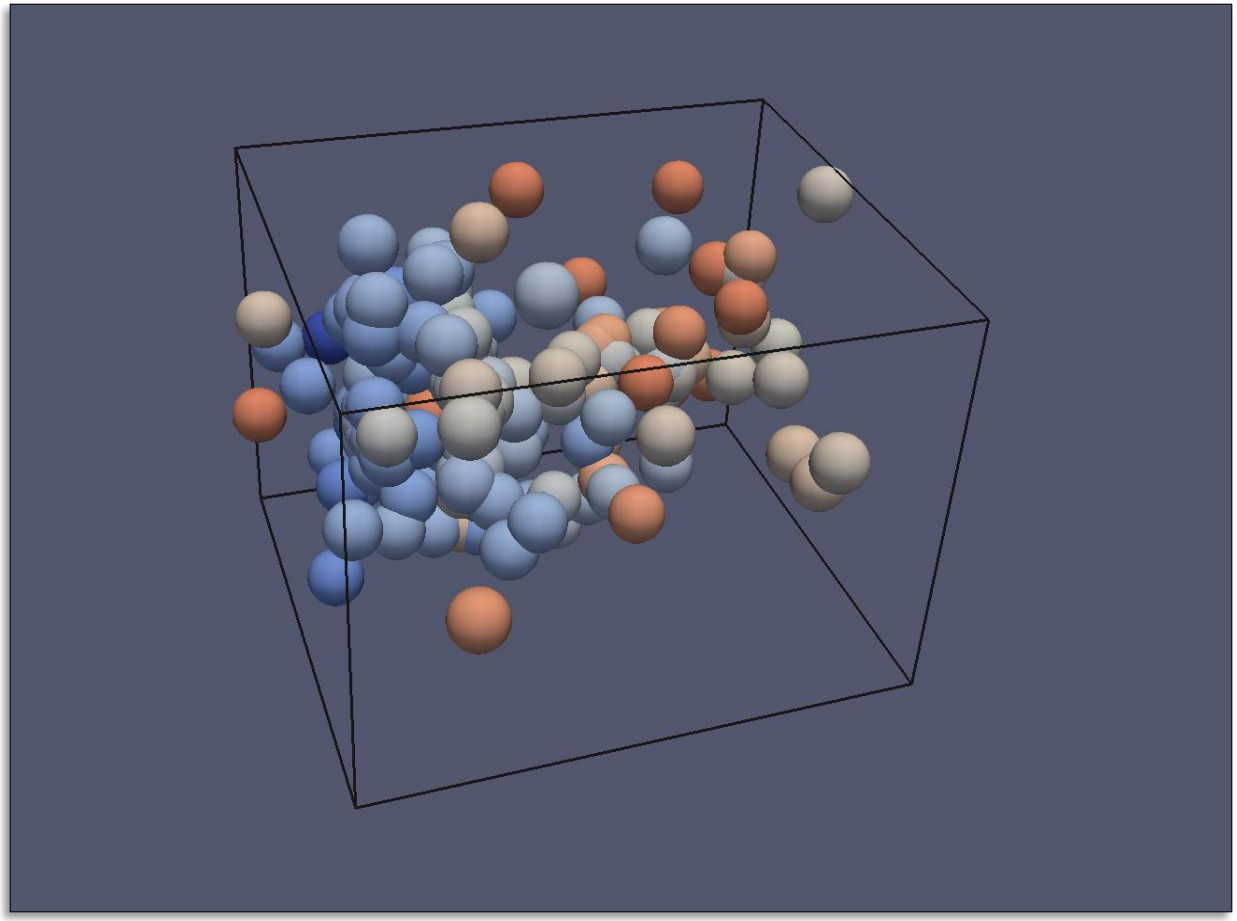
Spatial clustering & magnitudes



Points: 3D perspective projection (seismic event location)

Micro-seismic event locations

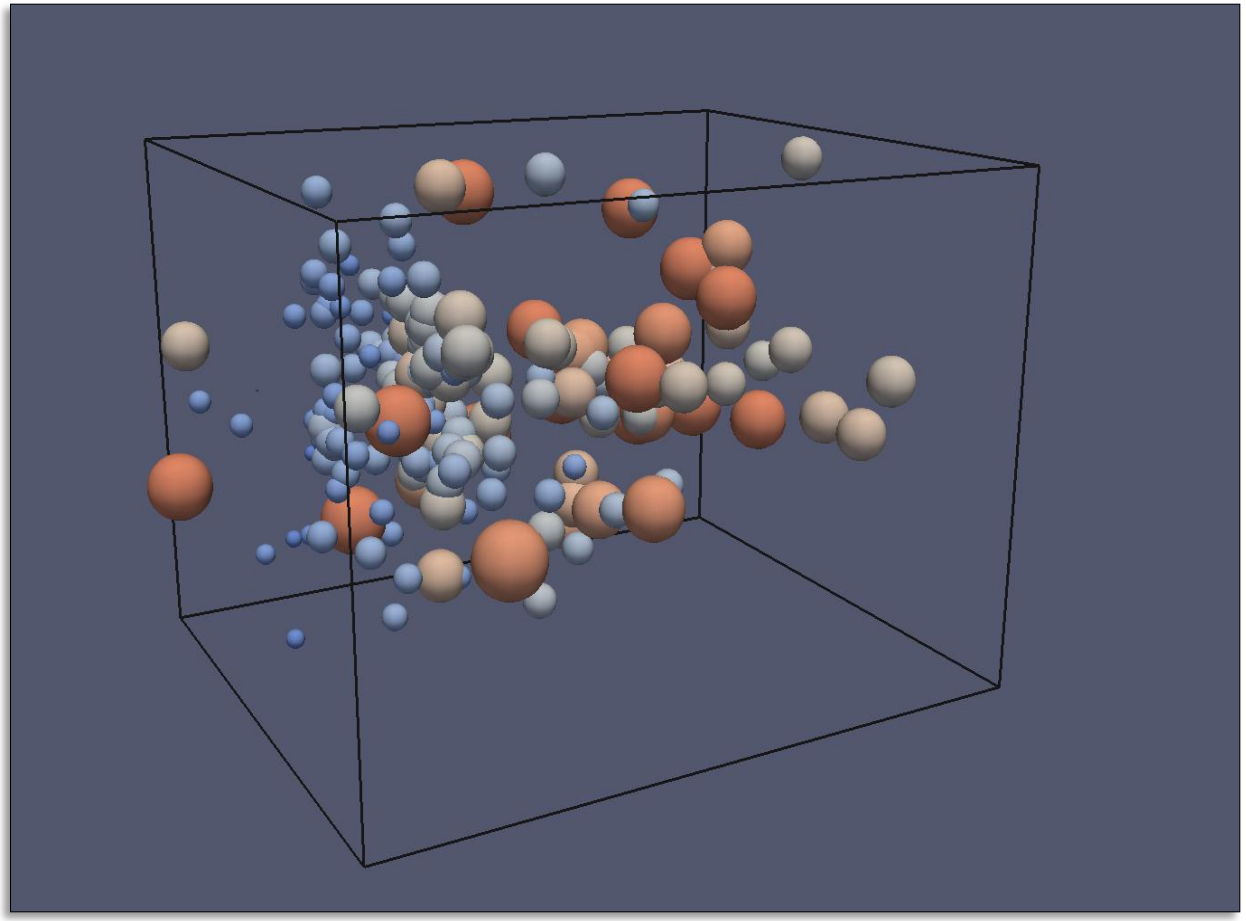
Spatial clustering & magnitudes



Glyphs: 3D perspective projection (seismic event location)

Micro-seismic event locations

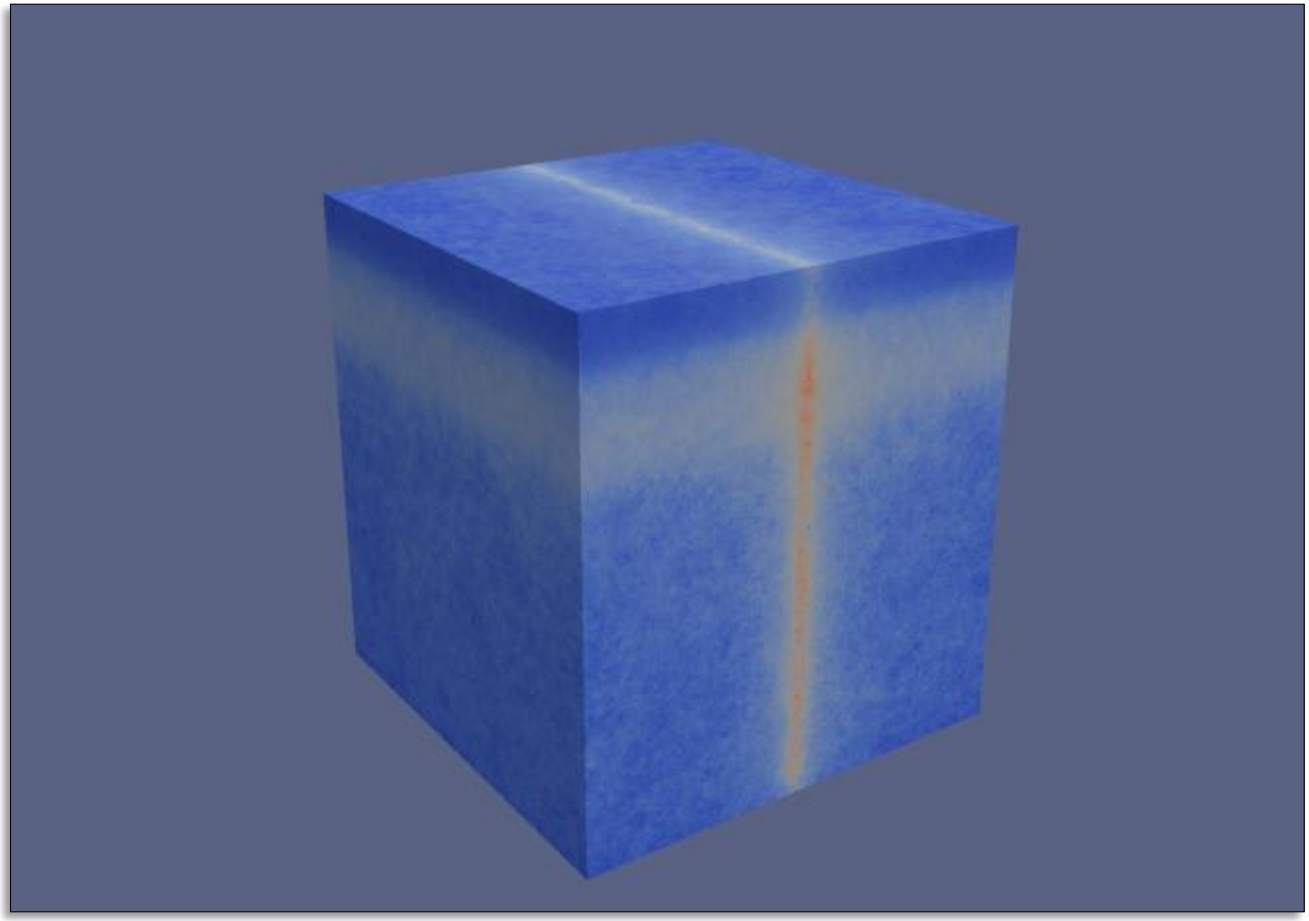
Spatial clustering & magnitudes



Coded glyphs: 3D perspective projection (seismic event location)

Fracture and porosity distributions

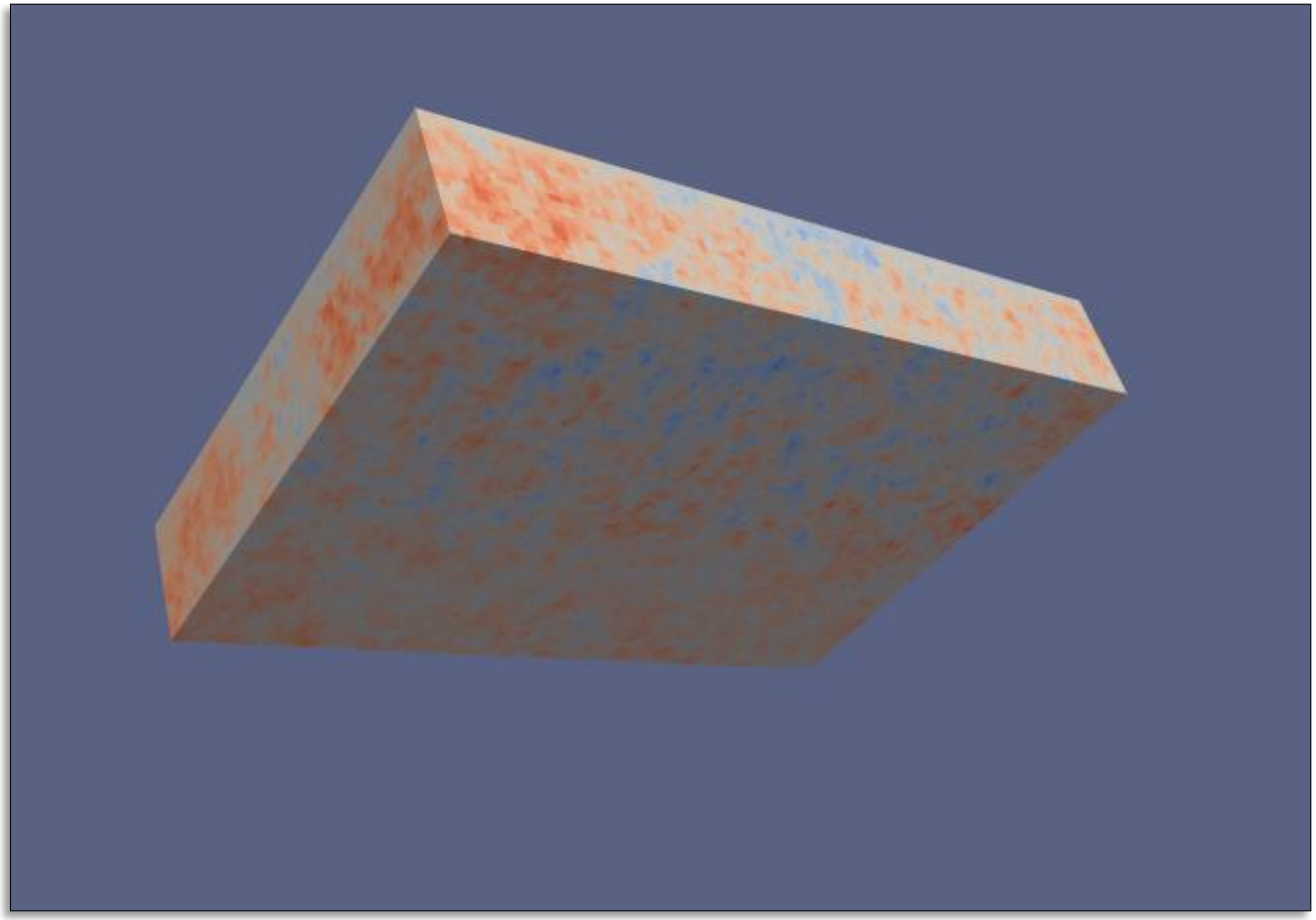
Volumetric data cubes and scalar data



Color-coded solid cube (synthetic porosity with depth & fracture)

Fracture and porosity distributions

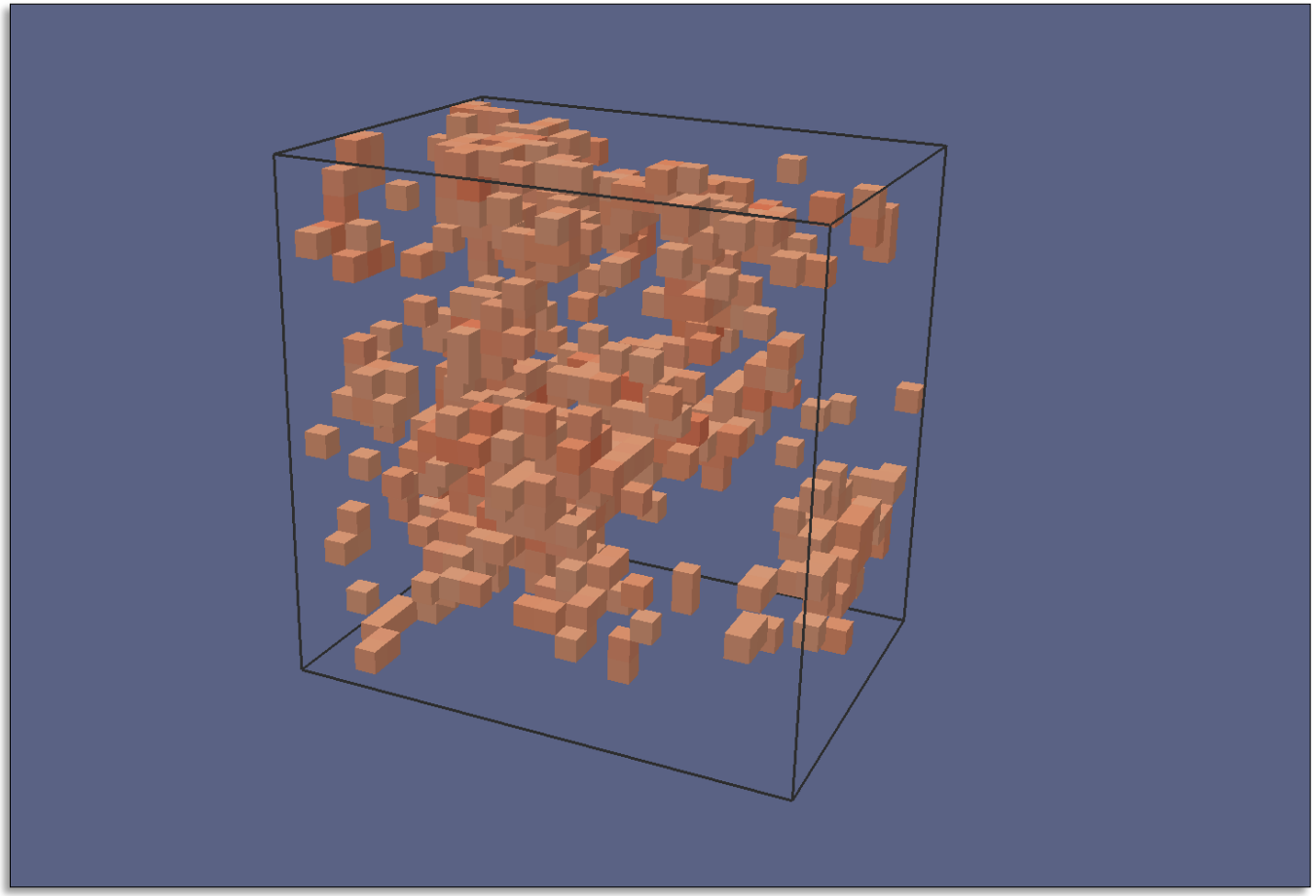
Volumetric data cubes and scalar data



Extracted fracture slab (synthetic porosity)

Fracture and porosity distributions

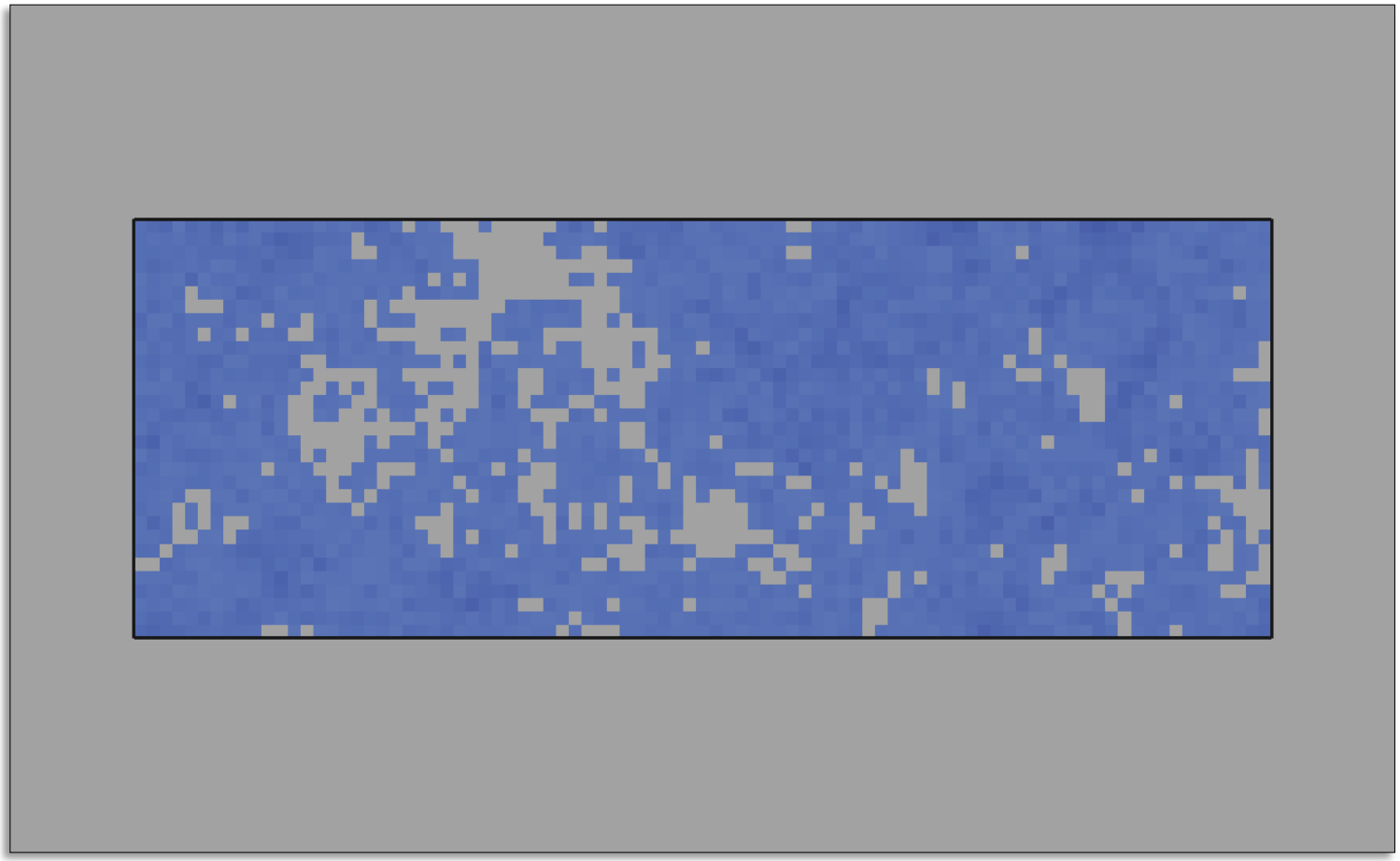
Volumetric data cubes and scalar data



Extracted high porosity cells (synthetic porosity)

Fracture and porosity distributions

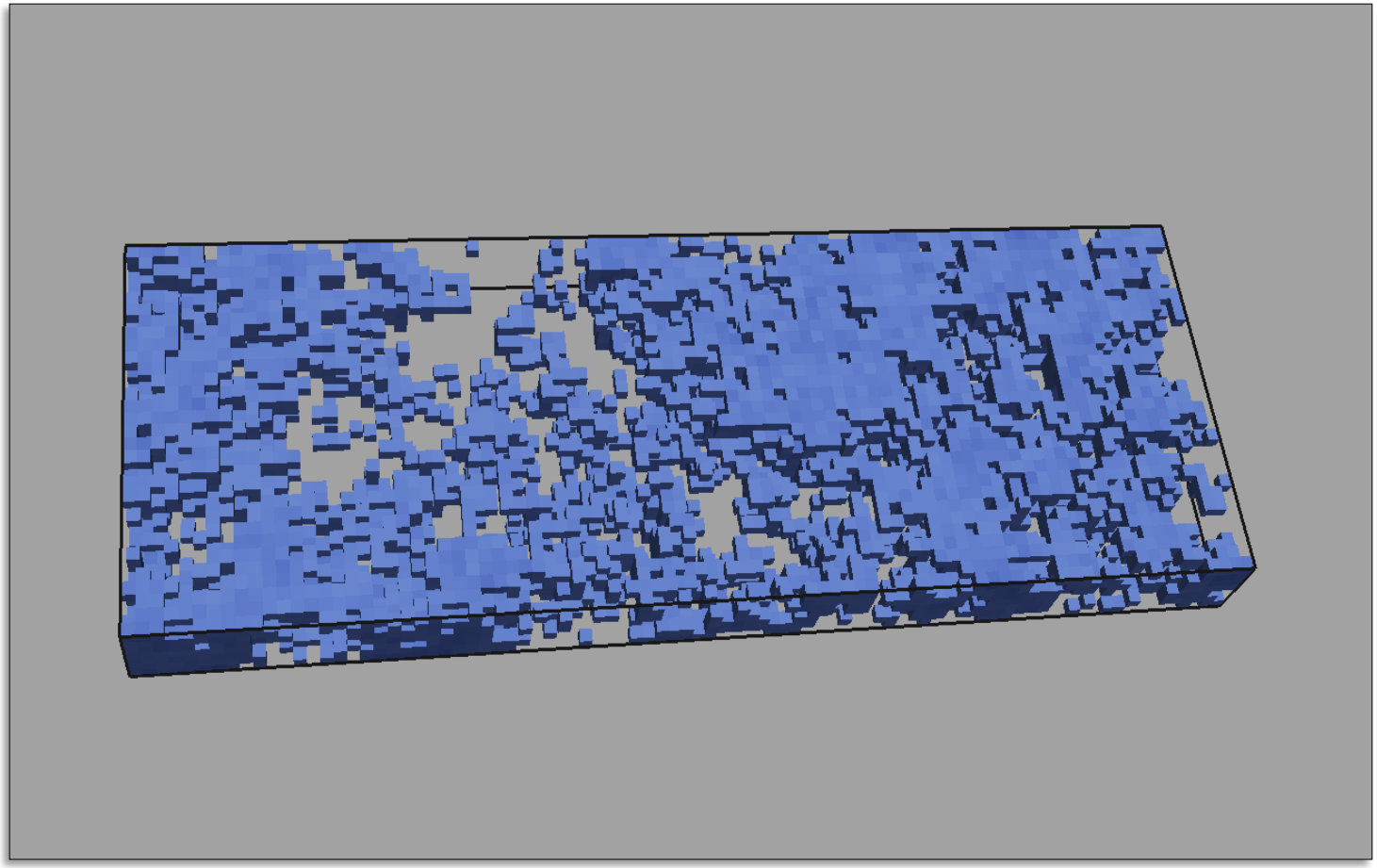
Volumetric data cubes and scalar data



Extracted low porosity slab (synthetic porosity)

Fracture and porosity distributions

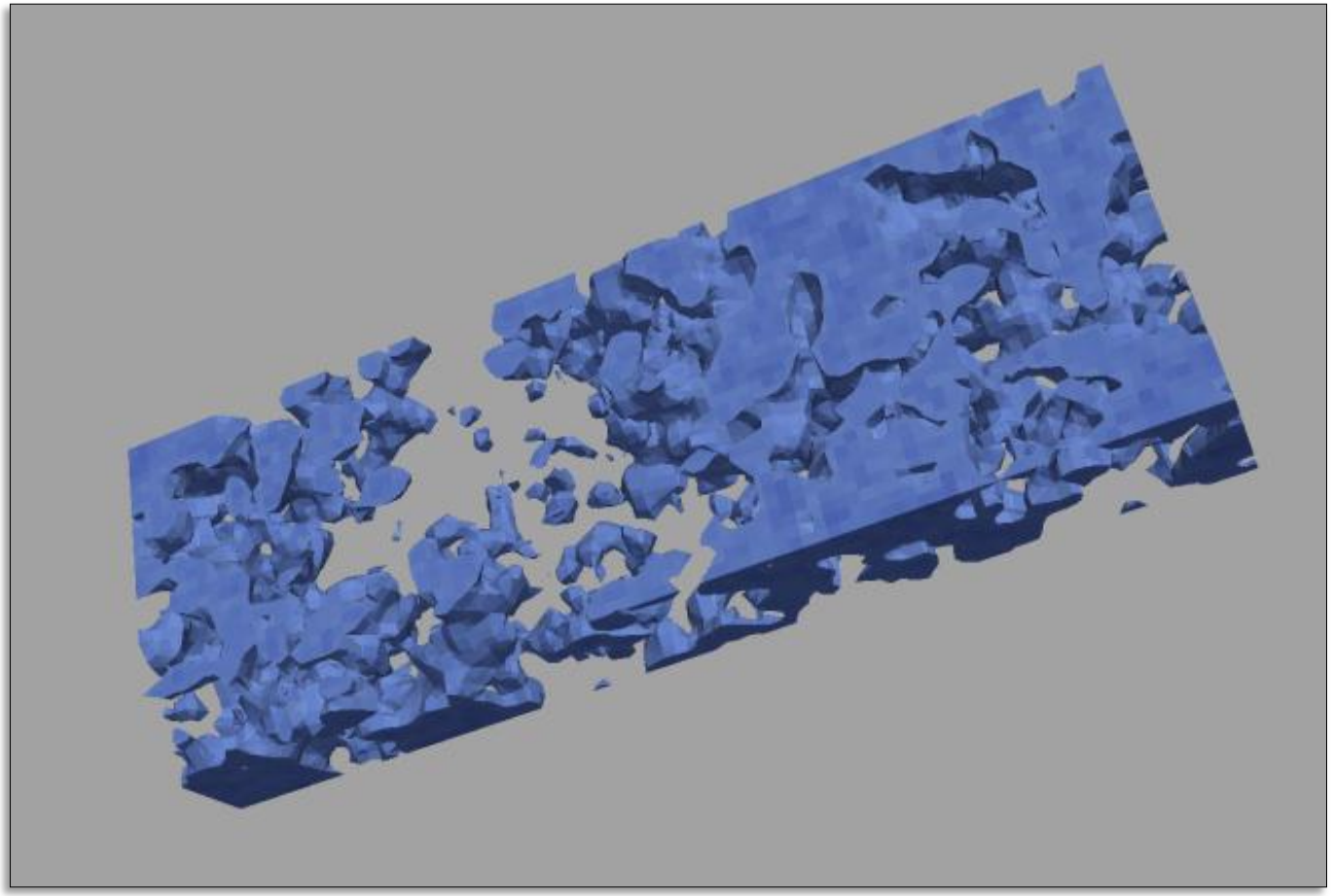
Volumetric data cubes and scalar data



Extracted low porosity slab: 3D perspective projection

Fracture and porosity distributions

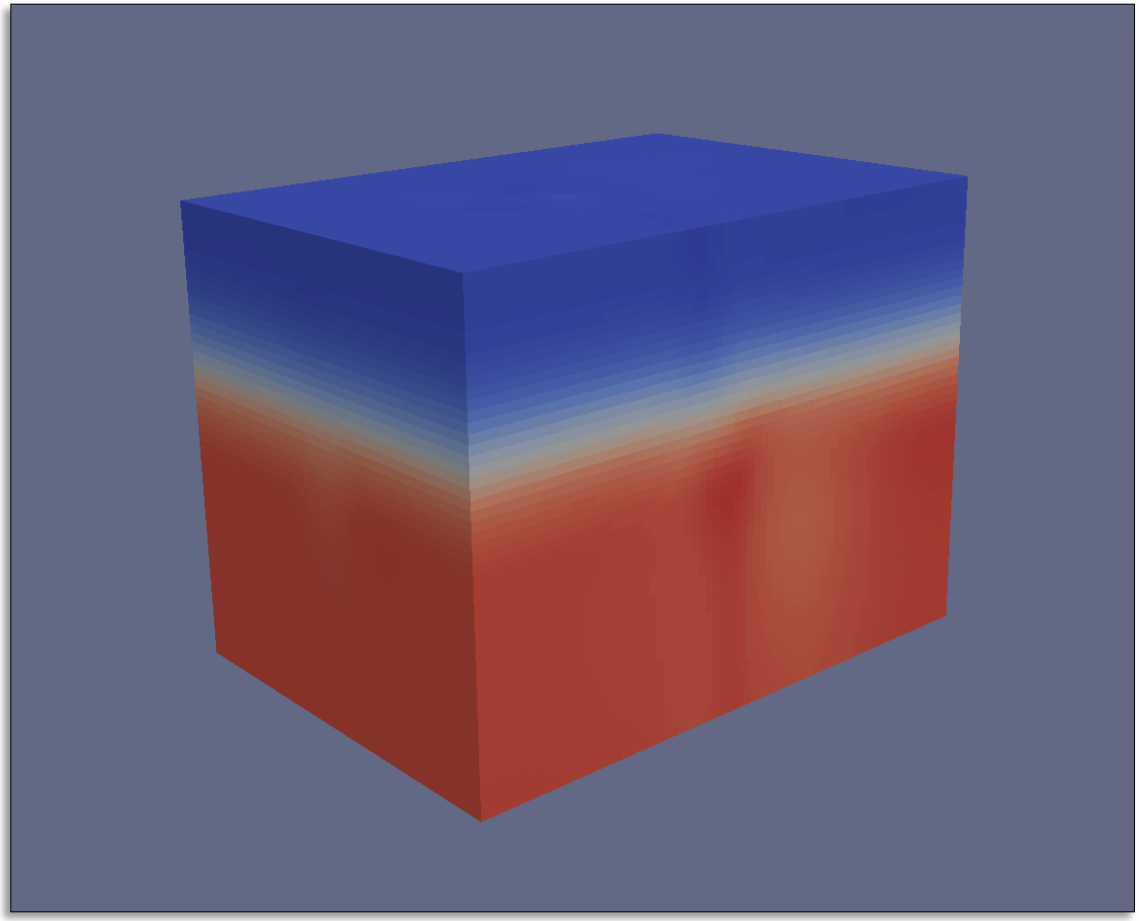
Volumetric data cubes and scalar data



Extracted low porosity slab: surface mesh

Seismic wave speed distributions

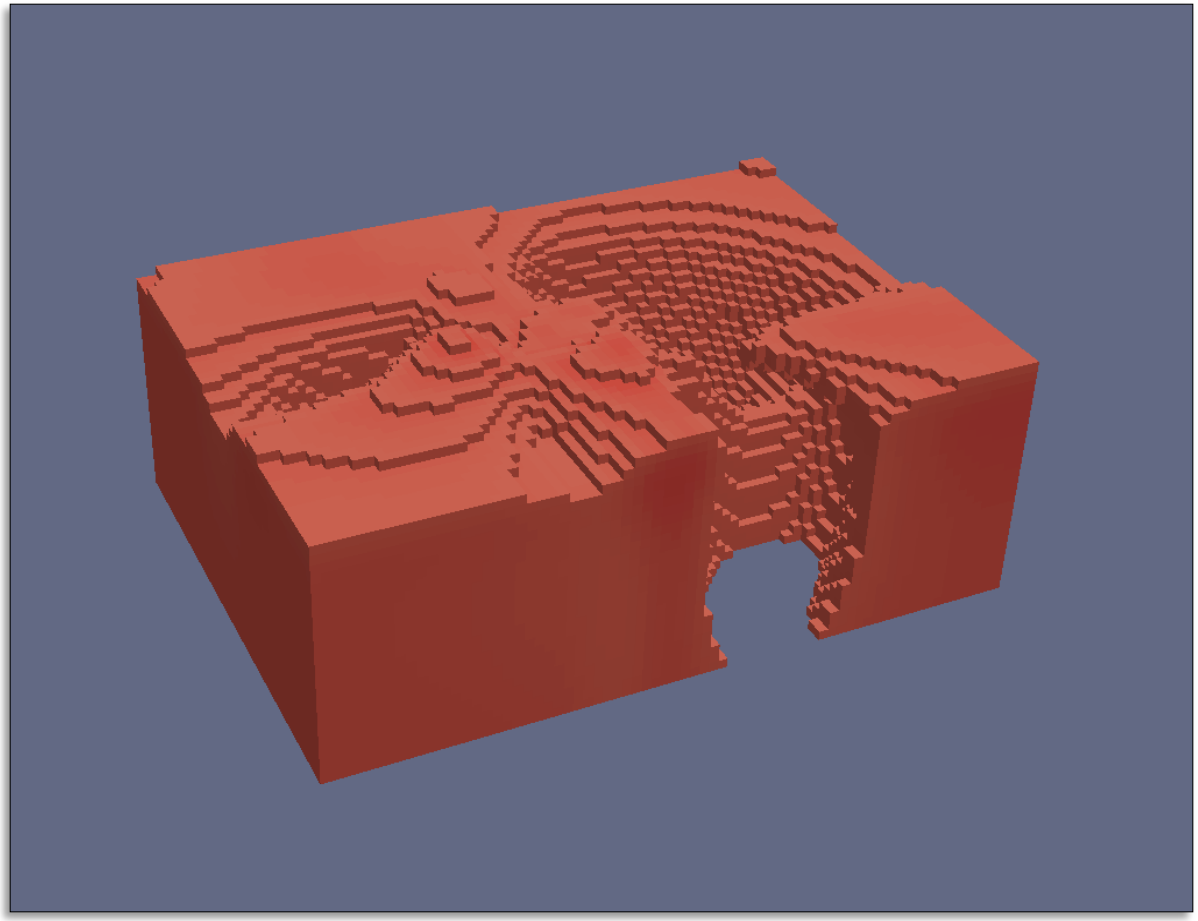
Method 1: Solid volumetric data cubes



3D solid data cube (pressure-wave velocity)

Seismic wave speed distributions

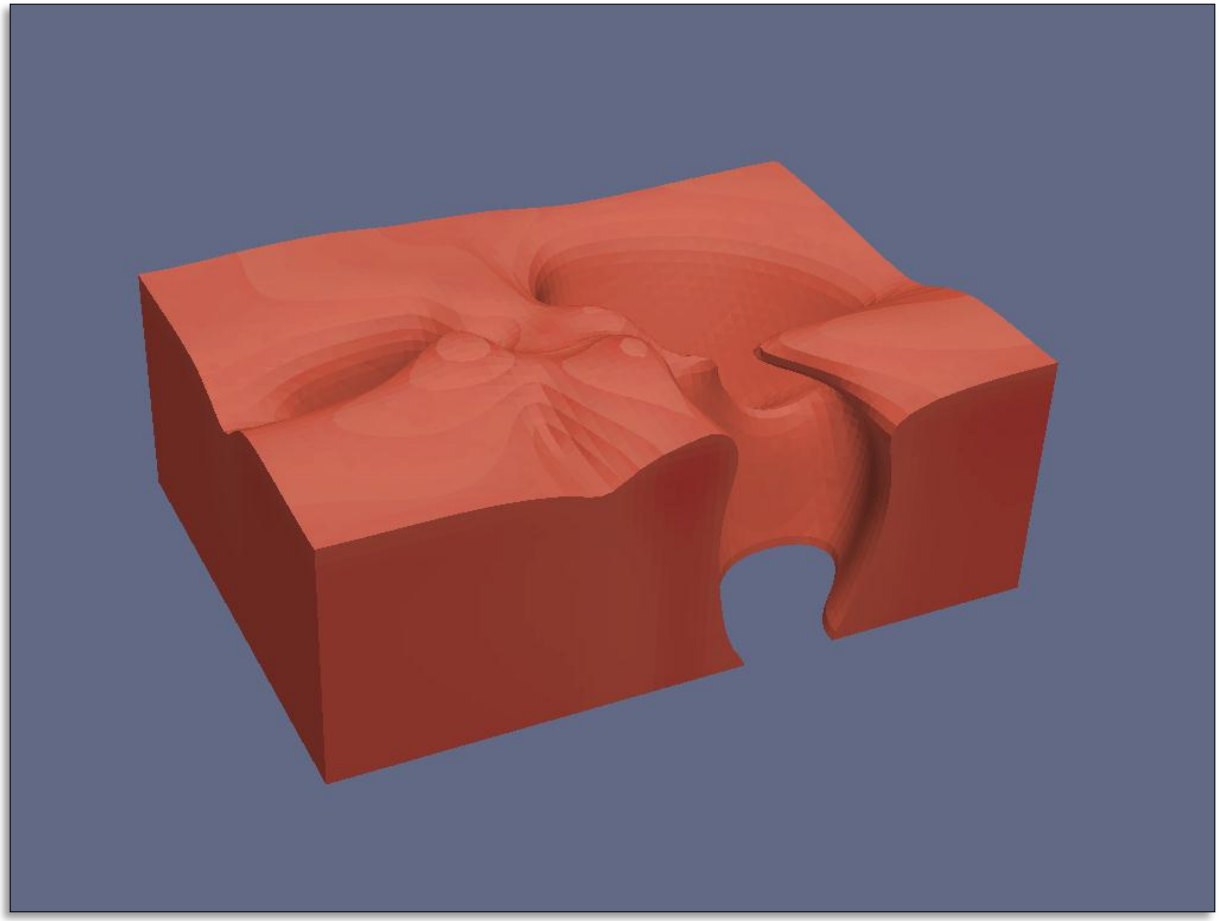
Method 1: Solid volumetric data cubes



3D data cube, threshold value cut-away (pressure-wave velocity)

Seismic wave speed distributions

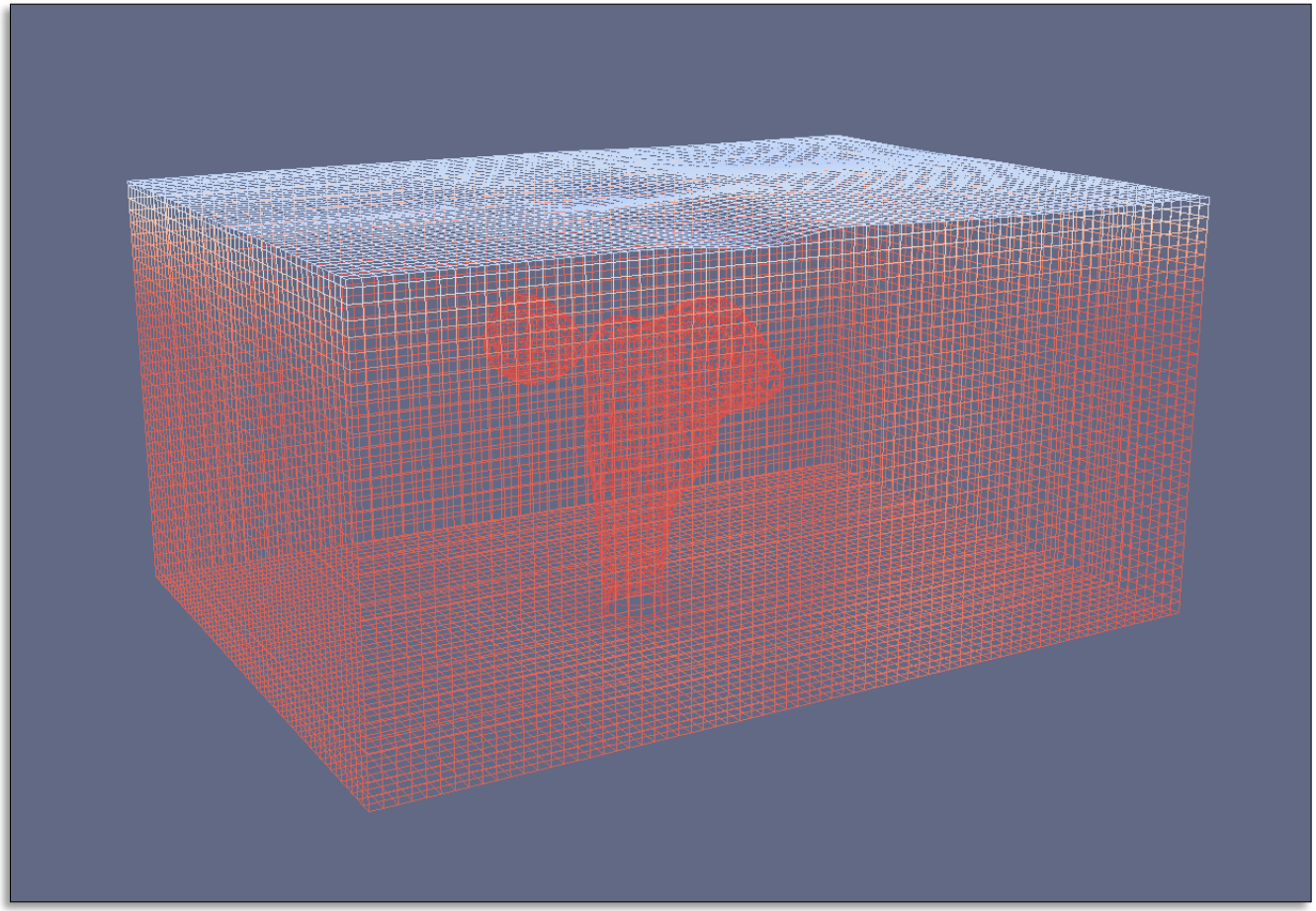
Method 1: Solid volumetric data cubes



3D data cube, smoothed surface (pressure-wave velocity)

Seismic wave speed distributions

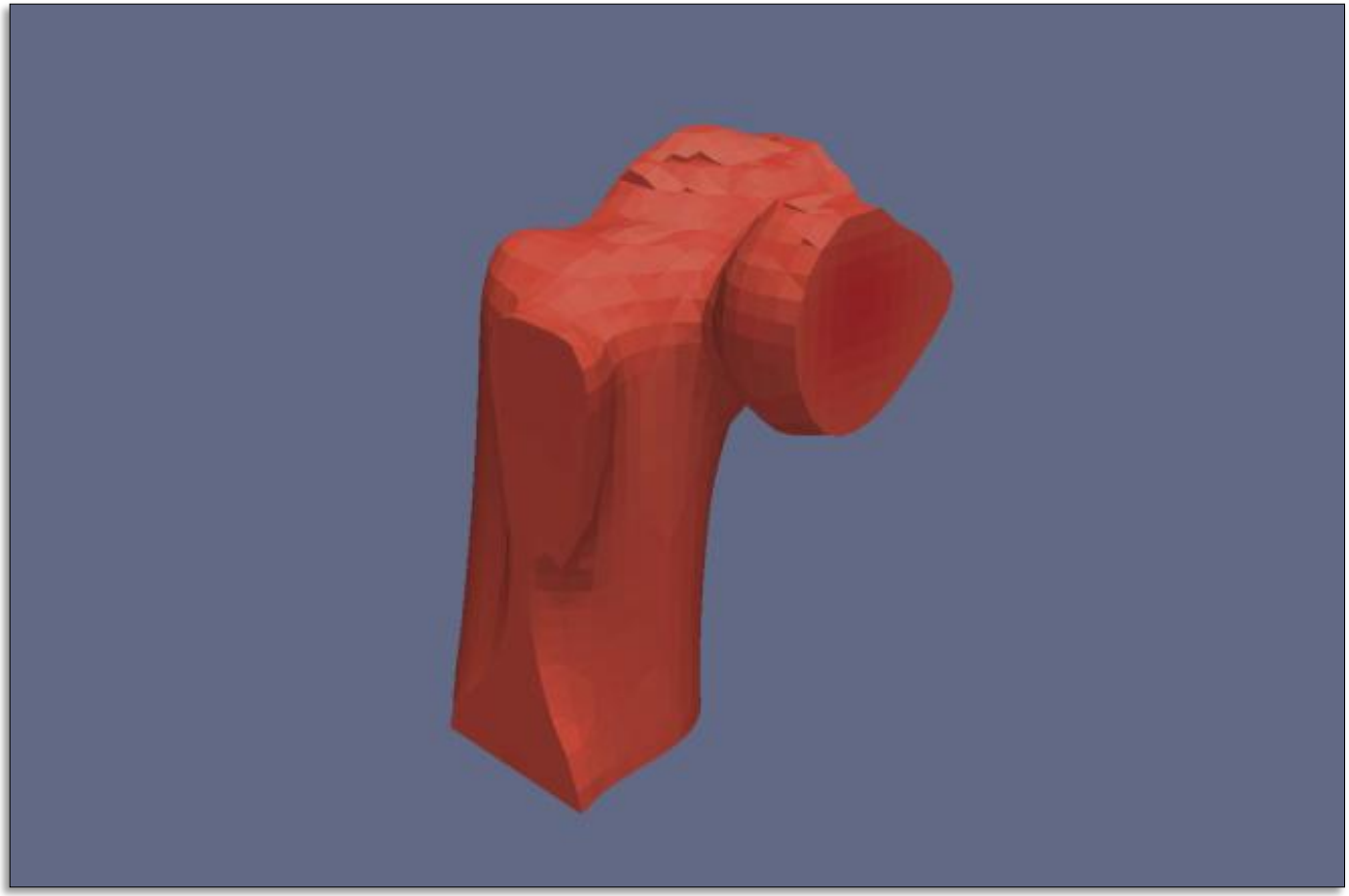
Method 1: Solid volumetric data cubes



3D data cube, wireframe cut-away (pressure-wave velocity)

Seismic wave speed distributions

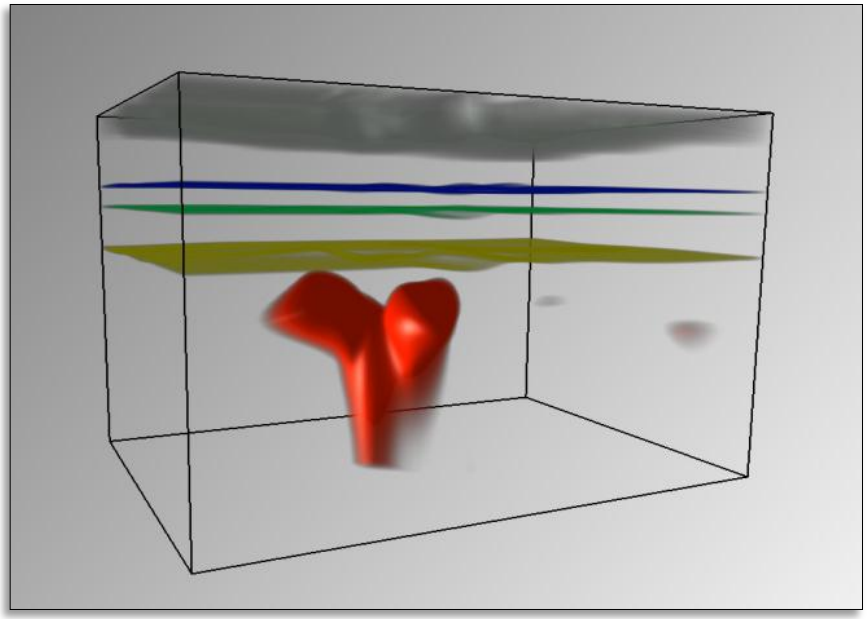
Method 1: Solid volumetric data cubes



3D data cube, threshold value cut-away (pressure-wave velocity)

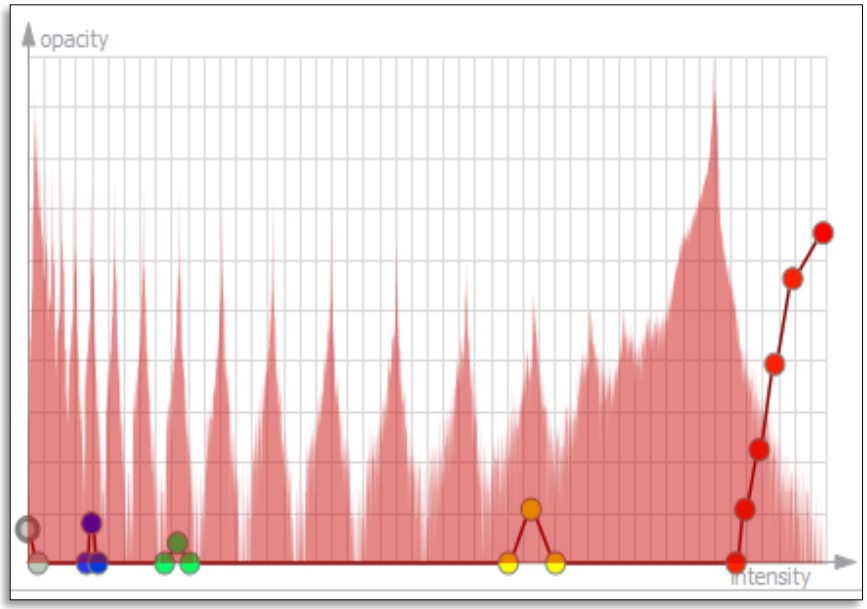
Seismic wave speed distributions

Method 2: Volumetric data cubes with transparency



3D solid data cube with transparency

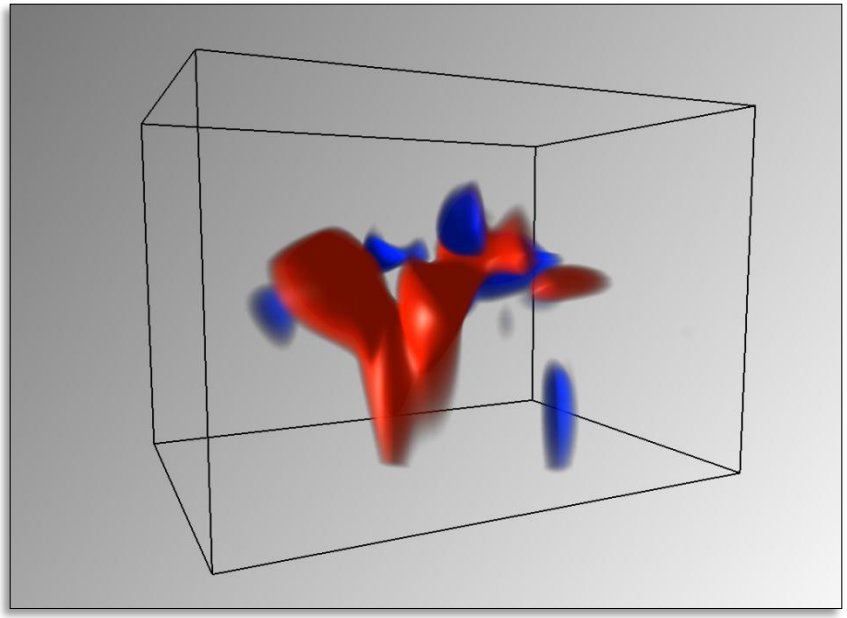
(pressure-wave velocity)



Visualization transfer function

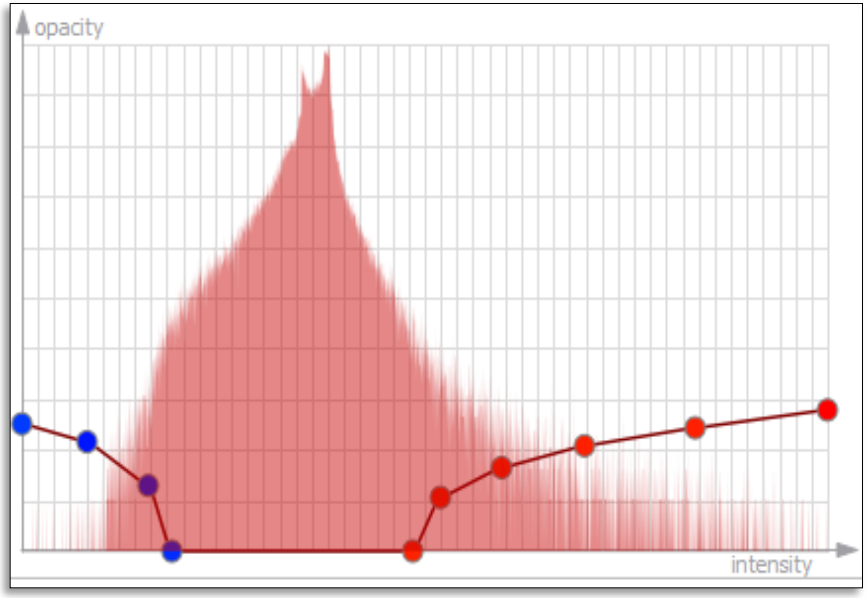
Seismic wave speed distributions

Method 2: Volumetric data cubes with transparency



3D solid data cube with transparency,

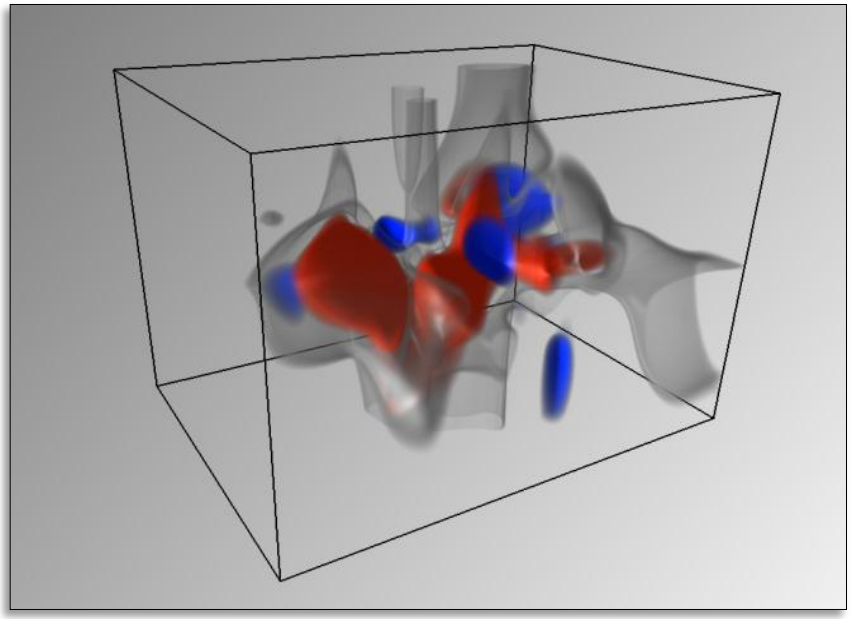
(depth normalized pressure-wave velocity)



Visualization transfer function

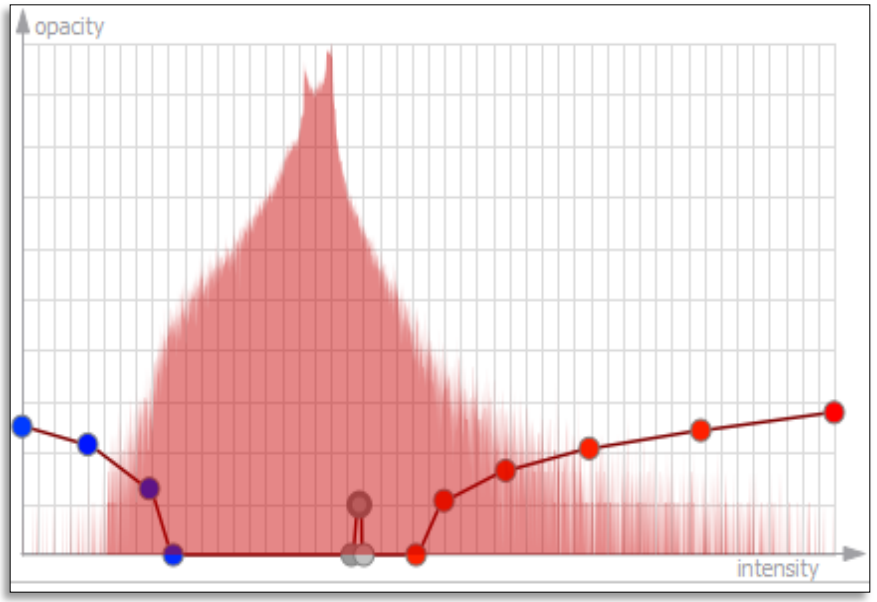
Seismic wave speed distributions

Method 2: Volumetric data cubes with transparency



3D solid data cube with transparency,

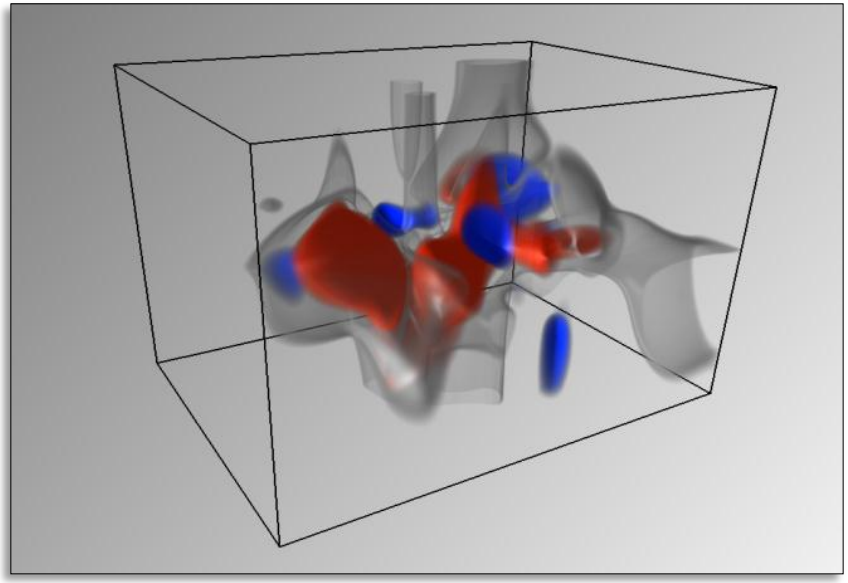
(depth normalized shear-wave velocity)



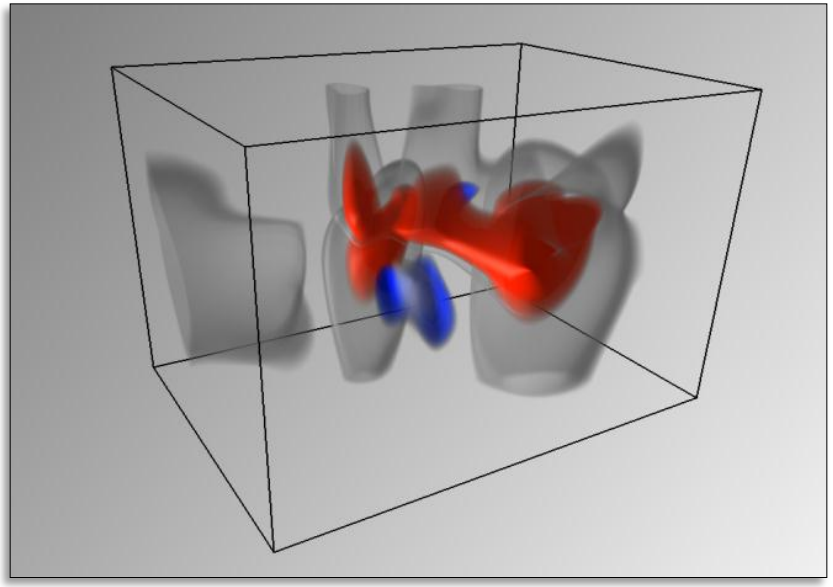
Visualization transfer function

Seismic wave speed distributions

Method 2: Volumetric data cubes with transparency



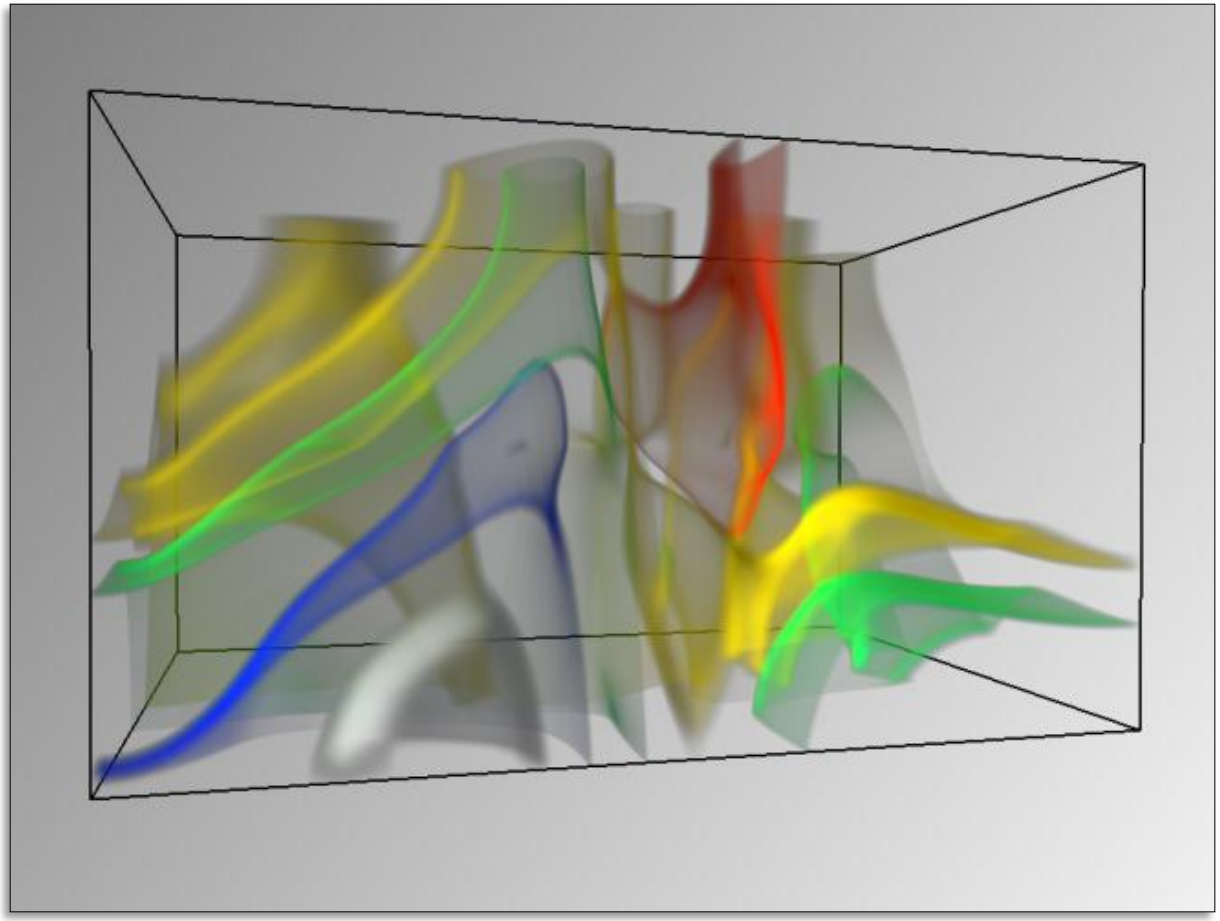
Depth normalized pressure-wave velocity



Depth normalized shear-wave velocity

Fracture density distribution

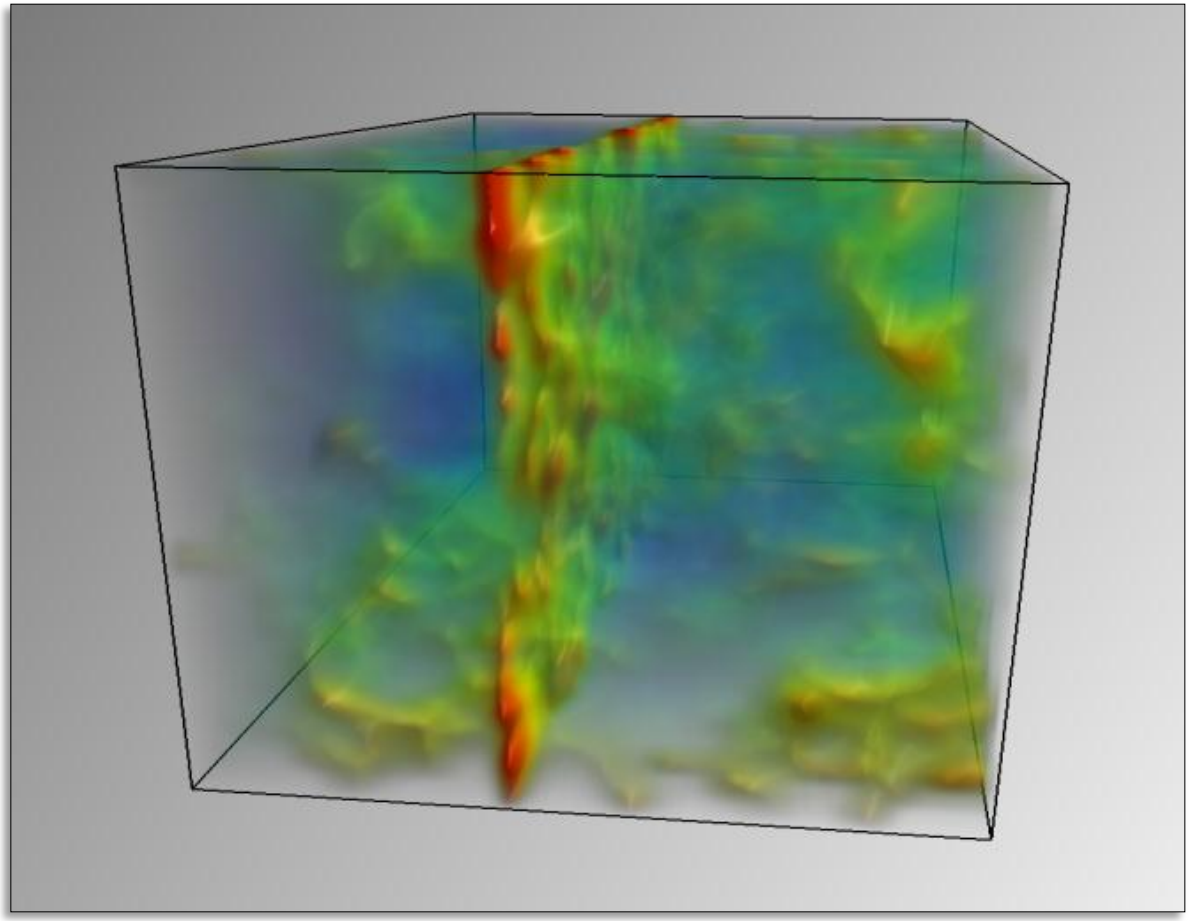
Thin shell volumetric “iso-surfaces”



3D data cube (crack density)

Magnetotelluric resistivity distribution

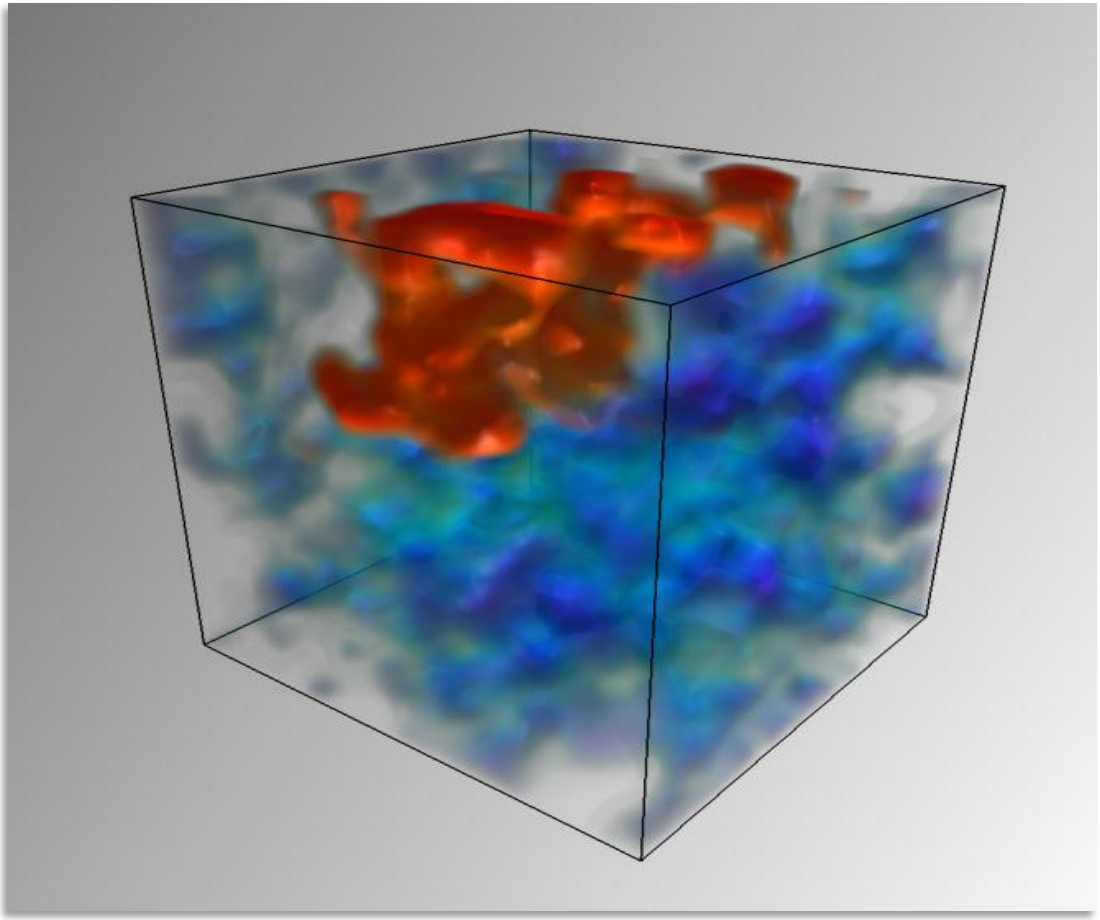
Complex volumetric structures with transparency



3D data cube (synthetic conductivity with fracture)

Magnetotelluric resistivity distribution

Complex volumetric structures with transparency



3D data cube (synthetic conductivity with thermal outcrop)

Discussion & Questions?