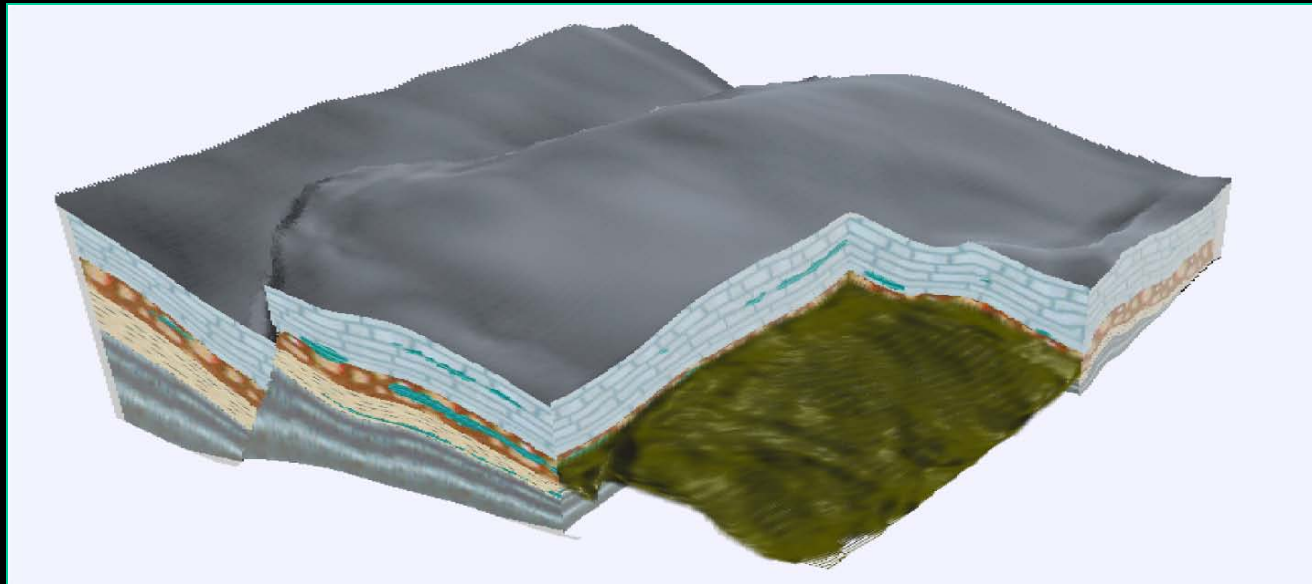


Illustrative Visualization for Rapid Interpretation in Geosciences

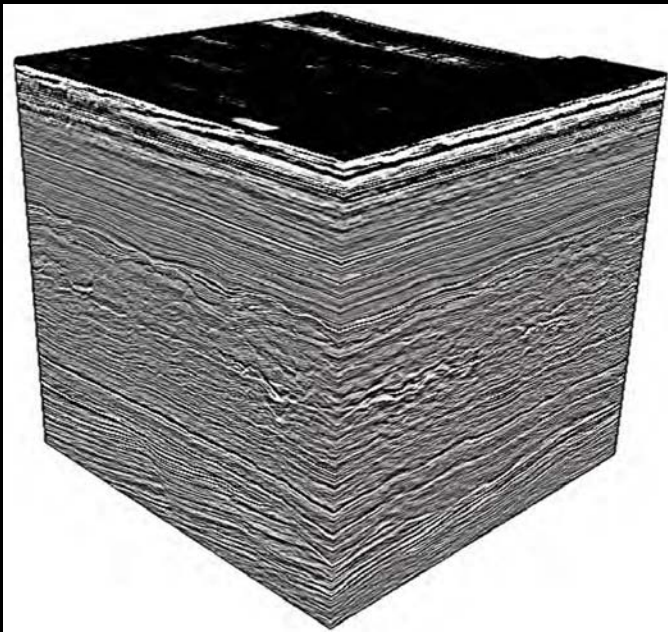


IllustraVis 2009
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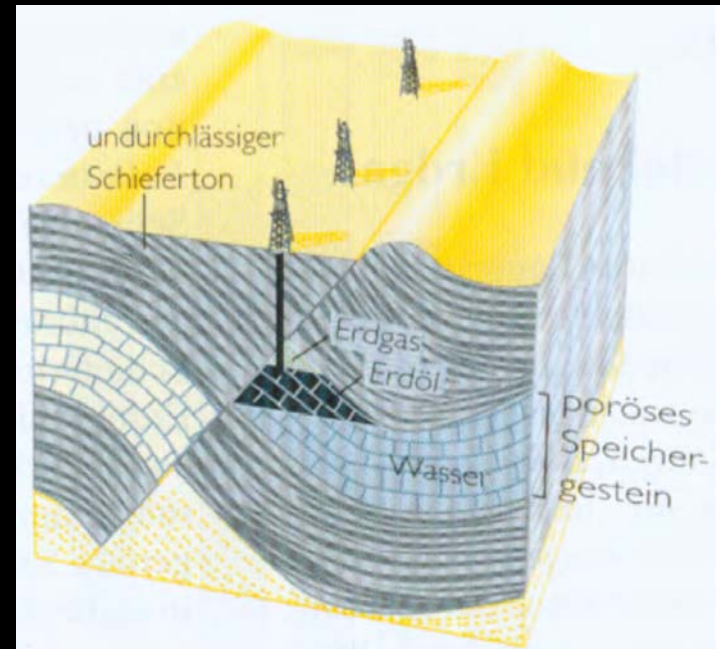
The essence of scientific illustrations

Data



- Raw data
- Visual overload

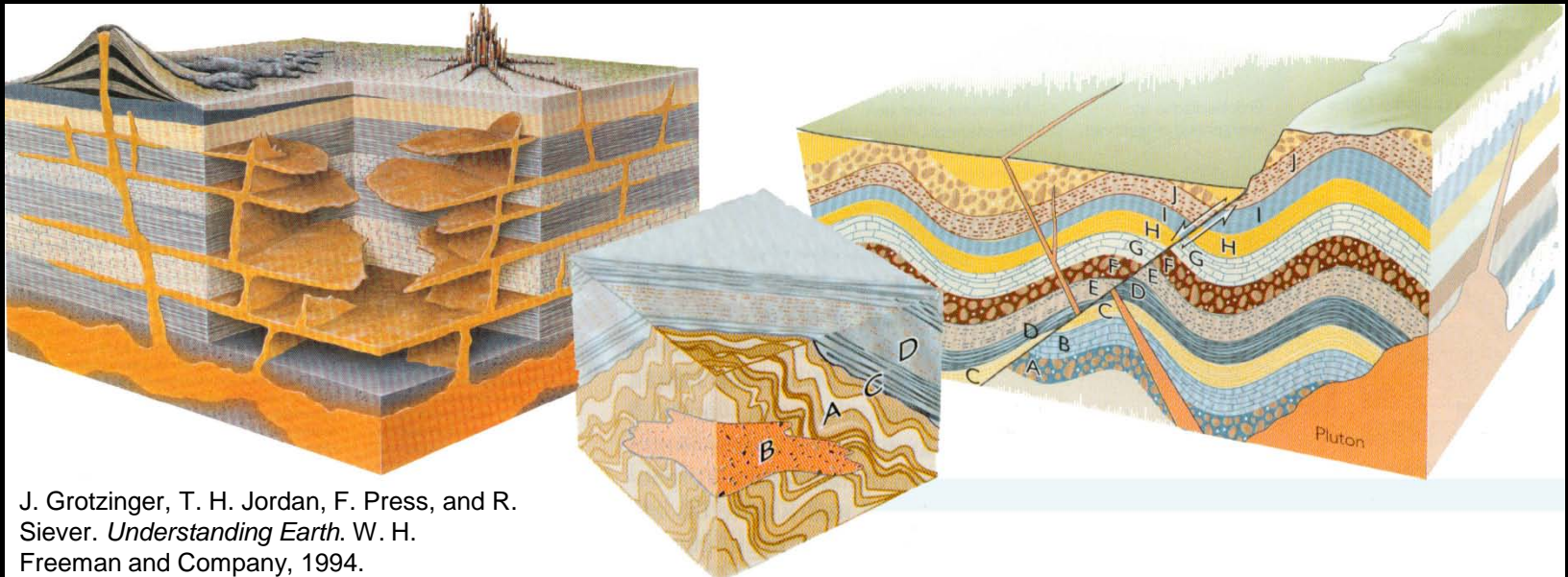
Illustration



- Abstracted
- Shows essential aspects

Techniques in geoscientific illustrations

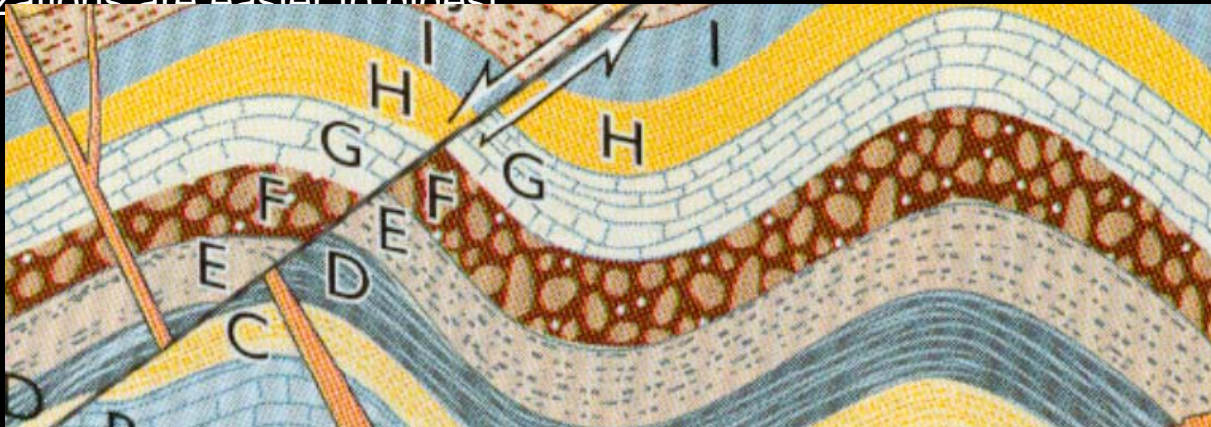
- Textures on planar surfaces to emphasize layers and faults
 - Textures bent along layers
 - Discontinuities over faults
- Opaque cubes with textured surfaces for 3D context
 - Axis-aligned cut outs
 - Extruding features












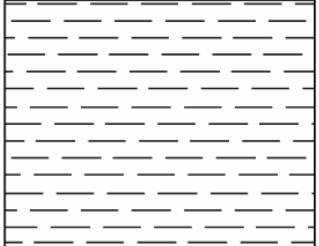
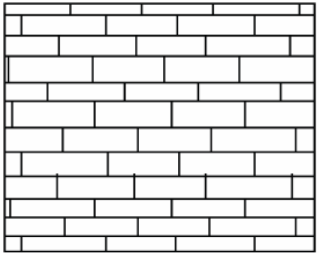
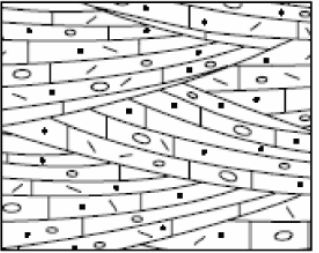












































J. Grotzinger, T. H. Jordan, F. Press, and R. Siever. *Understanding Earth*. W. H. Freeman and Company, 1994.

More about geological textures

- To ease communication, geologists and geographers use a standardized texture language for representing rock types.
- Textures have advantages in that they can give an integrated visualization of layers and faults.
- The layer type and its orientation is communicated locally at any point on the texture as opposed to when using labelling
- Visualizations are easier to digest



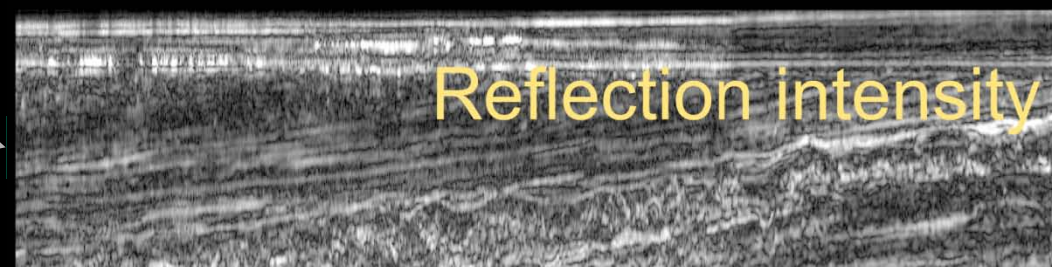
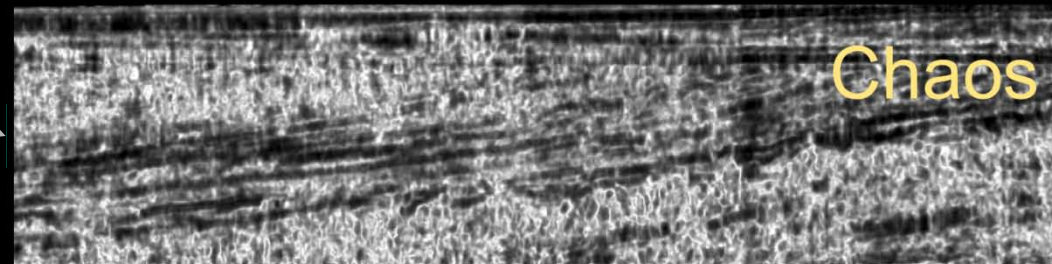
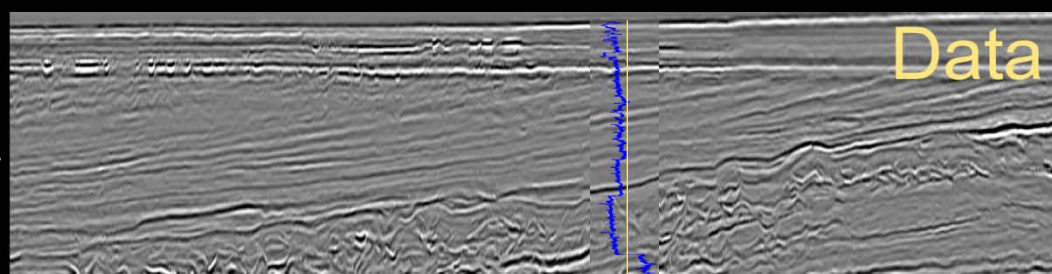
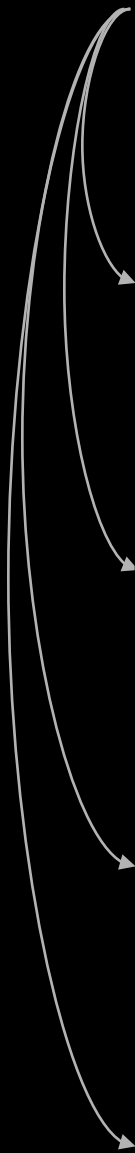
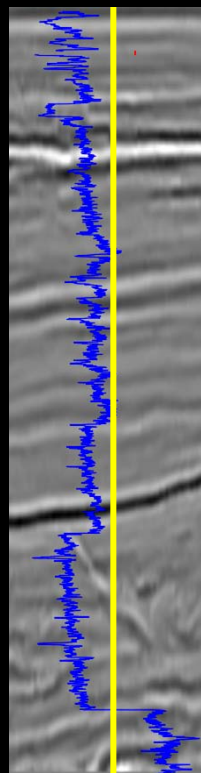
US standard geological textures

 701 Metamorphism	 702 Quartzite	 645 Sandy dolostone or dolomite	 646 Silty dolostone or dolomite	 647 Argillaceous or shaly dolostone or dolomite	 601 Gravel or conglomerate (1st option)	 602 Gravel or conglomerate (2nd option)	 603 Crossbedded gravel or conglomerate	 605 Breccia (1st option)	 620 Clay or clay shale  627 Limestone  634 Cherty and sandy crossbedded clastic limestone
 707 Schist and gneiss	 652 Fossiliferous rock	 653 Diatomaceous rock	 654 Subgraywacke	 609 Crossbedded sand or sandstone (1st option)	 610 Crossbedded sand or sandstone (2nd option)	 611 Ripple-bedded sand or sandstone	 612 Argillaceous or shaly sandstone		
 711 Tuffaceous rock	 712 Crystal tuff	 659 Bony coal or impure coal	 660 Underclay	 661 Flint clay	 617 Calcareous siltstone	 618 Dolomitic siltstone	 619 Sandy or silty shale	 620 Clay or clay shale	
 717 Basaltic flows	 718 Granite (1st option)	 666 Phosphatic-nodular rock	 667 Gypsum	 668 Salt	 624 Carbonaceous shale	 625 Oil shale	 626 Chalk	 627 Limestone	
 723 Igneous rock (3rd option)	 724 Igneous rock (4th option)	 673 Interbedded shale and limestone (shale dominant) (1st option)	 674 Interbedded shale and limestone (shale dominant) (2nd option)	 675 Interbedded calcareous shale and limestone (shale dominant)	 631 Limestone, irregular (burrow?) fillings of bioheroidal dolomite	 632 Crossbedded limestone	 633 Cherty crossbedded limestone	 634 Cherty and sandy crossbedded clastic limestone	
 729 Porphyritic rock (1st option)	 730 Porphyritic rock (2nd option)	 680 Interbedded limestone and calcareous shale	 681 Till or diamicton (1st option)	 682 Till or diamicton (2nd option)	 638 Argillaceous or shaly limestone	 639 Cherty limestone (1st option)	 640 Cherty limestone (2nd option)	 641 Dolomitic limestone, limy dolostone, or limy dolomite	

Illustrative rendering of uninterpreted data

Seismic data

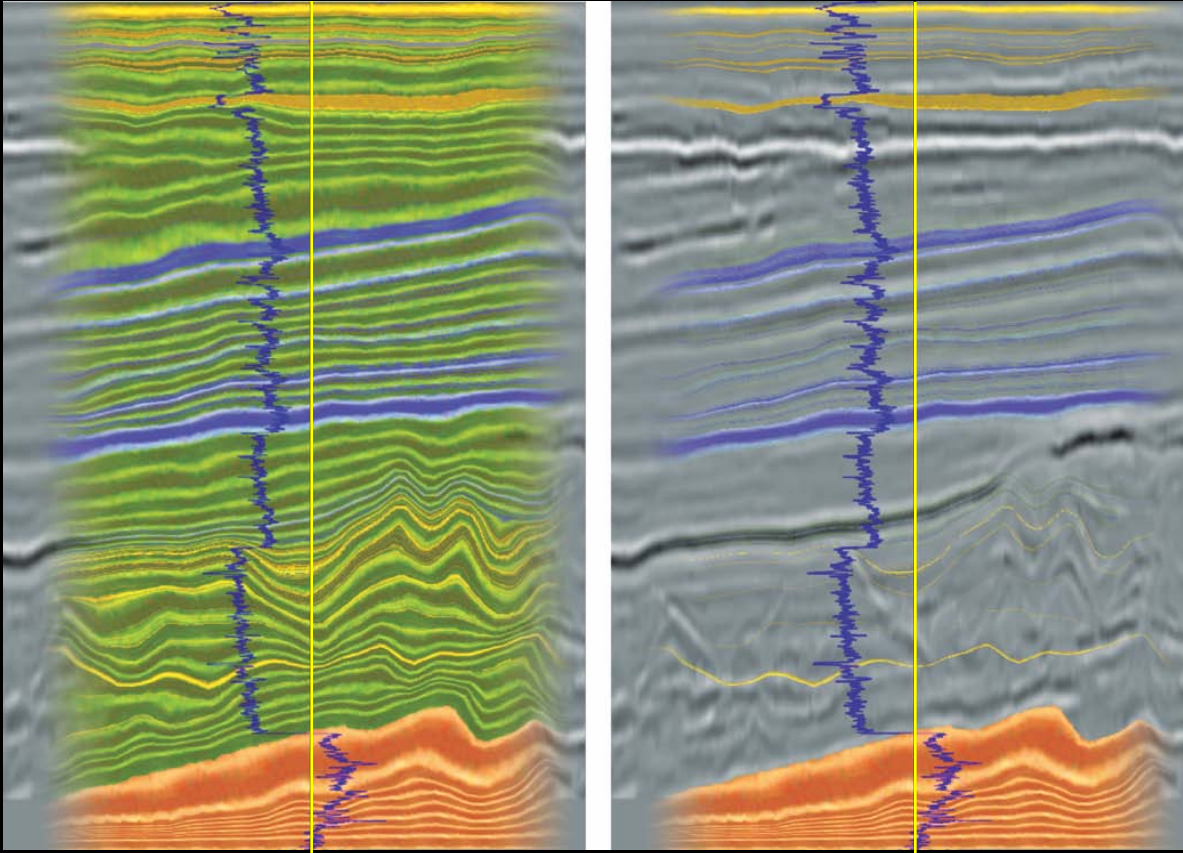
- derived attributes
- well logs



Automatic interpretation

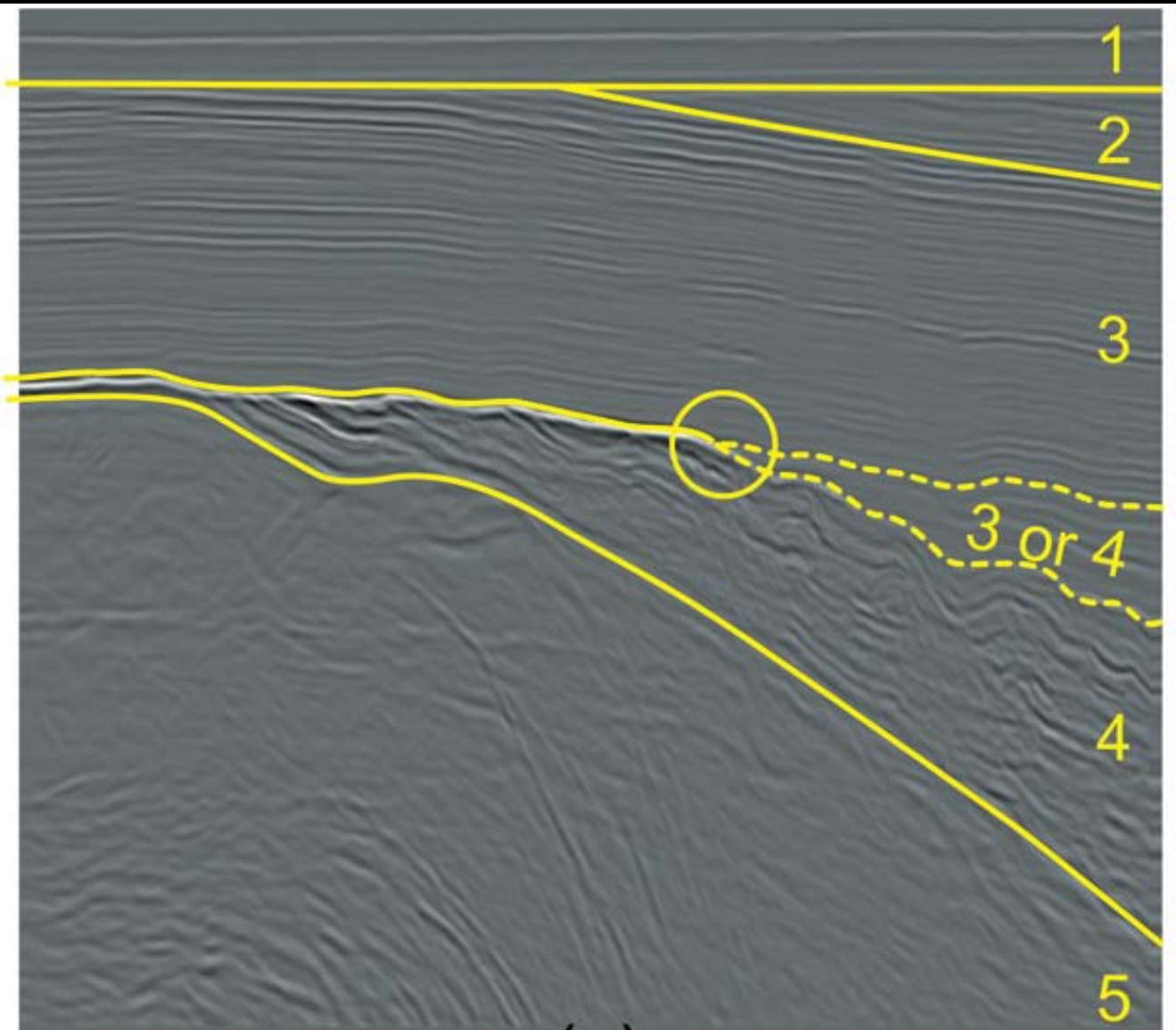
- Horizon finding
- Parameterization

Well logs

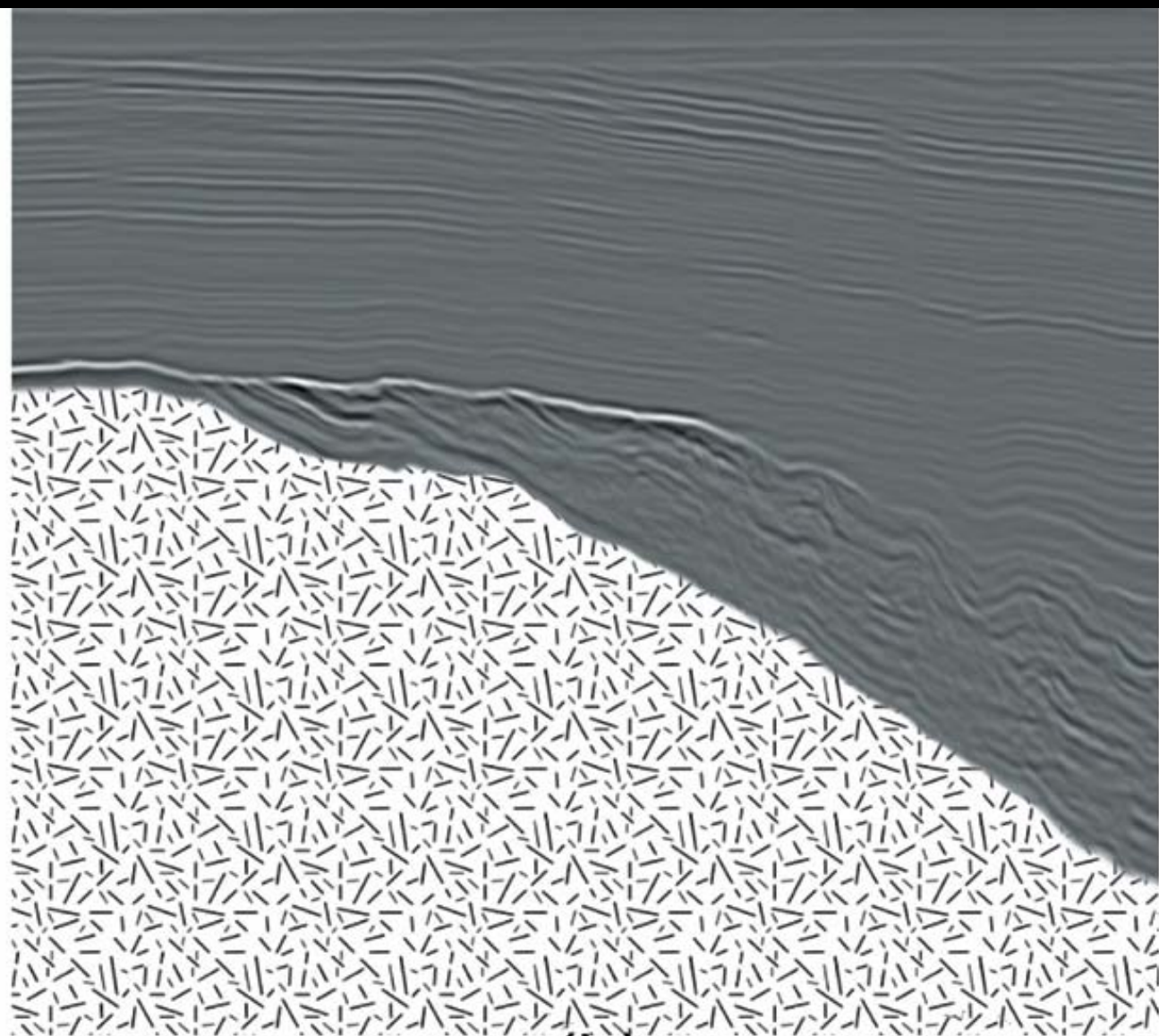


- Textures are extrapolated along horizons by using a parameterization

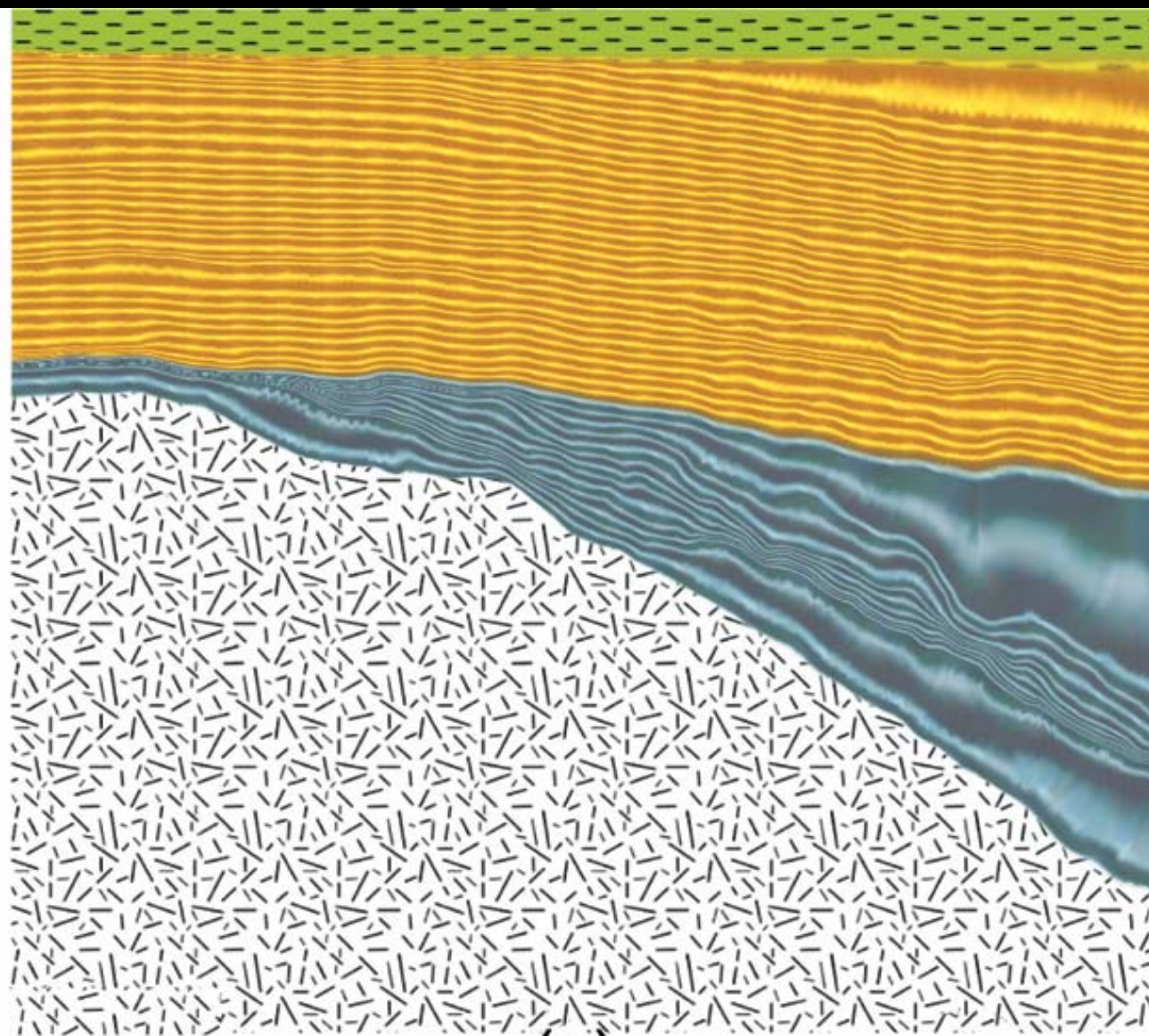
Results – use case developed with StatoilHydro



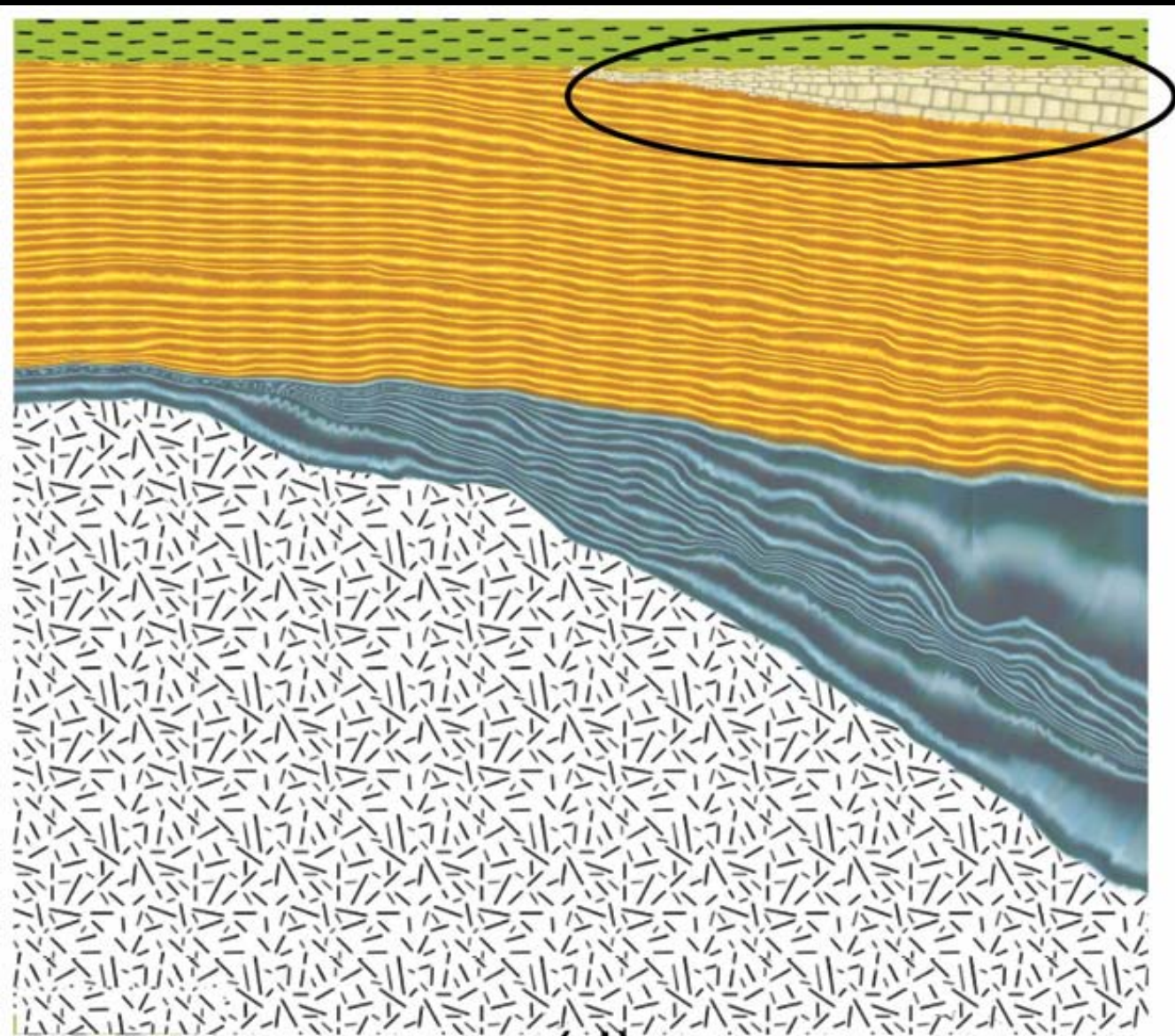
(a)



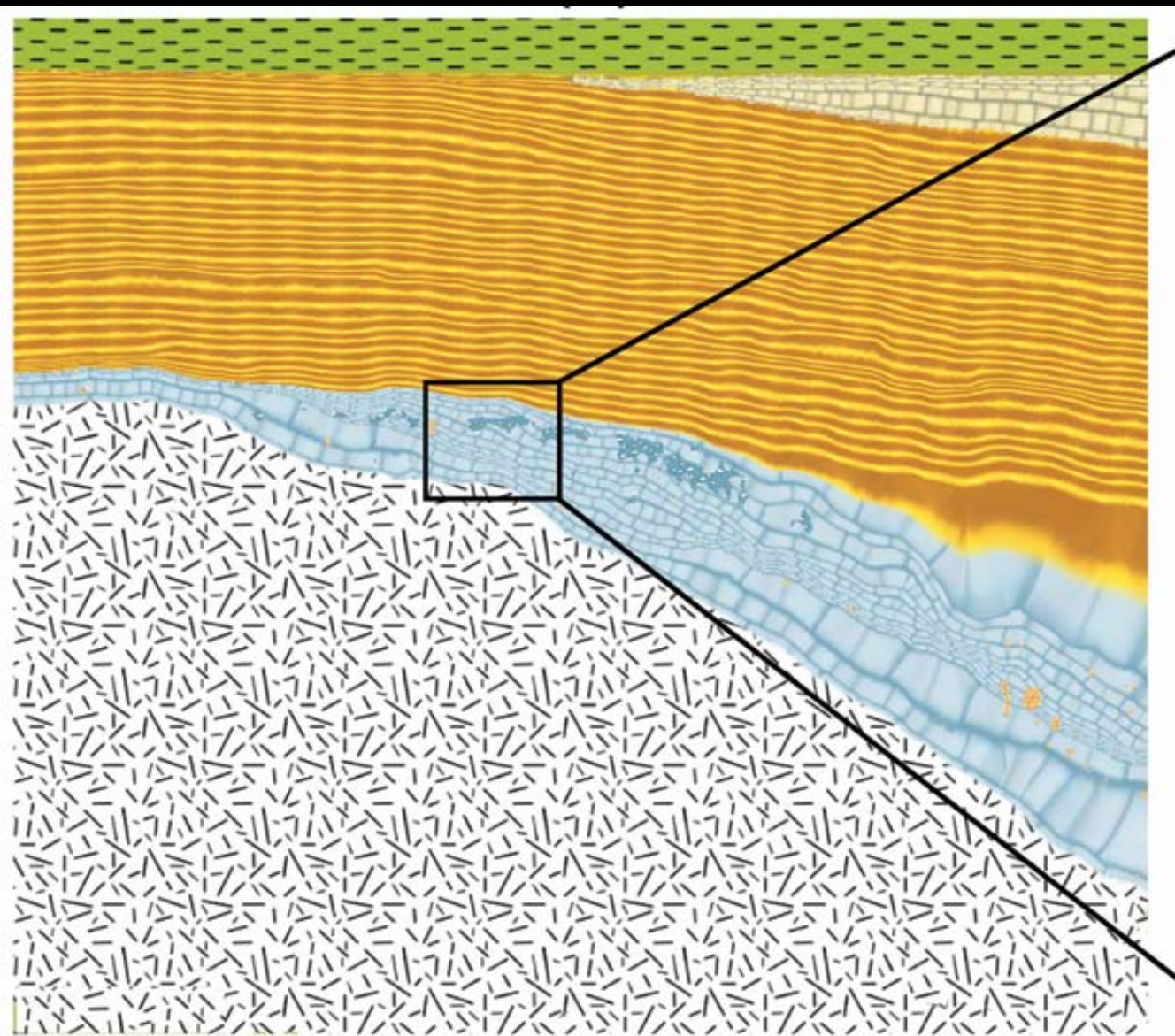
(b)



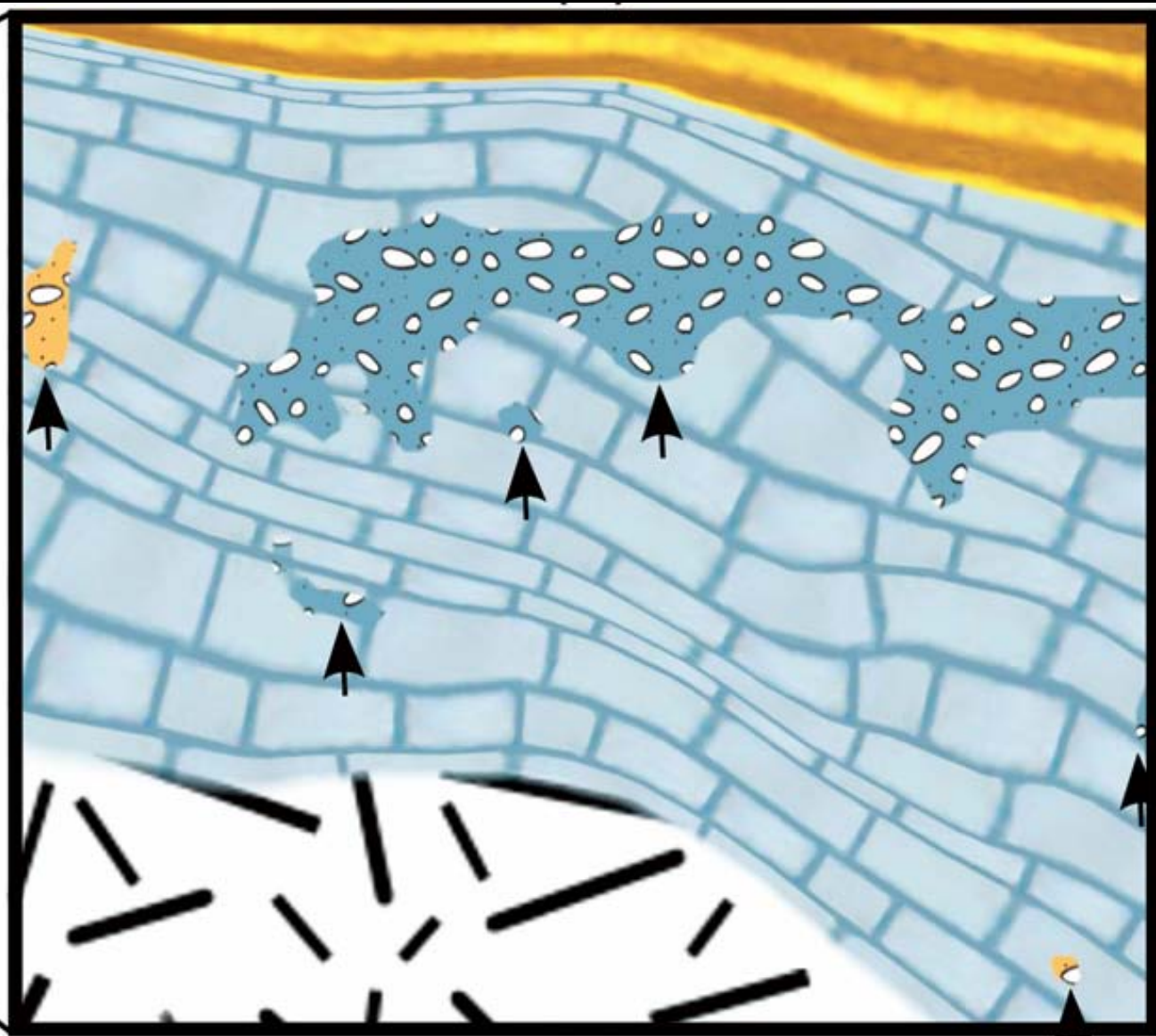
(c)



(d)



(g)



(h)

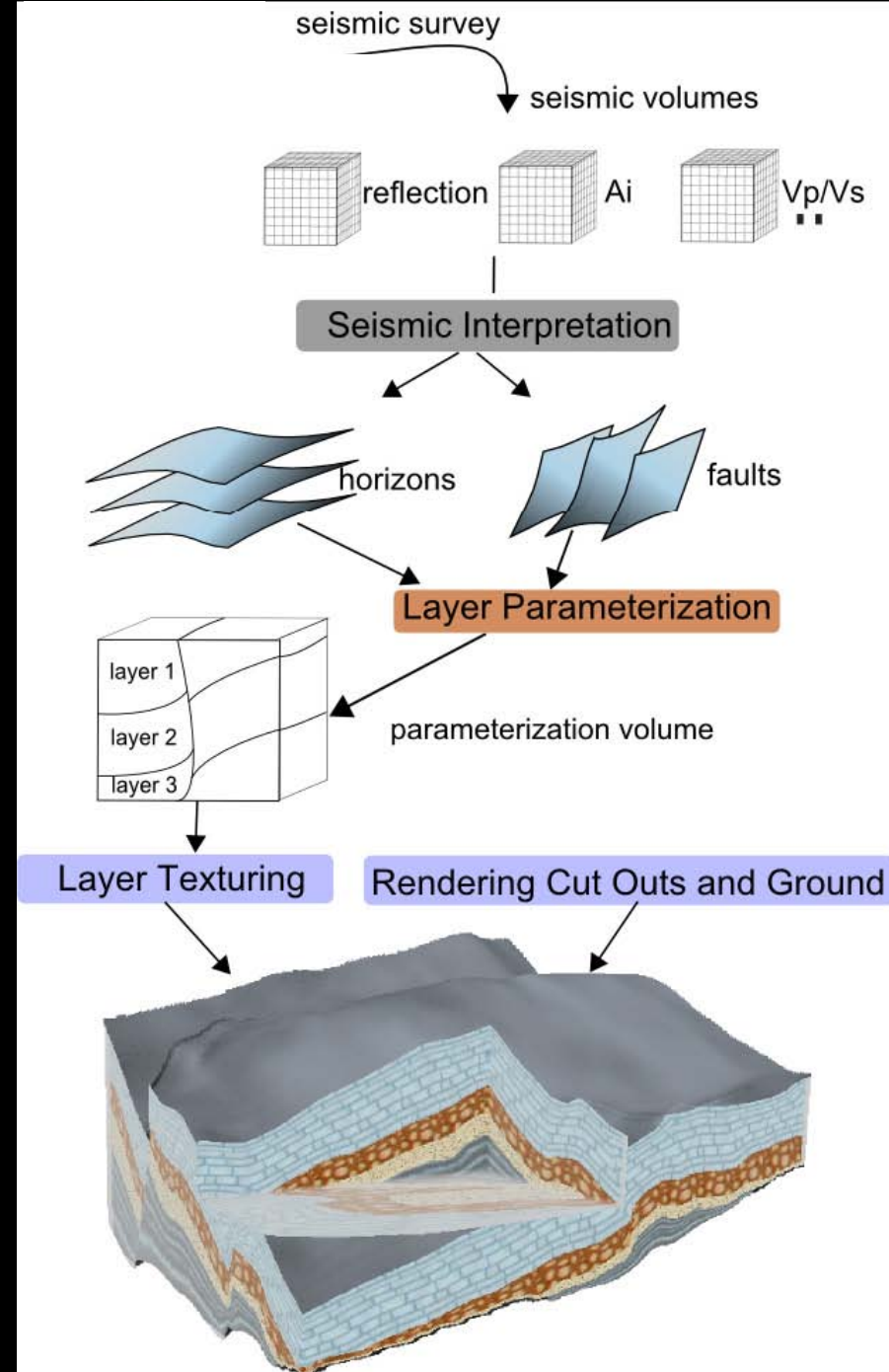
Illustrative rendering of uninterpreted data

- Tight interpretation-illustration loop speeds up interpretation
- Work faster by studying combinations of attributes instead of one at the time
- Communicate easier by sharing expressive images instead of mental images
- A good way to handle seismic data with its chaotic nature
- Textures give an integrated visualization of layers, faults and attributes
- Images are aesthetic regardless of zoom factor

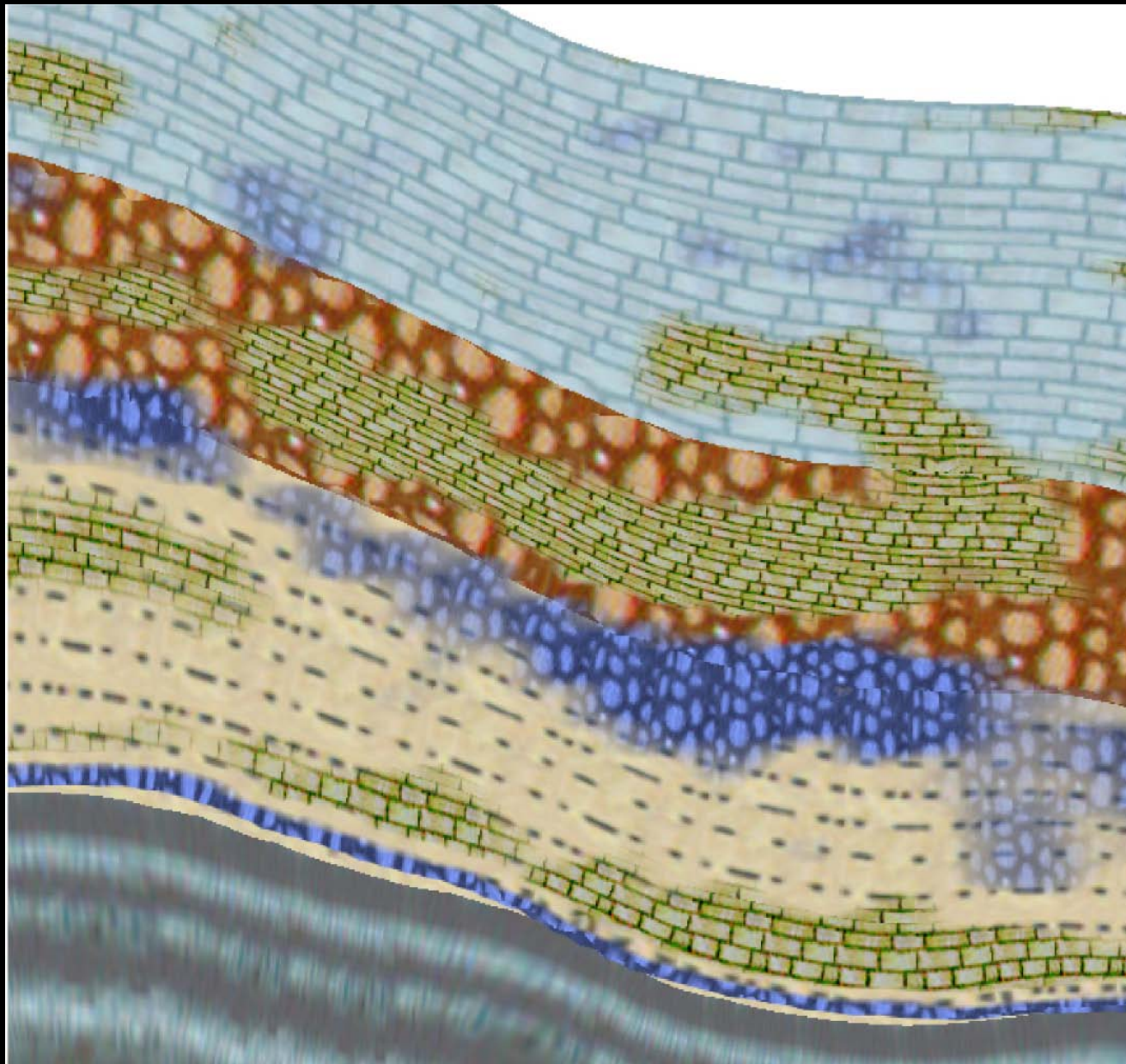
Illustrative rendering of *interpreted* data

Illustrative rendering of faults, layers and cut outs

- Horizon and fault surfaces define a parameterization volume
- Parameterization volume describes texture flow and layer segmentation
- By moving a roaming box into the dataset a cutout is created



User-configurable textures



Legend



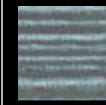
Layer 1



Layer 2



Layer 3

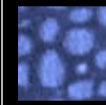


Layer 4

Reflectance



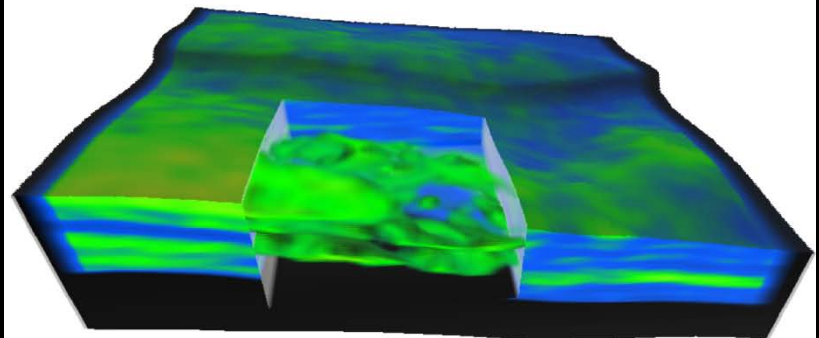
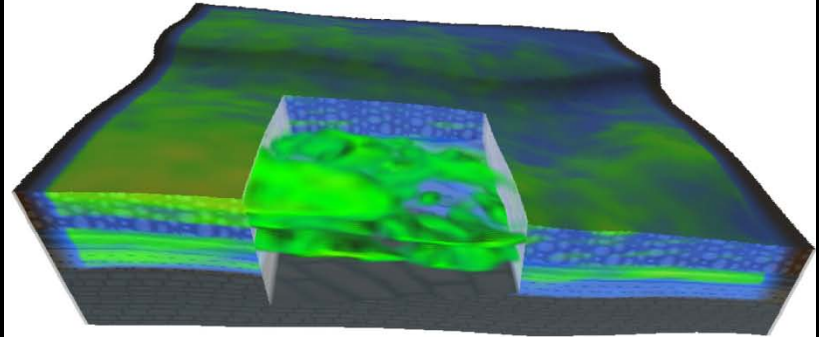
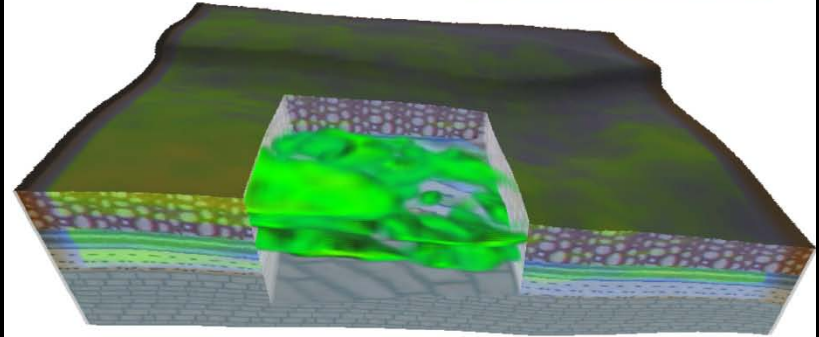
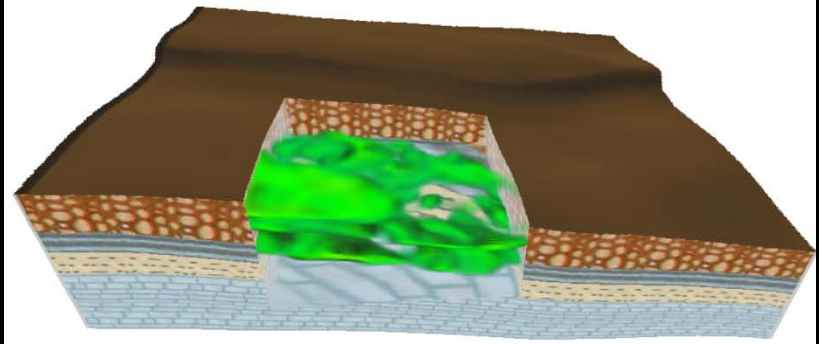
High values



Low values

3D features

- Volume rendering in cut outs
 - Targeted in selected layers or regions of interest
- Smooth blending in 3D
 - From interpreted to uninterpreted data for verification

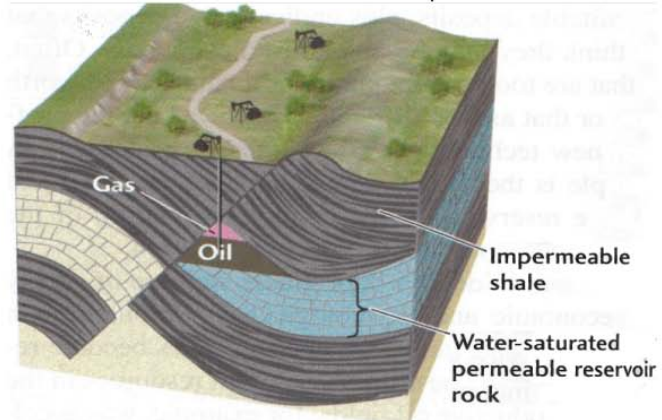
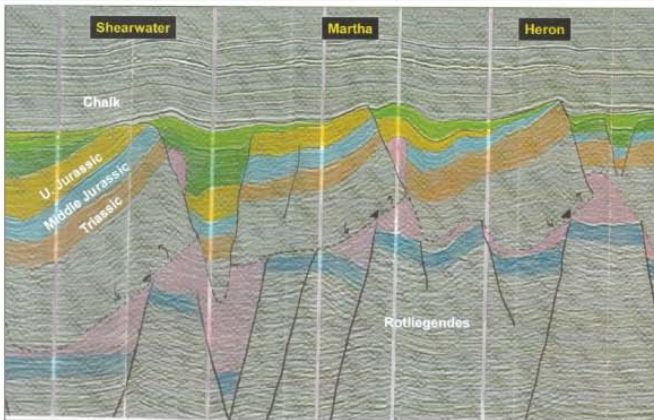
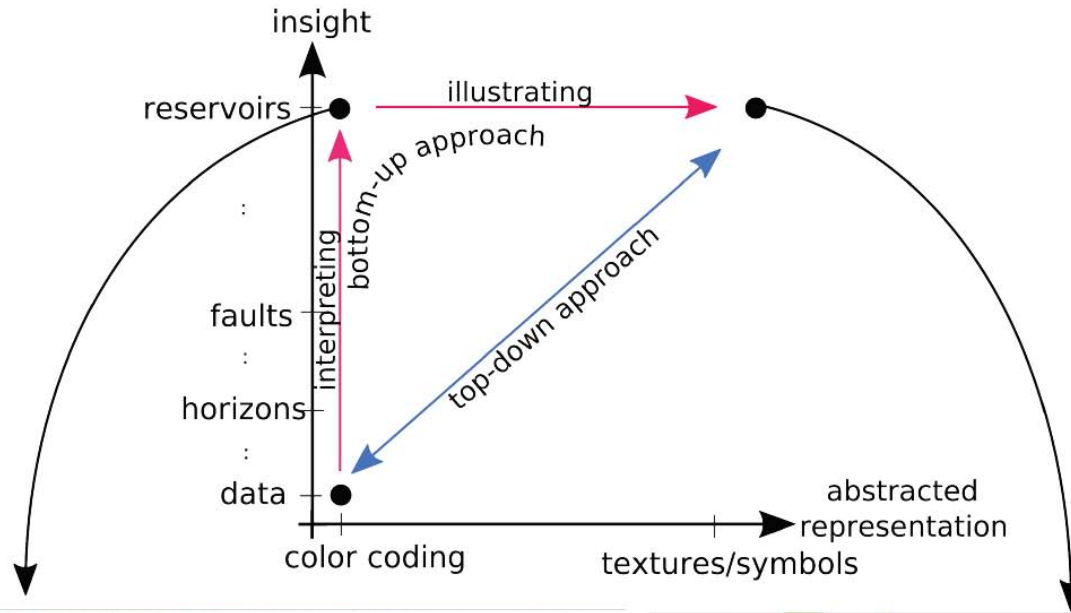


Illustrative rendering of *interpreted* data

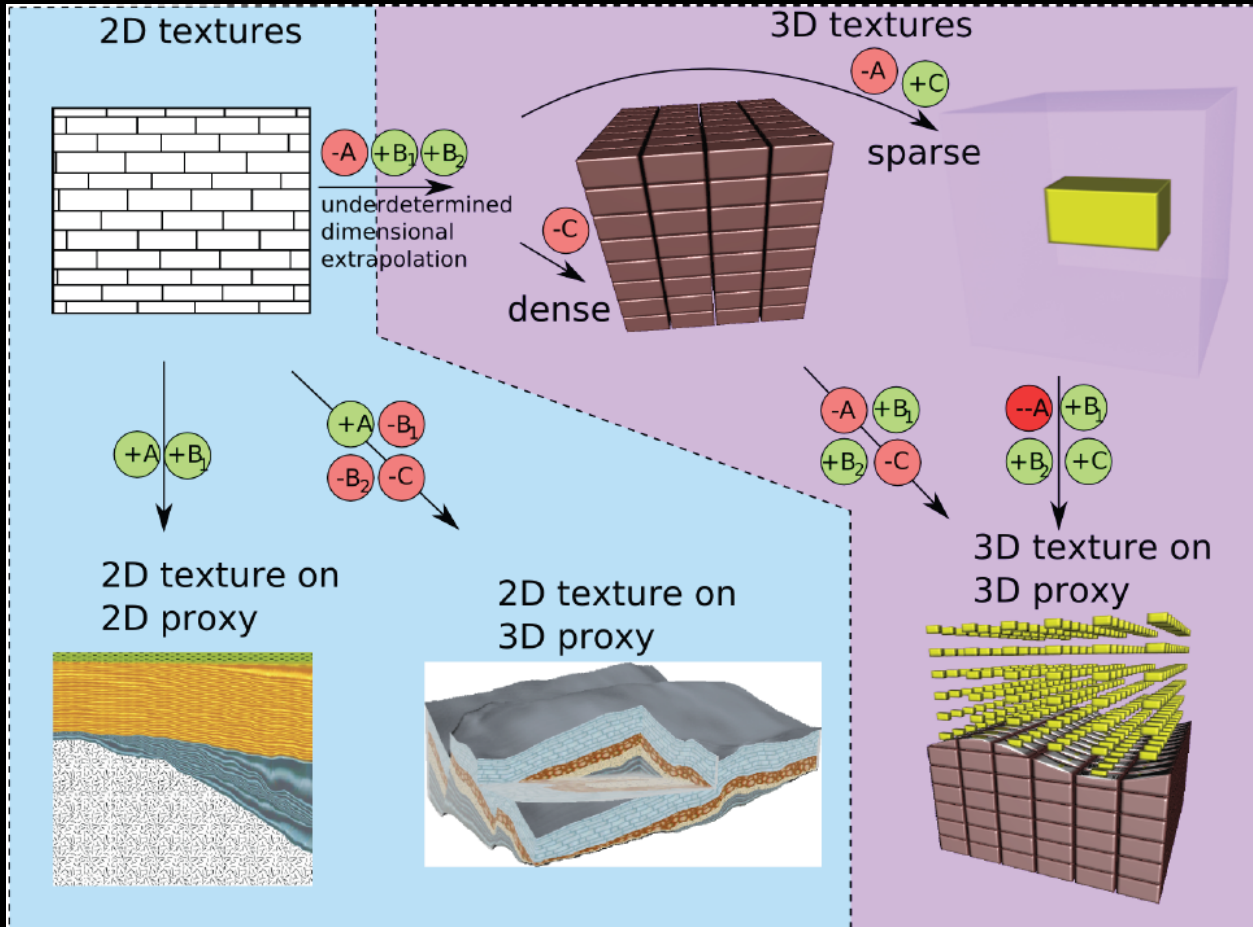
Advantages of geology illustrations

- all big oil companies have illustrators, this can cut time and cost
- for use in reports and government drilling applications

Comparison

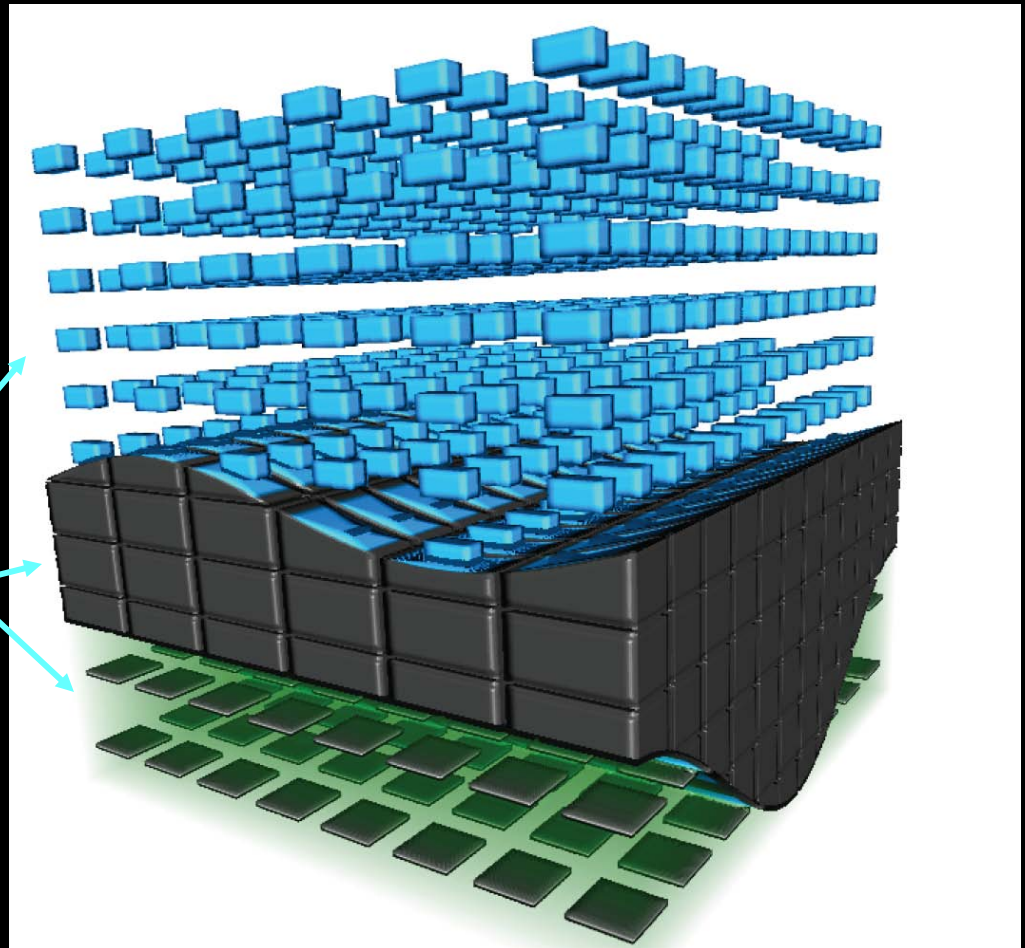
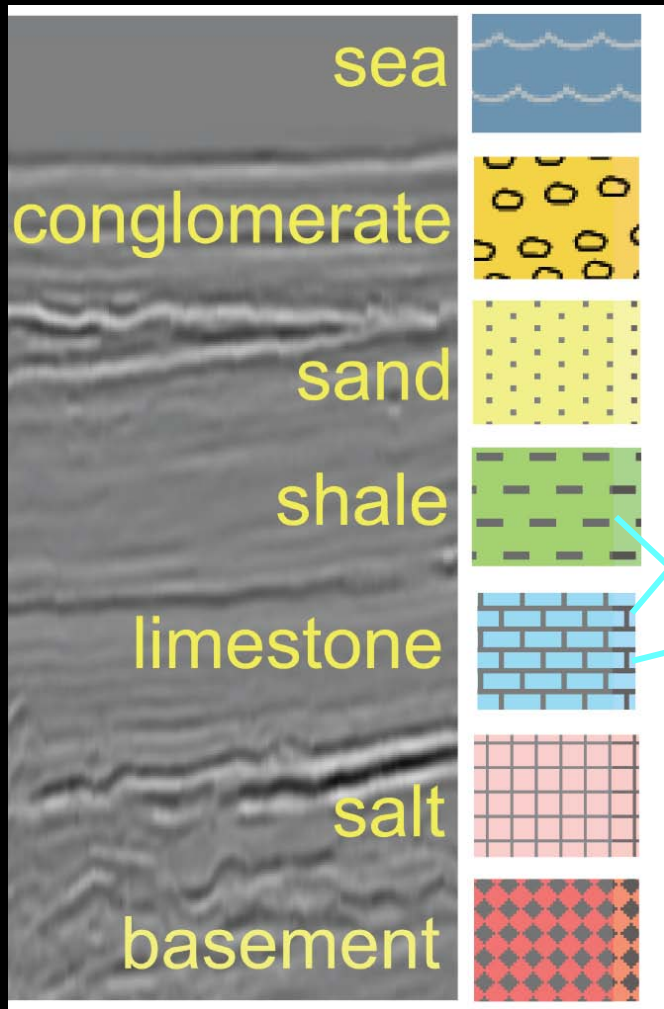


2D vs 3D texturing



- (A) Recognizability after final projection to 2D screenspace
- (B₁) Spatial coherency
- (B₂) Frame-to-frame coherency when moving cut-plane
- (C) True 3D that works with transparency

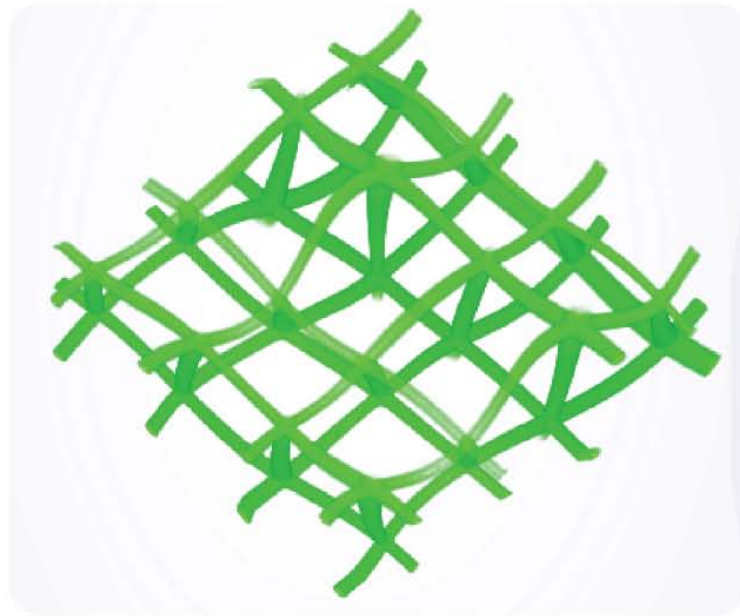
From 2D textures to 3D textures



Deformed 3D sparse textures



a)



b)



c)

THE END