



Complex Overthrust Land Example: 3D Simulation and Imaging

Wave Imaging Technology Inc.

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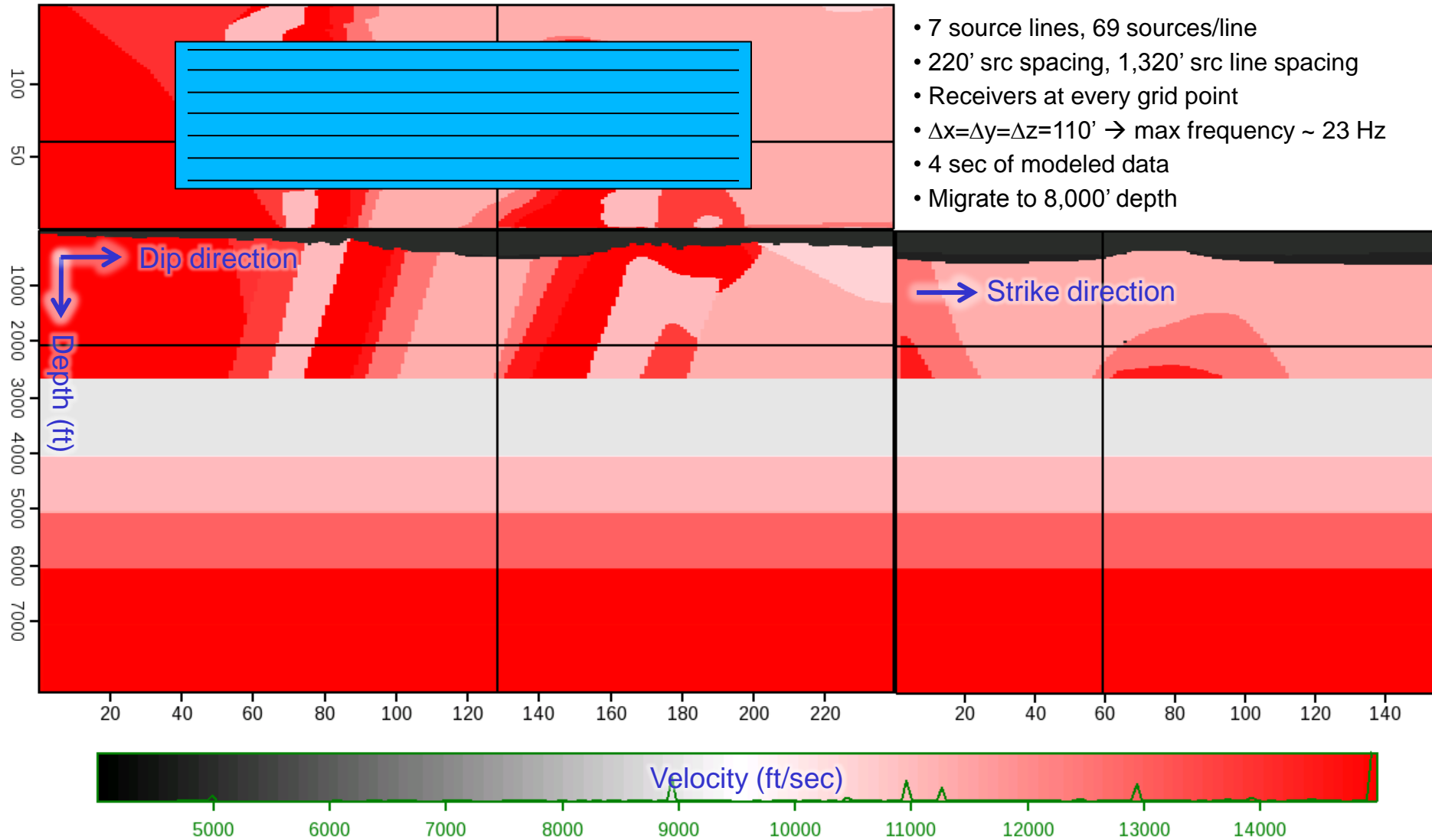


Summary

- 3D geologic model (with guess at velocity) was used to construct an earth model for a full wave simulation and imaging project.
- Model extends only about 3000' below the surface; flat reflectors were inserted below the shallow model. Total depth: 8000'
- 483 full-azimuth shot gathers were simulated (7 source lines of 69 shots each) and migrated with WIT's wave equation shot record migration.

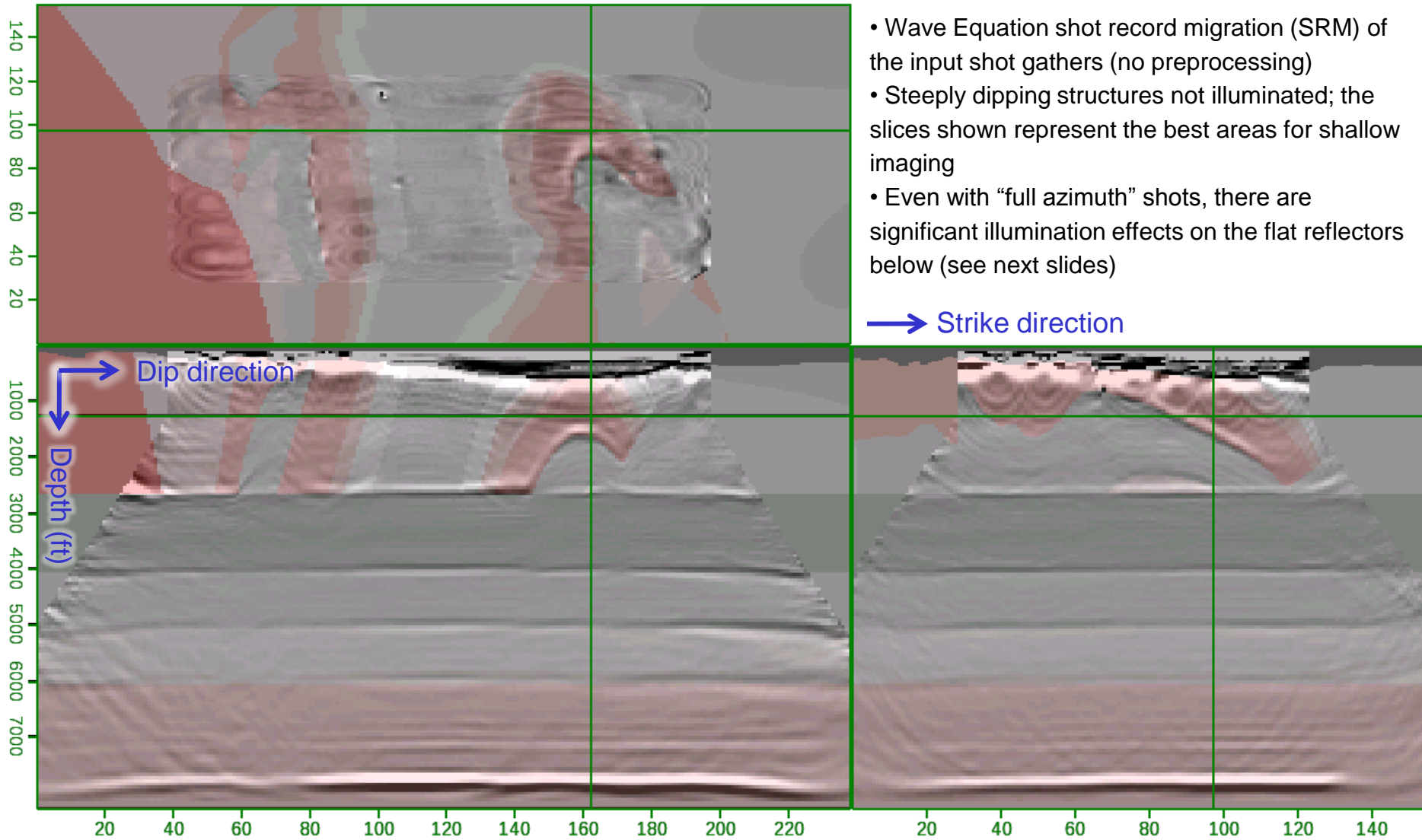


Velocity Model and Survey Geometry





SRM Image



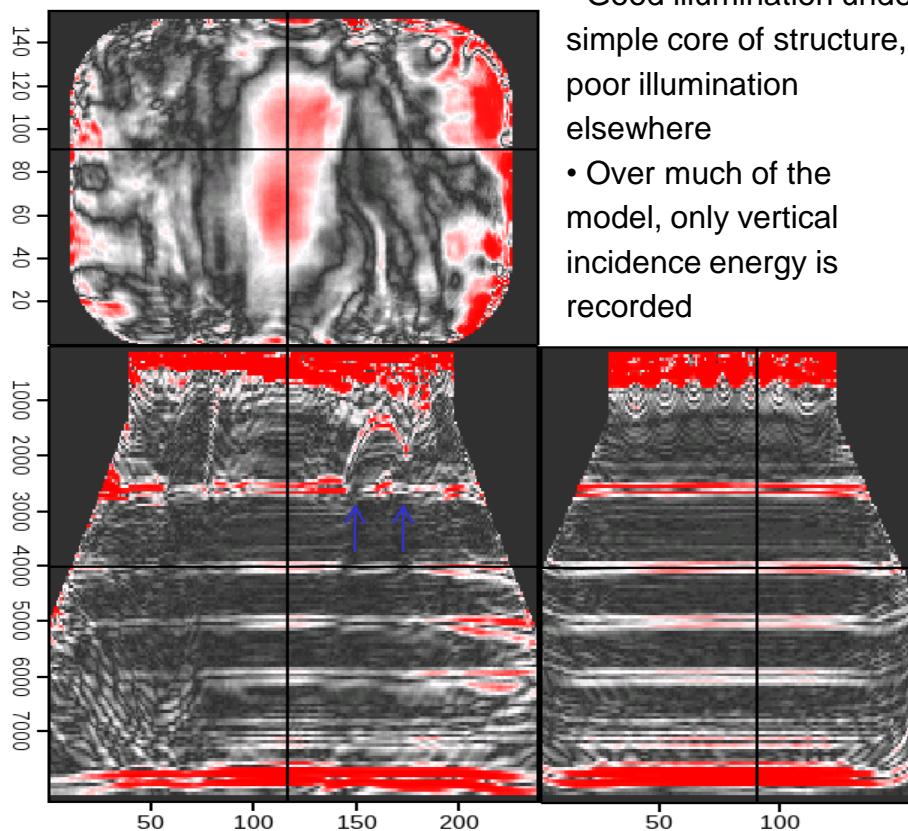
|SRM Image| and Illumination

Main Navigate View Orient Display Clip

General Wiggle Contour

Data: cgsi Overlay: grey Opacity: [slider] Lines: red

- Absolute value of the SRM image, with depth slice taken through reflector at $z=4,000'$.
- Good illumination under simple core of structure, poor illumination elsewhere
- Over much of the model, only vertical incidence energy is recorded

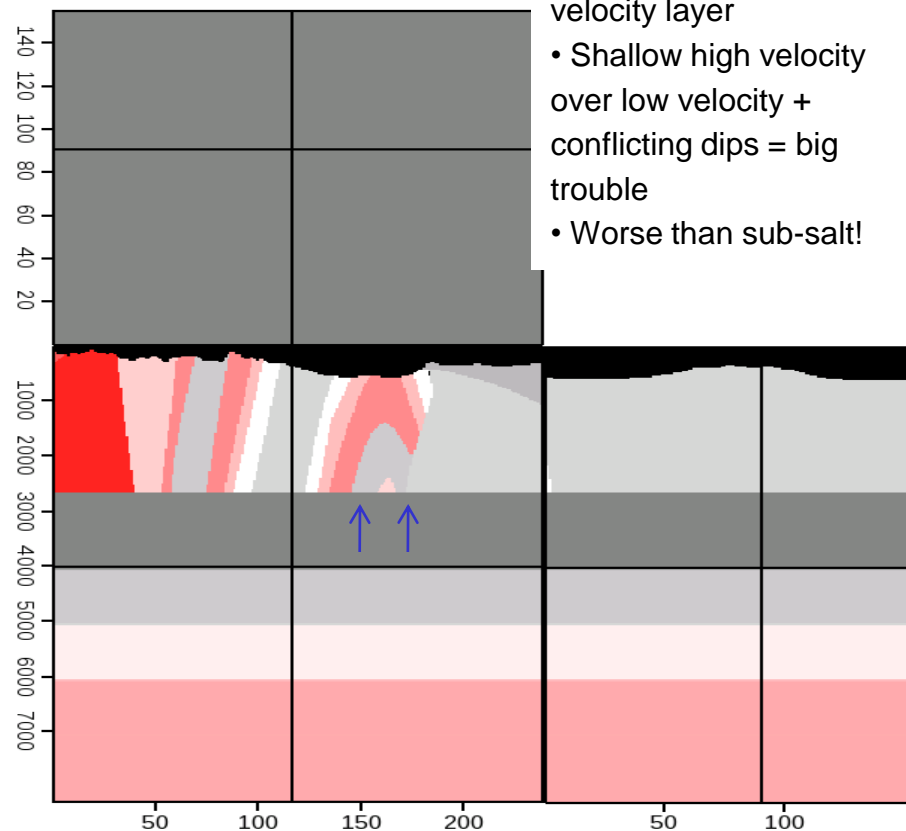


Navigate View Orient Display Clip Aut

General Wiggle Contour

Data: cgsi Overlay: grey Opacity: [slider] Lines: red

- The blue arrows illustrate almost zero illumination under a steeply dipping high velocity layer
- Shallow high velocity over low velocity + conflicting dips = big trouble
- Worse than sub-salt!



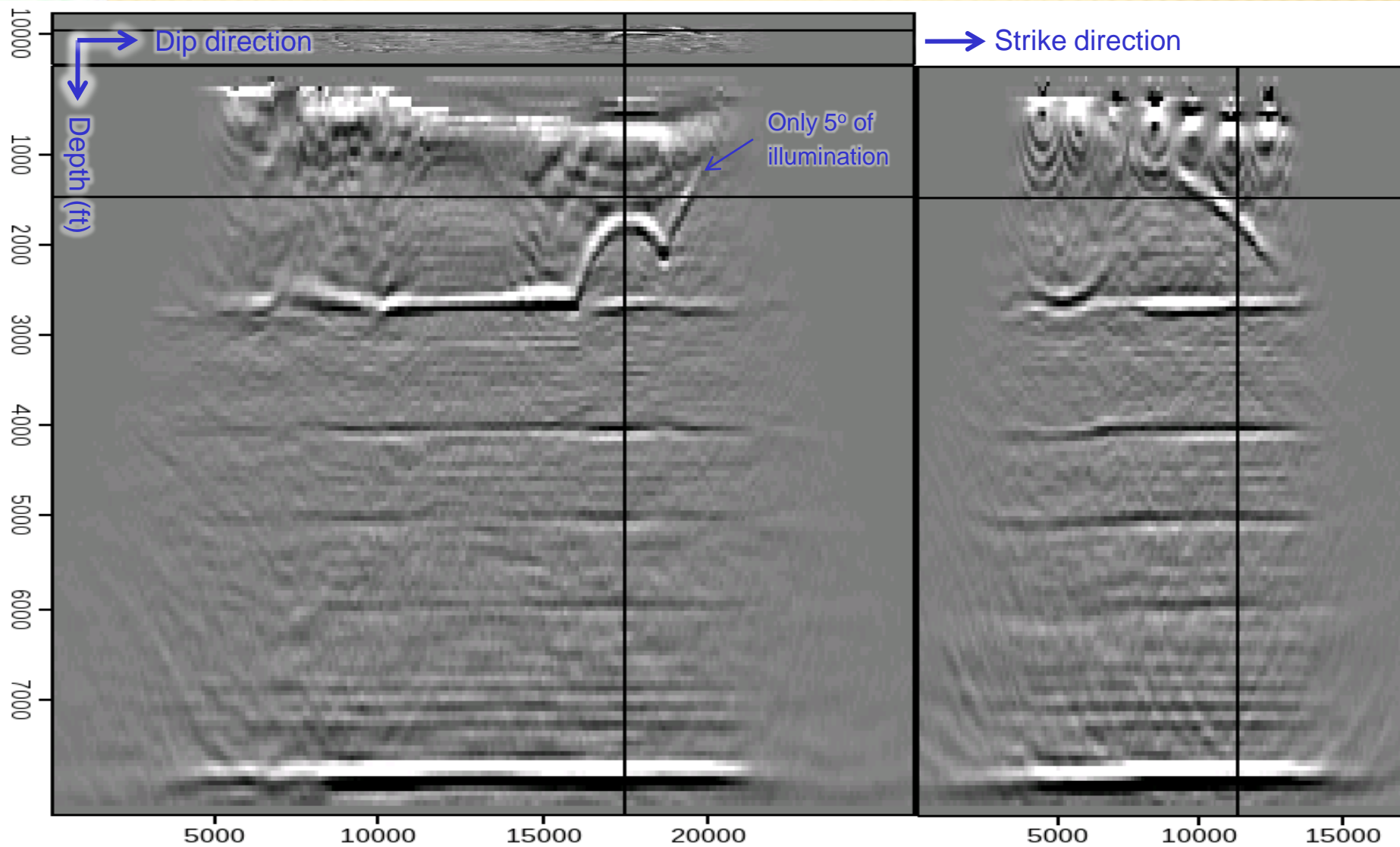


Angle Decomposition Imaging Condition

- An exciting new WIT technology is the ability to decompose Wave Equation SRM images according to incidence angle or azimuth angle at the reflector.
- Besides the obvious application to AVA/AVO work, opportunities exist to do **true** azimuth-based processing
- Here, we focus on using the incidence angle images to understand the amount of “angular bandwidth” in the data—poor angle range implies poor velocity resolution ability

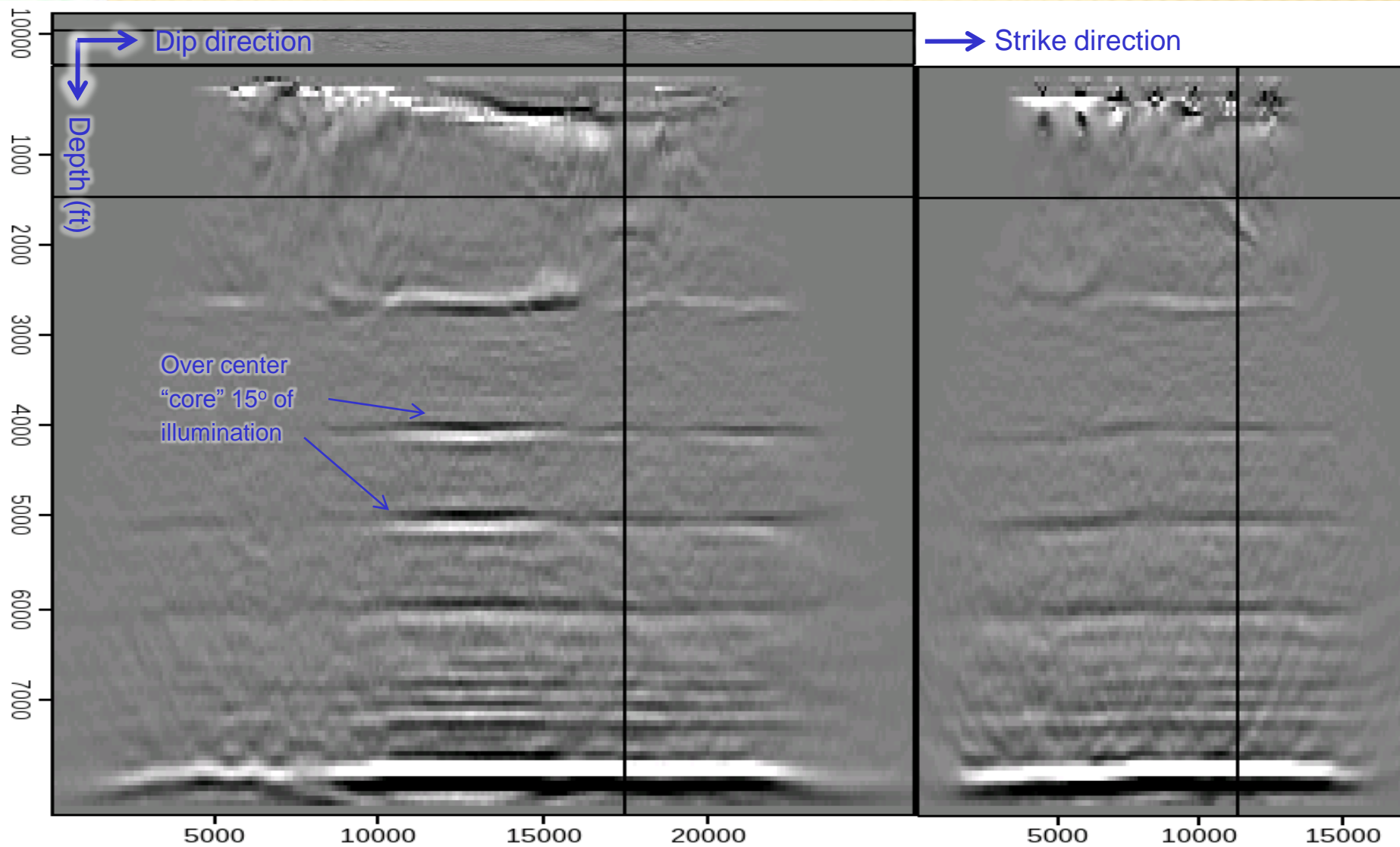


Angle Decomposition 0-5° image



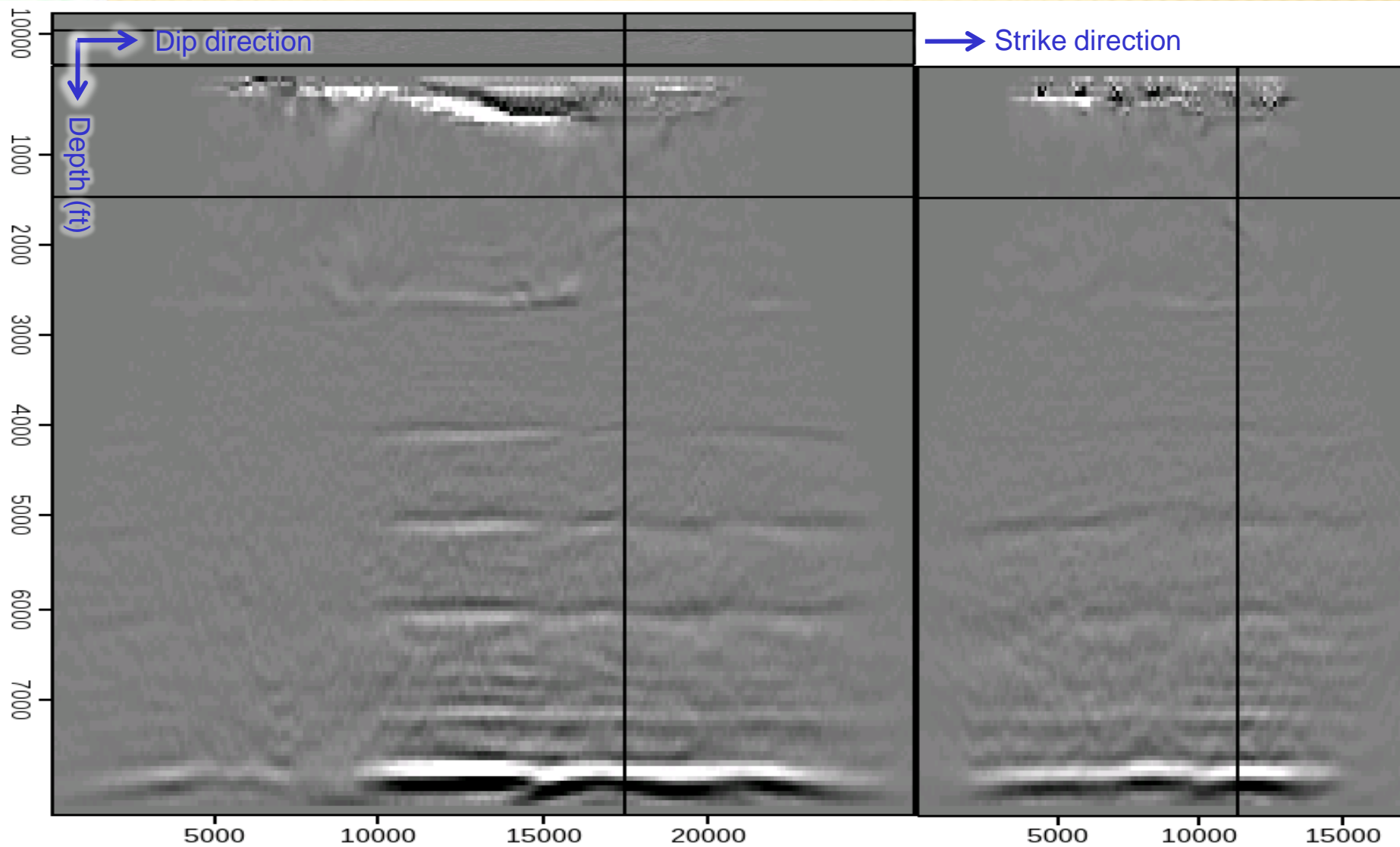


Angle Decomposition 10-15° image



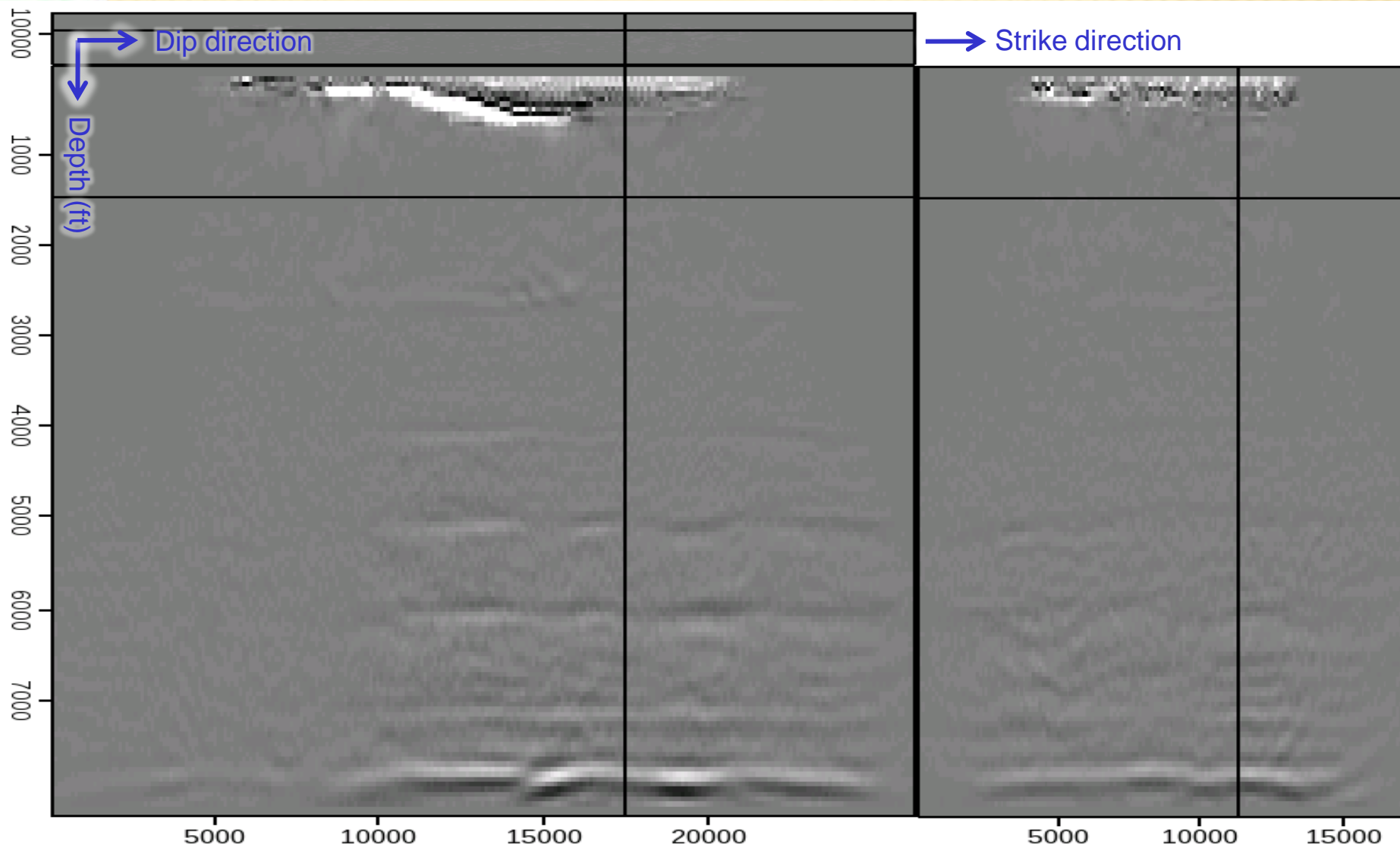


Angle Decomposition 20-25° image





Angle Decomposition 30-35° image





Full Volume Angle Gathers

qt_cube

Main Navigate View Orient Display Clip Auto Region Picks Help

Main Data Save Show Extras

Save

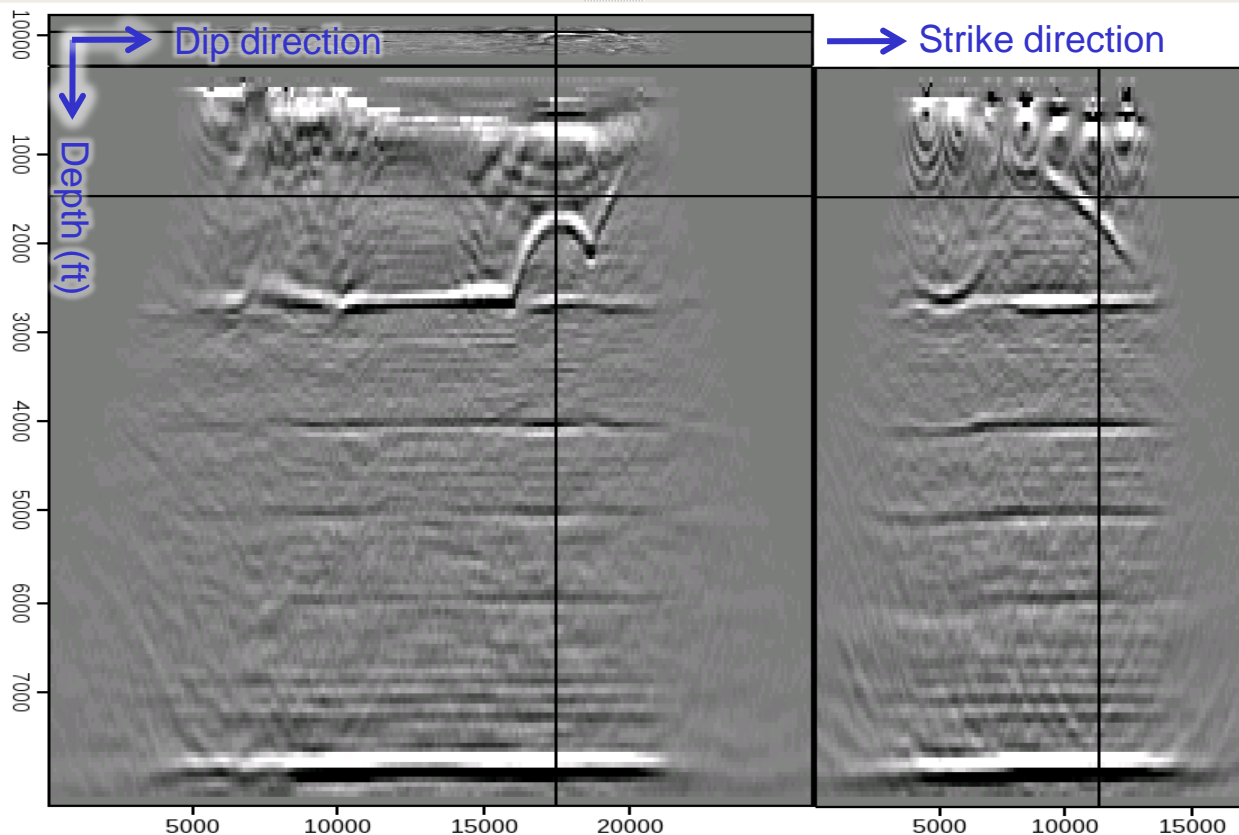
ppm ps-S ps-B

Navigate View Orient Display Clip Auto

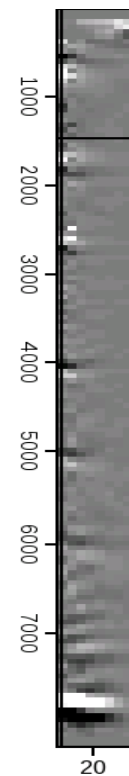
Movie Direction

Movie Direction

-Z +Z -X +X -Y +Y



Incidence Angle (deg)



- The angle volumes may be arranged into “angle gathers”, one for every (x,y) location in the model
- Normally, for a fixed offset range, we have wide illumination up shallow, narrowing with depth
- Here, we see very limited angle range up shallow, broader at depth
- Energy is trapped in “wave pipes”; only record normal incidence
- At depth, we are able to “undershoot”



Conclusions

- Full-azimuth simulation over simplified 3D model
- Illustrated a serious imaging problem
 - Poor imaging of steep dips → hard to build/update earth model
 - Poor “angular bandwidth” → Poor resolution of velocity
 - And this was with flat layers down deep! Extrapolating the same steep dips would mean nearly impossible imaging
- Other ways to leverage these studies
 - Test various acquisition geometries
 - Acquire synthetic 2D/3D walkaway VSPs
 - Test seismic response of various geologic interpretations
 - Decide to cancel a seismic shoot!