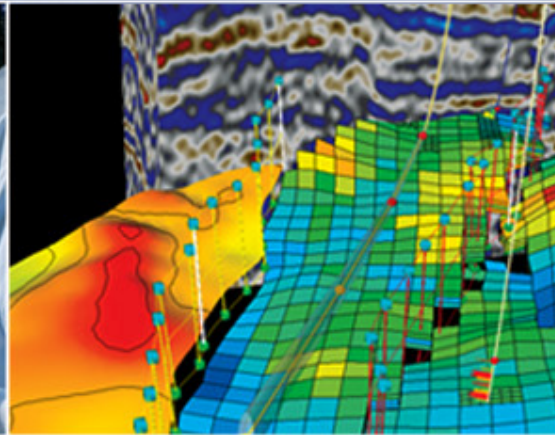


Reduce Depth Uncertainty with Real-Time Borehole Seismic

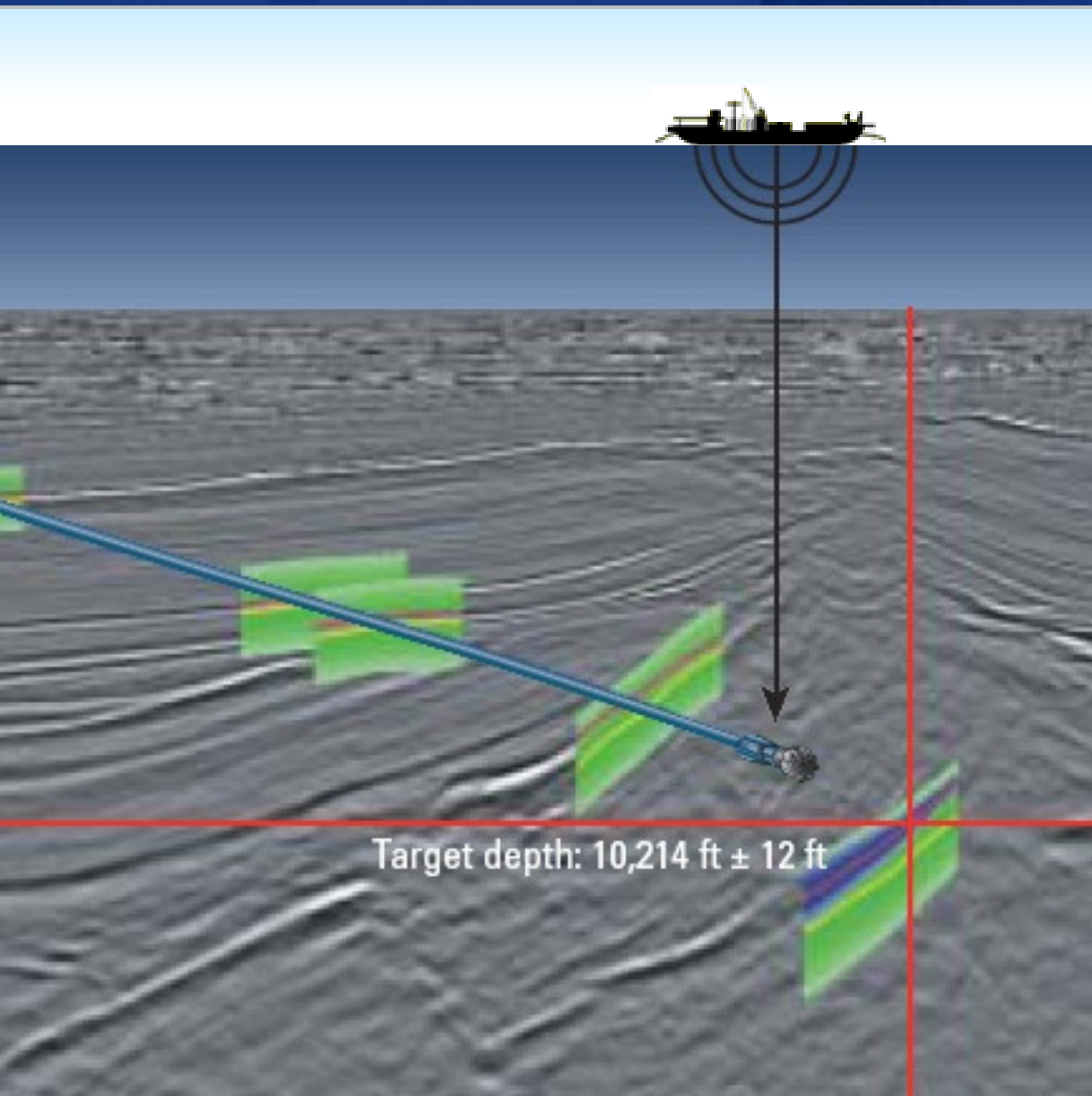
Wade McCutcheon
Vice President, Schlumberger North America



Innovative and Integrated Solutions

Schl

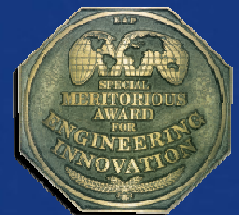
VISION—Borehole Seismic on LWD



World Oil
AWARDS 2004

OTC 2004 winner

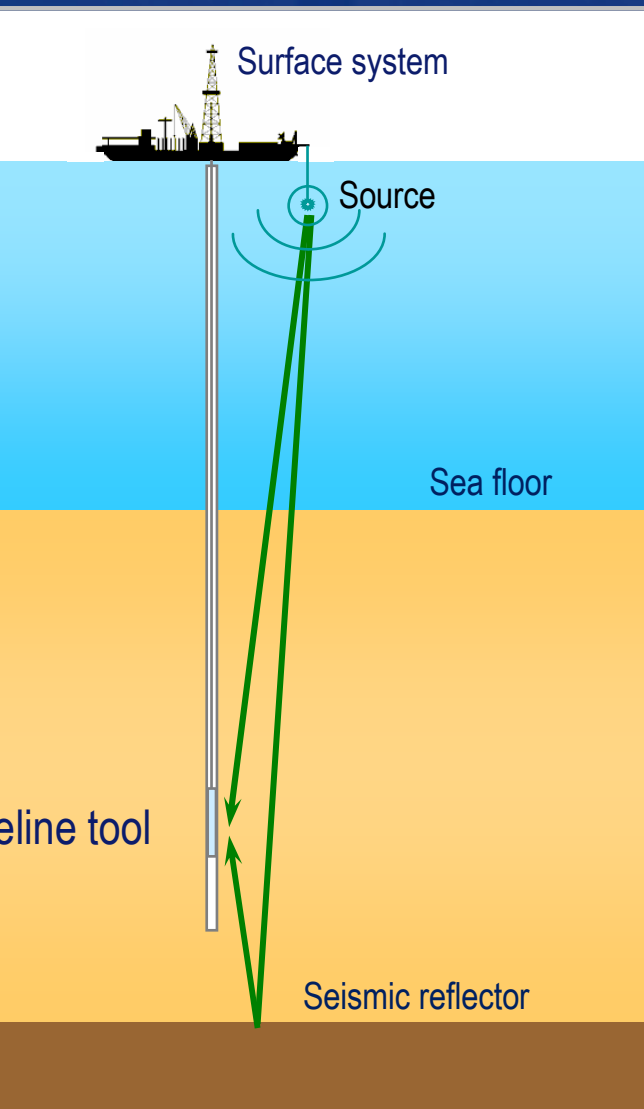
Spotlight
on new
TECHNOLOGY



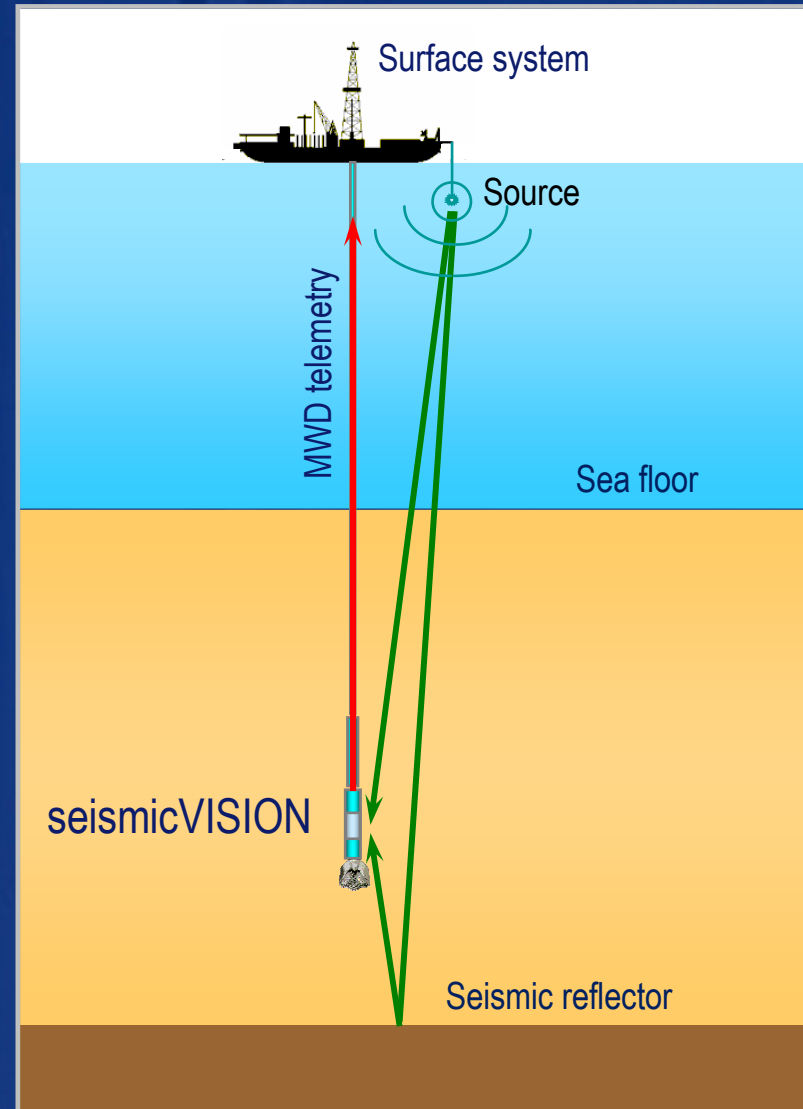
Schlumberger

er of Technology to Drilling Ops

Wireline Borehole Seismic



seismicVISION



Mode of Operation

Use air gun source

Use geophones and hydrophone

Use synchronized high precision clocks

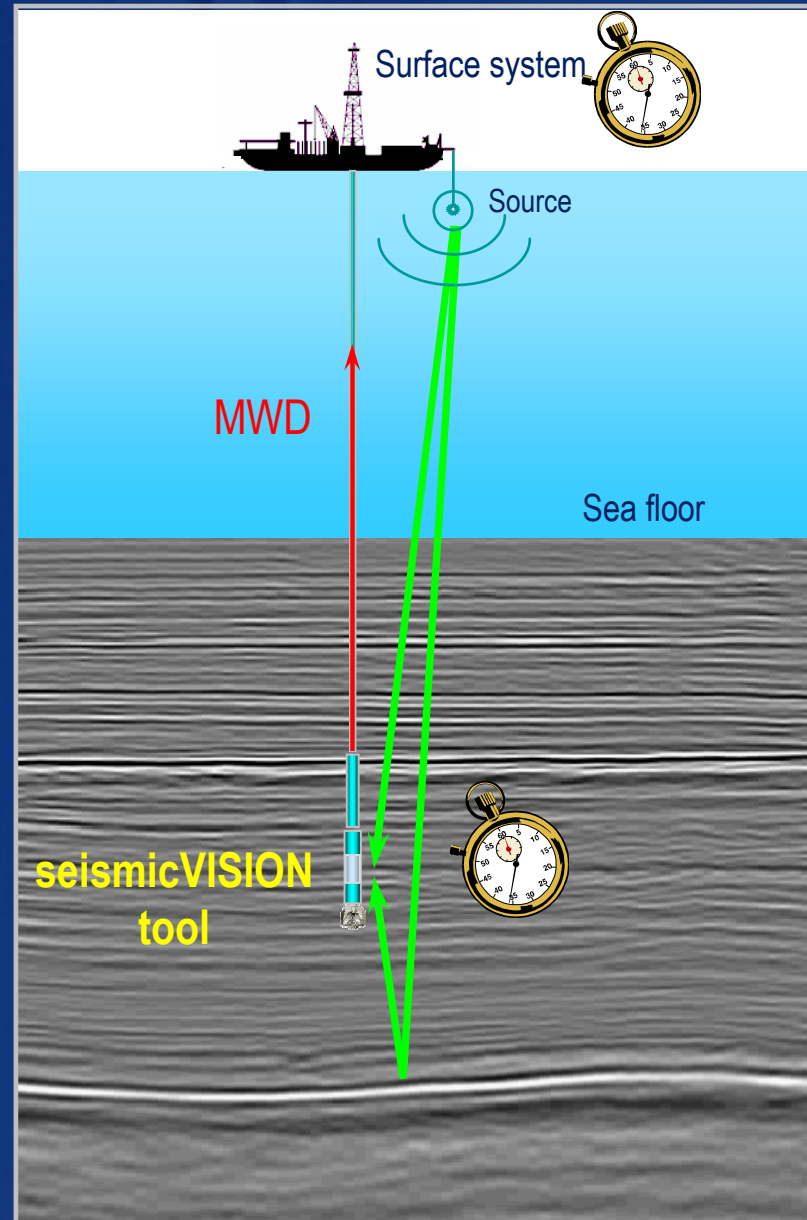
Seismic forms recorded in

Tool joint memory

Onboard processing

Time check shot via

Telemetry



Time Waveforms

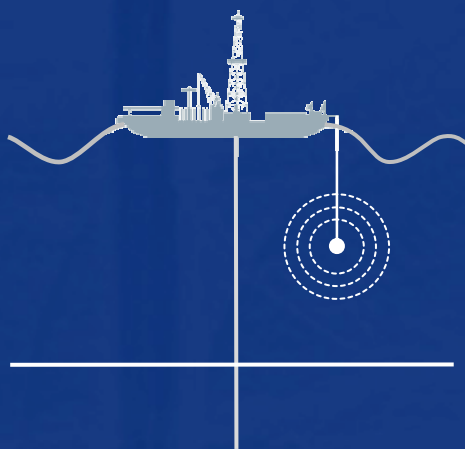
Improved quality control
Fast arrival

Improved interval velocities

Industry first seismic look-ahead
Capability in real time



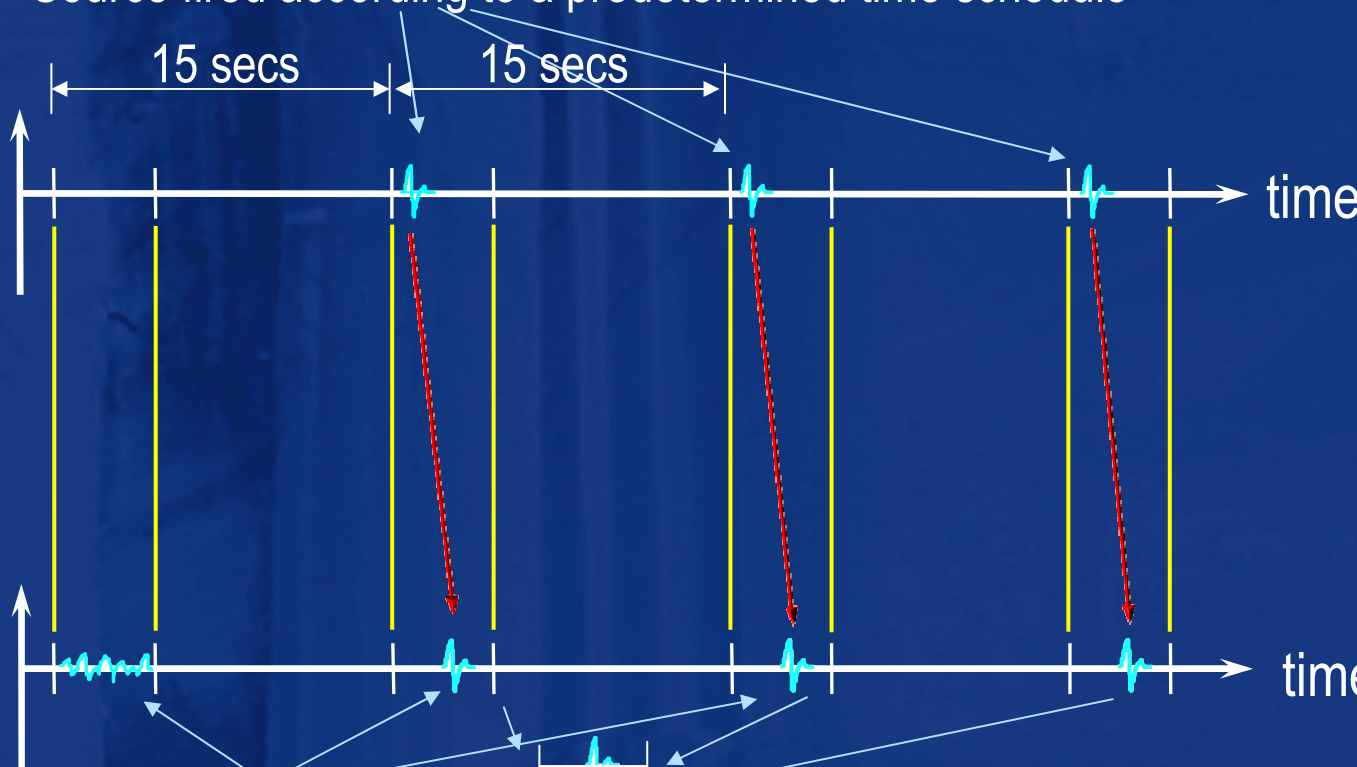
VISION Acquisition Timing



h



Source fired according to a predetermined time schedule



Downhole system records data on predetermined time schedule synchronized with surface. Surface and downhole are synchronized and cycles begin. Transit time T_r . Every 15 seconds are stacked downhole and a time pick taken from the stacked result, sent uphole once pumps resume.

s and Applications



reduces depth uncertainty

saves rig time and cost

reduces casing runs

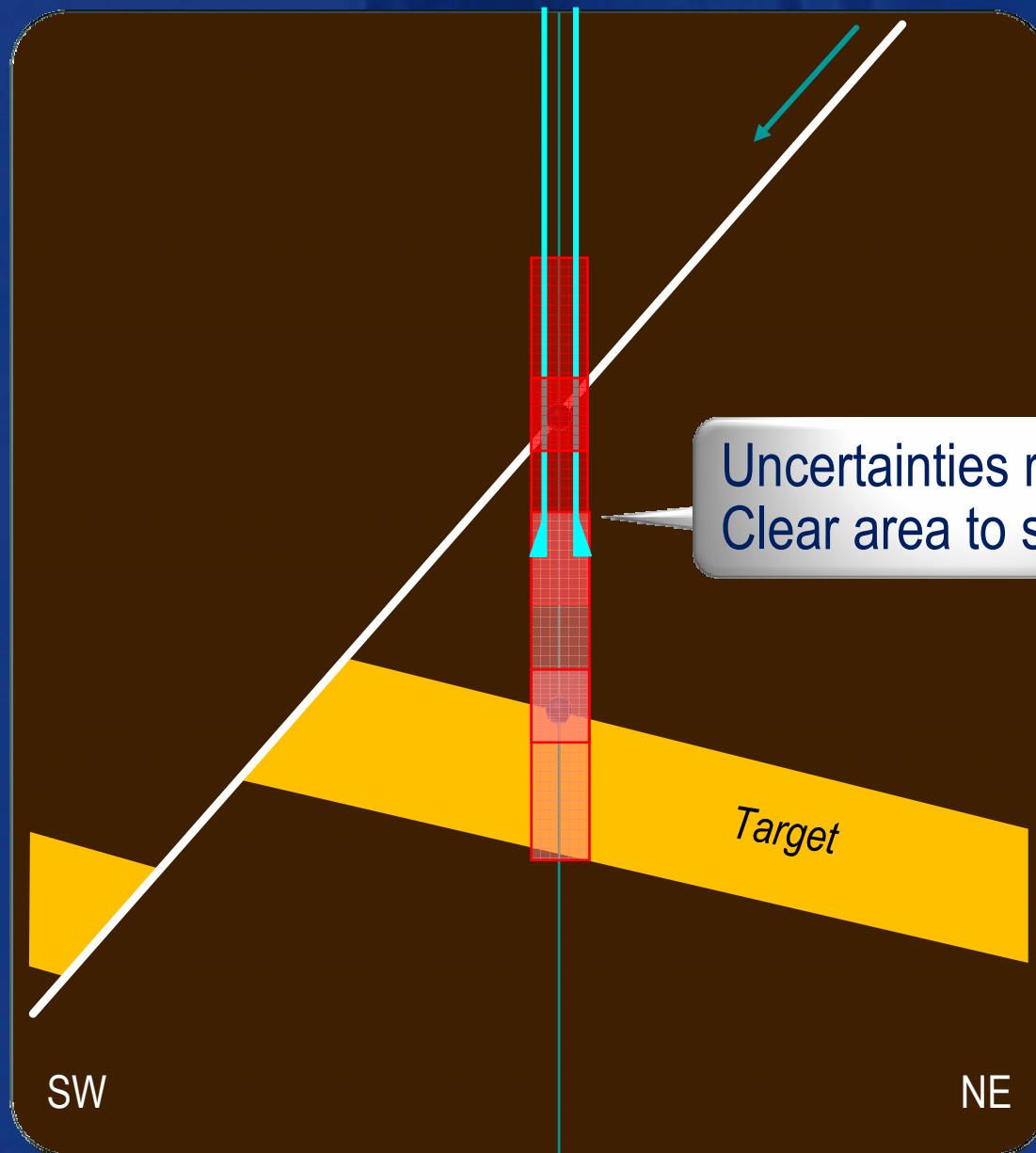
reduces sidetracks and pilot holes

improves safety

- Put the bit on the seismic
- Casing and coring point se
- Target depth prediction
- Landing well without pilot
- Pore pressure prediction/c
- Salt proximity

SeismicVISION Used to Select Casing Point

Uncertainties taken in real time
to reduce uncertainty



Problem:
Setting casing below
and above target

Uncertainties reduced:
Clear area to set casing

Study—Real-Time Seismic Steering with seismic Gulf of Mexico

Plan

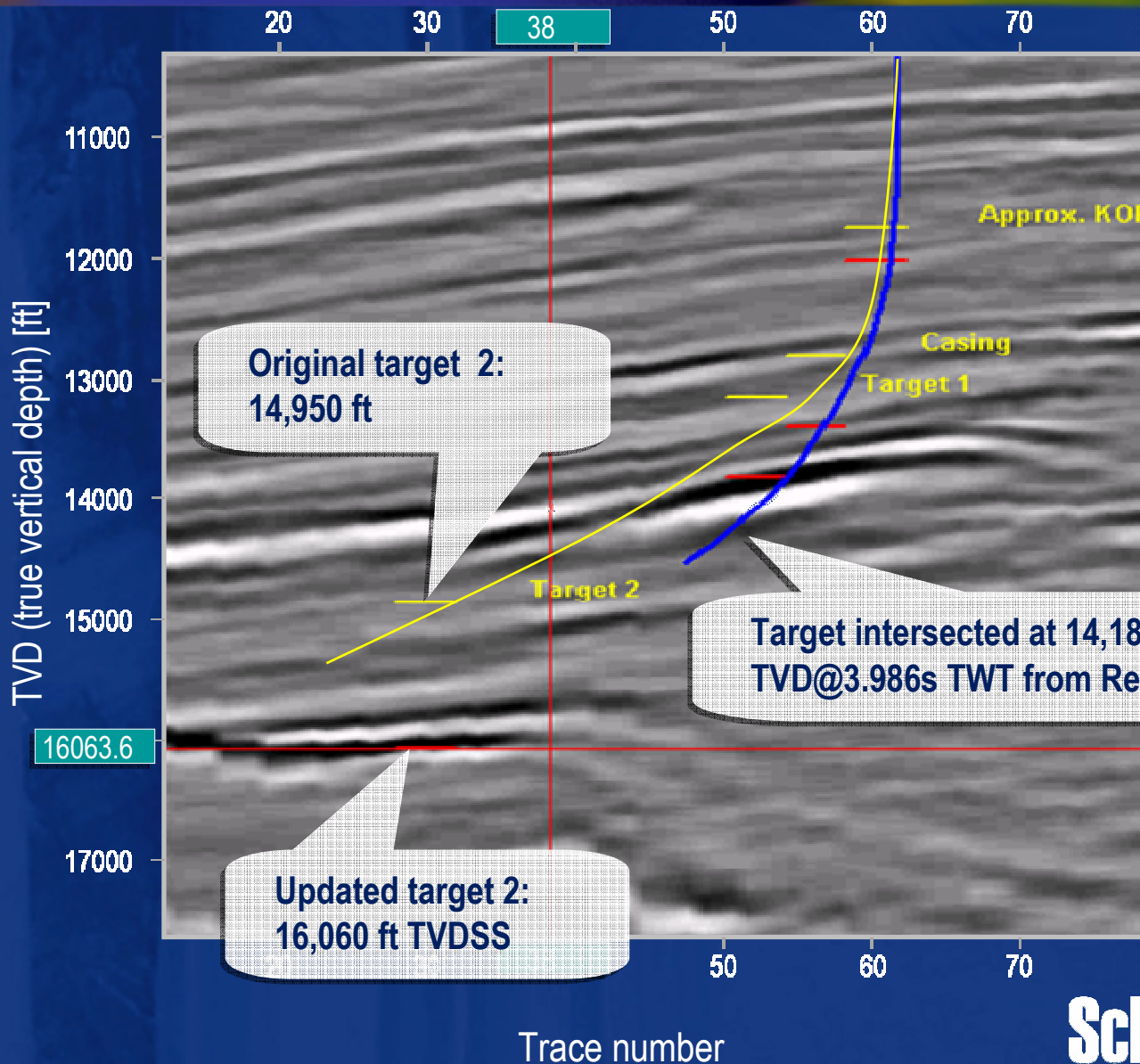
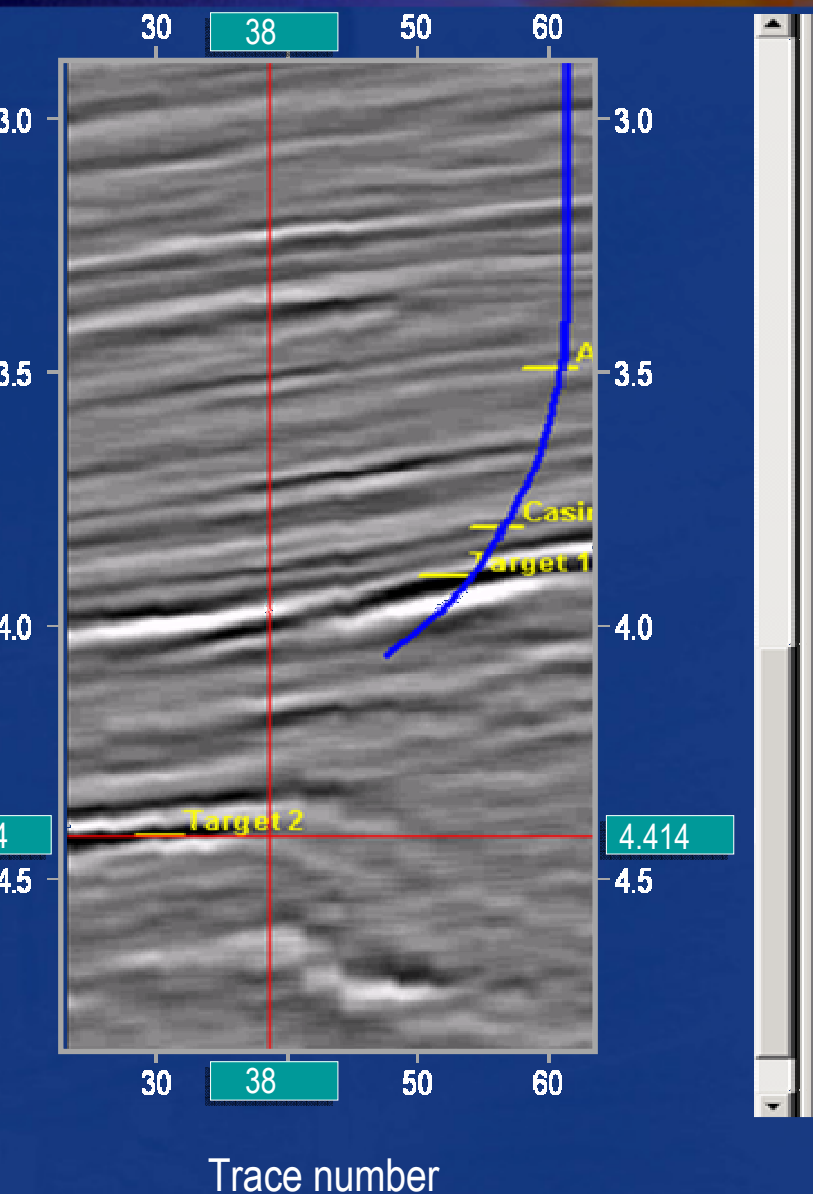
Steer well to intersect two targets at optimal locations at end of stratigraphic trap

Location critical to identify reservoir size/flank and economic hydrocarbon volume

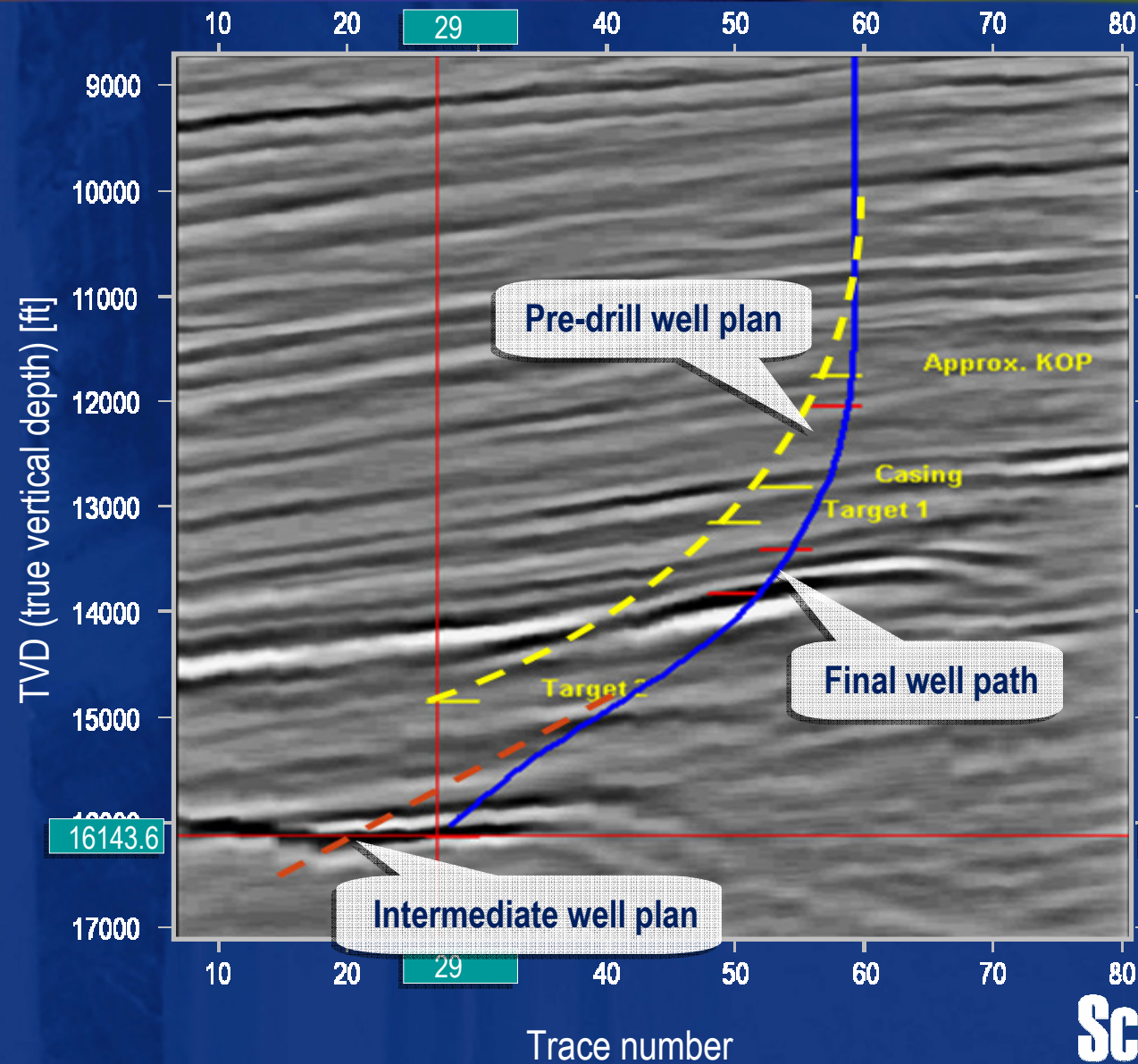
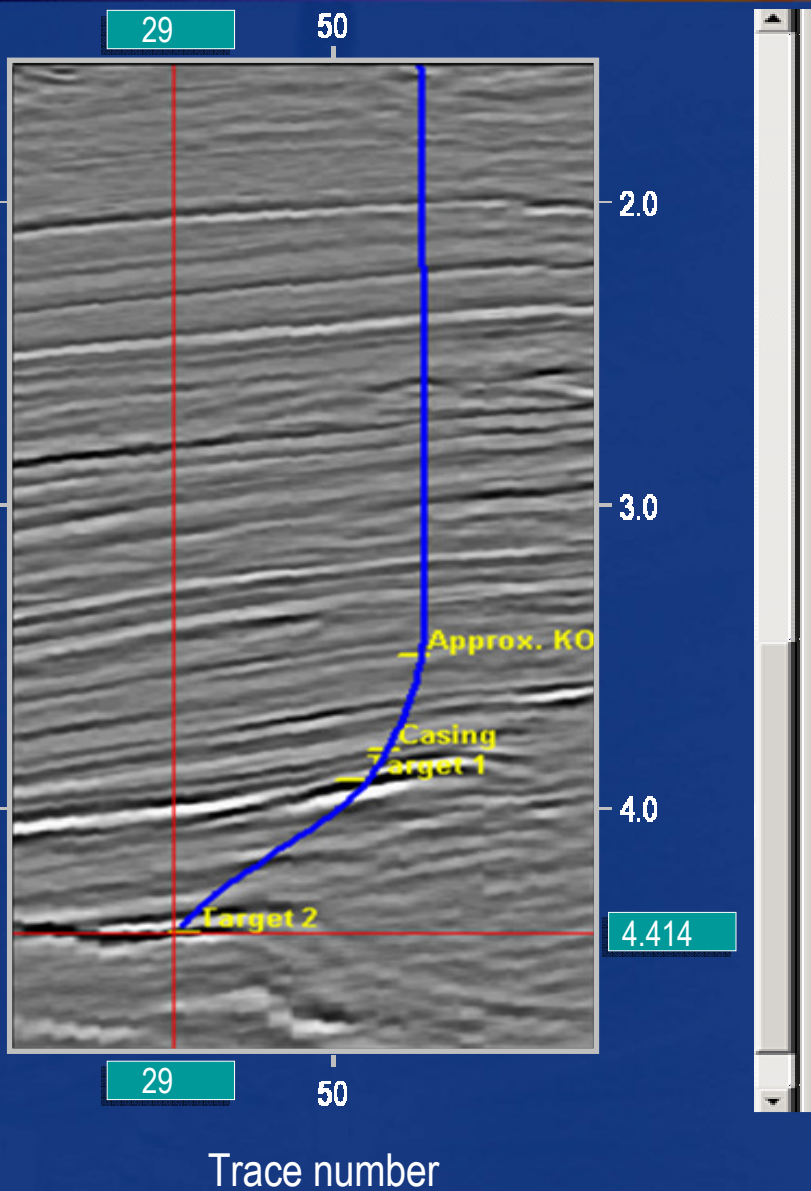
Problem

Seismic velocity uncertainty between nearest seismic lines

olution—seismicVISION



t-On-Seismic Plot



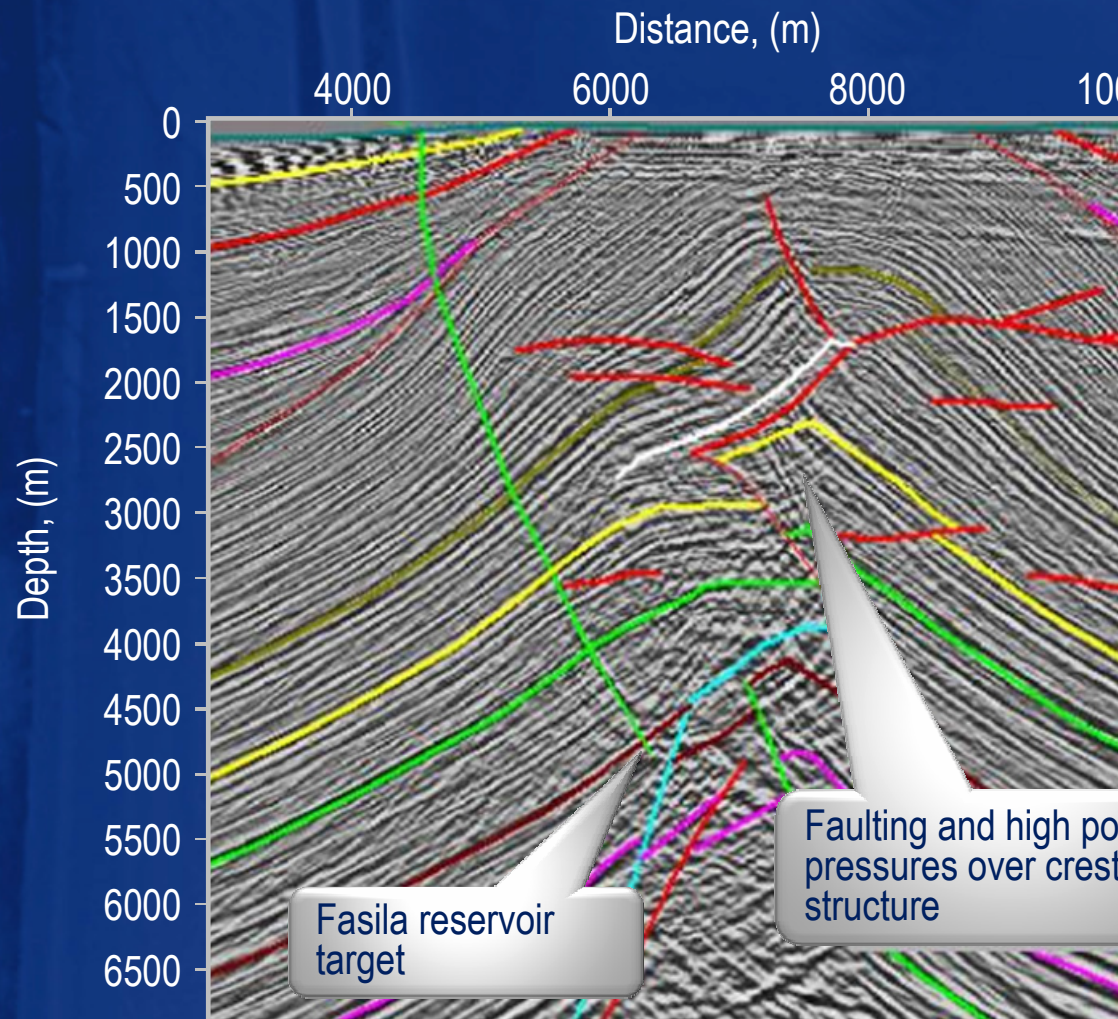
ore on a South Caspian Well

icated structure, dips up
degrees

eviated to avoid high pressure
faulting at crest of structure

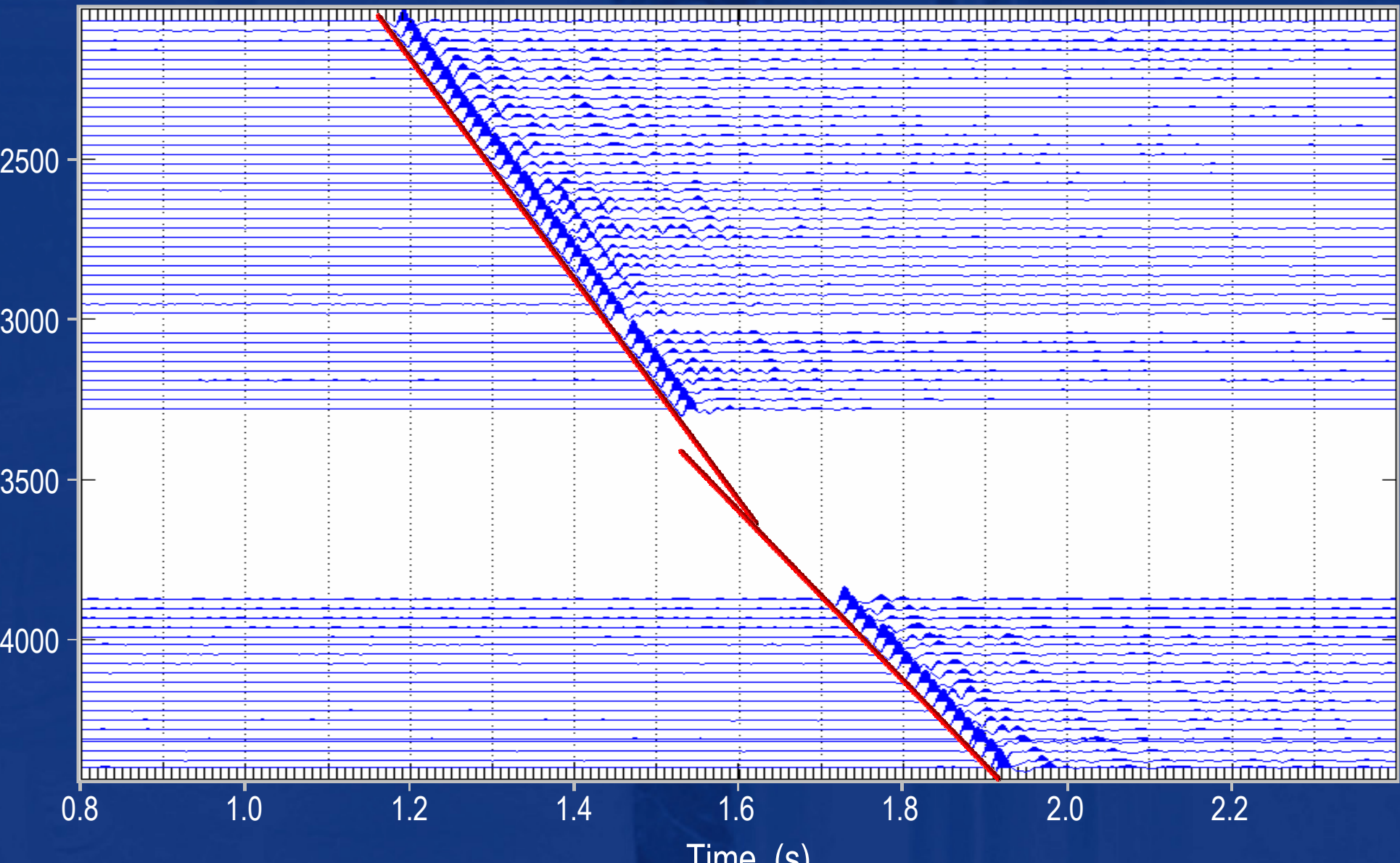
uncertainty on target reservoir
00 m

VISION used to reduce depth
ainty/geosteer

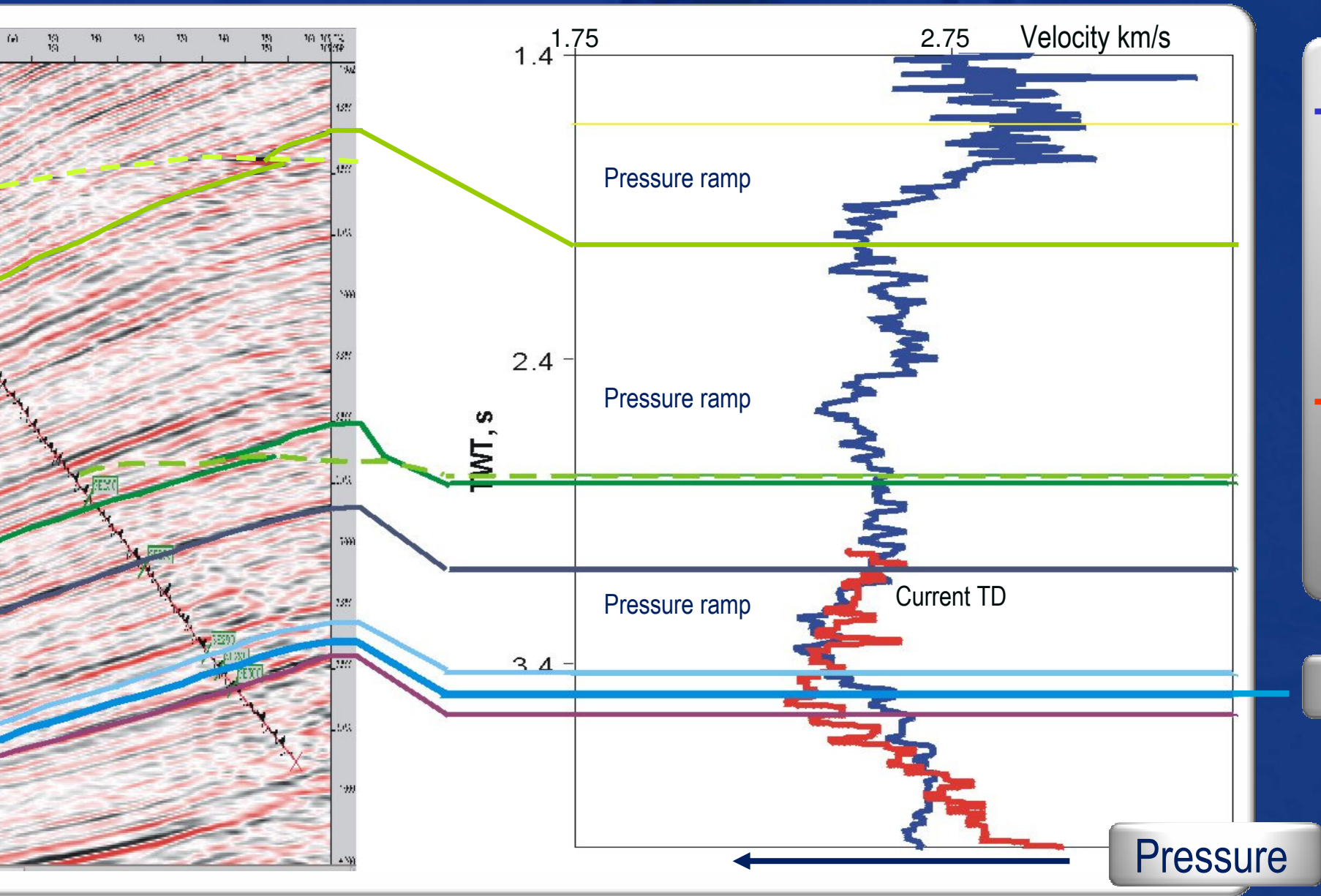


one Stacks

Stacks COMP BP (10-75 HZ) Grouped Rcvs: 4



Lead Results



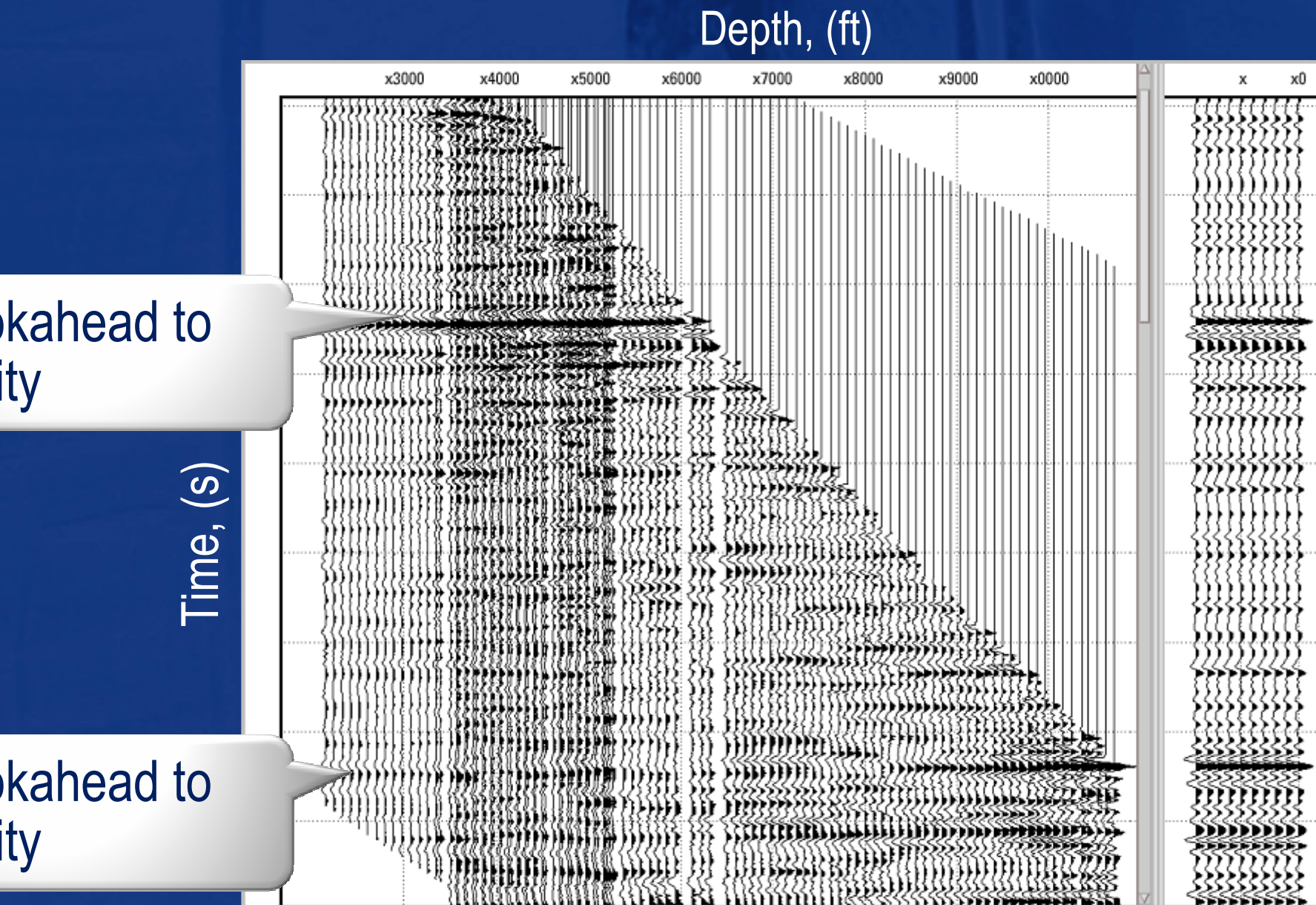
- Lookahead at 2 km
- Trend slope
- pressure reservoir
- SVWD of lookahead wireline

Pereriv Target

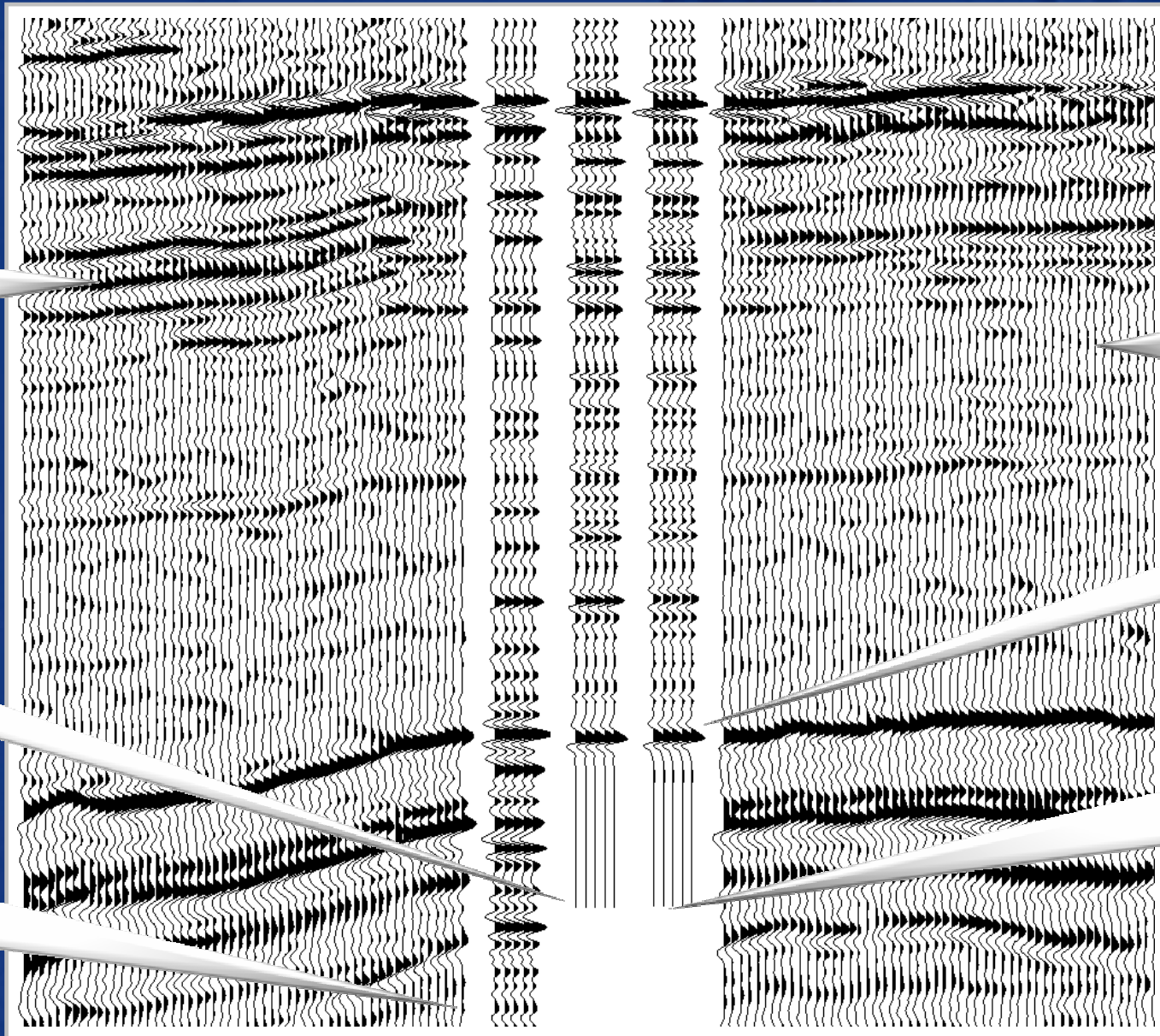
Pressure

Sci

Combined Hydrophone VSP—Vertical



VISION/sonicVISION

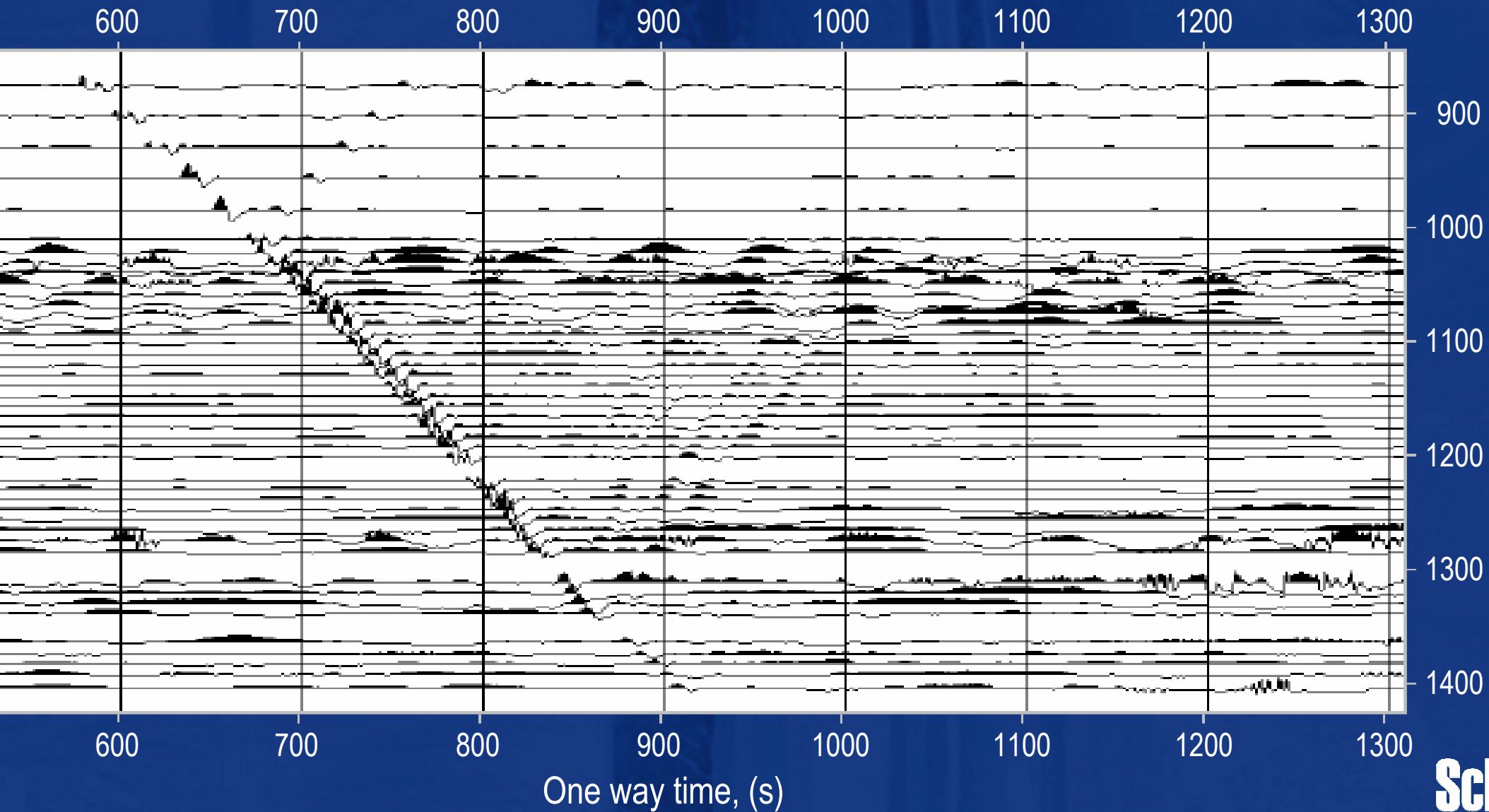


Surface seismic

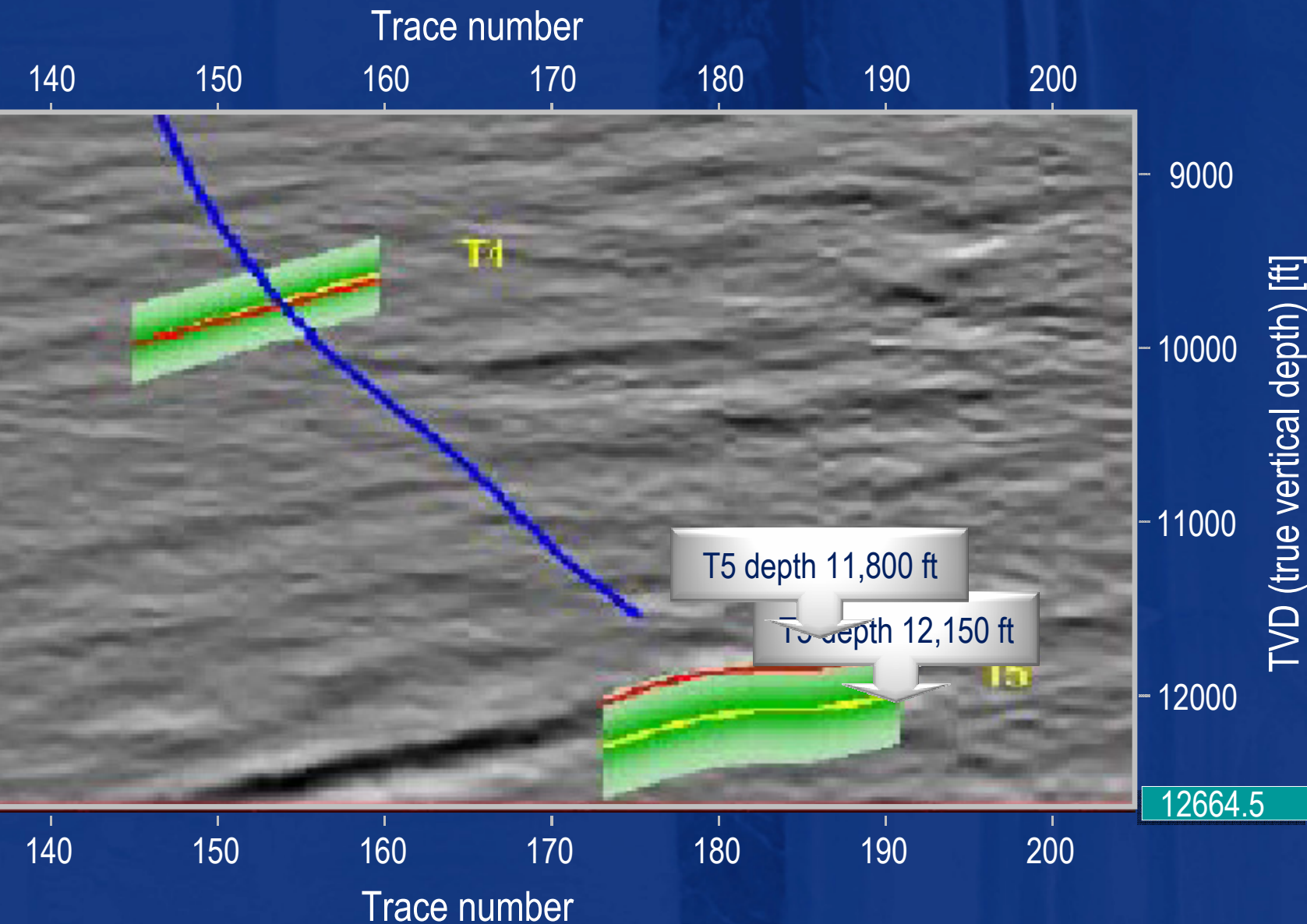
Current bit position

sonicVISION
Synthetic – real time
(corrected by real-time checkshot)

Seismic Drilling for Gas Hydrates, Japan



ing Surprises—Exploration

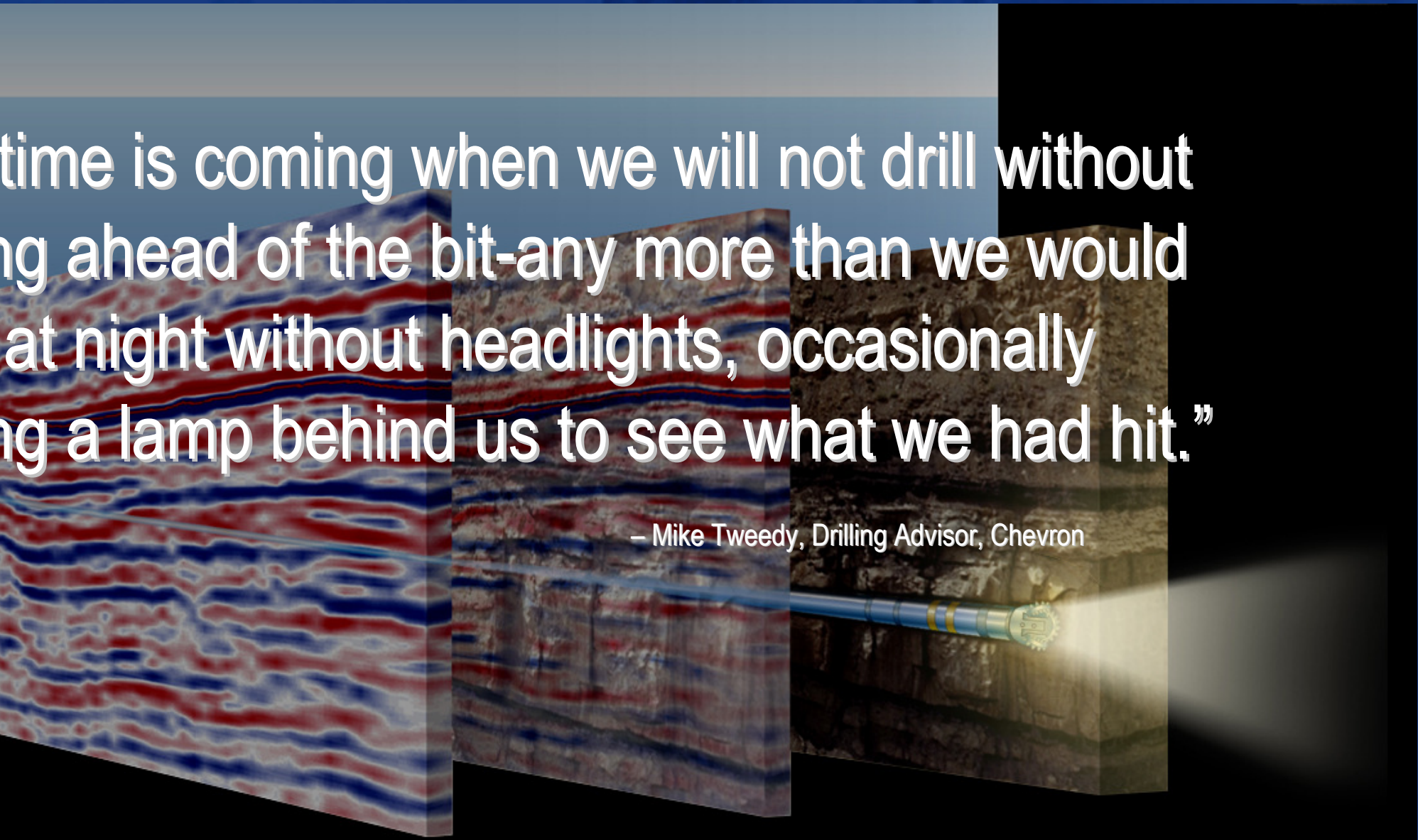


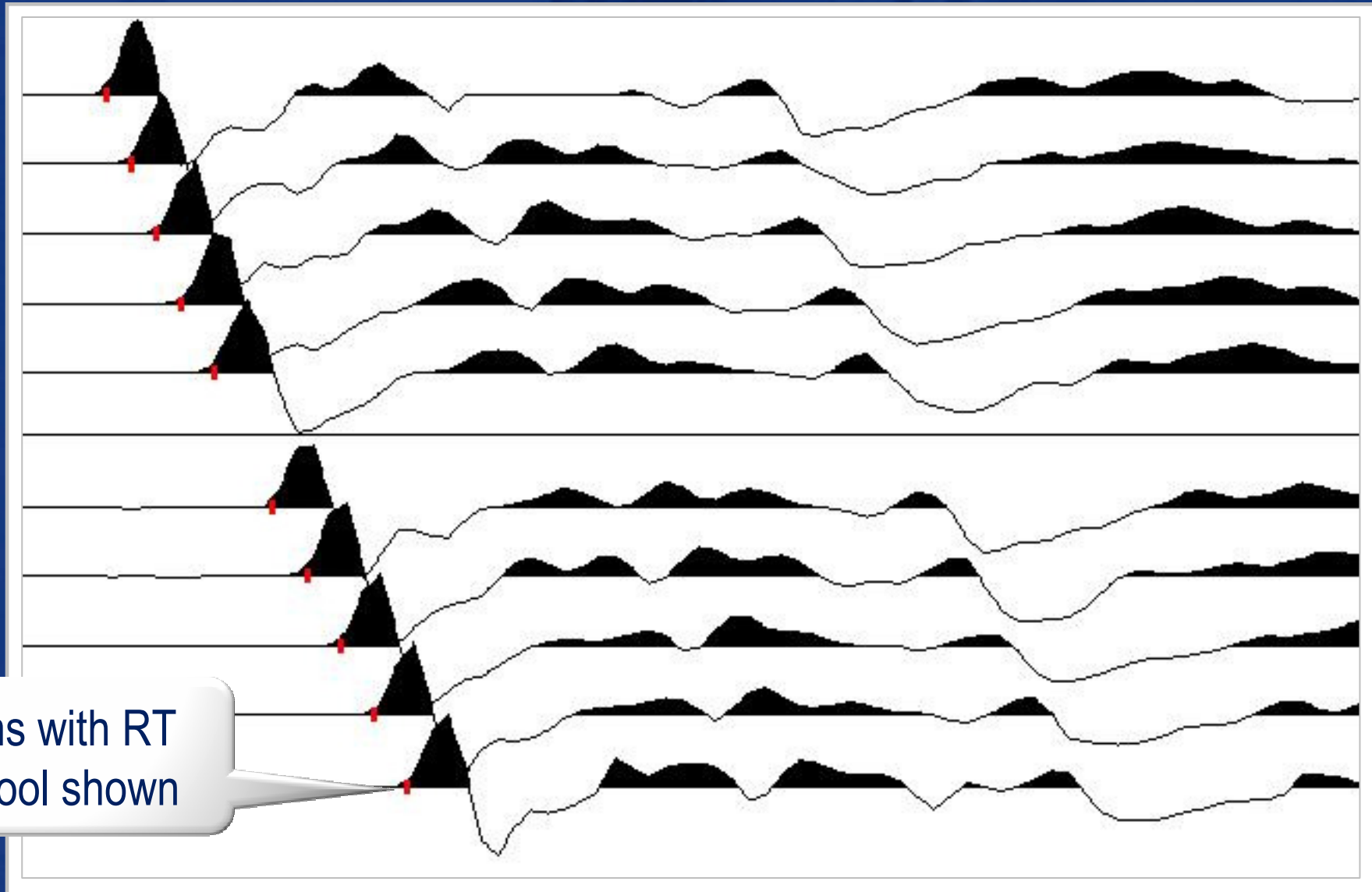
- T5 is over p
- Objective wa
- above T5 an
- No drilling s
- with SVWD
- real-time up
- velocity and
- SVWD in re
- that T5 is ac
- higher than
- Casing set—
- surprises

g Ahead

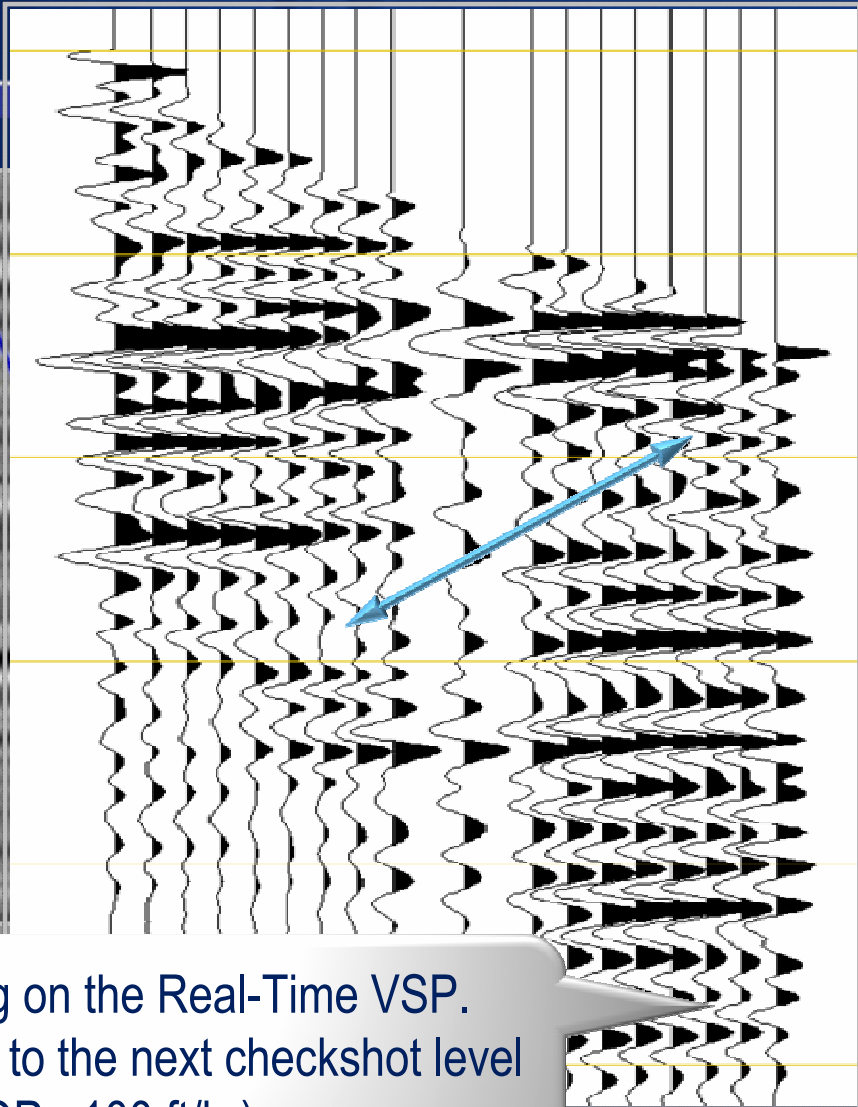
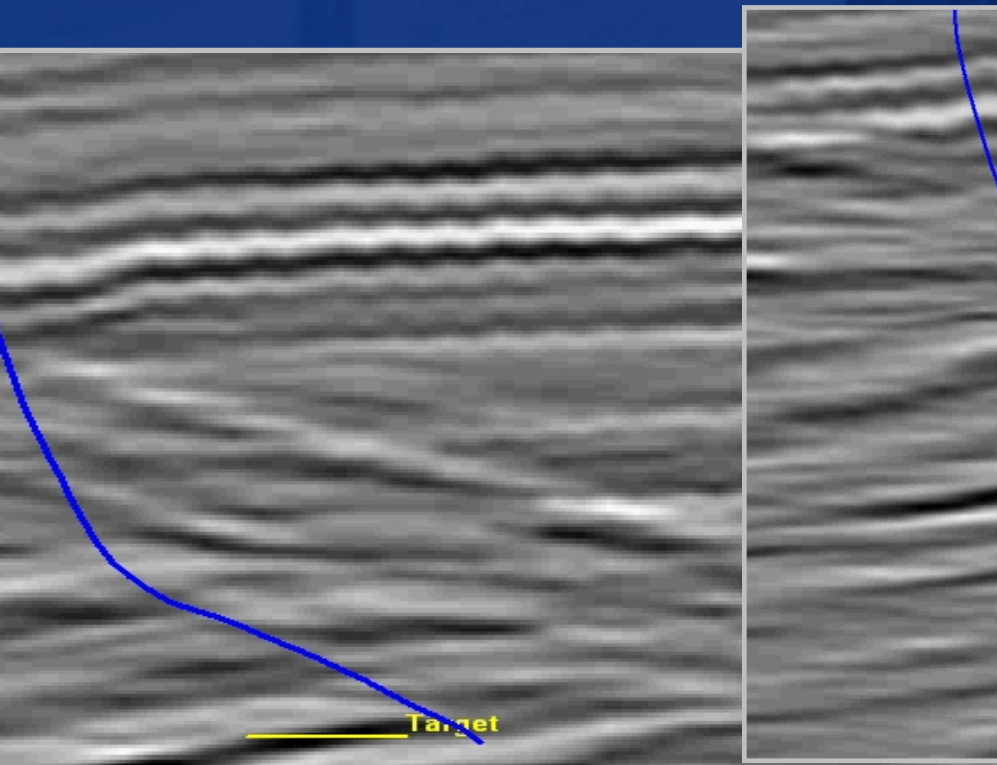
time is coming when we will not drill without
ng ahead of the bit-any more than we would
at night without headlights, occasionally
ng a lamp behind us to see what we had hit.”

– Mike Tweedy, Drilling Advisor, Chevron





Waveforms with RT
by the tool shown



Target reflector may be seen approaching on the Real-Time VSP. VSP is updated with checkshot data prior to the next checkshot level (shooting at connections while drilling, ROP <100 ft/hr)

Increased significantly over pre-drill model
300ft TVD deeper than the pre-drill

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