

Thank you CREWES sponsors! I'd like to stress the importance of supporting the next generation of ideas, applications, and geophysicists ...



Ms. Skye Baxter (courtesy of her dad)

CSEG & GSH Memo of understanding: Linking Houston & Calgary



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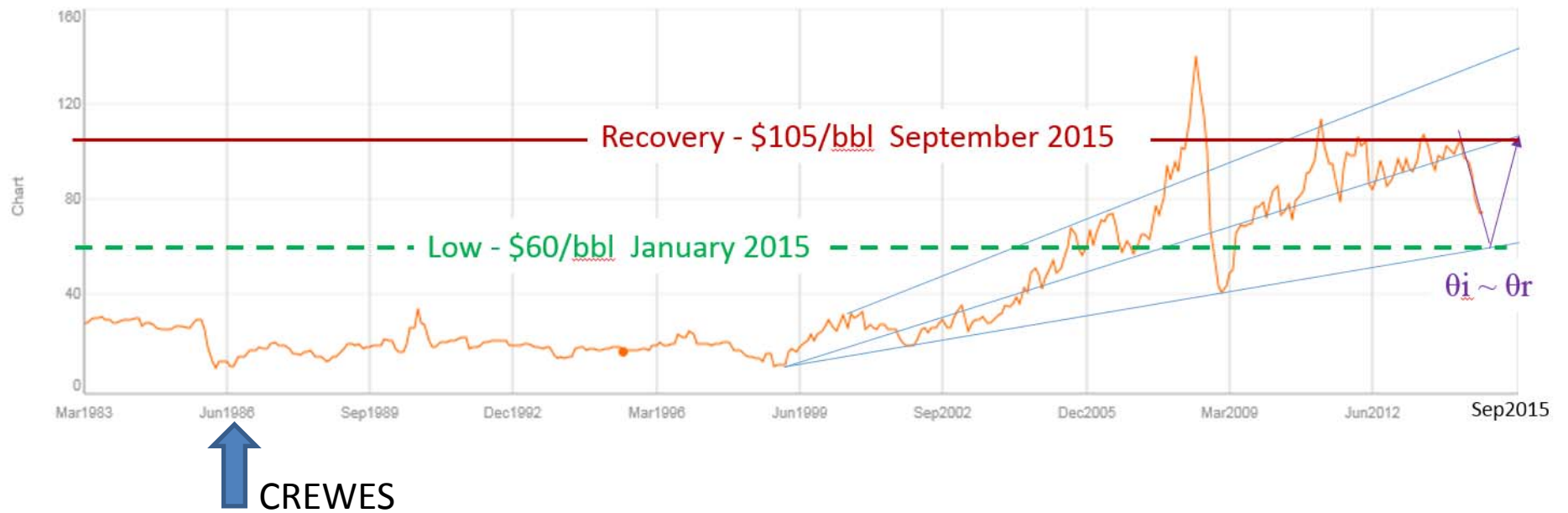
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Geophysical Society of Houston (GSH) Events

GSH-SEG Annual Symposium (2 days)

Rock physics, well log properties, and seismic amplitudes

Fun with figures! Price of oil prediction (RRS - Nov. 12, 2014)



Small chance of \$140/bbl by 2017 – two standard deviations

Mapping & Migrating Ground Roll Reflections

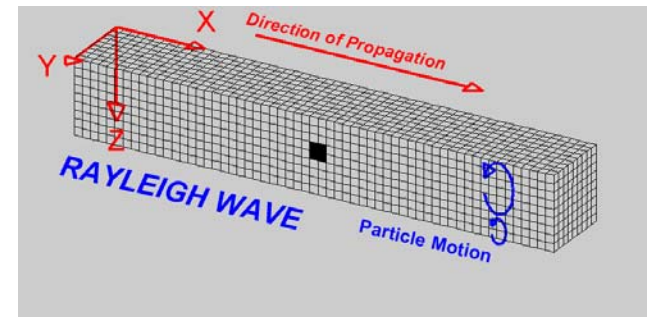
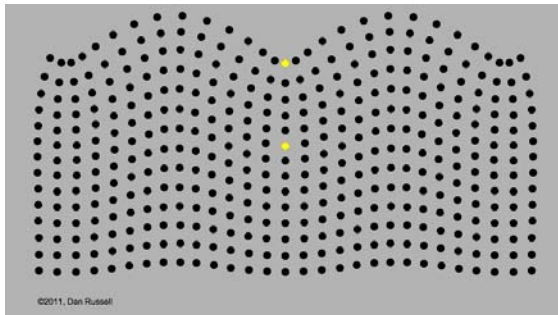
Craig Hyslop* and Robert Stewart**

* University of Houston and ExxonMobil Research


** Universities of Houston and Calgary

CREWES Project Sponsors Meeting

Dec. 3-5, 2014
Banff, AB



Outline – Ground roll imaging

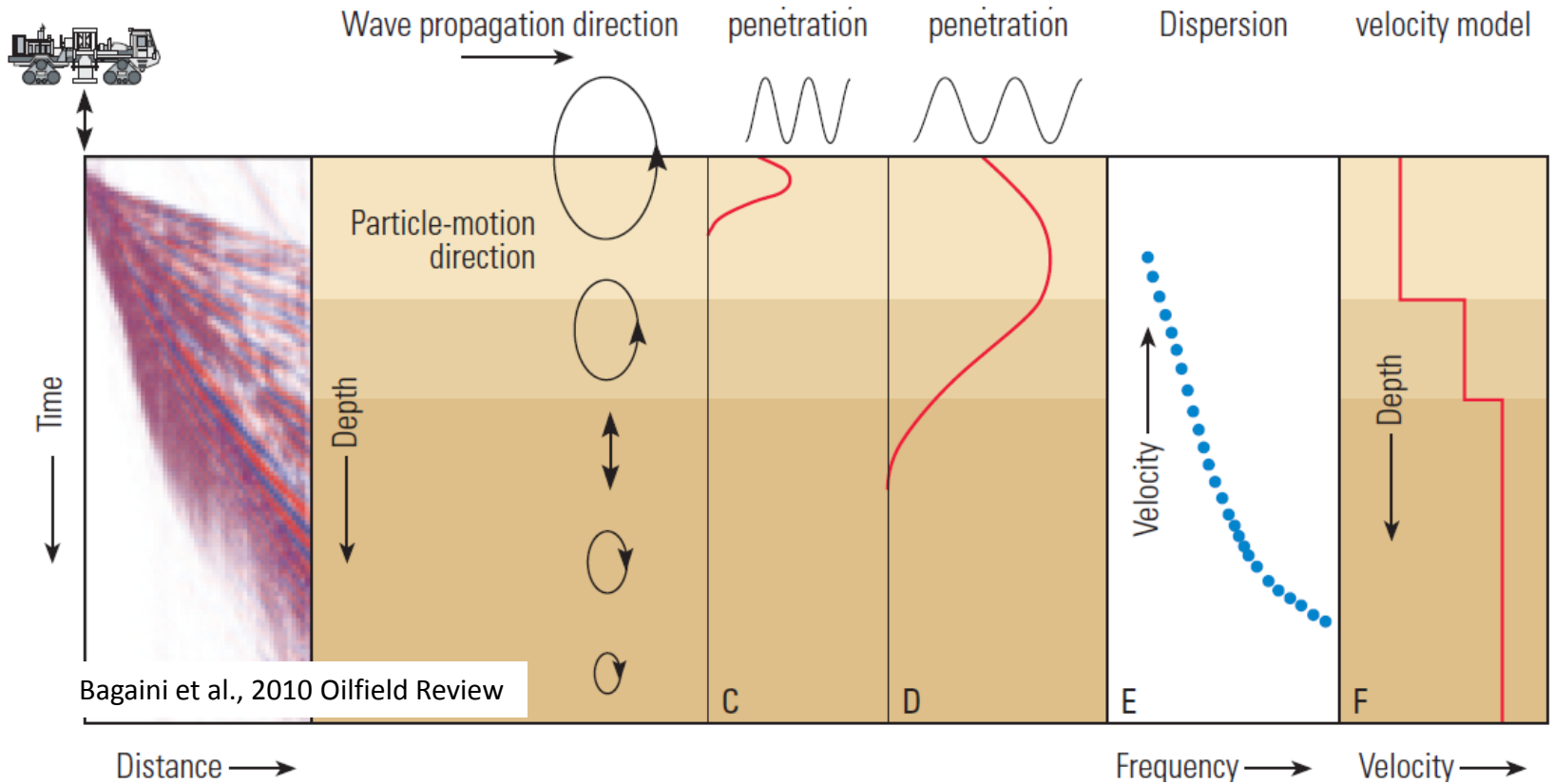
- Motivation for using ground roll
 - There’s a lot of it there! 
- Rayleigh-wave basics
- Ground roll reflection processing
- 2D fault imaging “in-line”
- 3D fault imaging “off-line”
- Summary – the promise of Rayleigh wave imaging

Motivation to use ground roll

- **Direct surface waves - for soil & rock properties, structure, statics**
 - **Reflected surface waves –**
 - **Image lateral heterogeneity & faults**
 - **Discover near-surface anomalies**
 - **Determine velocity and statics**
 - **Design better reject filters & flows**

Ground roll basics

(John W. Strutt = Lord Rayleigh) Strut your stuff

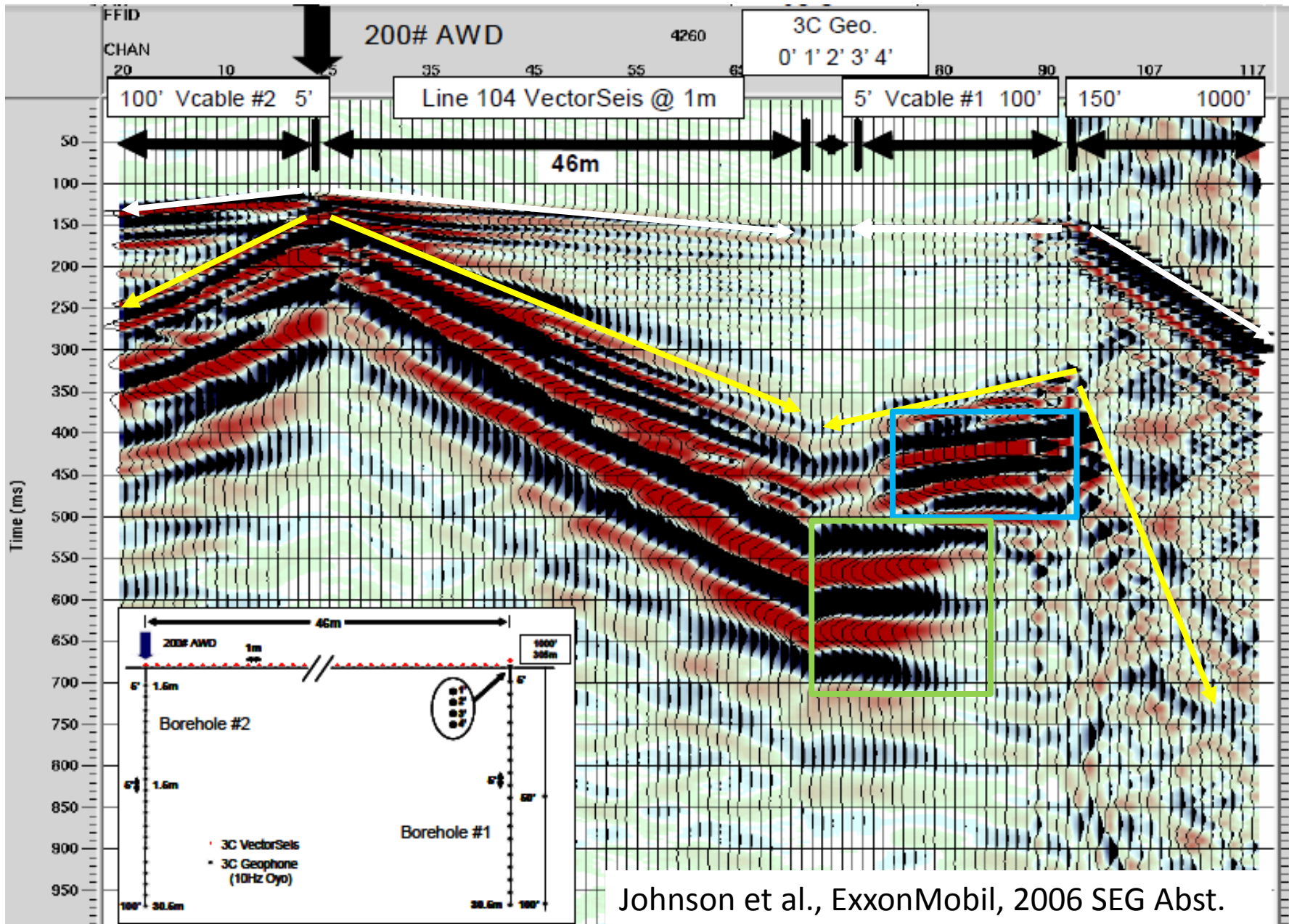


http://www.youtube.com/watch?v=6yXgfYHAS7c&feature=player_detailpage

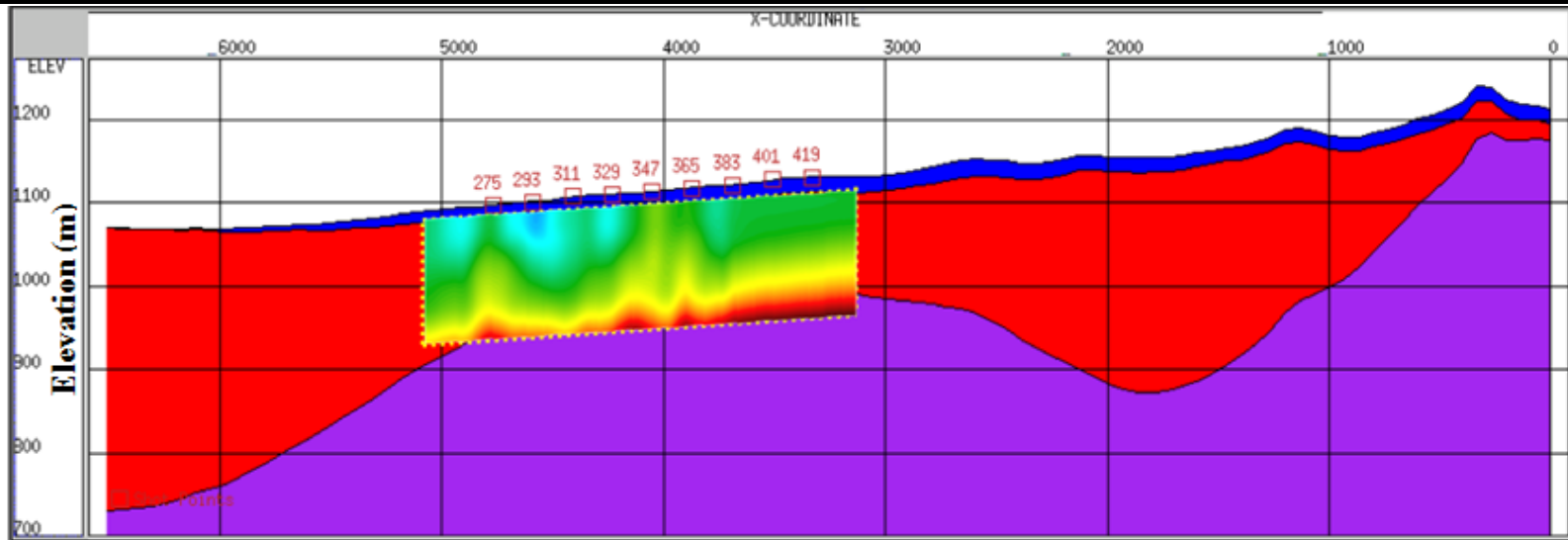
Need non-planar source
 V_r about .9Vs
 A varies as $1/r^{1/2}$

Surface and Guided Waves Lexicon

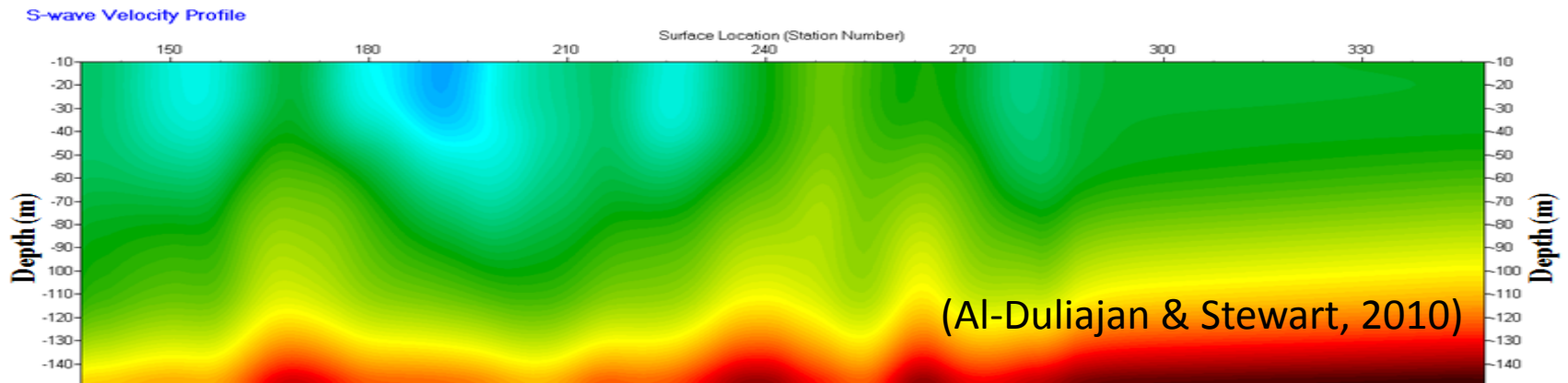
- Rayleigh: P and S with decrease from free surface e^{-z}
- Stoneley: P and S with decrease from interface $e^{-|z|}$
 - Scholte: Stoneley wave at fluid-solid interface
- Marine guided wave: P in fluid layer, elastic below and $e^{-|z|}$
- Love: SH in layer and decrease below e^{-z}



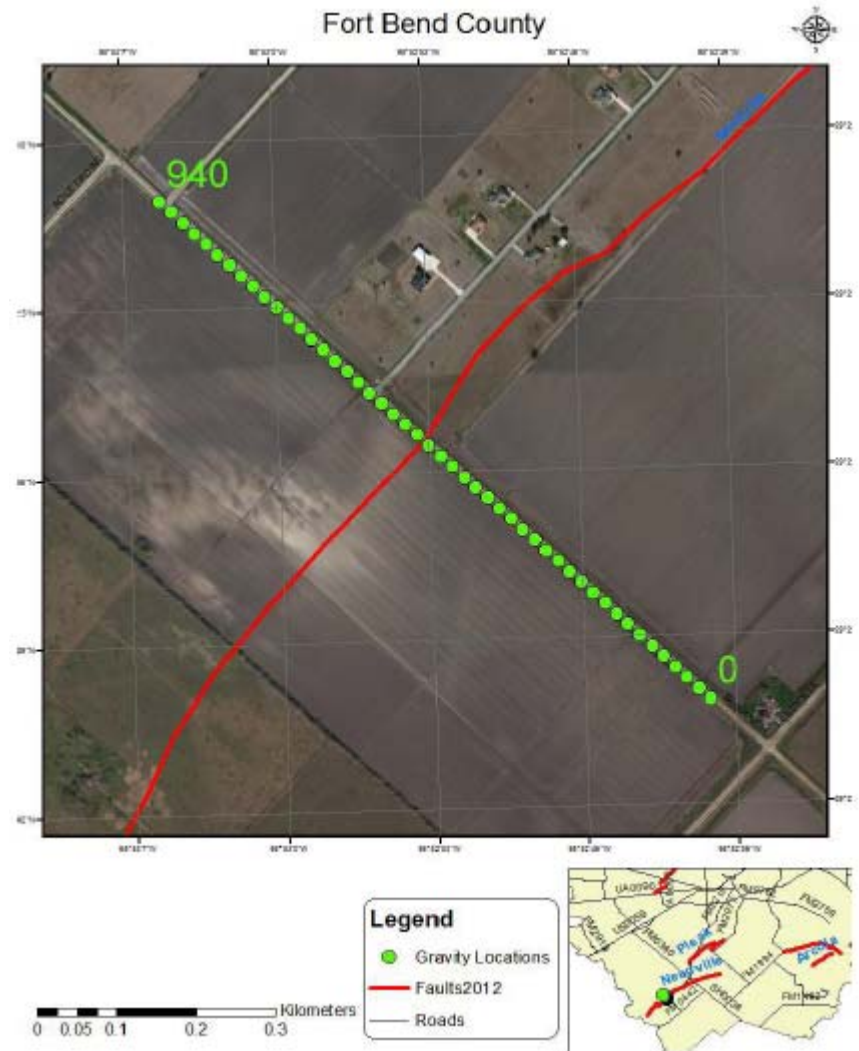
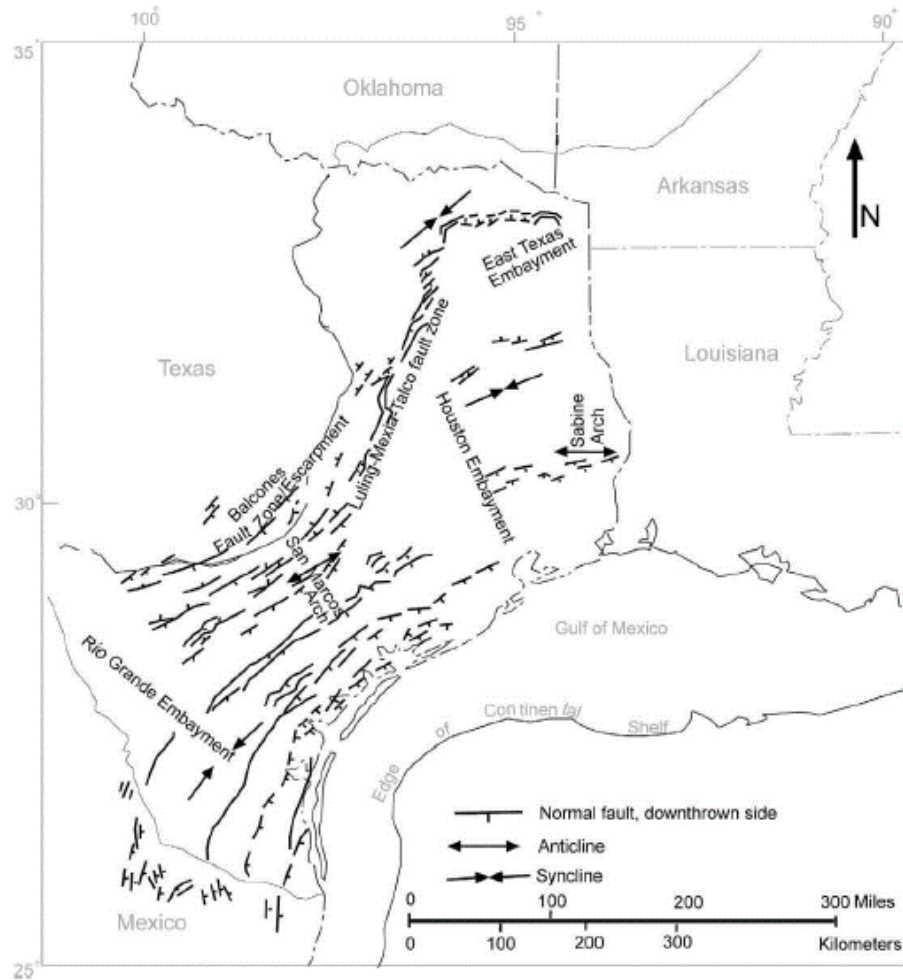
S-wave velocity at Spring Coulee from MASW and refractions



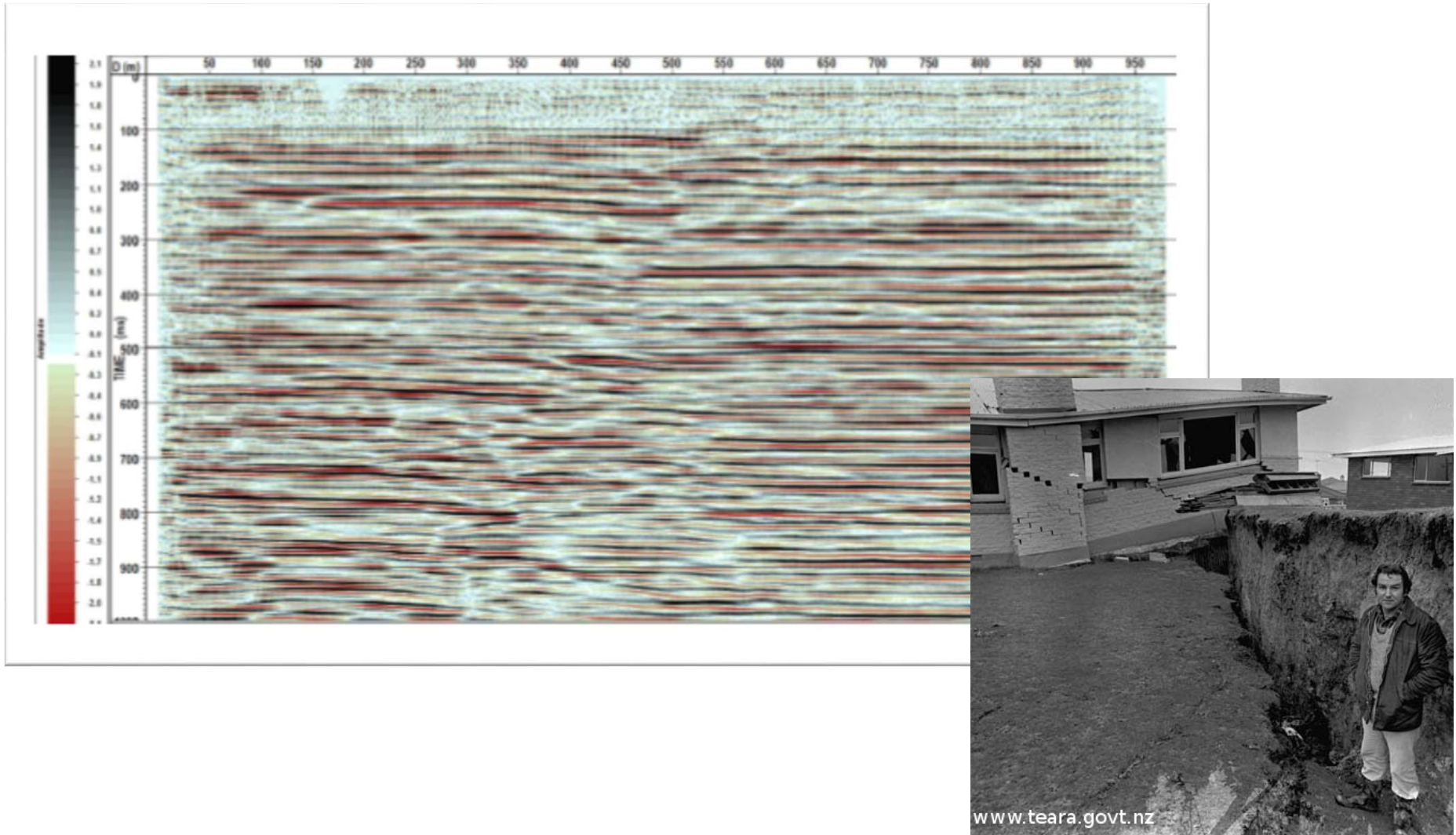
S-wave Velocity (m/s)



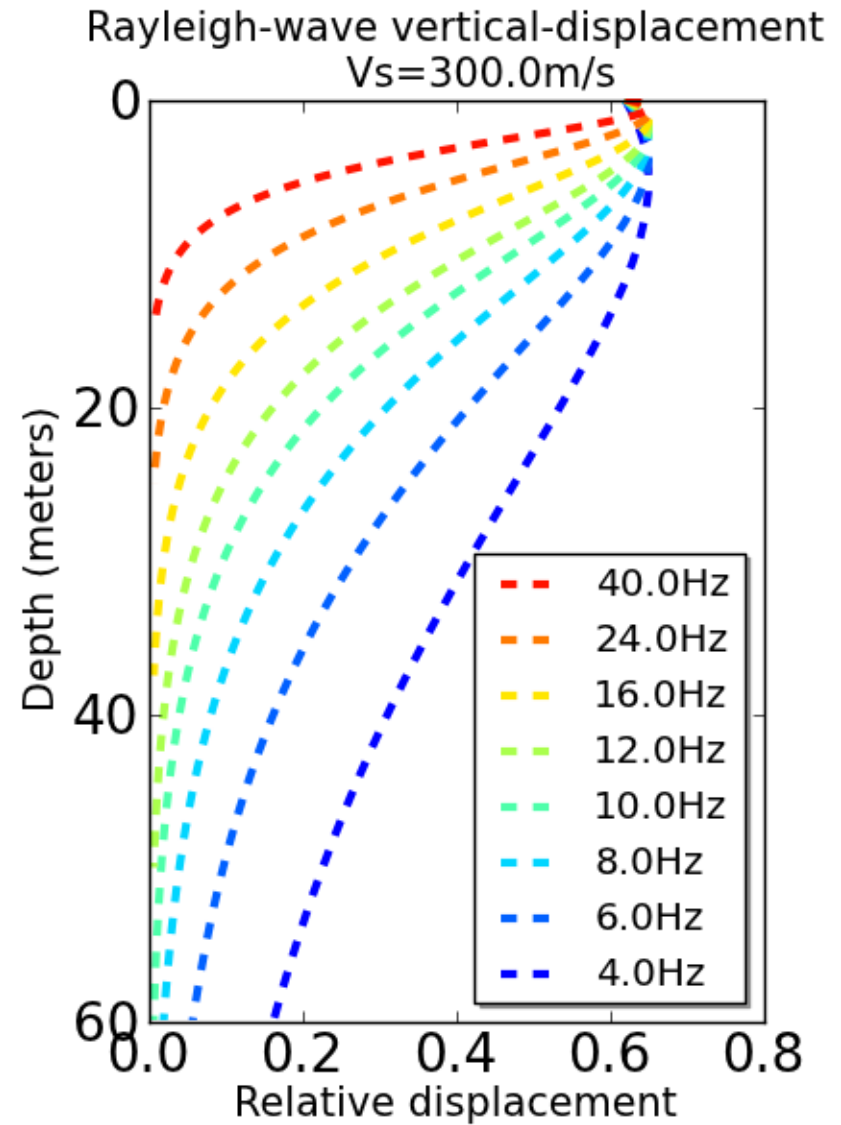
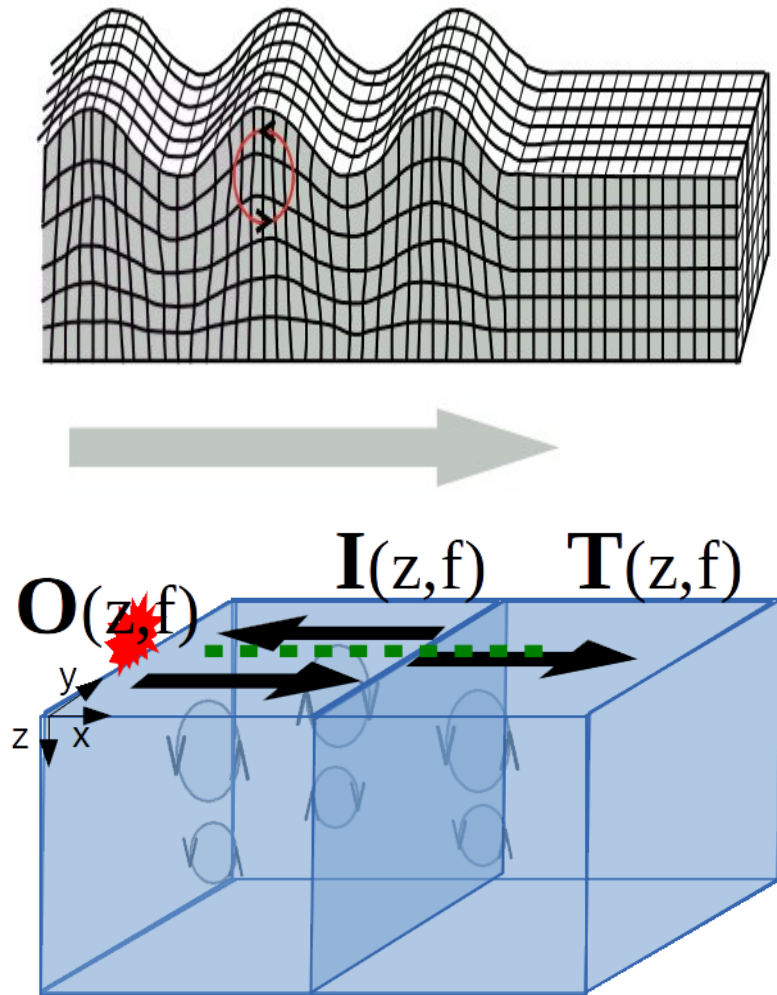
Find fault: Mapping near-surface deformations



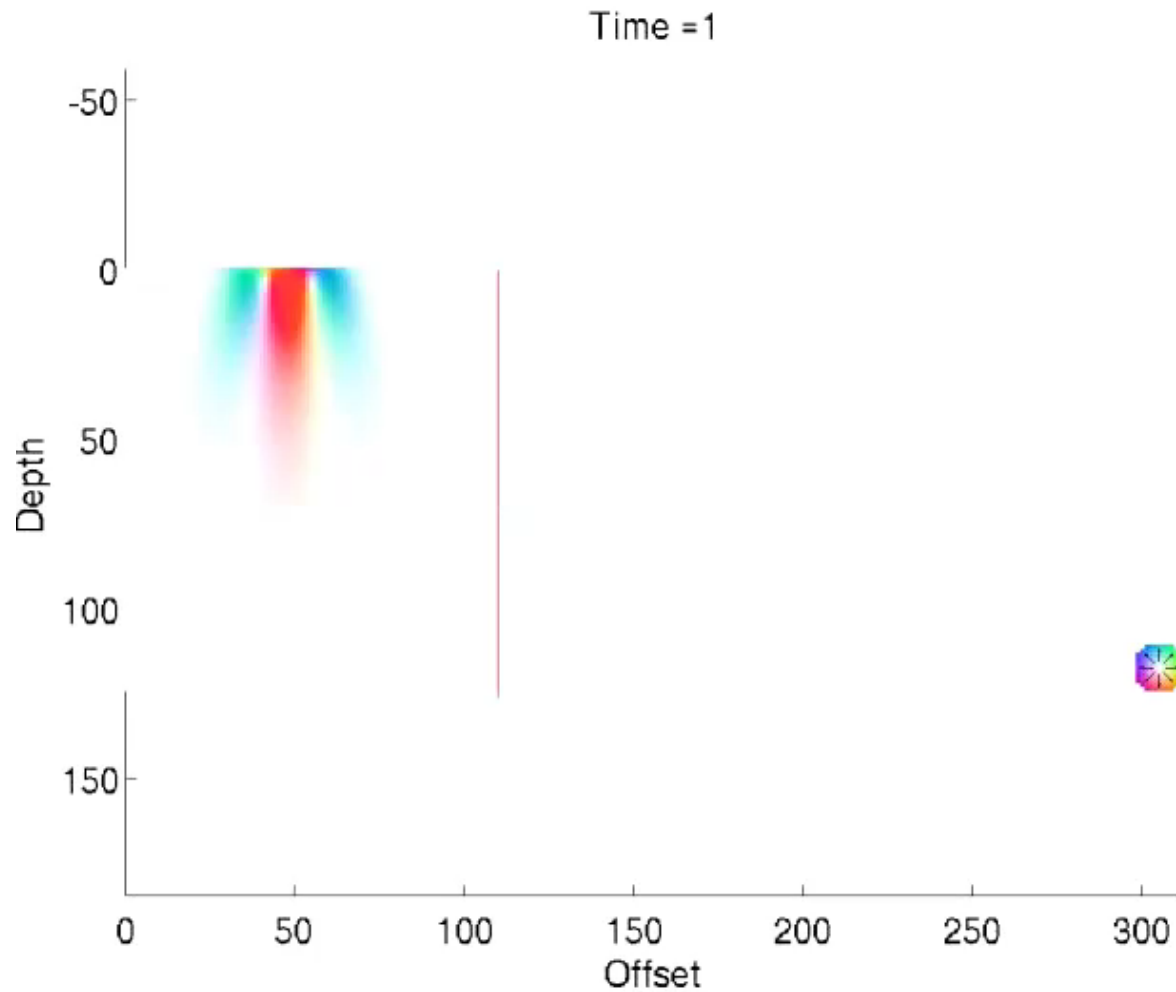
Where is the fault?



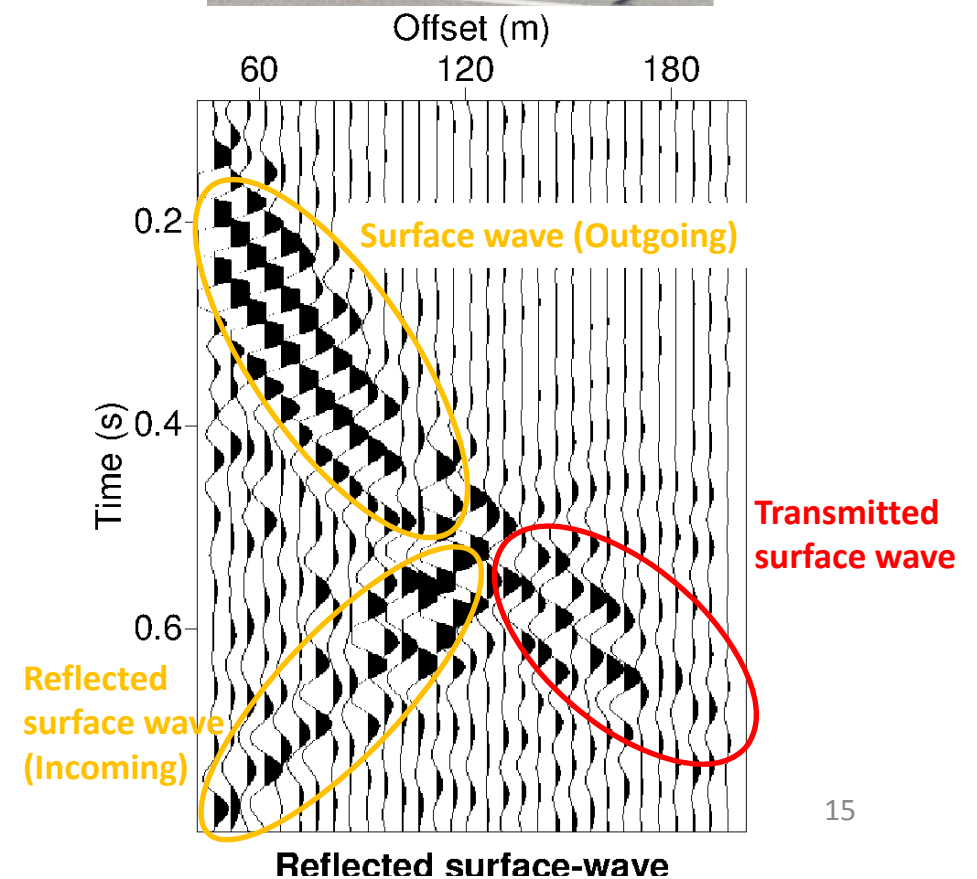
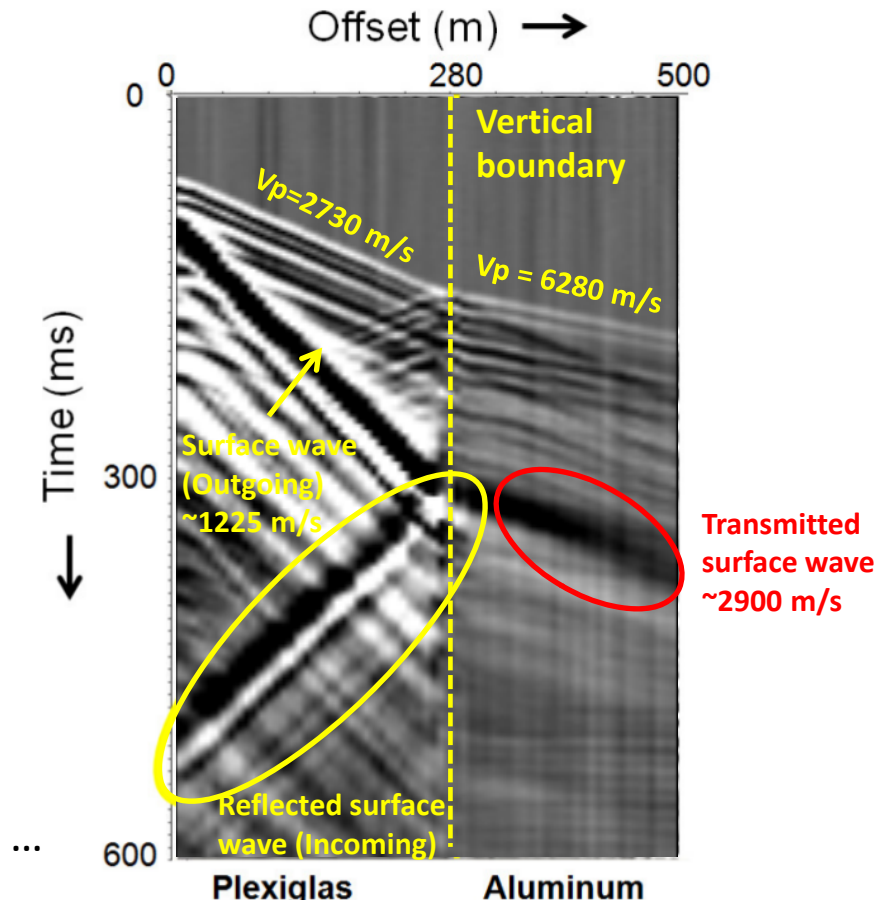
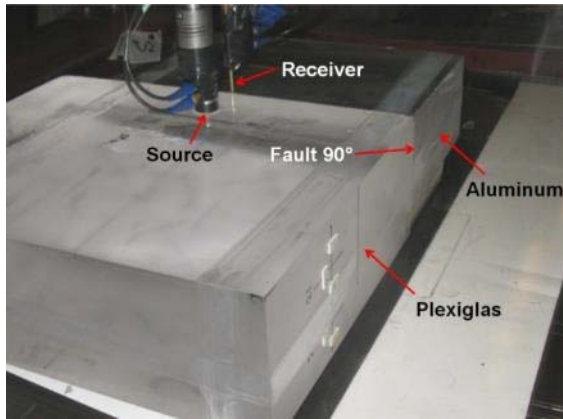
Theory



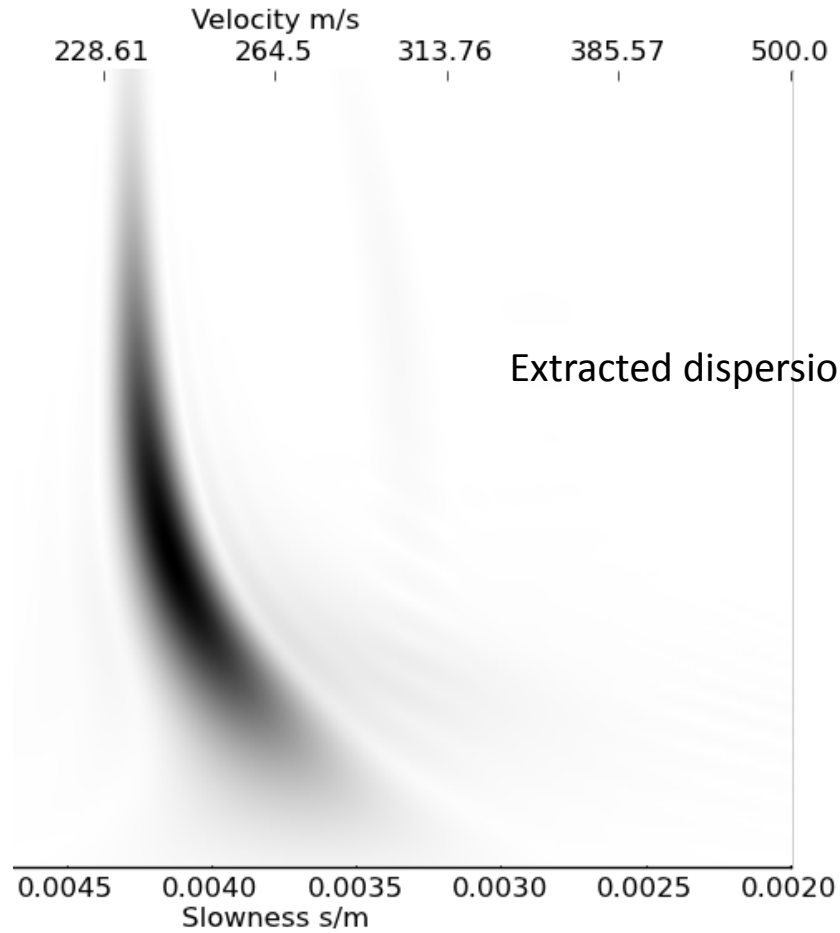
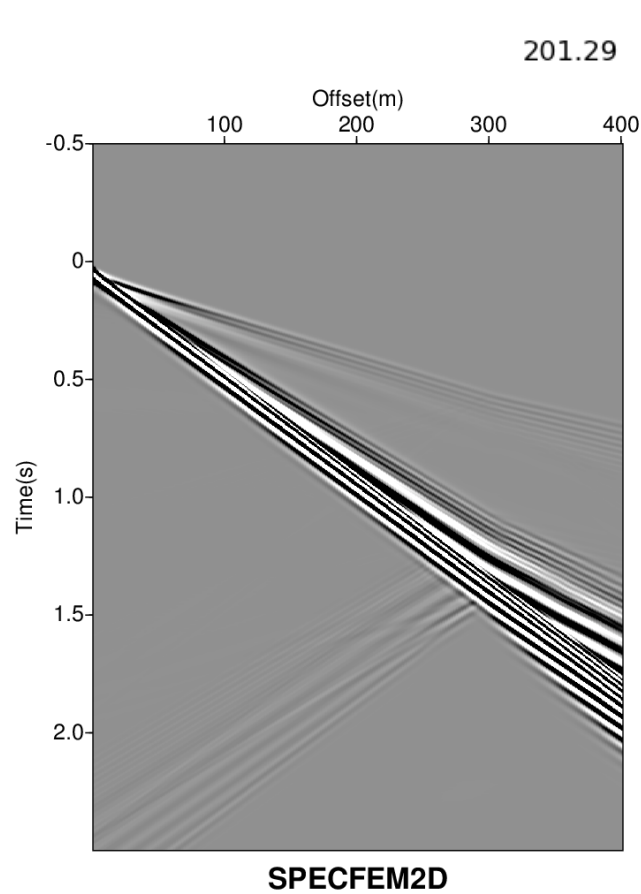
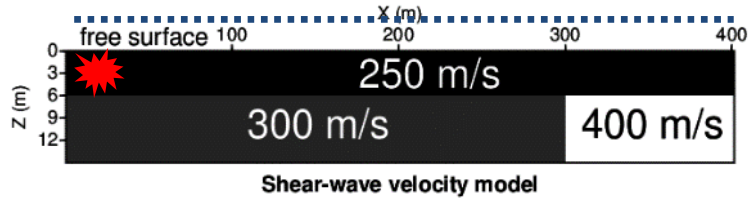
Ground Roll Reflections (Manning, 2011)



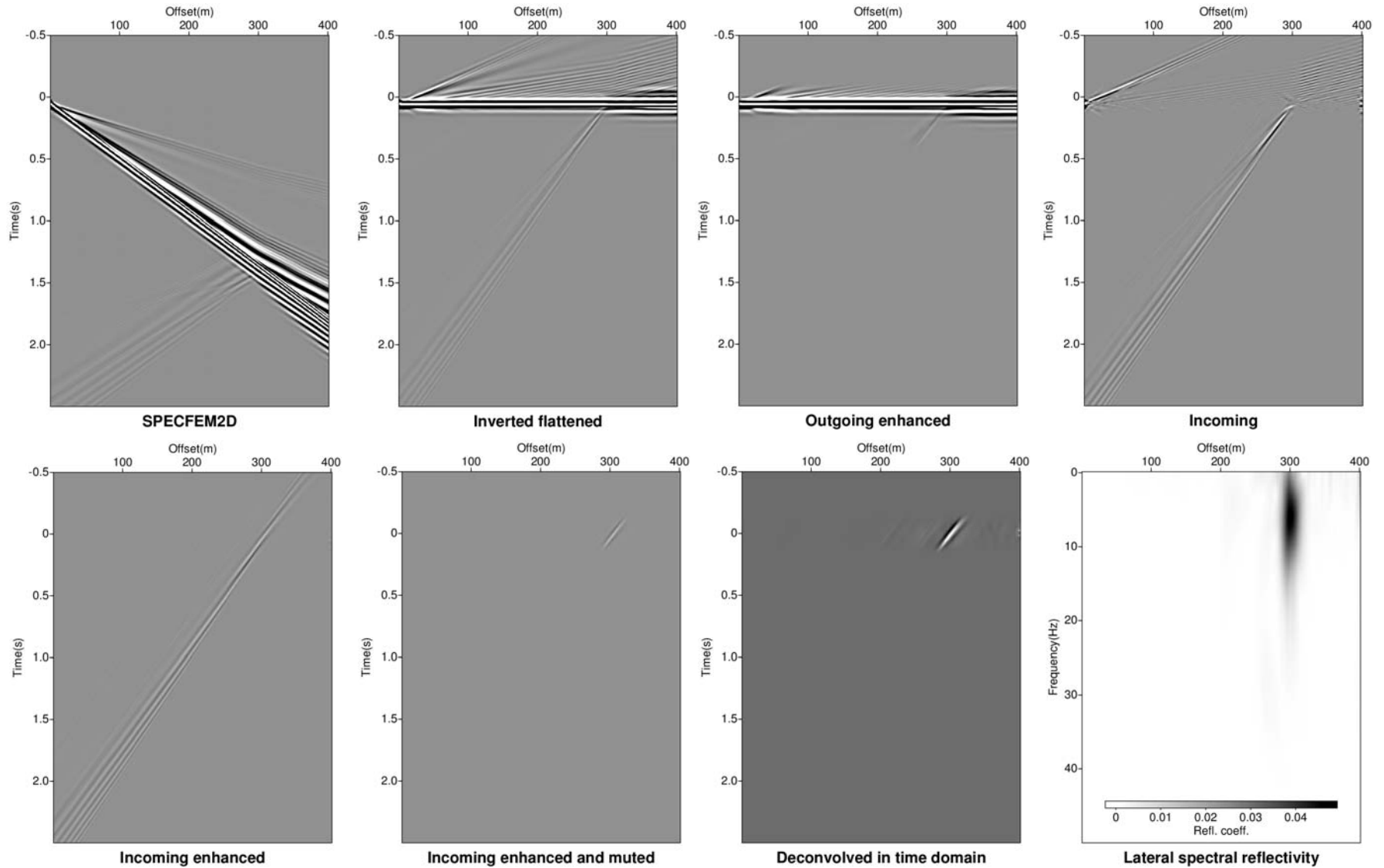
Reflected surface waves



2D fault imaging

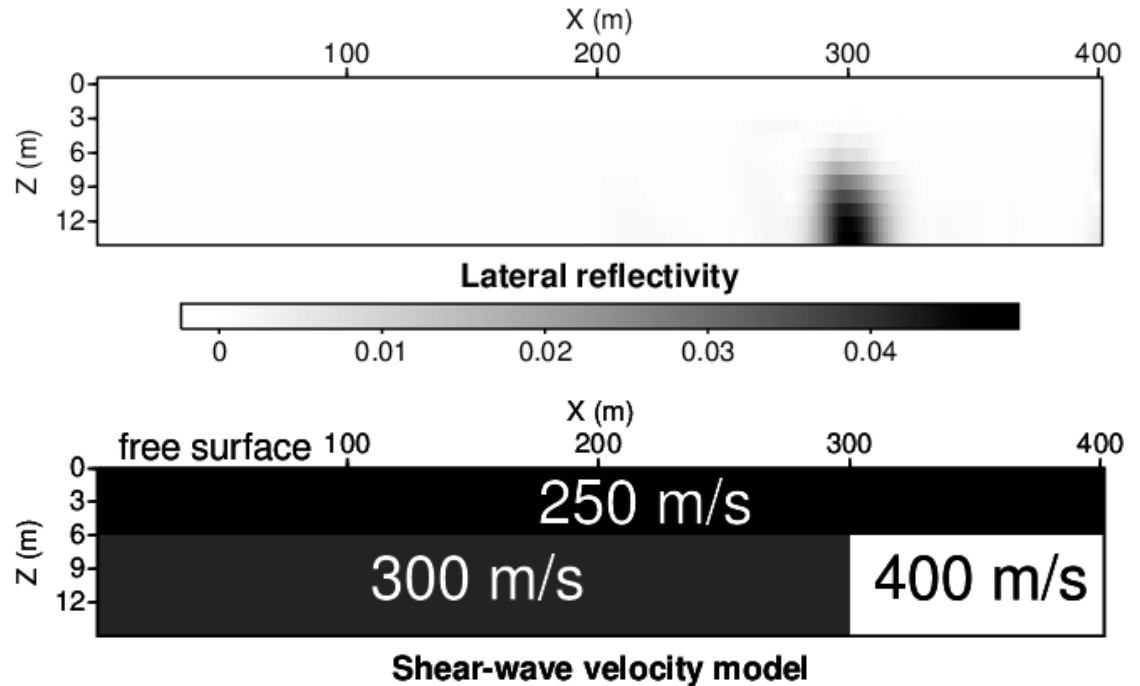
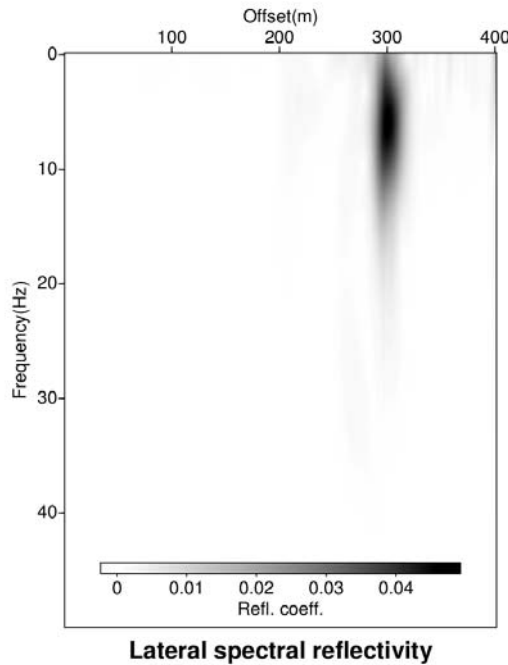


Processing ground roll reflections

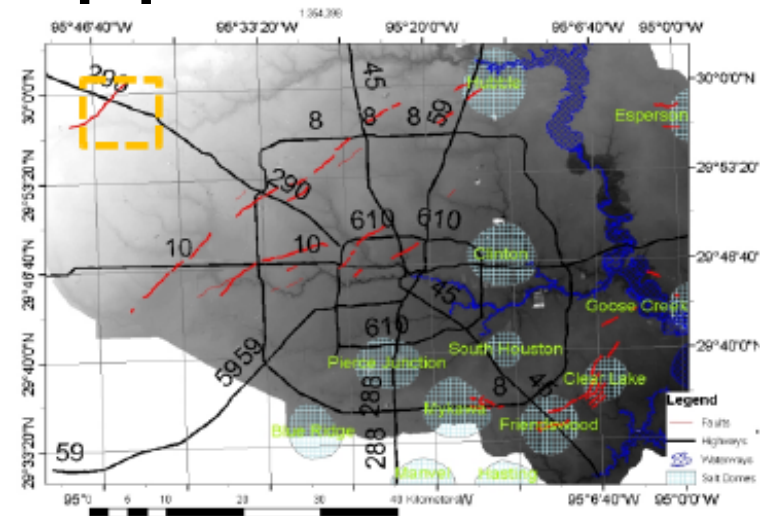
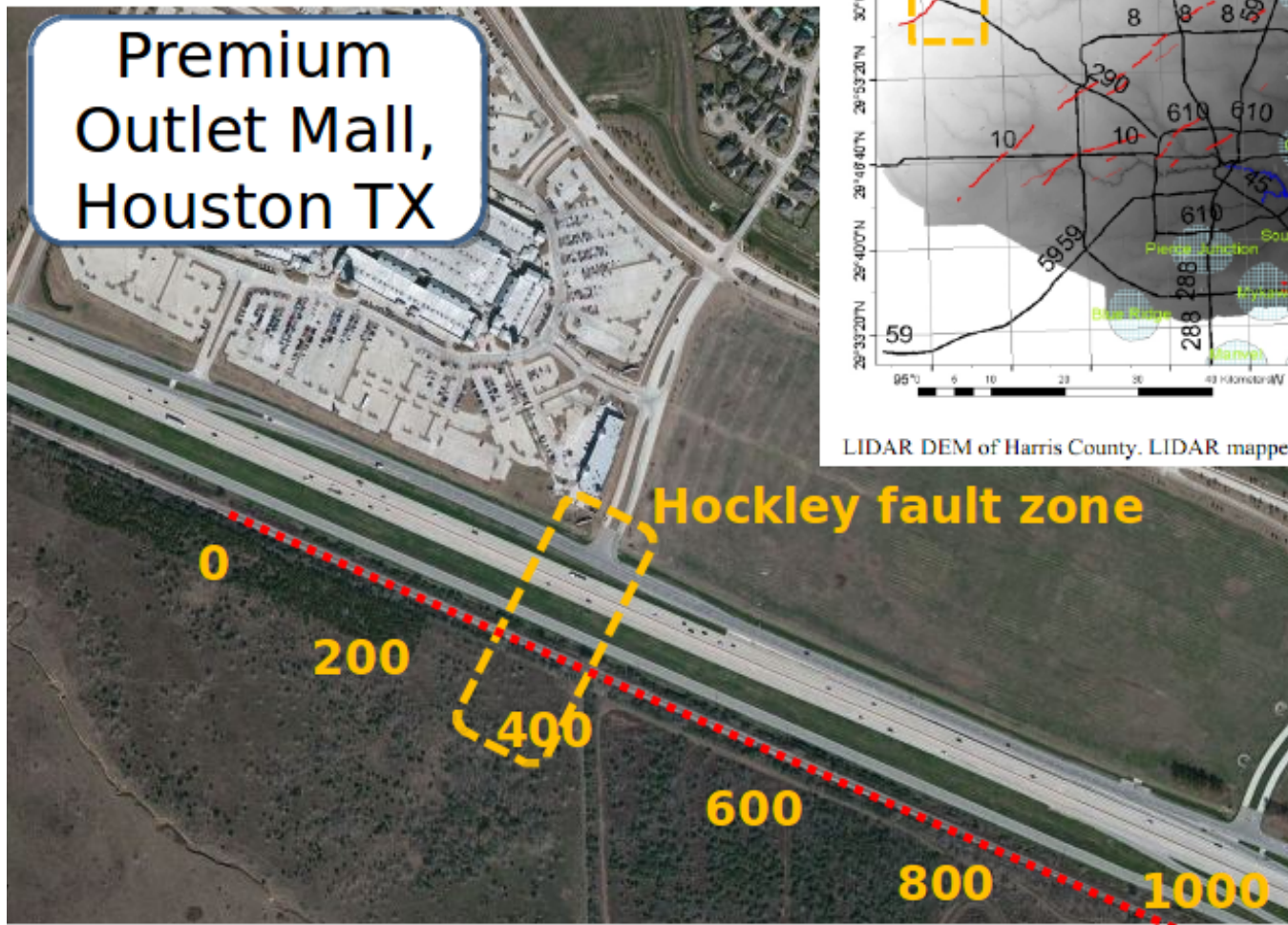


2D fault imaging: depth mapping

$$\text{depth} \cong v/f * .5$$



Premium Outlet Mall, Houston TX



LIDAR DEM of Harris County. LIDAR mapped faults, salt dome locations.

Source: vertical vib.
 Receiver: vertical component
 Source interval: 5m
 Receiver interval: 5m

Field

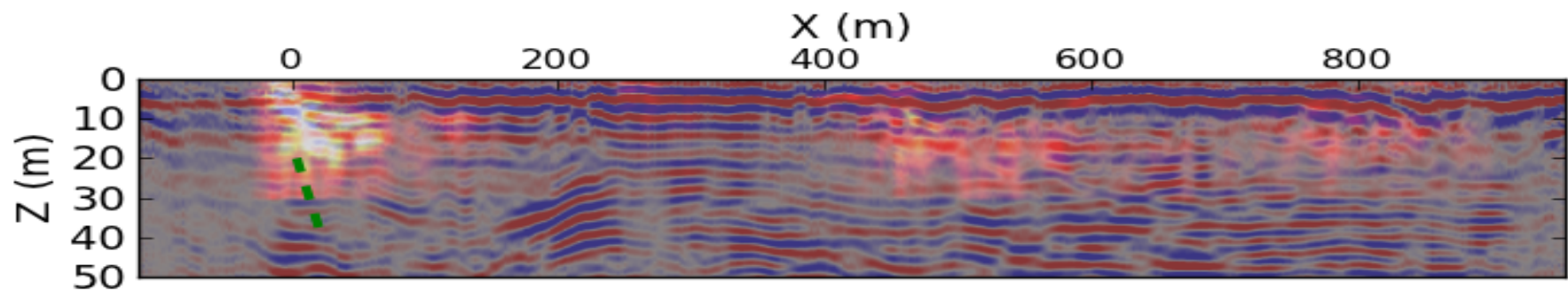
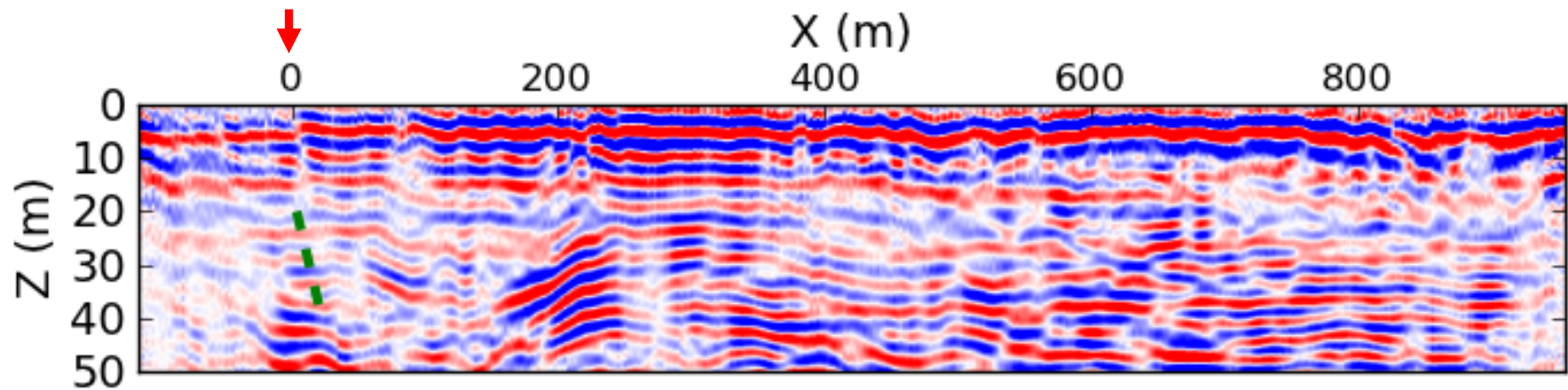
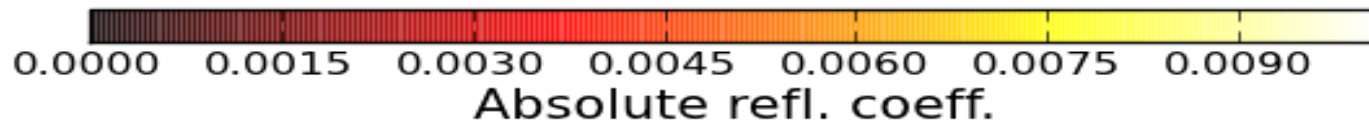
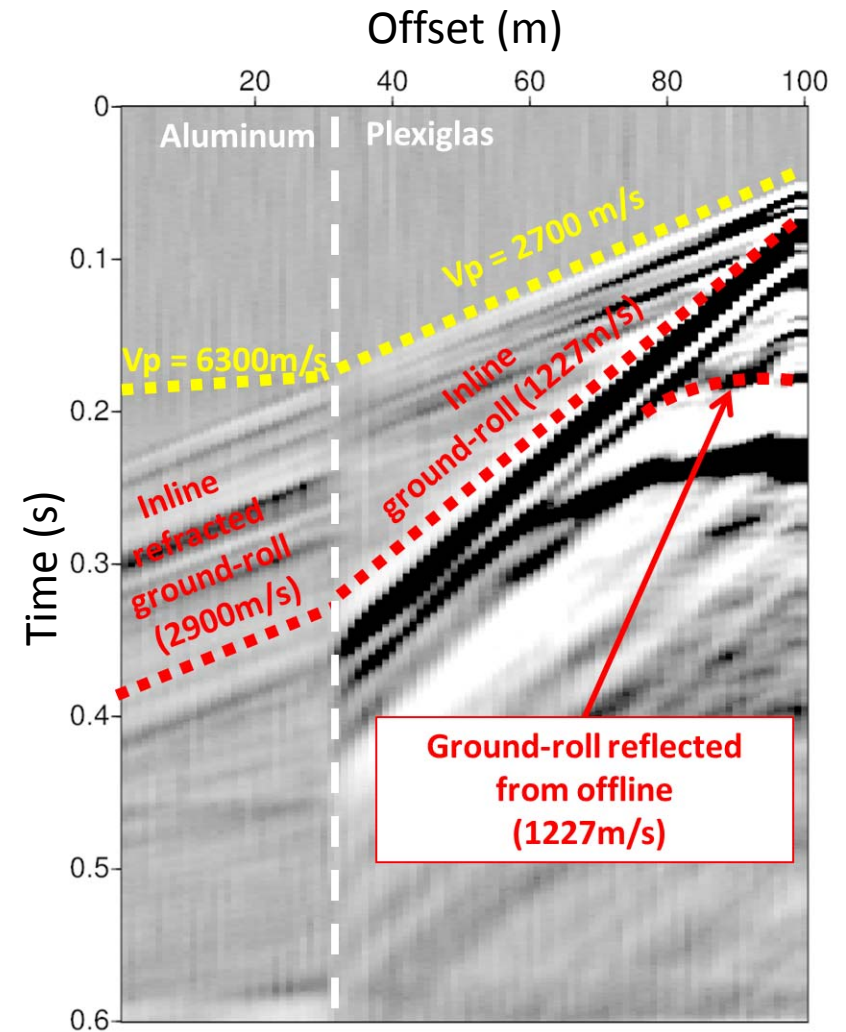
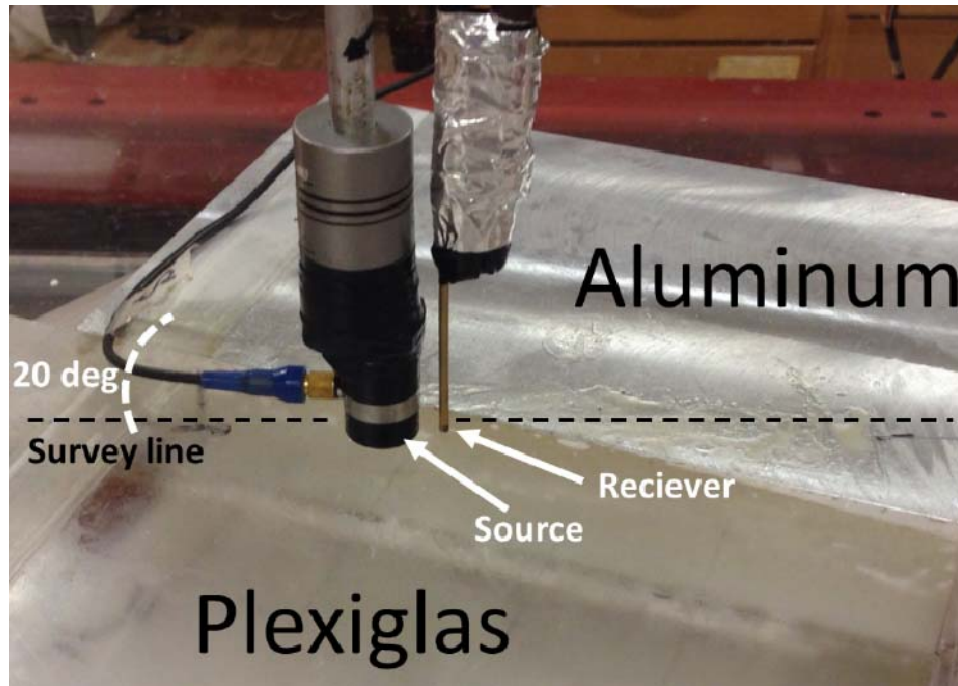


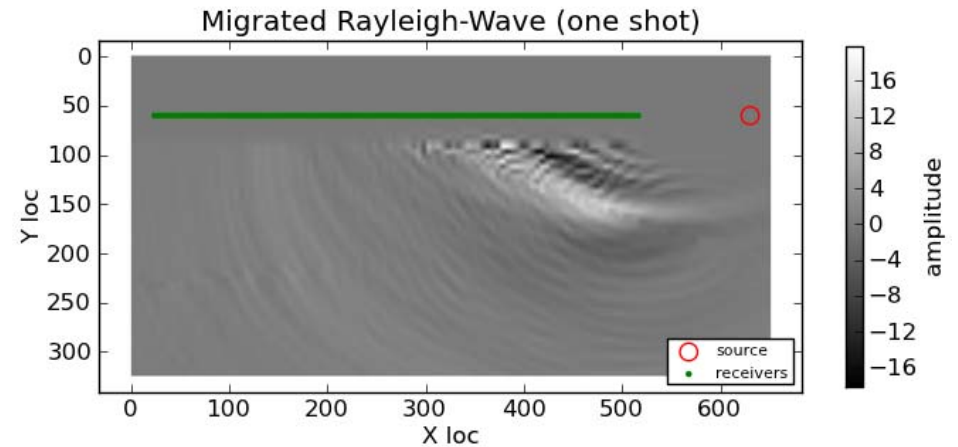
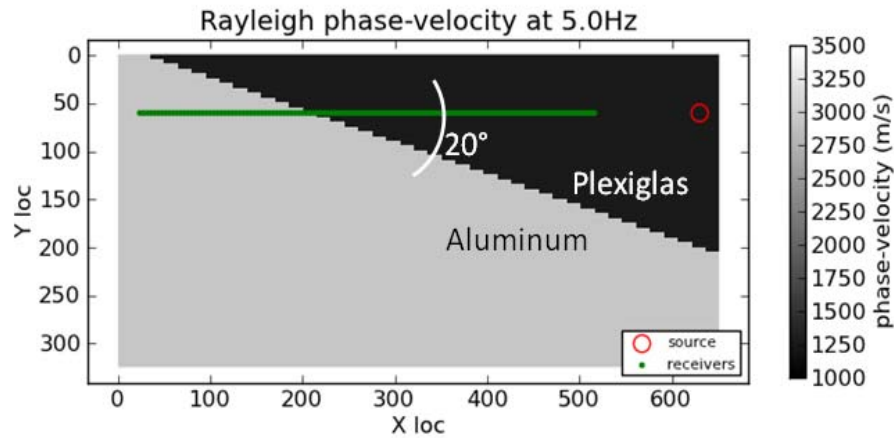
Image with refl. overlay (illum. from. left.)



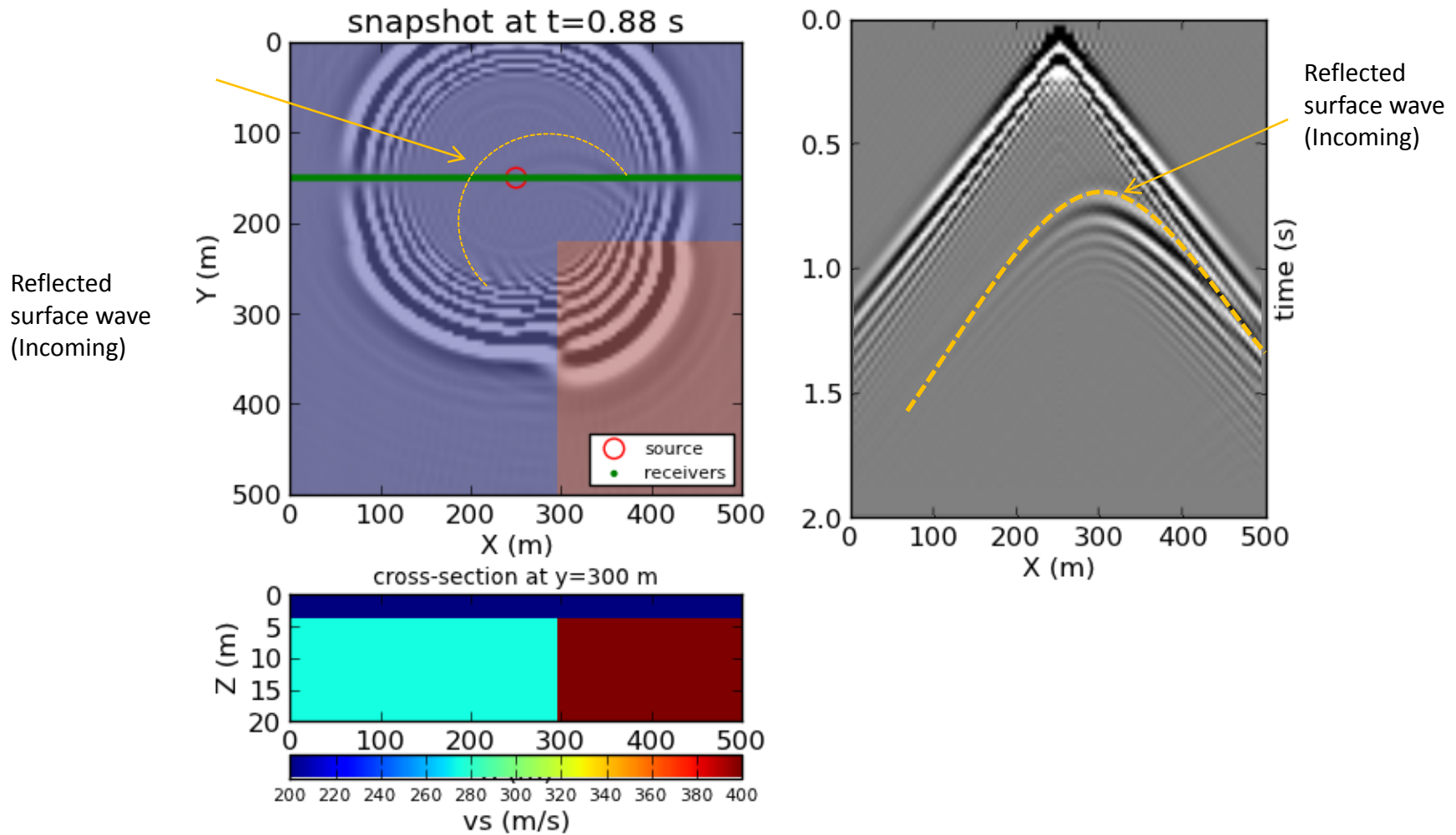
Fault imaging: physical model



Fault imaging: physical model

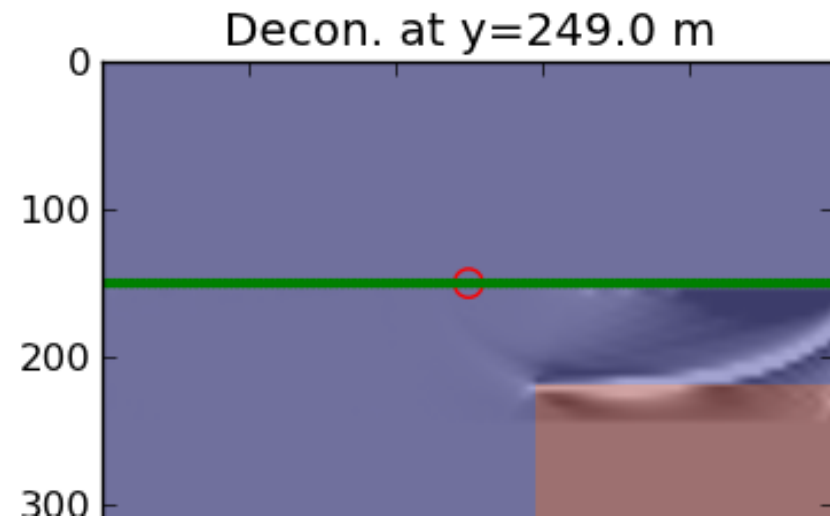
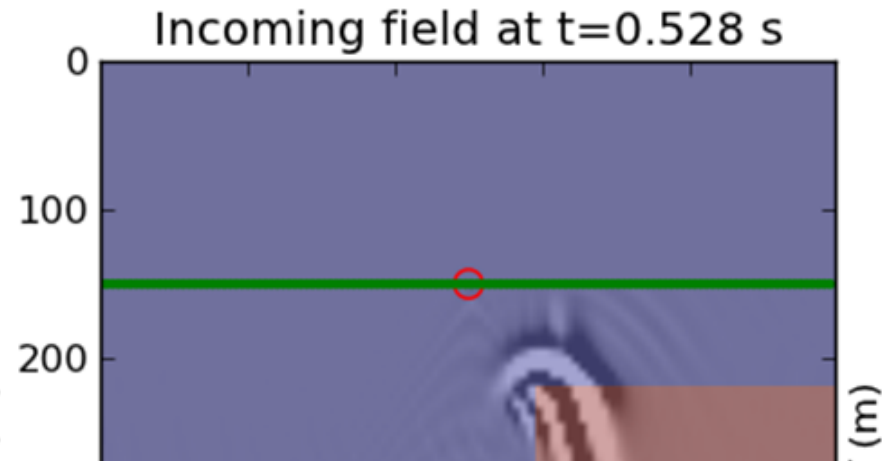
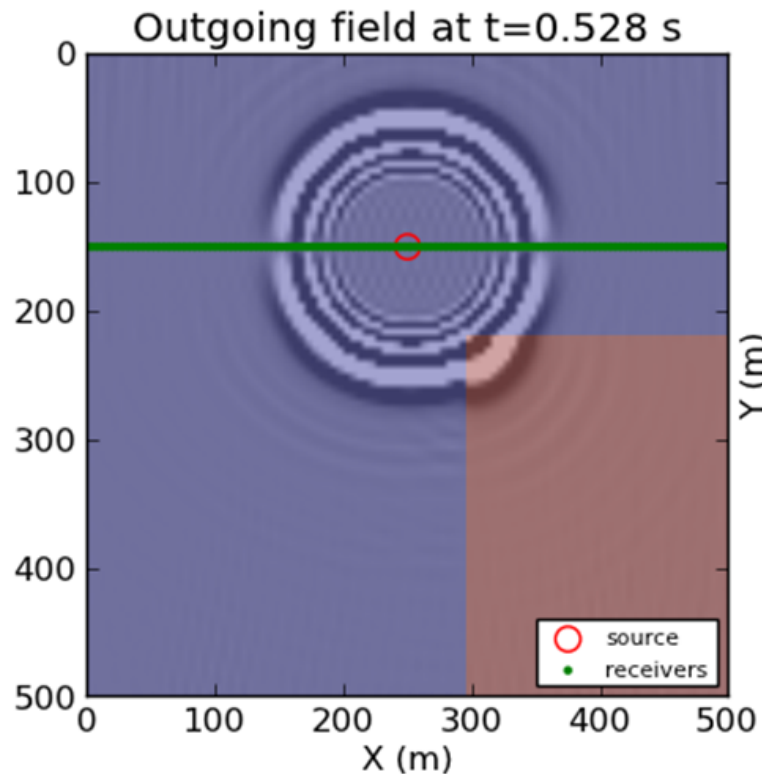


Inline vs. Offline: Offline



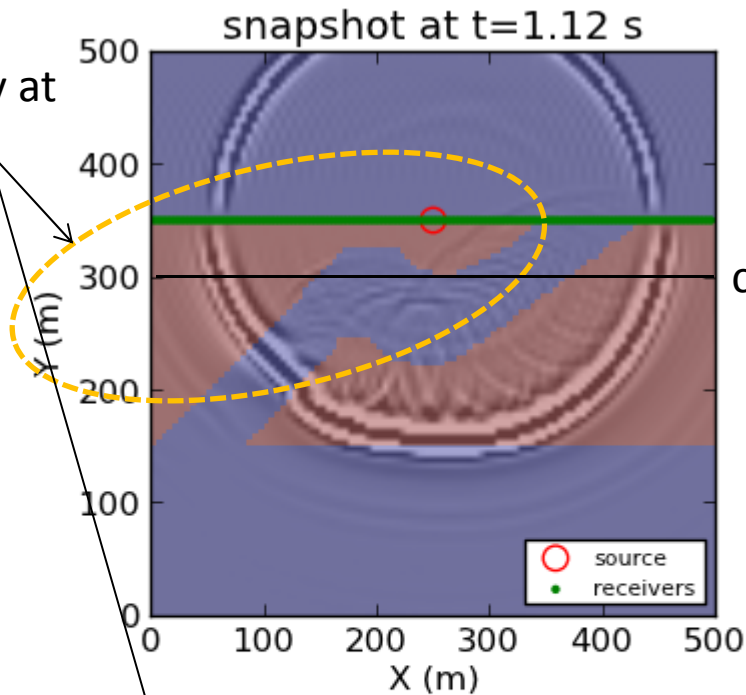
Ground-roll migration

- One-way split-step phase-shift (Stoffa, 90)
 - 2D X-Y (propagation in X+,X-,Y+,Y-)
 - Modified for dispersion
 - Imaging condition: deconv

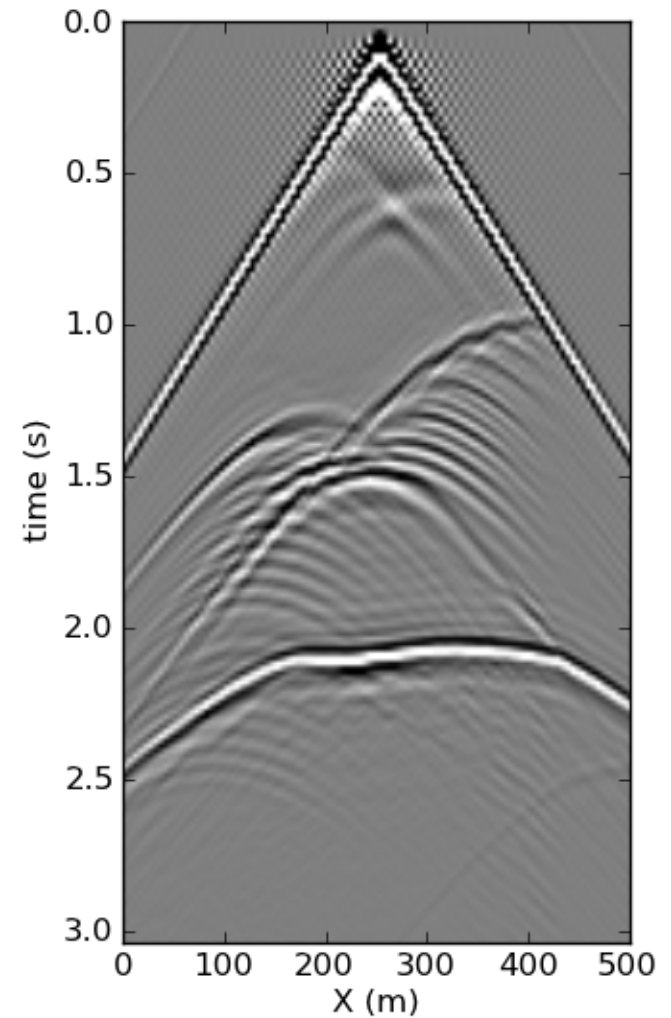
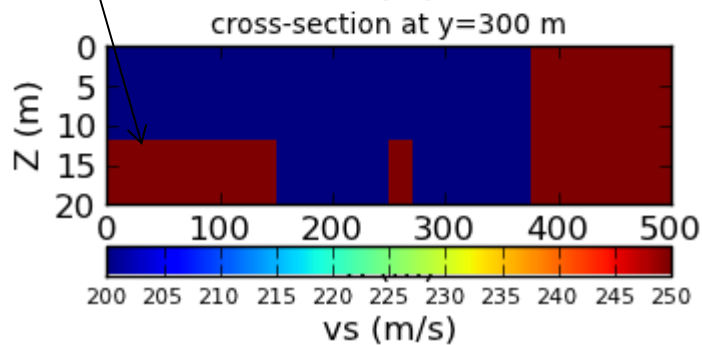


Sharp channel imaging

“upper”
anomaly at
depth

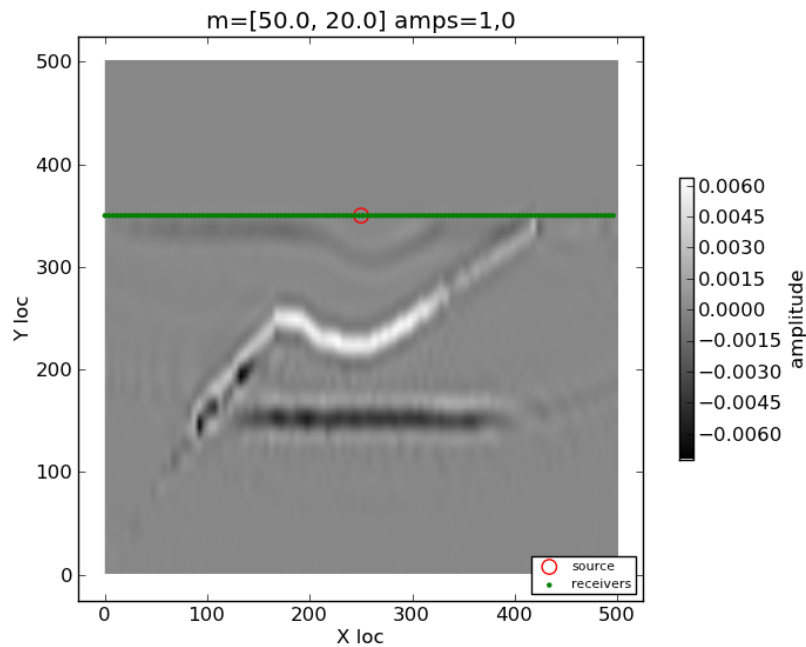


cross-section

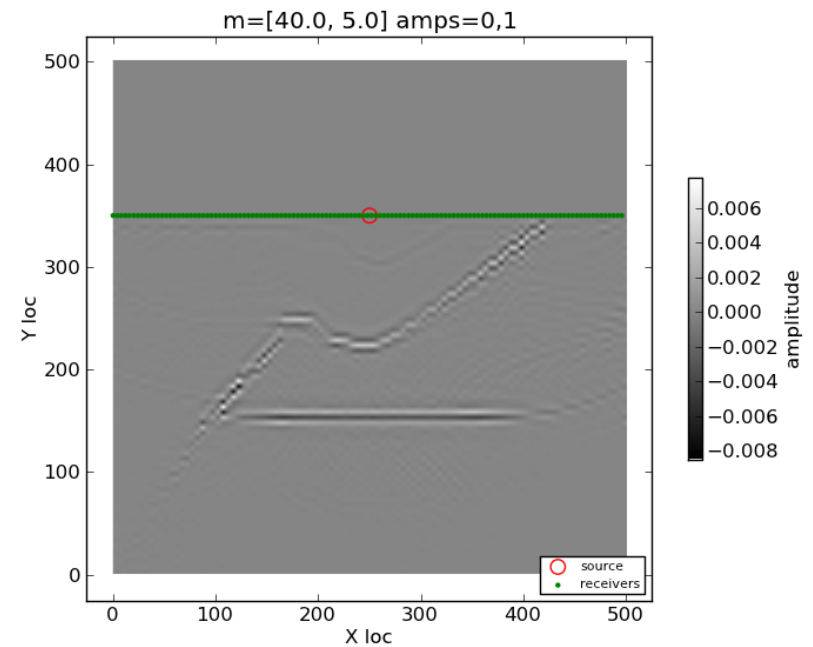


Sharp channel imaging

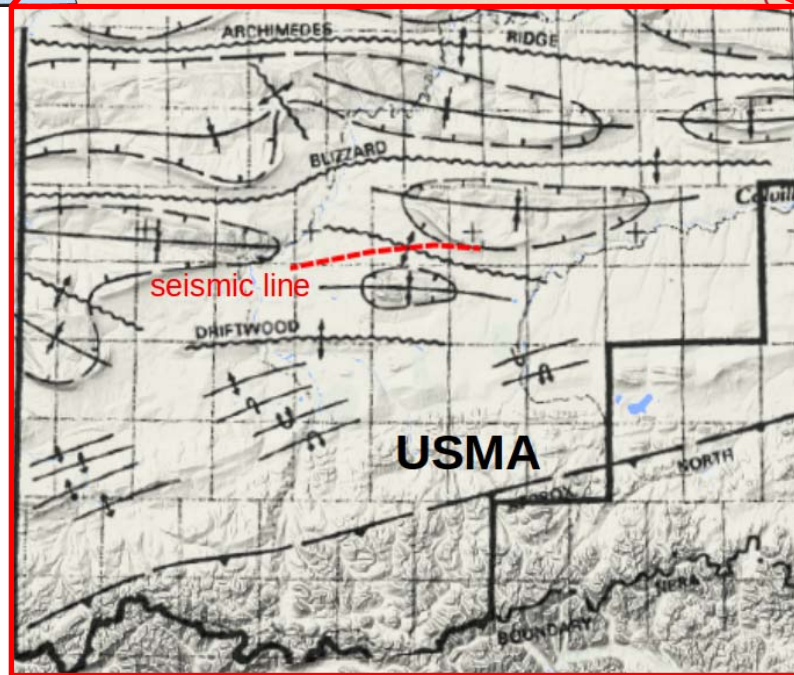
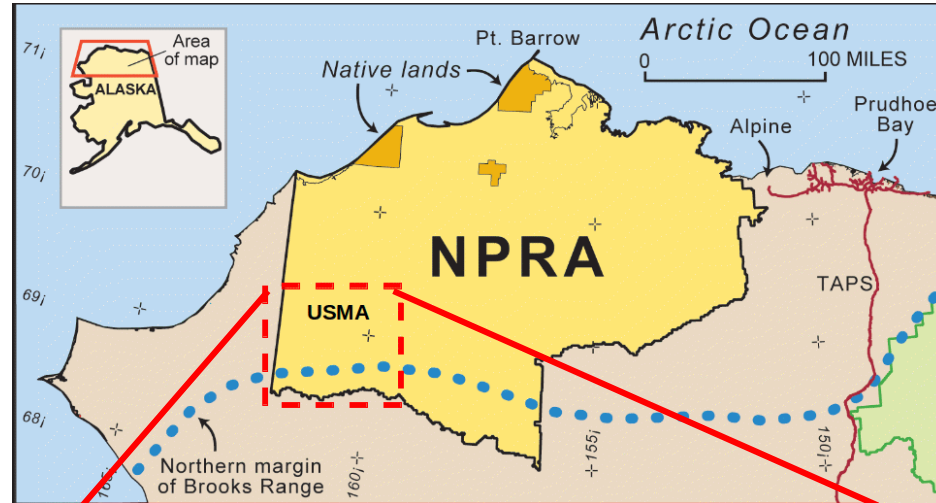
Long-wavelength image



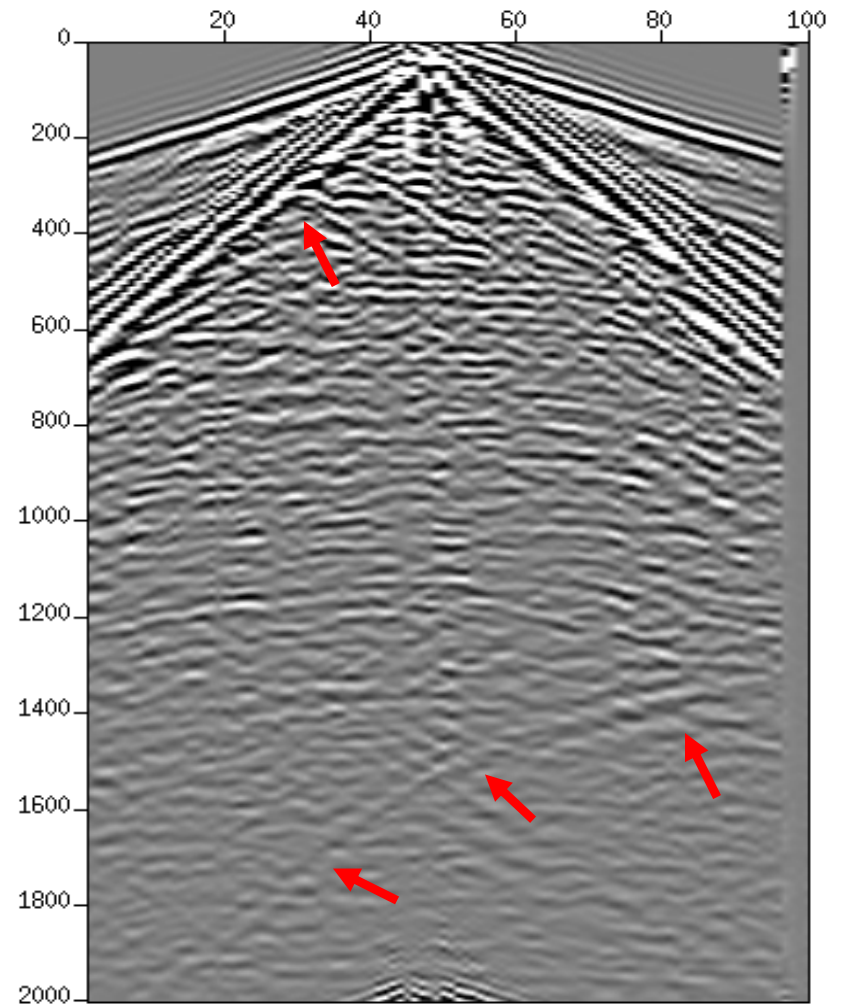
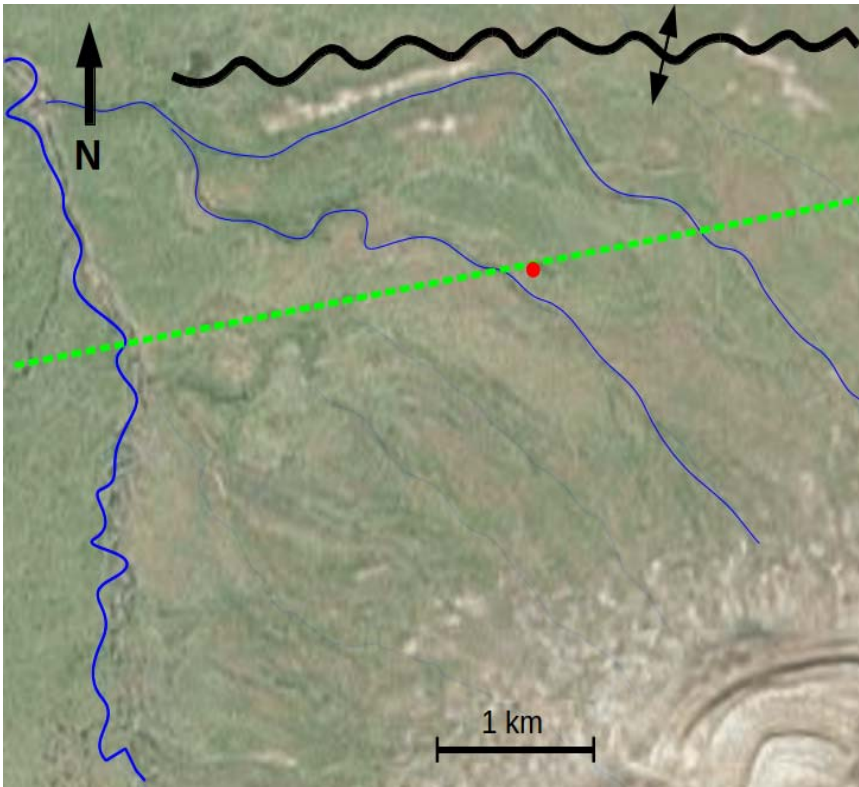
Short-wavelength image



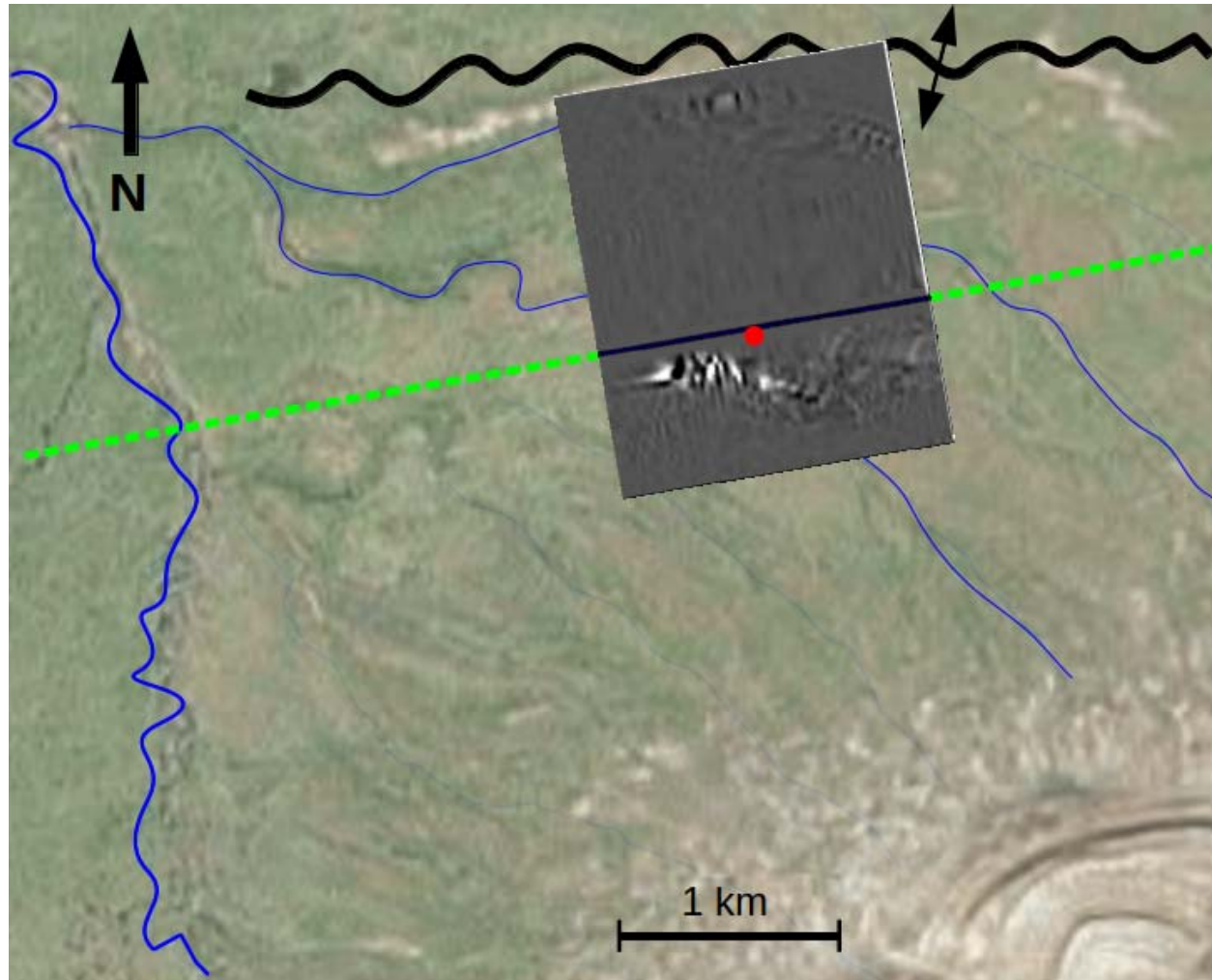
US National Petroleum Reserve



Field



Field



Summary – Ground Roll Imaging

- It is essential to characterize the near surface to:
 - Locate anomalies
 - Image faults
 - Provide better parameters (velocity model) for traditional imaging flows
- There is useful information in back-reflected ground-roll in
 - Defining sharp lateral heterogeneity
 - Using frequency content to add depth dimension
- Ground roll imaging may become a key element of routine processing to provide a detailed near-surface model

Thank you, muchas gracias, merci, xie
xie, abrigado, arigato, tousen tak

Best of the Season!



Field: preliminary results

Bradford 3D3C survey

Source: dynamite

Receiver: 3C

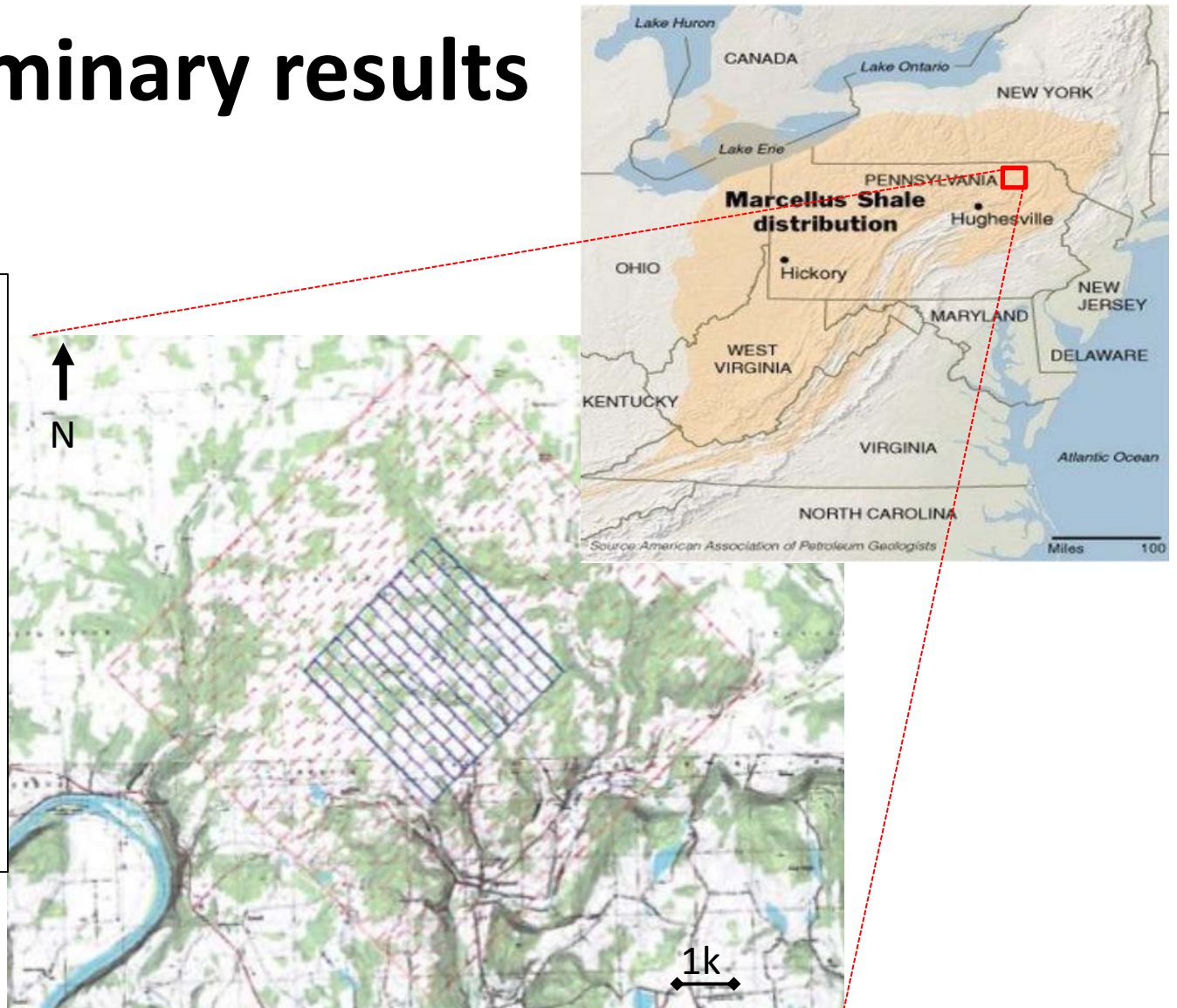
Source pattern: 67 X 201 m

Rec. pattern: 33 X 268 m

Source area: 80 km²

Receiver area: 12 km²

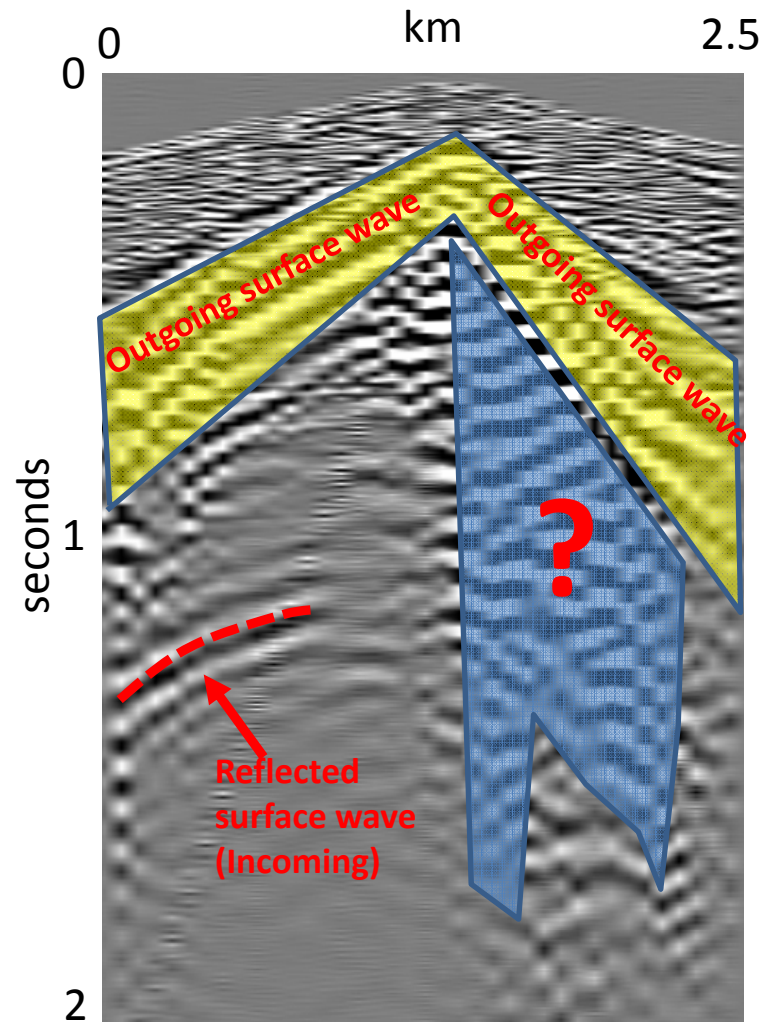
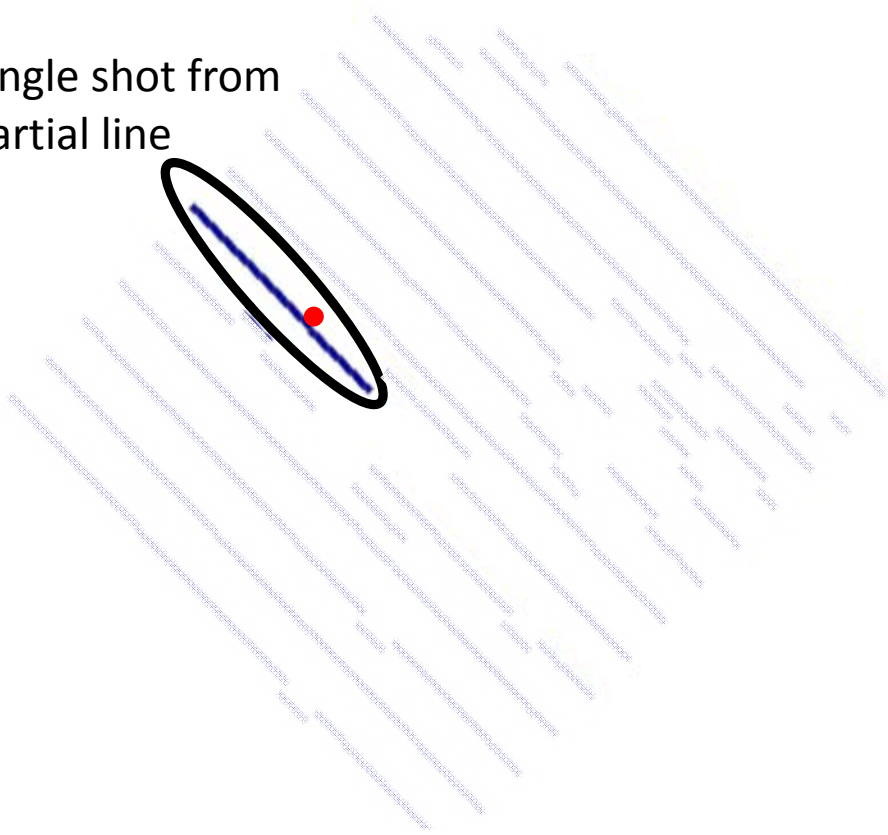
Thank you, Geokinetics for
donation of these data!



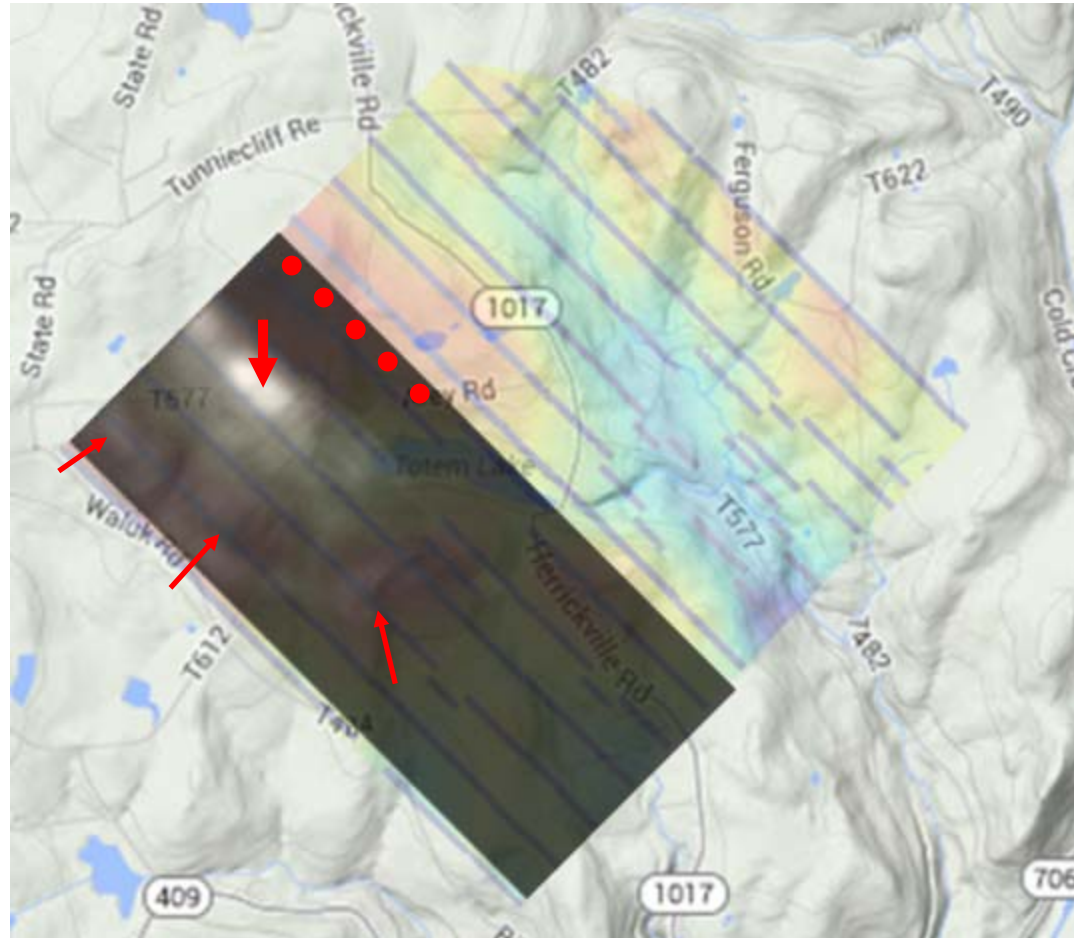
red: sources blue: receivers

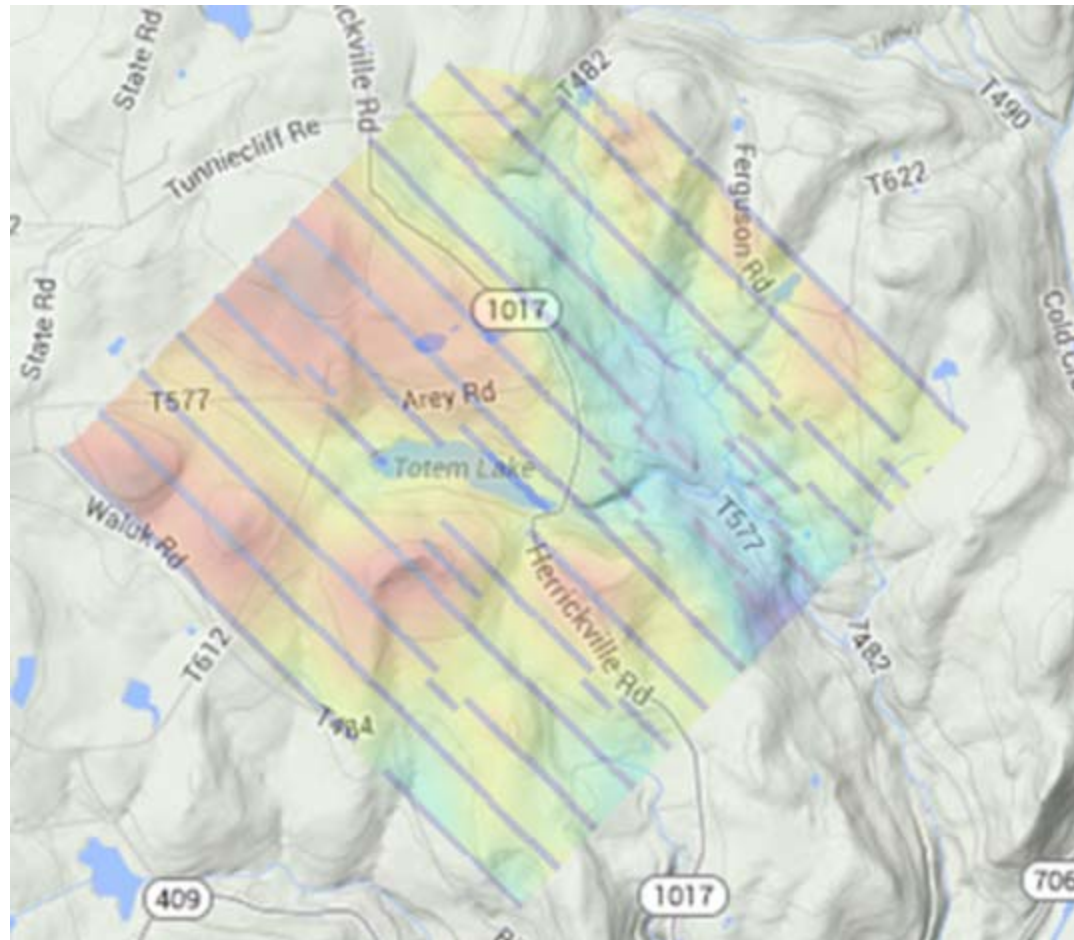
Field: preliminary results

Single shot from
partial line



Field: preliminary results

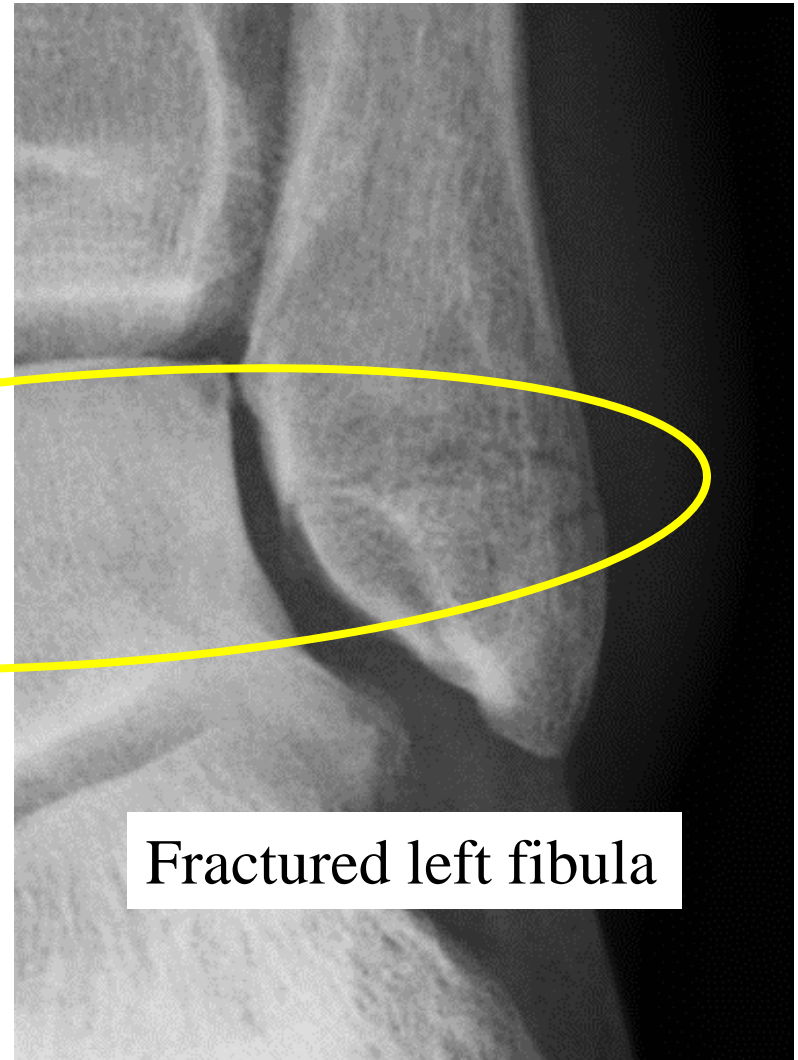
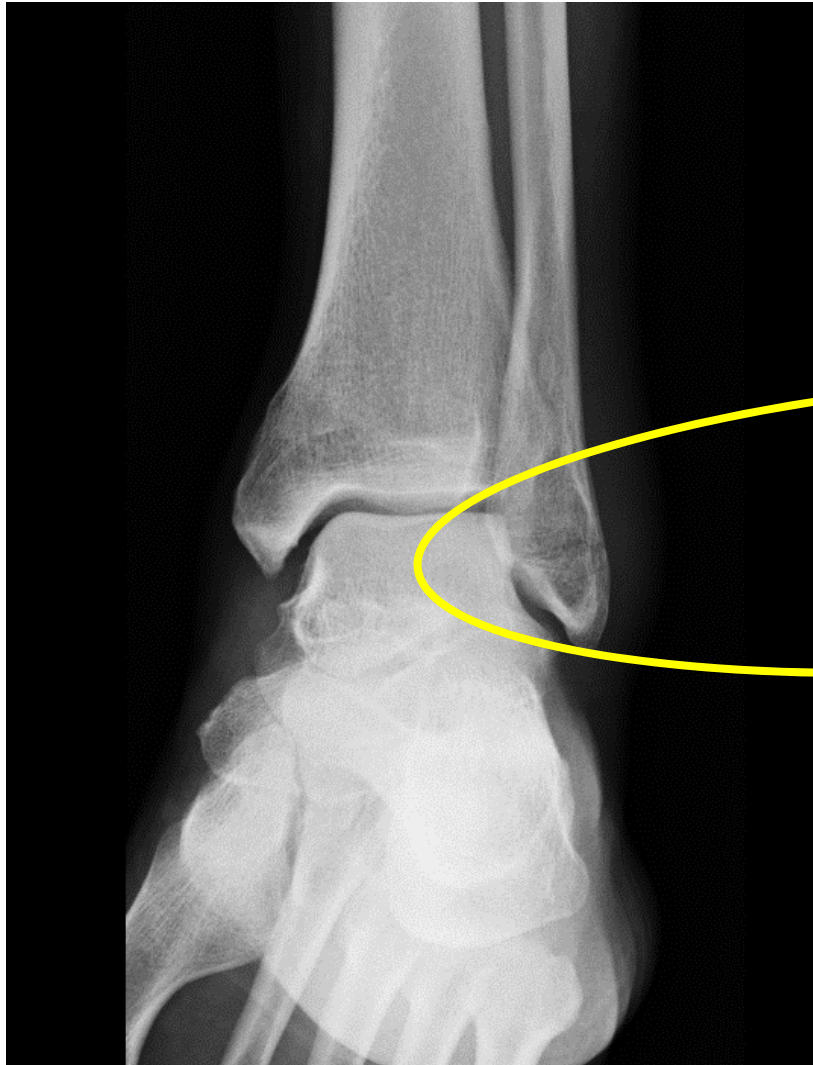




Just one more coffee, then we'll start



Interesting induced seismicity in a mechanical fracture zone – unfortunately, my ankle



Fractured left fibula

Inline vs. Offline: Inline

