

Well log study and seismic survey of a coal-bed methane site

Alder Flats, Alberta

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Outline

- Introduction
- Petrophysics of wet and dry coals
- Modelling reflectivity with offset
- Results of preliminary field survey
- Conclusions

Purpose of the Study

- During production of CBM reservoirs, water is initially produced; changing the coals from wet to dry.
- The seismic reflectivity of wet and dry coals is investigated in order to understand the time-lapsed change under reservoir dewatering.
- A field survey was conducted to gain a preliminary understanding of the coals and acquisition parameters at the study site.

Study Well

Scollard Formation

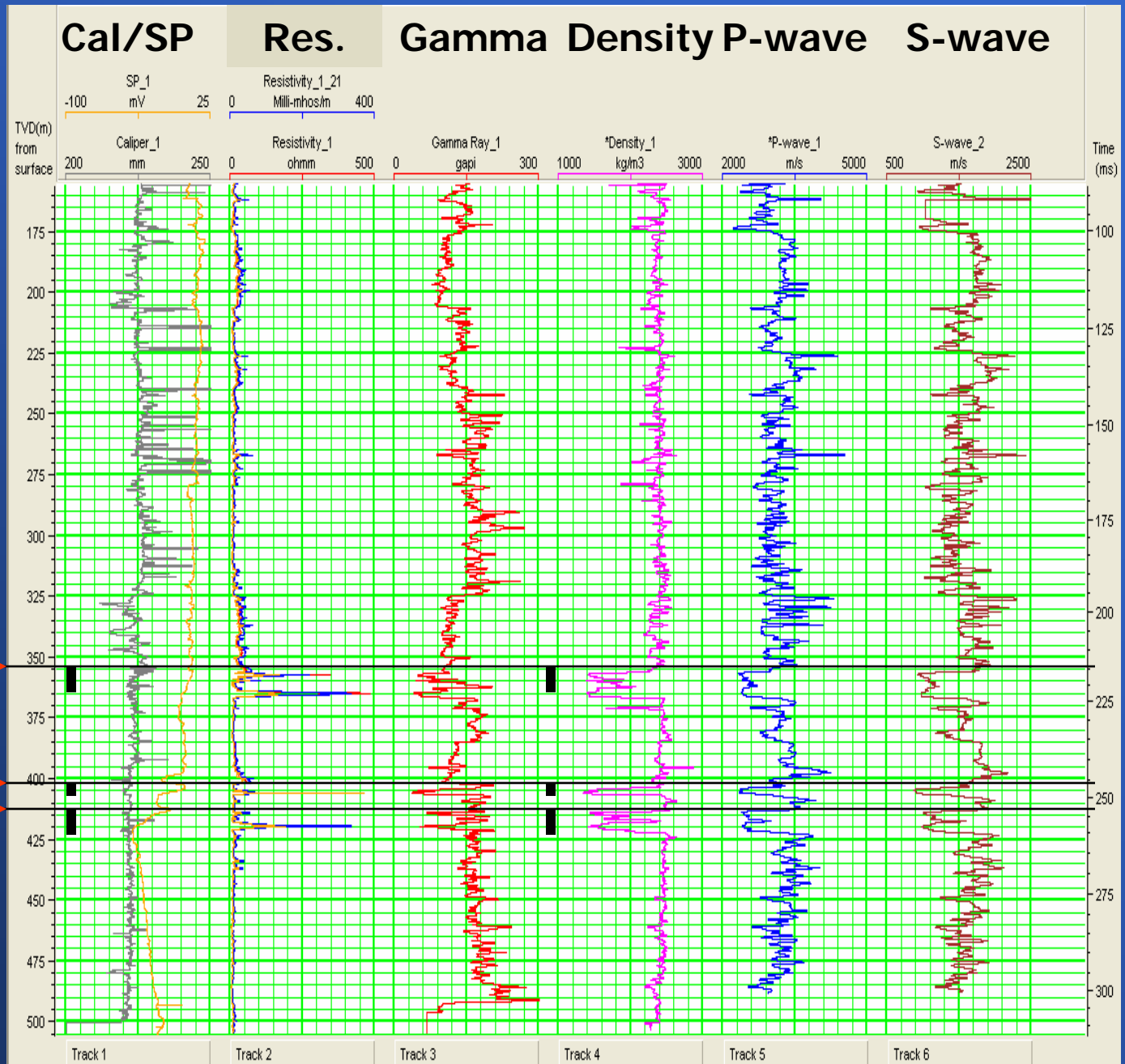
TVD 200 m

Ardley coal 3

Ardley coal 2

Ardley coal 1

TVD 500 m

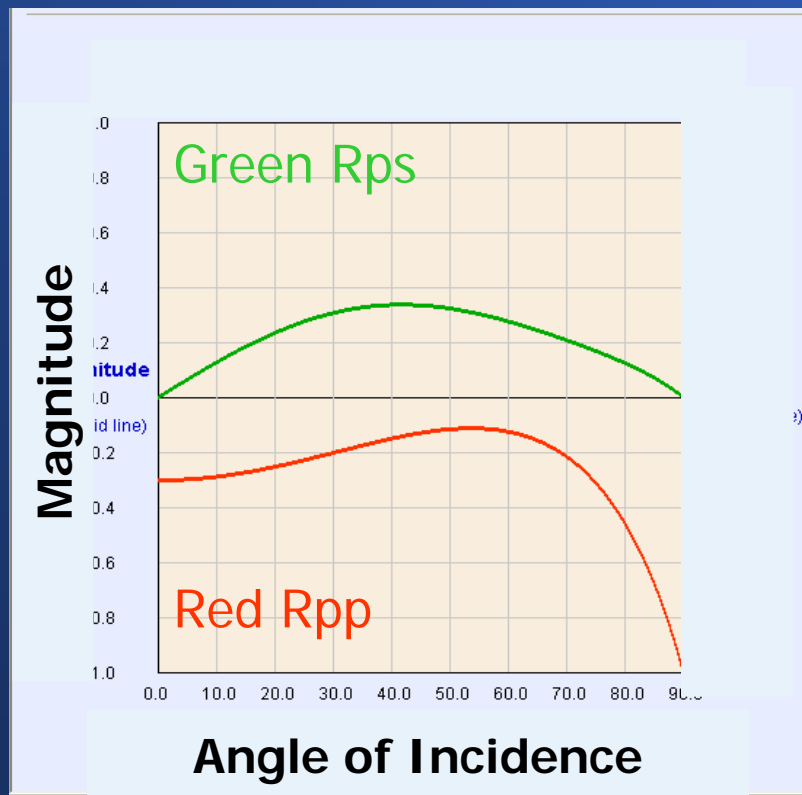


Coal Properties: Wet/Dry

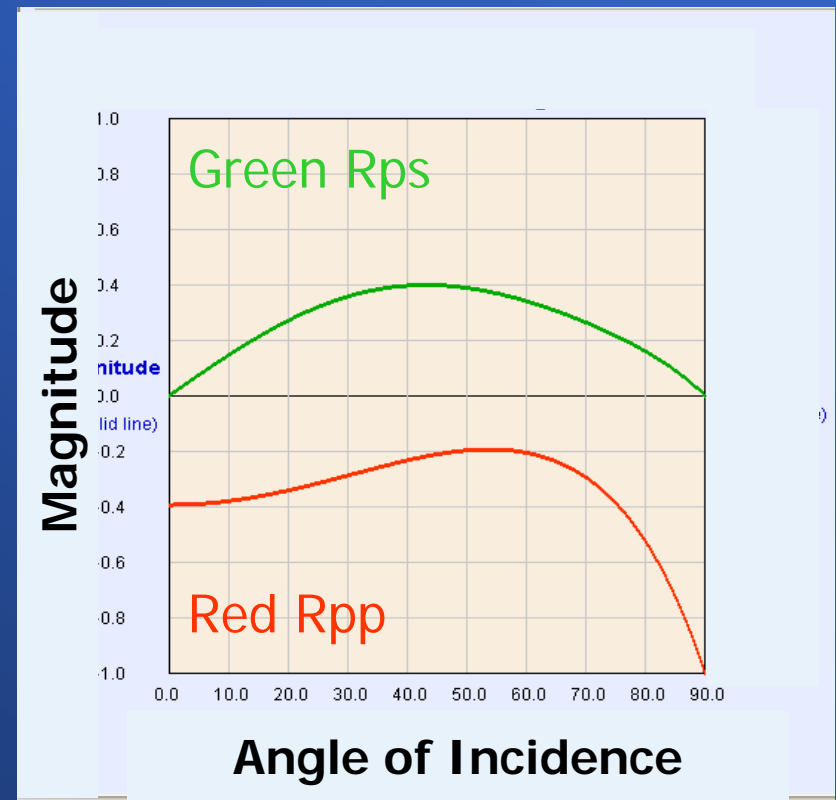
- Dewatering of coals is assumed to be a fluid substitution – therefore V_p and density should change.
- V_s is assumed to be unaffected by a change in coal water content.
- Sarah E. Richardson and Don C. Lawton (2002) found that a reasonable estimate of the decrease in coal V_p and density due to dewatering of coals was 10%.

Offset Reflection Coefficients

Top of the Ardley 1
shale over coal



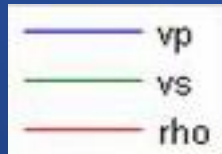
Wet coals



Dry coals

PP AVO Synthetic Seismogram

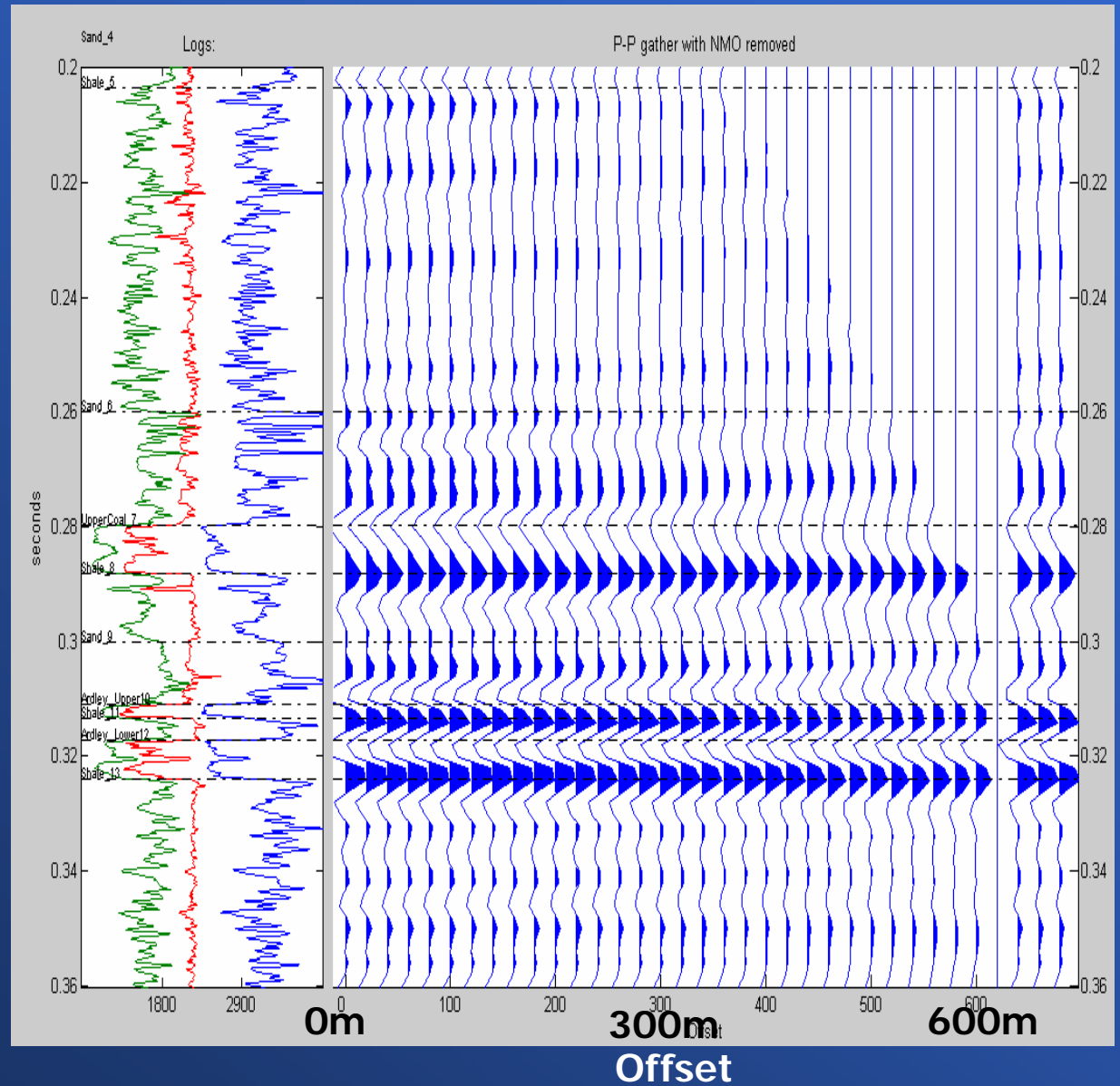
90 Hz Ricker – Wet coals



Ardley coal 3 →

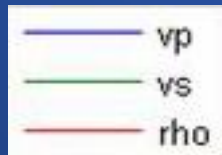
Ardley coal 2 →

Ardley coal 1 →



PP AVO Synthetic Seismogram

90 Hz Ricker – Dry coals

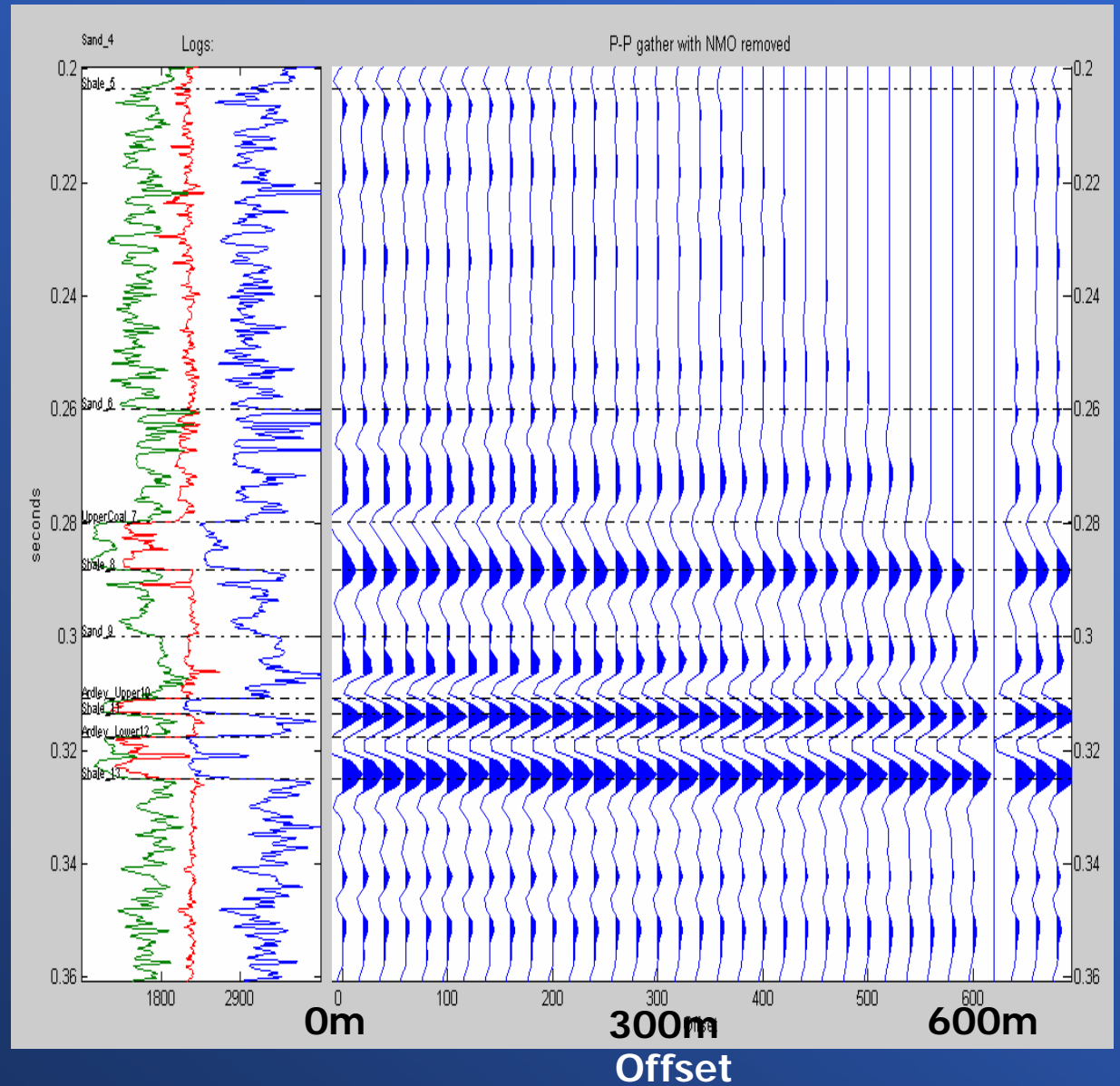


Ardley coal 3

Ardley coal 2

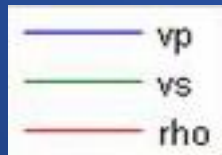
Ardley coal 1

Vp and density reduced by 10%



PS AVO Synthetic Seismogram

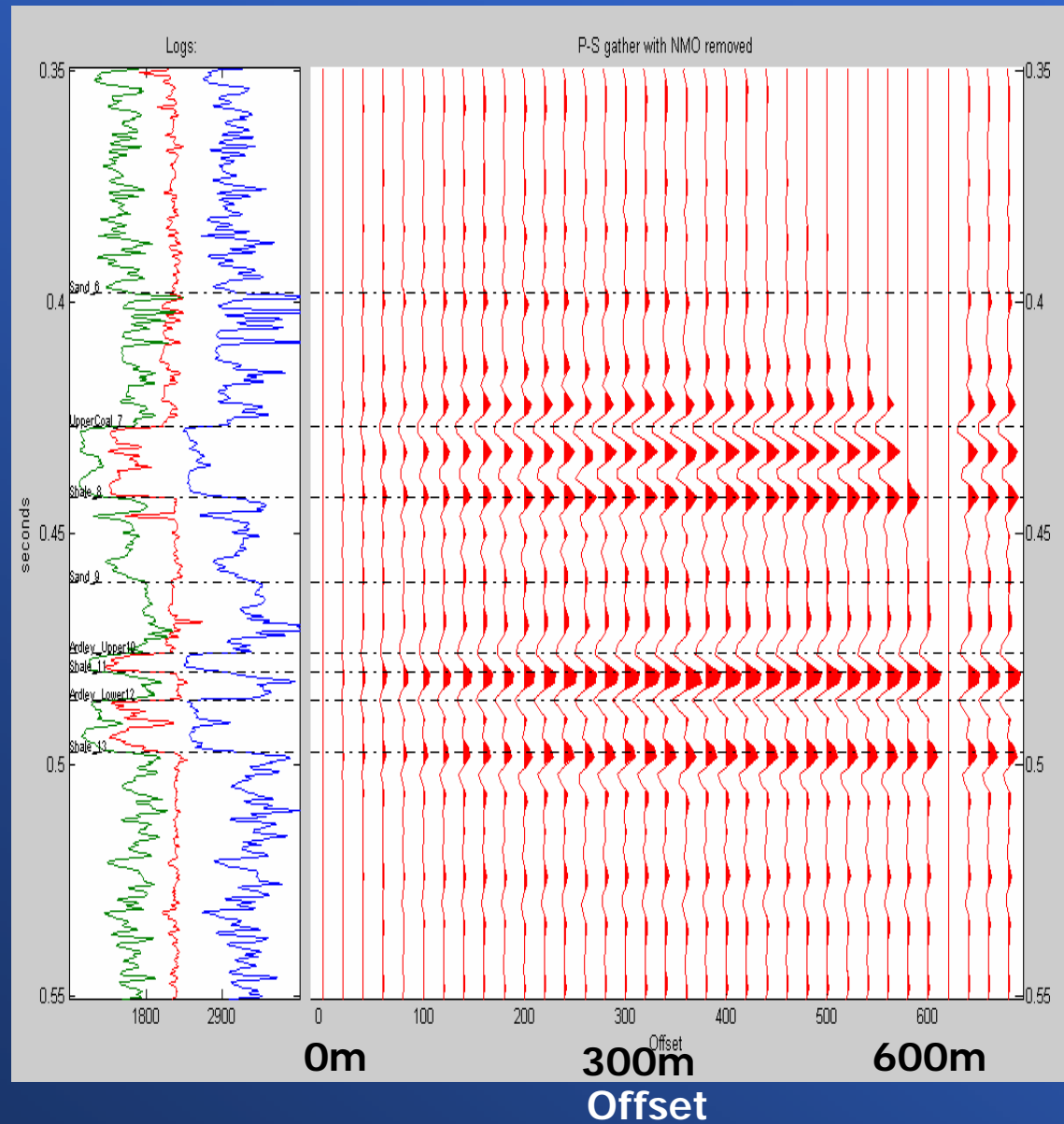
90 Hz Ricker – Wet coals



Ardley coal 3 →

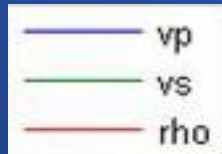
Ardley coal 2 →

Ardley coal 1 →



PS AVO Synthetic Seismogram

90 Hz Ricker – Dry coals

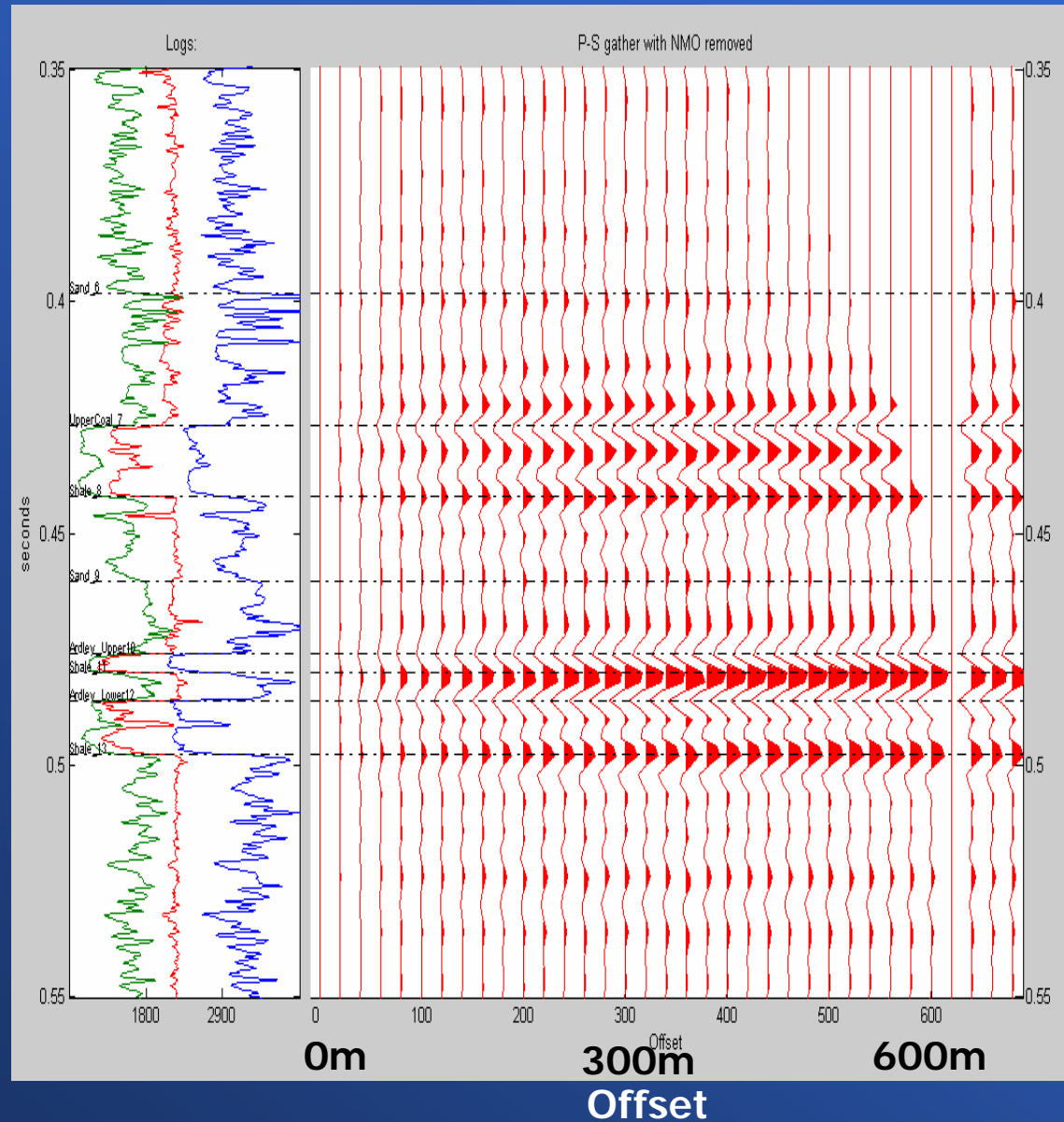


Ardley coal 3 →

Ardley coal 2 →

Ardley coal 1 →

Vp and density reduced by 10%



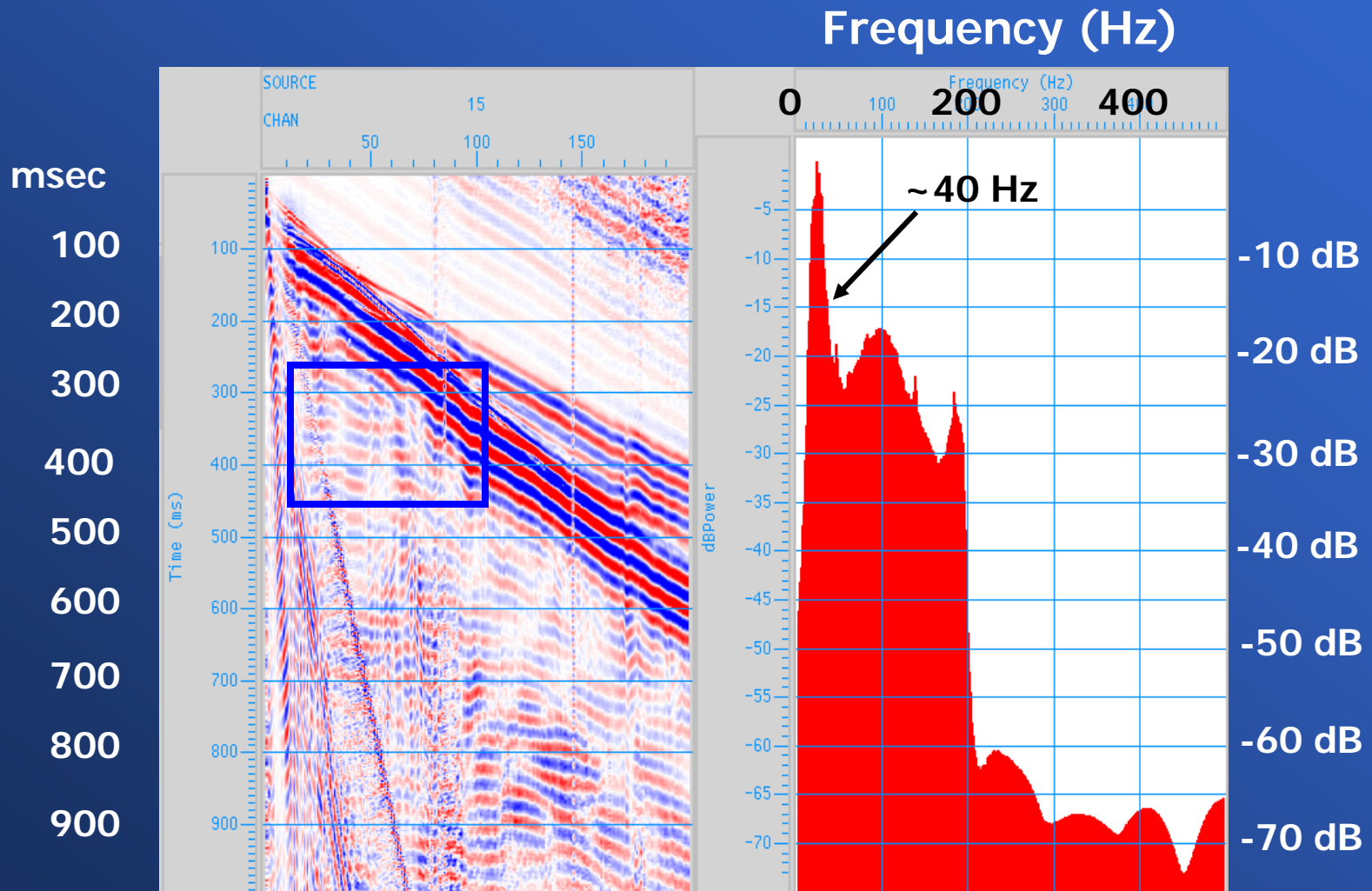
Field Survey June 2006



Acquisition Parameters

Two lines	N-S and E-W – total distance ~4km
Source	EnviroVibe 10-200 Hz
Vertical stack	Diversity Stack - 4 sweeps per VP
Source interval	10 m for N-S line, 30 m for E-W line;
Receivers	SM-24 Marsh phone (10 Hz dominant)
Receiver interval	5 m for N-S and E-W lines

Raw Shot Gather and Amplitude Spectrum

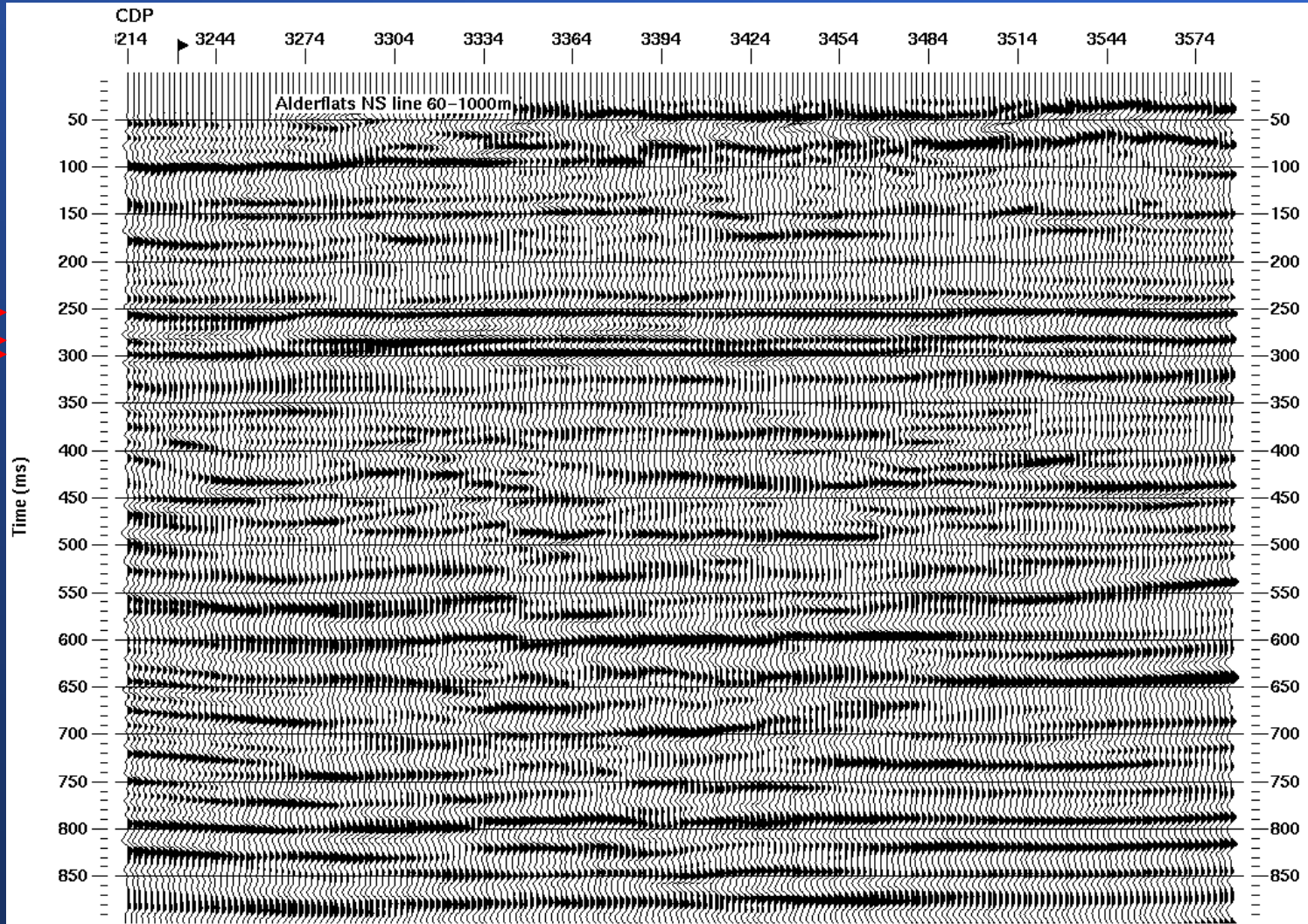


Standard Processing Flow

TRACE EDIT
TRUE AMPLITUDE RECOVERY
SURFACE CONSISTENT DECONVOLUTION
TIME VARIANT SPECTRAL WHITENING
ELEVATION AND REFRACTION STATIC CORRECTIONS
VELOCITY ANALYSIS
RESIDUAL SURFACE CONSISTENT STATICS
NORMAL MOVEOUT
TRIM STATICS
FRONT END MUTING
CDP STACK
TIME VARIANT SPECTRAL WHITENING
TRACE EQUALIZATION
F-XY DECONVOLUTION
3D PHASE-SHIFT MIGRATION
FOR TRACE DISPLAY:
TRACE EQUALIZATION
BANDPASS FILTER
TIME VARIANT SCALING

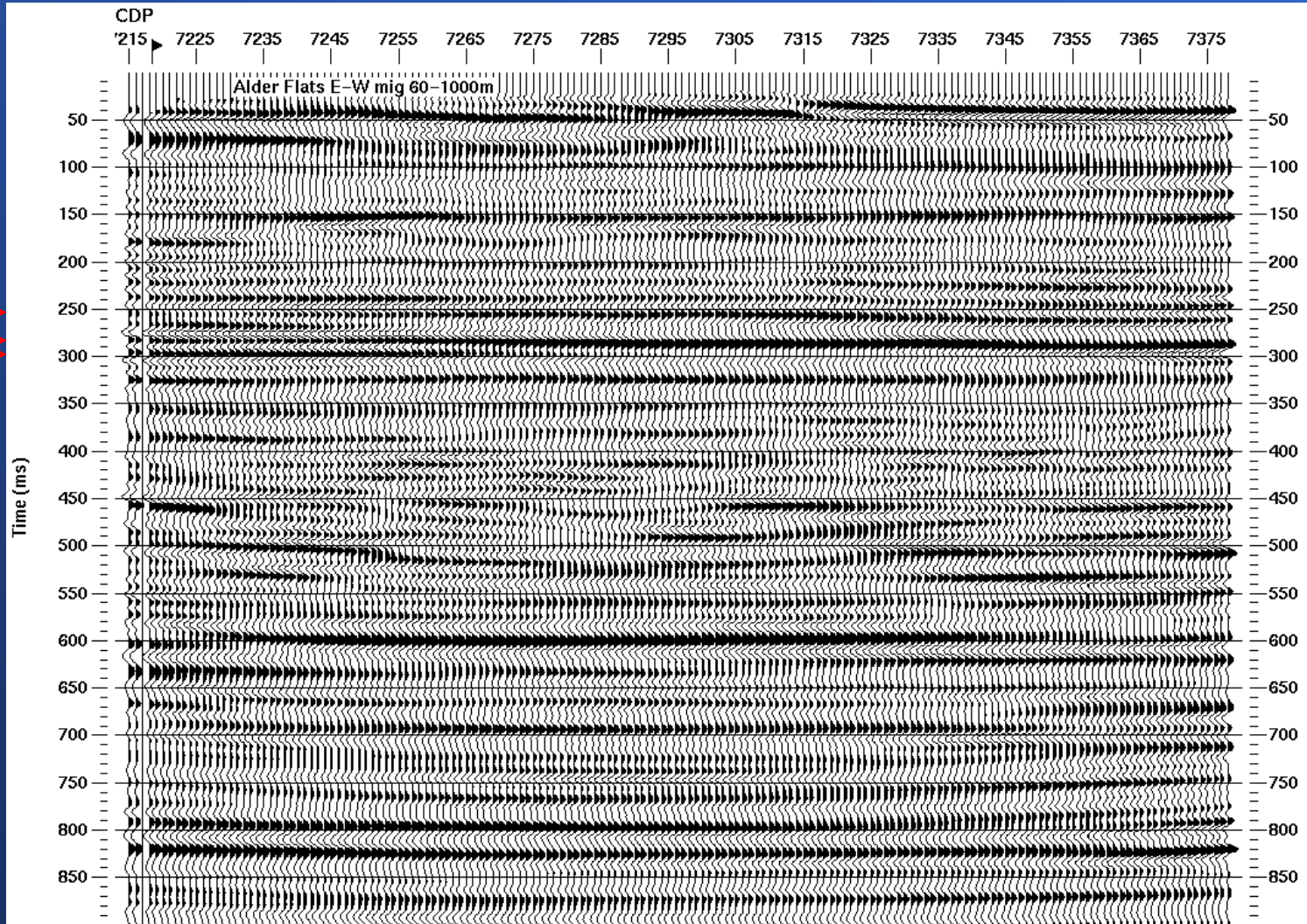
NS standard processing

Coals

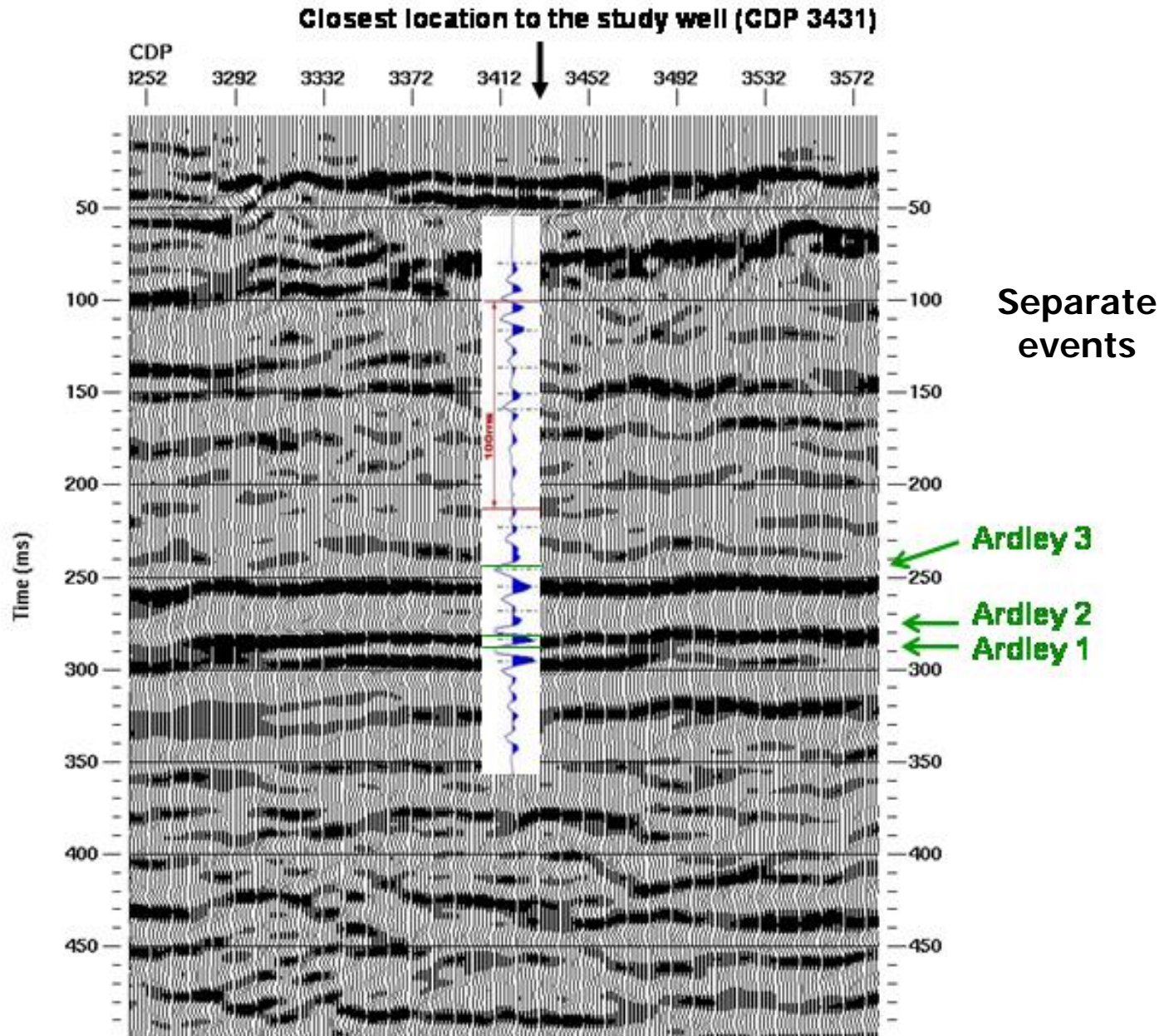


EW standard processing

Coals

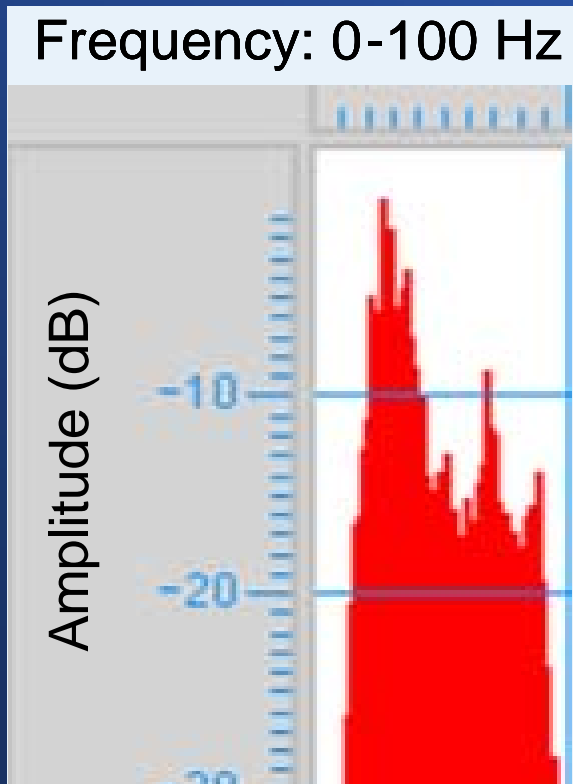


Migrated N-S line

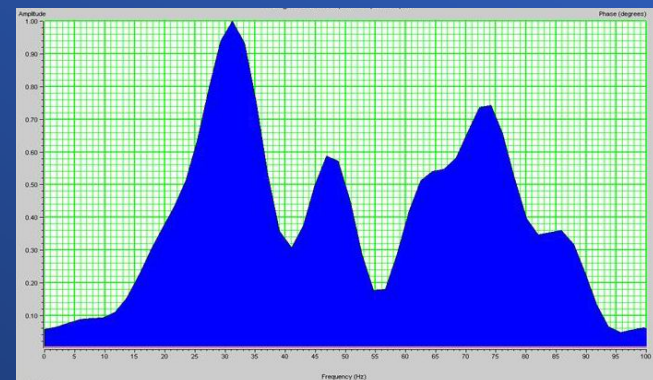
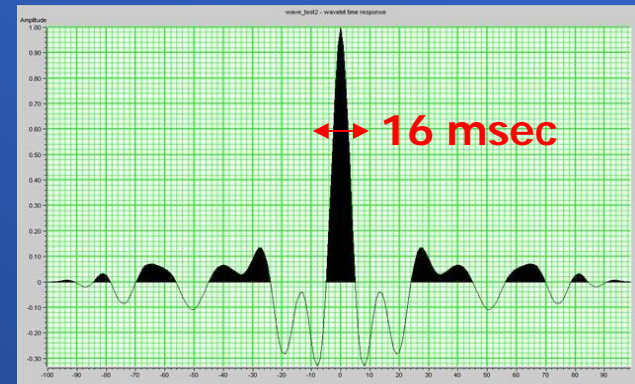


Extracted Wavelet

Amplitude spectrum
from processing NS line
(after bandpass filtering)



200 msec zero phase wavelet
extracted from migrated seismic section



0 25 50 75 100
Frequency (Hz)

Conclusions

- Synthetic modelling shows that wet and dry coals can be discriminated with AVO analysis.
- A field survey using the University of Calgary seismic acquisition system successfully imaged the coals.
- The raw shot gather data had bandwidth that dropped below 15 dB down above 40 Hz.
- The migrated sections resolve each coal seam as a separate seismic event.

Thank you

CREWES Sponsors

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Software, and CREWES Syngram and Zoeppritz

Explorer