Overview ta3520
Introduction to seismics

- Fourier Analysis
- Basic principles of the Seismic Method
- Interpretation of Raw Seismic Records
- Seismic Instrumentation
- Processing of Seismic Reflection Data
- Vertical Seismic Profiles

Practical:

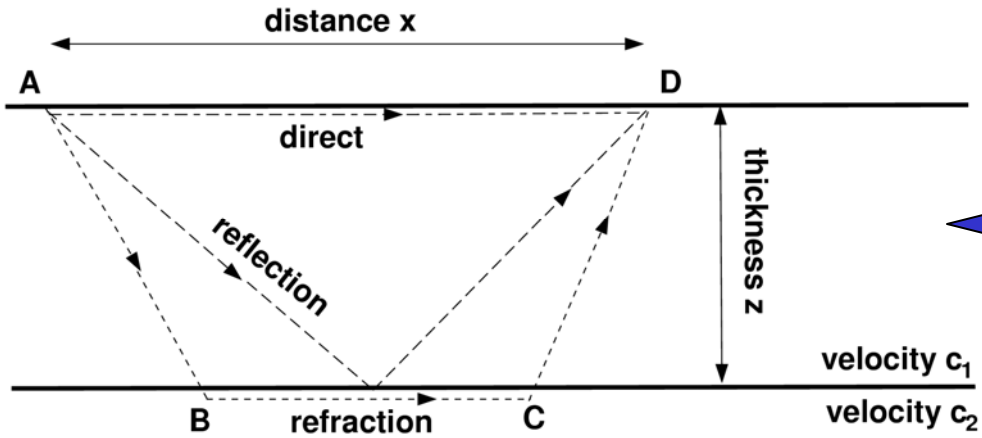
- Processing practical (with MATLAB)

Signal and Noise

Signal: desired
Noise: not desired

So for reflection seismology:
- Primary reflections are signal
- Everything else is noise!

Signal and Noise (2)

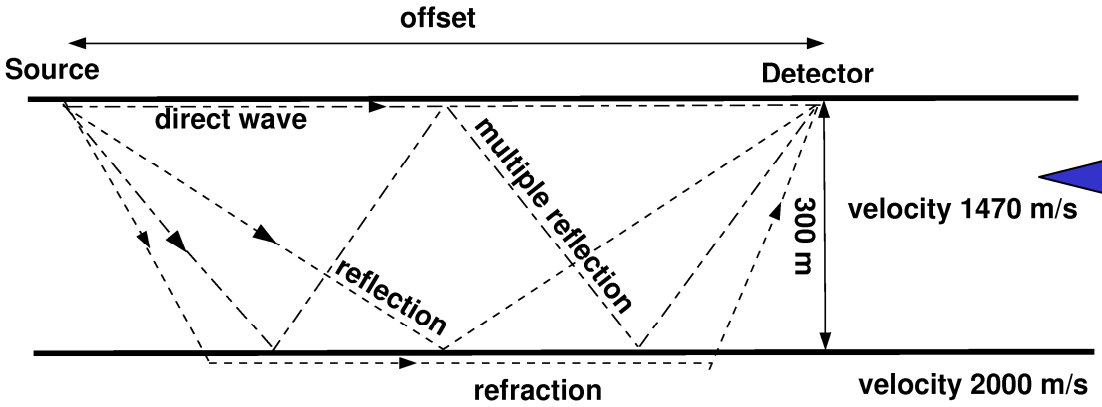


Direct wave: noise

Reflection: (desired) signal

Refraction: noise

Signal and Noise (3)



Direct wave: noise

Multiply reflected : noise

Reflection: signal

Refraction: noise

Signal and Noise for P-wave survey

Desired signal:
- primary reflected P-waves

Noise:
- direct wave through first layer
- direct air wave
- direct surface wave
- S-wave
- Multiply reflected wave
- Refraction / Head wave

Signal and Noise for P-wave survey

$$\frac{\text{Signal}}{\text{Noise}} = \frac{\text{Primary P-wave Reflected Energy}}{\text{All but Primary Reflection Energy}}$$

Goal of Processing:

Remove effects of All-but-Primary-Reflection Energy

Processing of Signal (Primary-reflected energy)

Goal of processing:

Focus energy to where it comes from

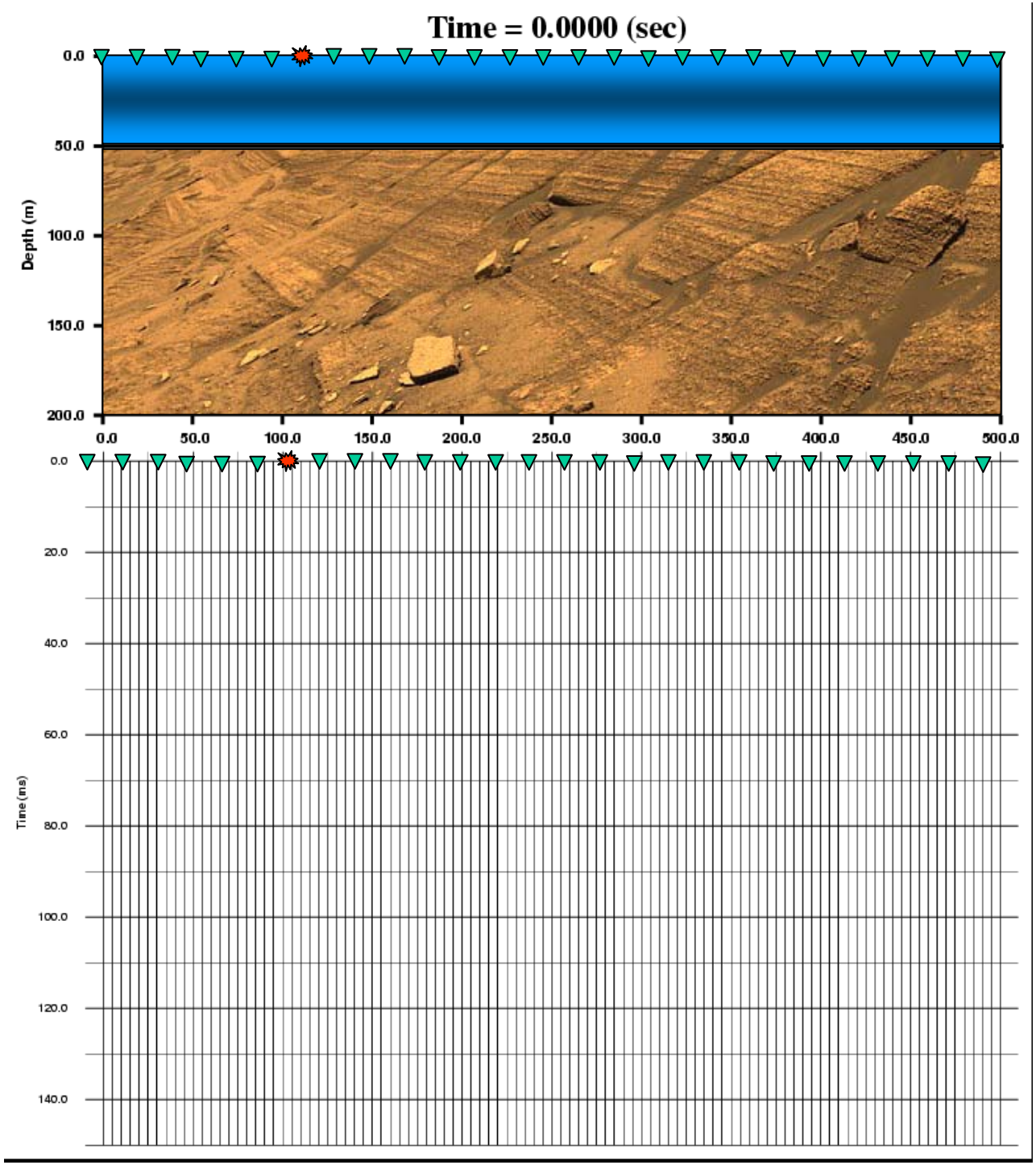
Understanding signal and noise: wave theory

Basic physics underlying signal is captured by wave equation

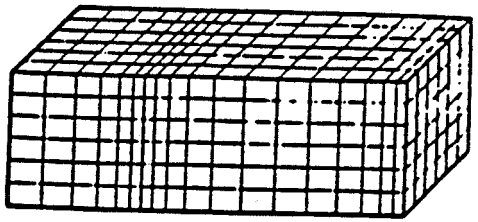
Ray theory: approximation of wave equation (“high-frequency”)
Resonances: modes expansion of wave equation

S-waves, P-waves: elastic form of wave equation

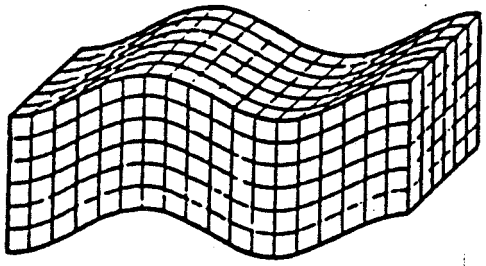
The seismic record



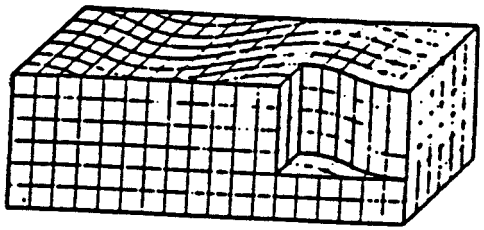
Body waves:



p-wave

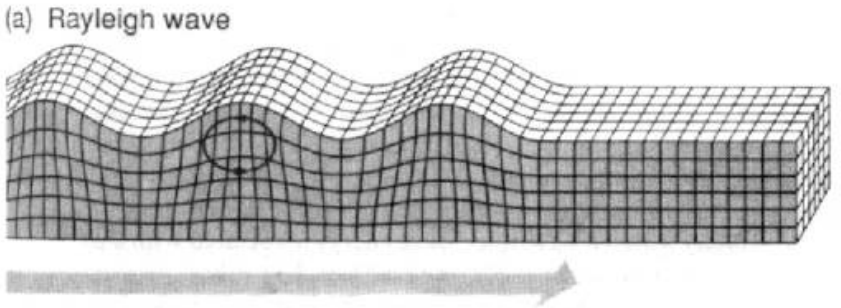


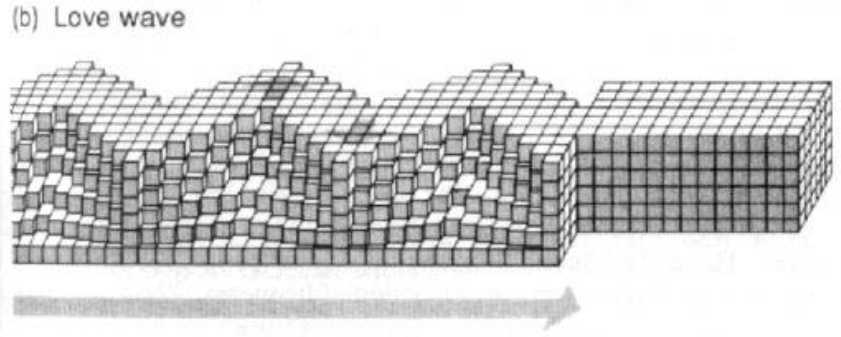
SV-wave



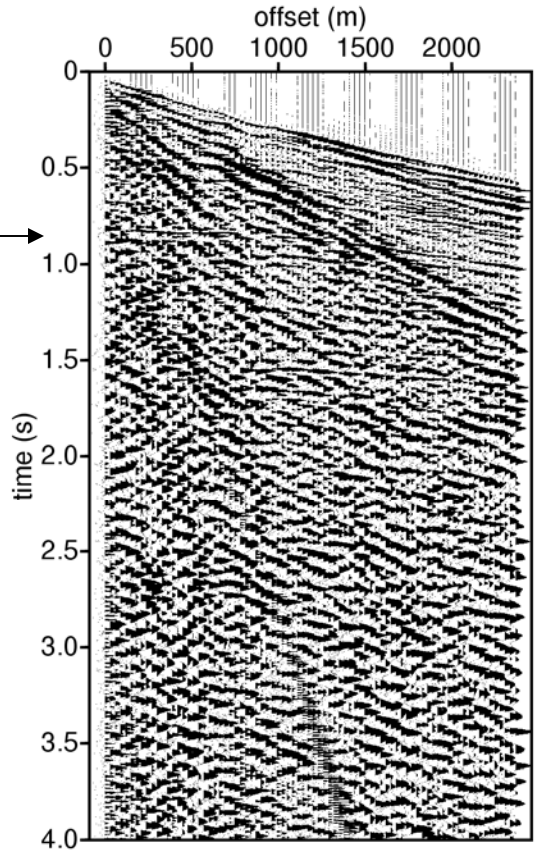
SH-wave

Surface waves:





A seismic shot record on land



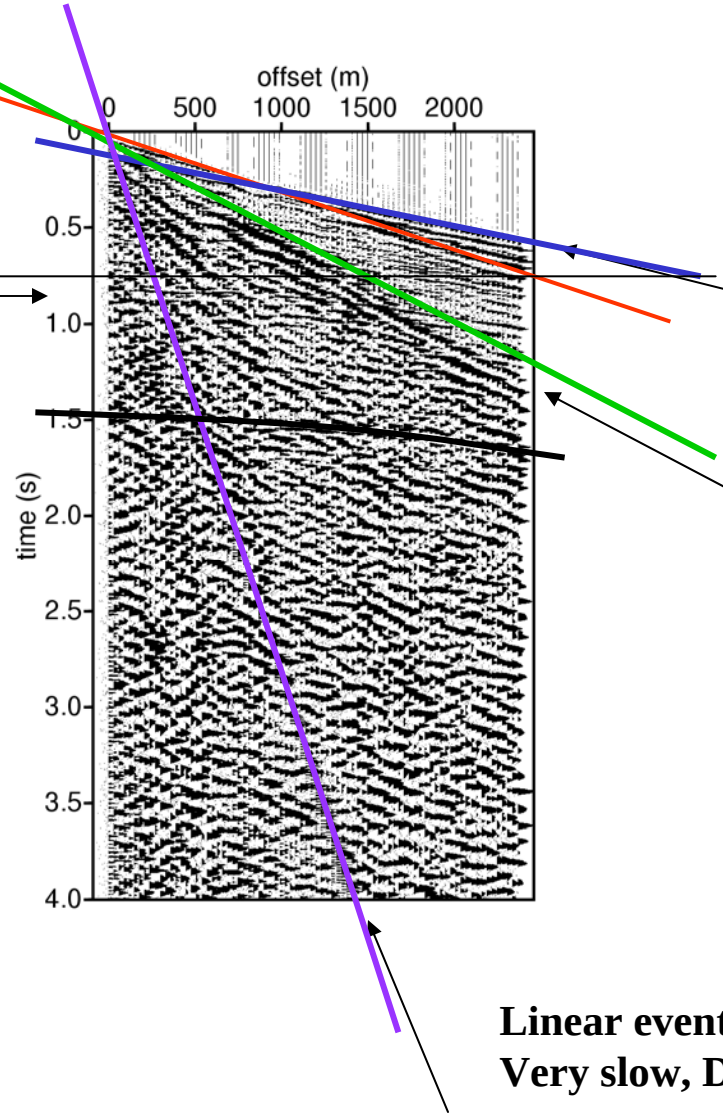
Slightly hyperbolic event: Reflection

Linear event: Direct/refraction

Linear event: Slower, Direct

Linear event: Very slow, Direct

A seismic shot record on land



Slightly hyperbolic event: Reflection

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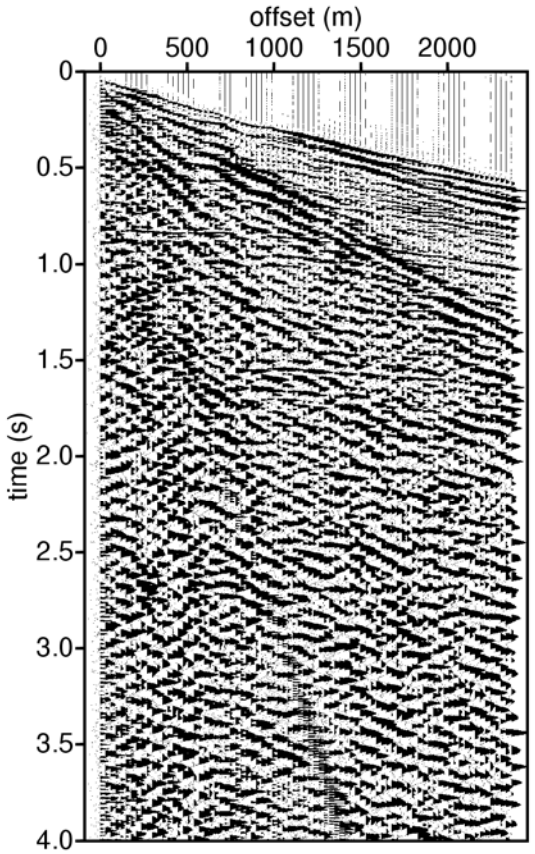
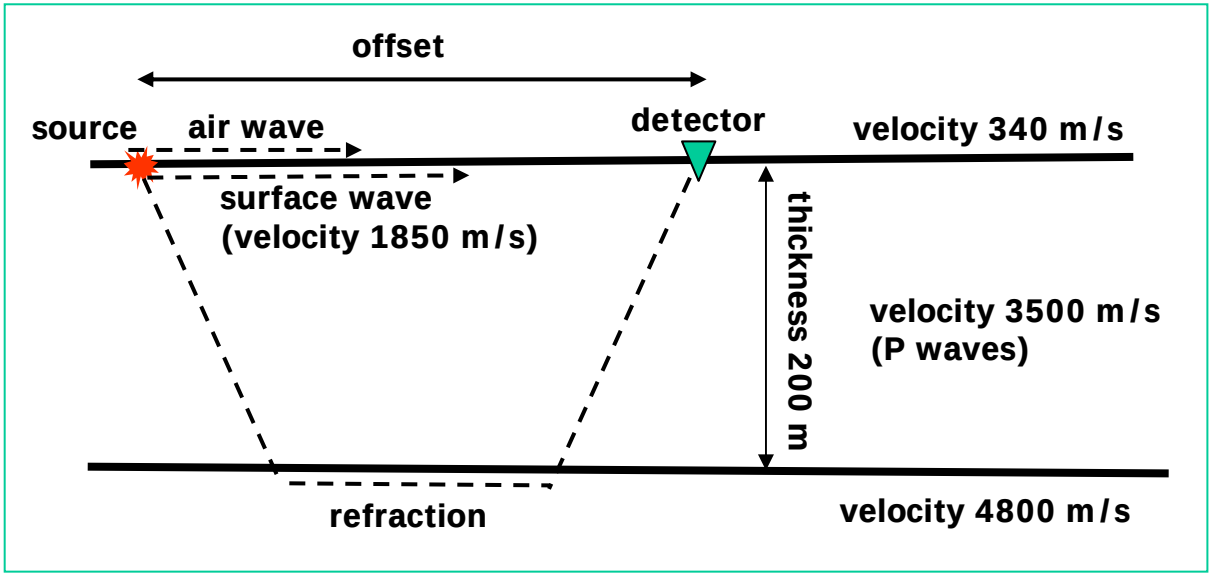
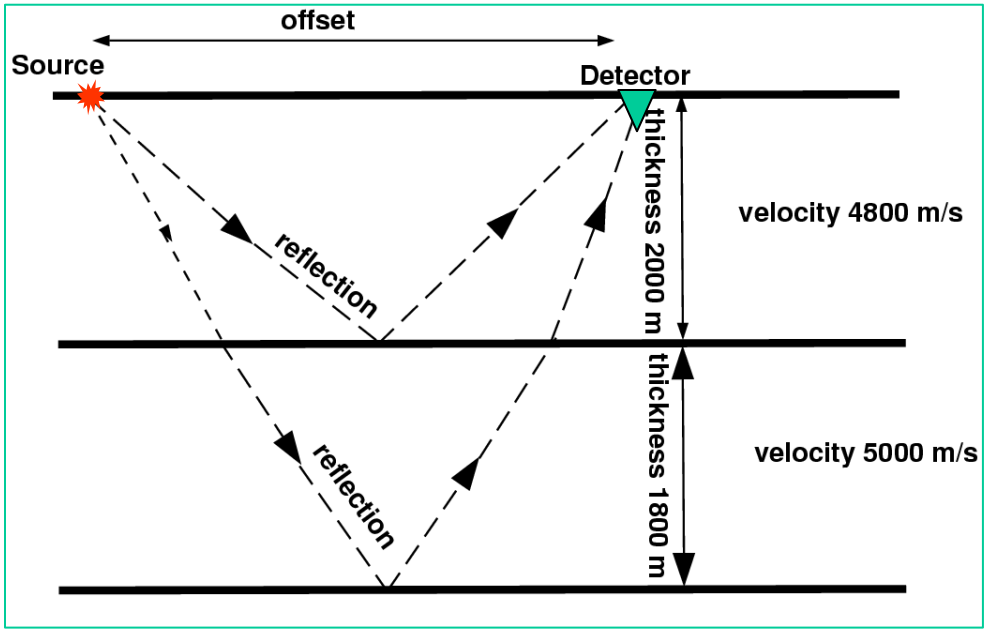
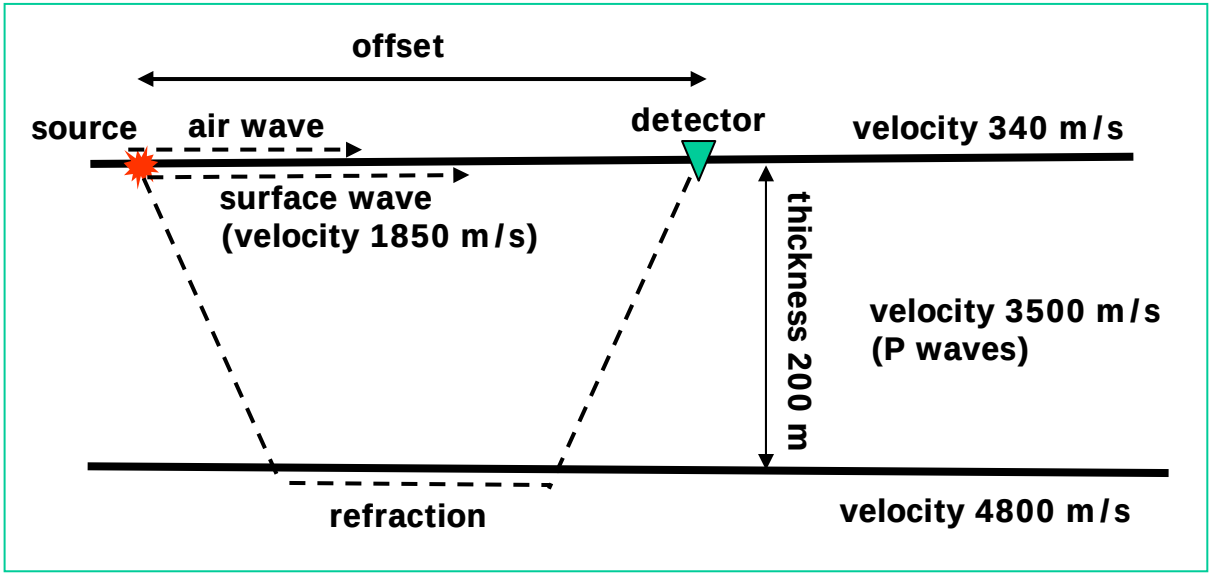
Interpretation of seismic land record



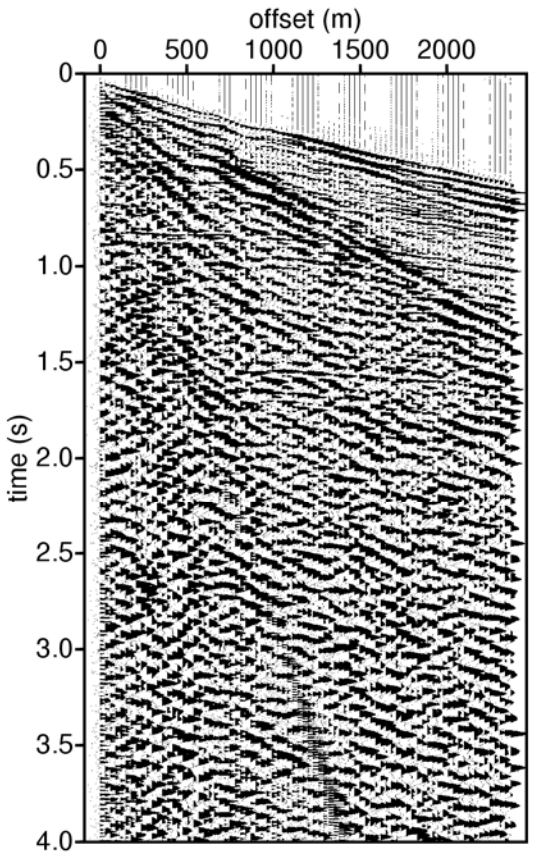




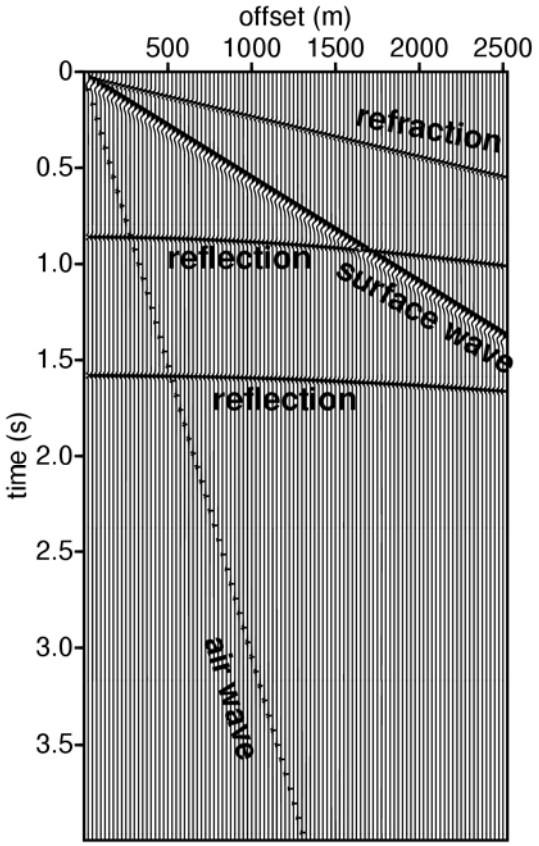
Picture made within PowerPoint



Modelling of seismic land record



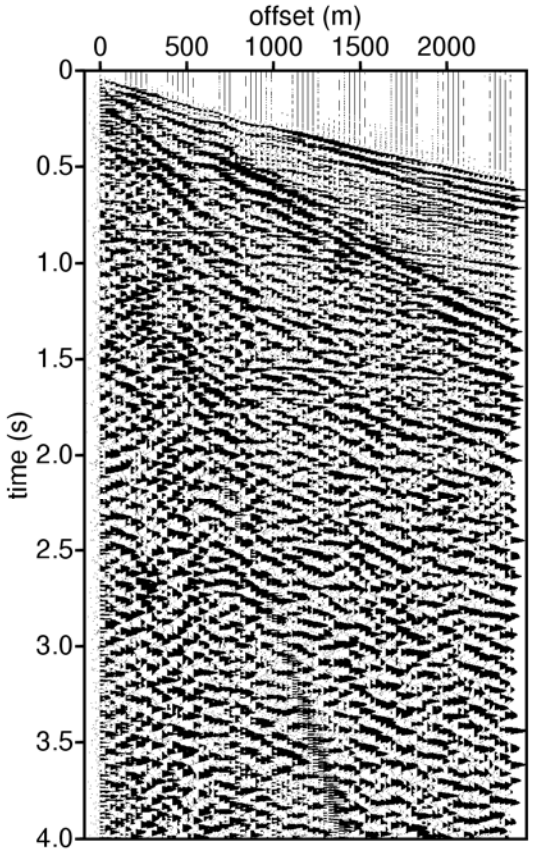
Observed data



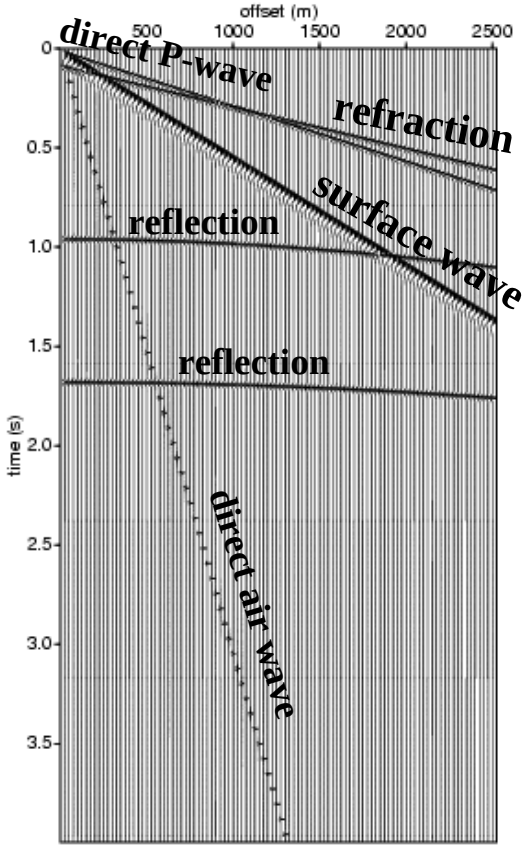
Modelled data

(ray theory approx.)

Modelling of seismic land record



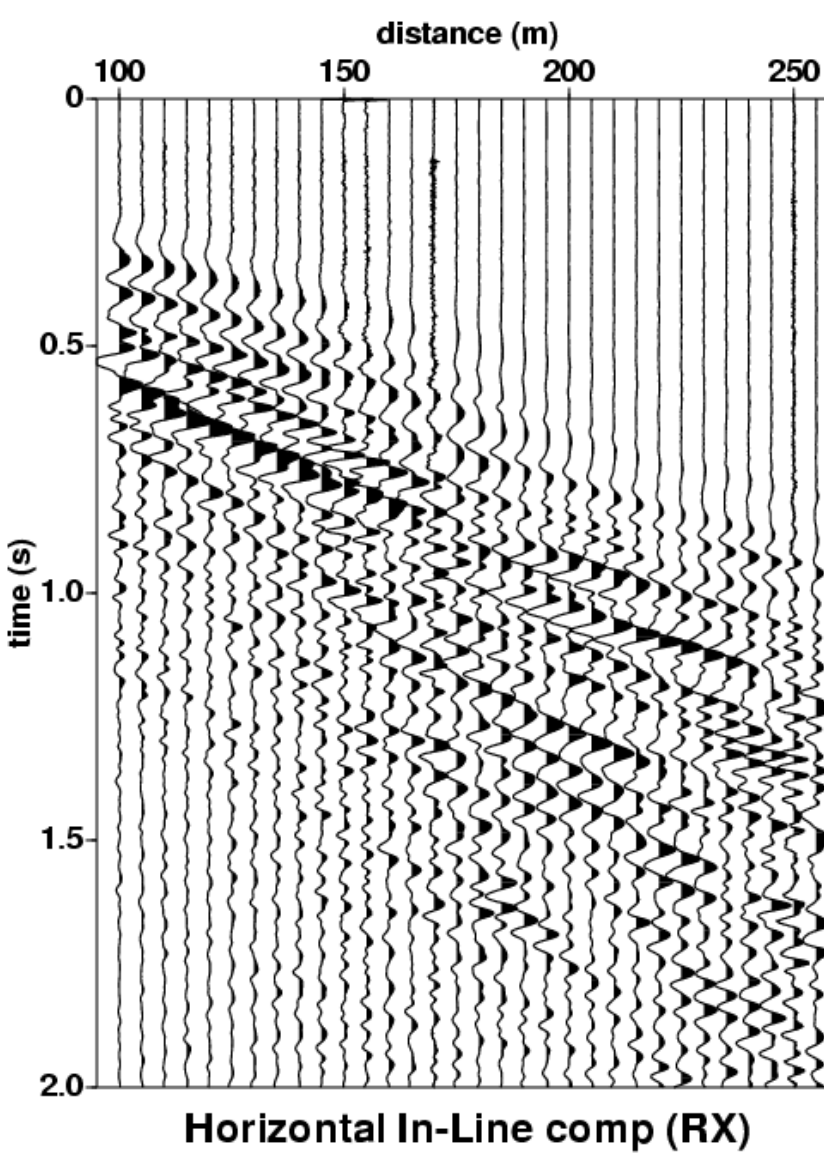
Observed data

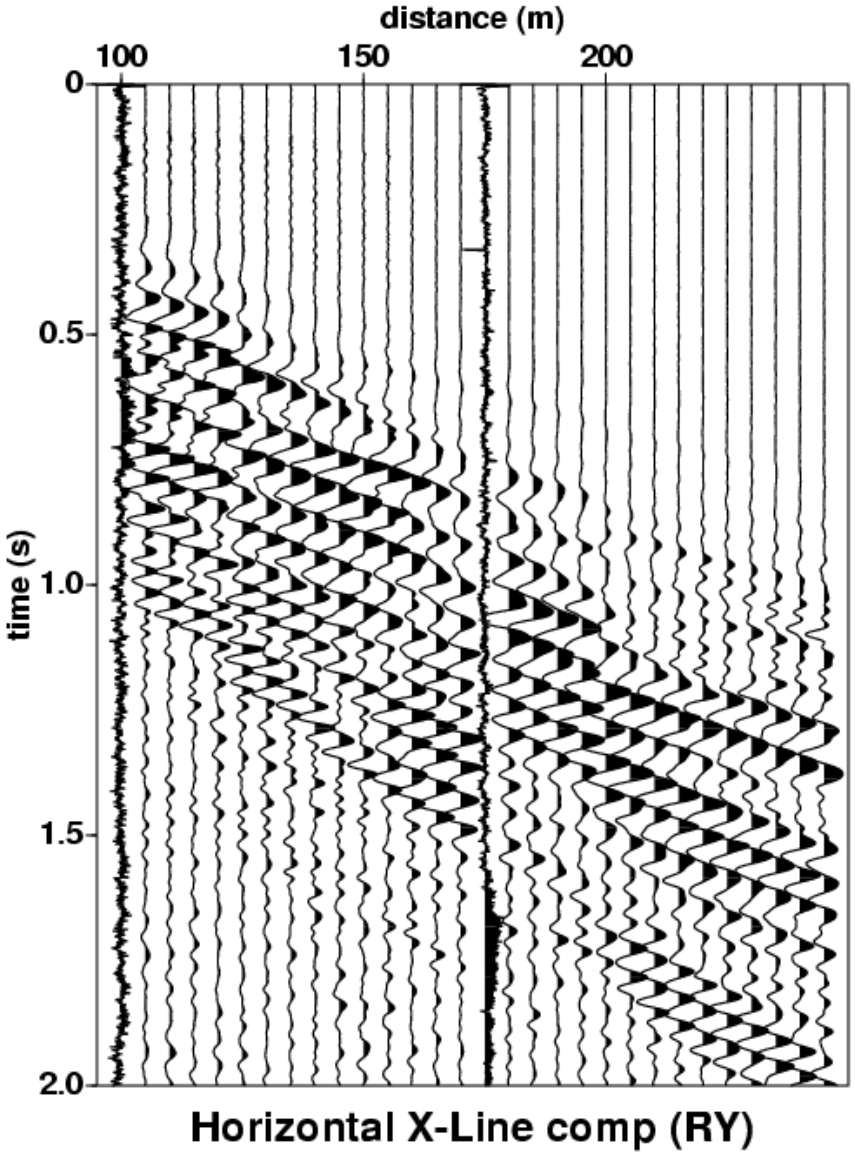


Modelled data

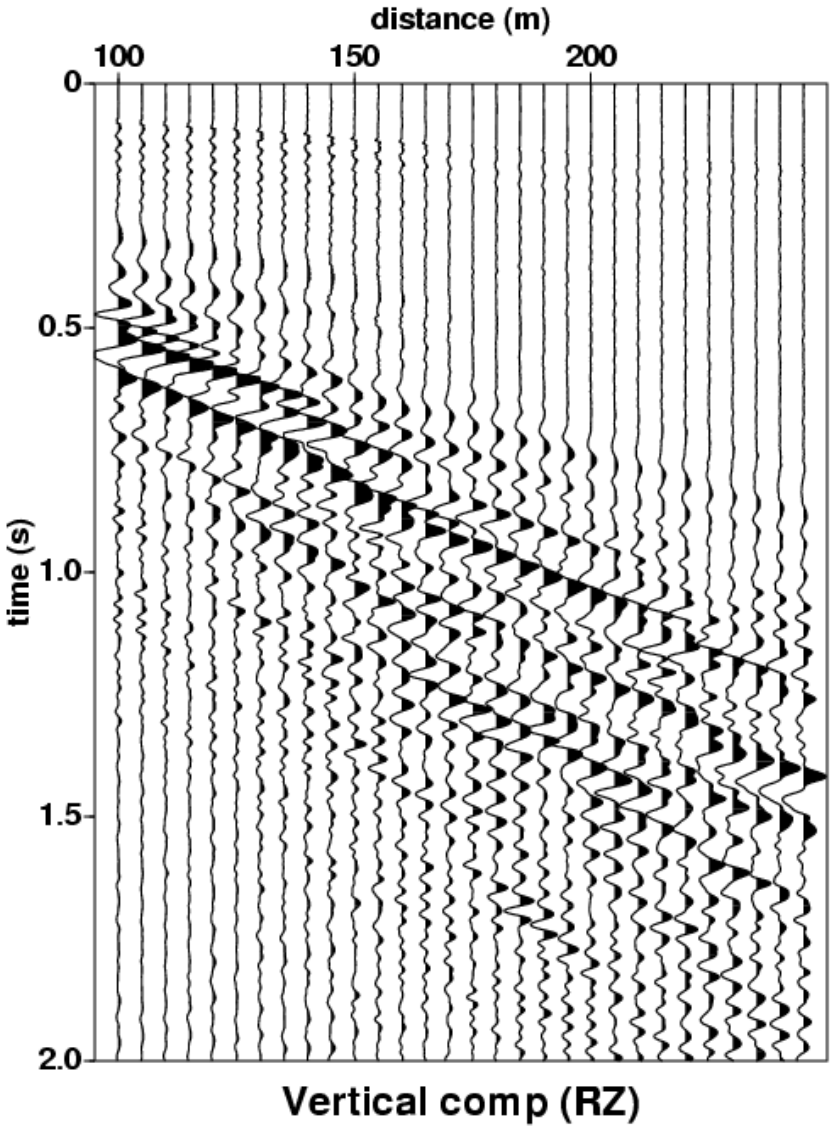
(ray theory approx.)

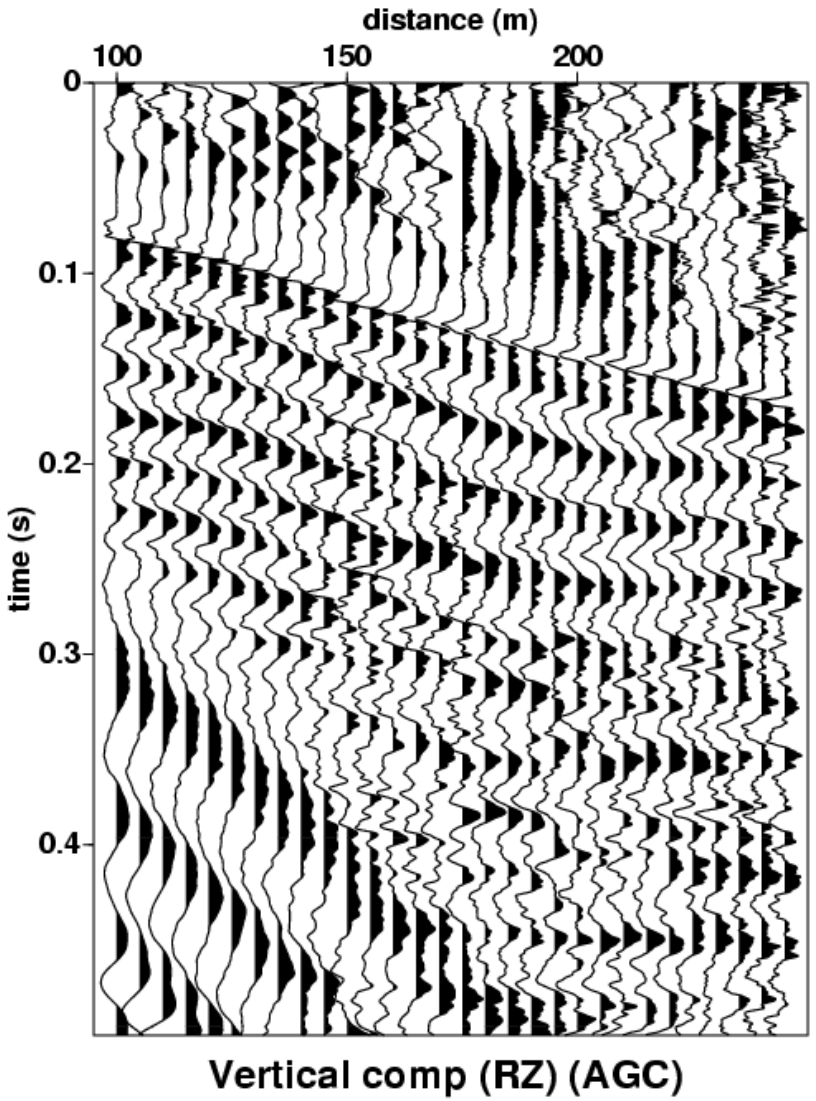
Wassenaar-beach data: Wednesday



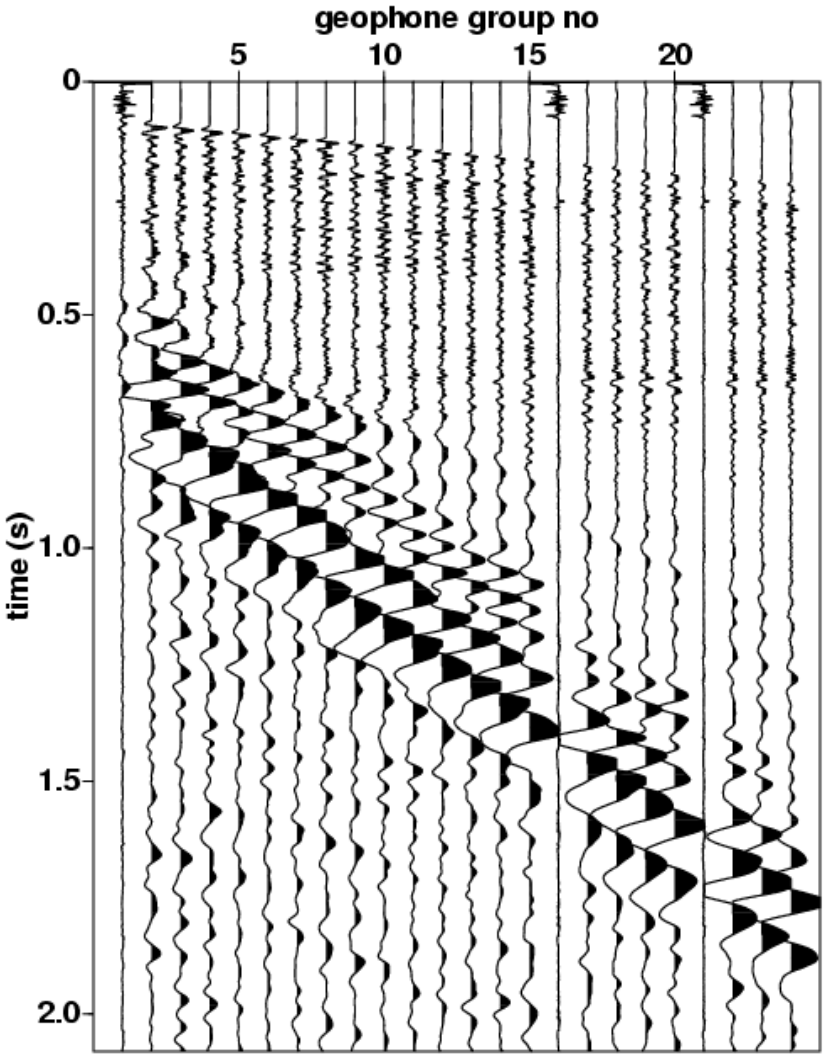


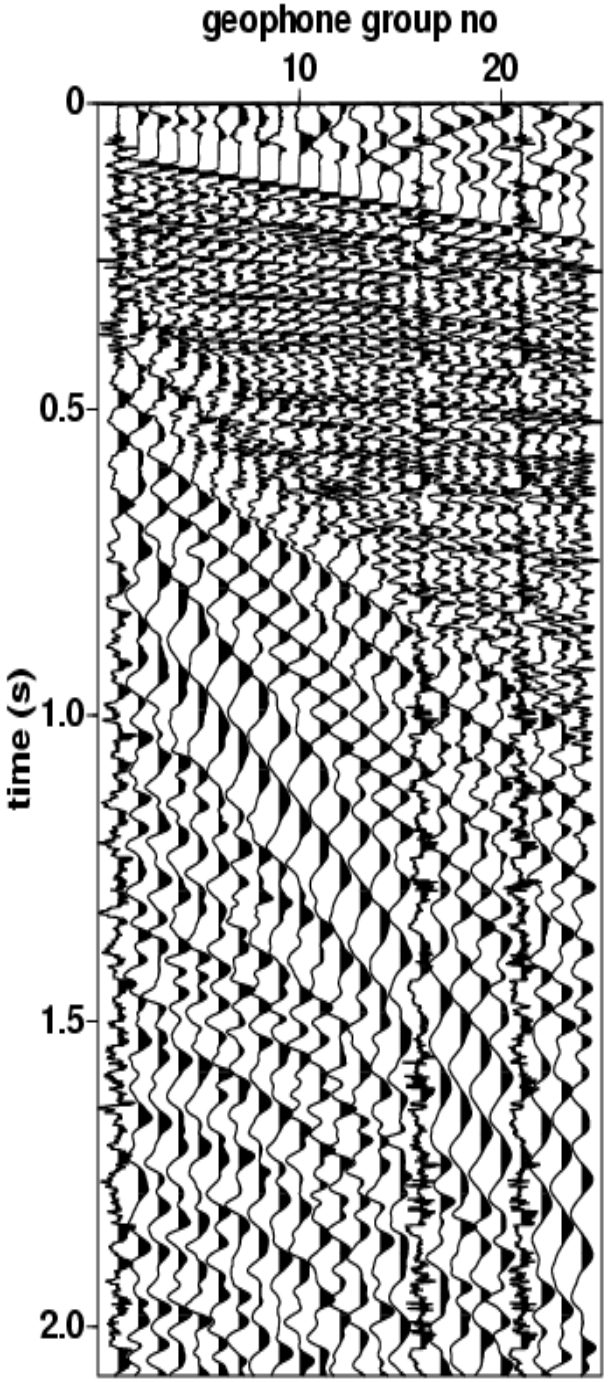
Wassenaar-beach data: Wednesday



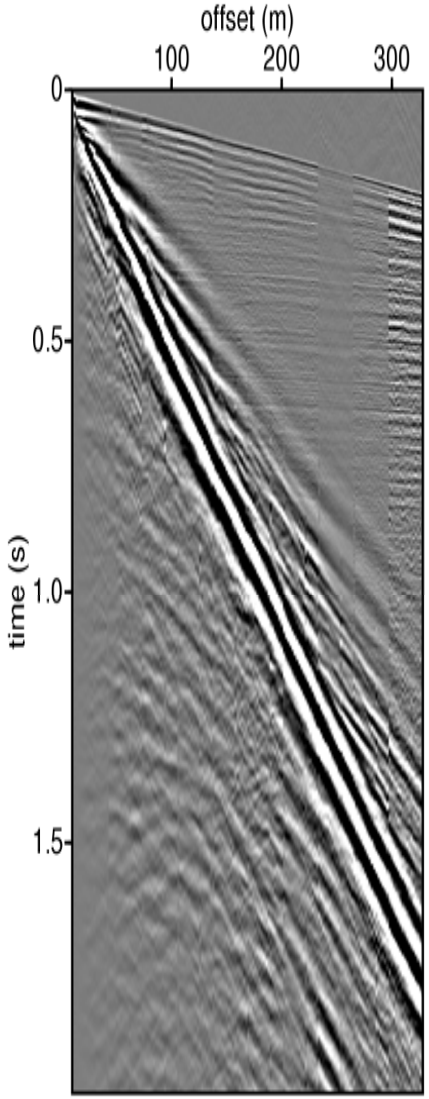


Wassenaar-beach data: array data (Thursday)





A seismic shot record at Wassenaar beach



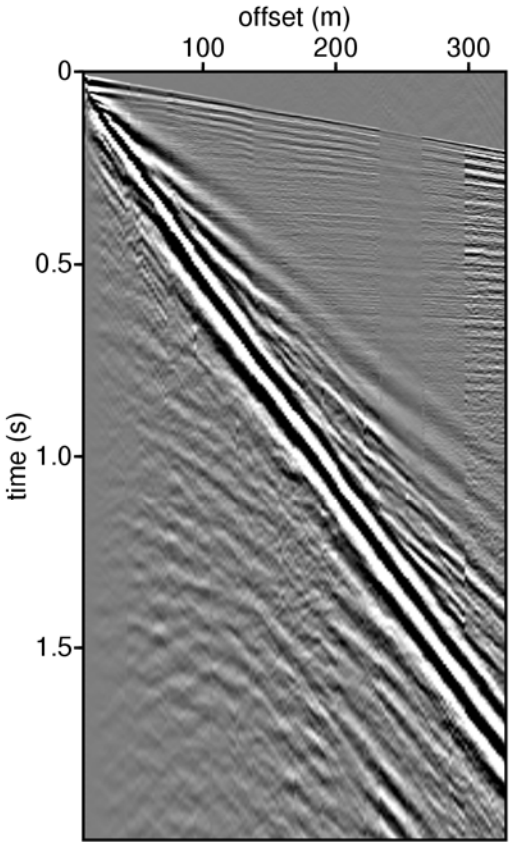
Linear event:
Direct/refraction

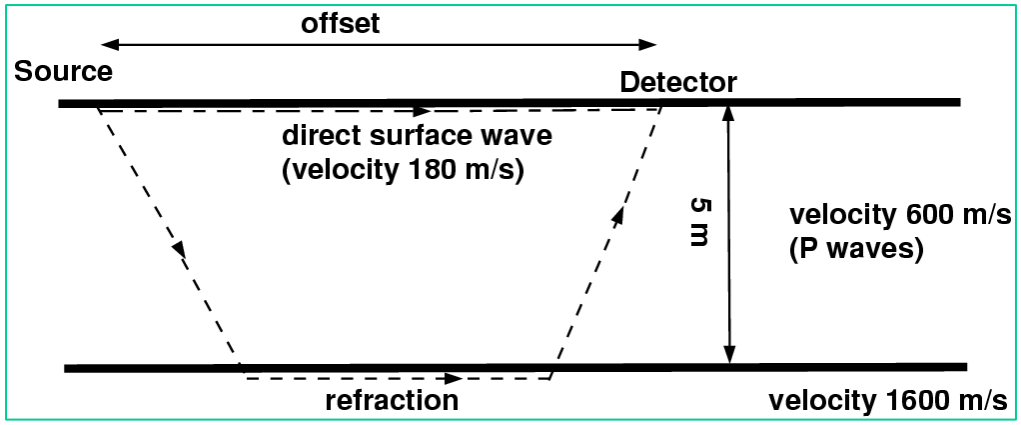
Many slightly hyperbolic
events: Reflections !

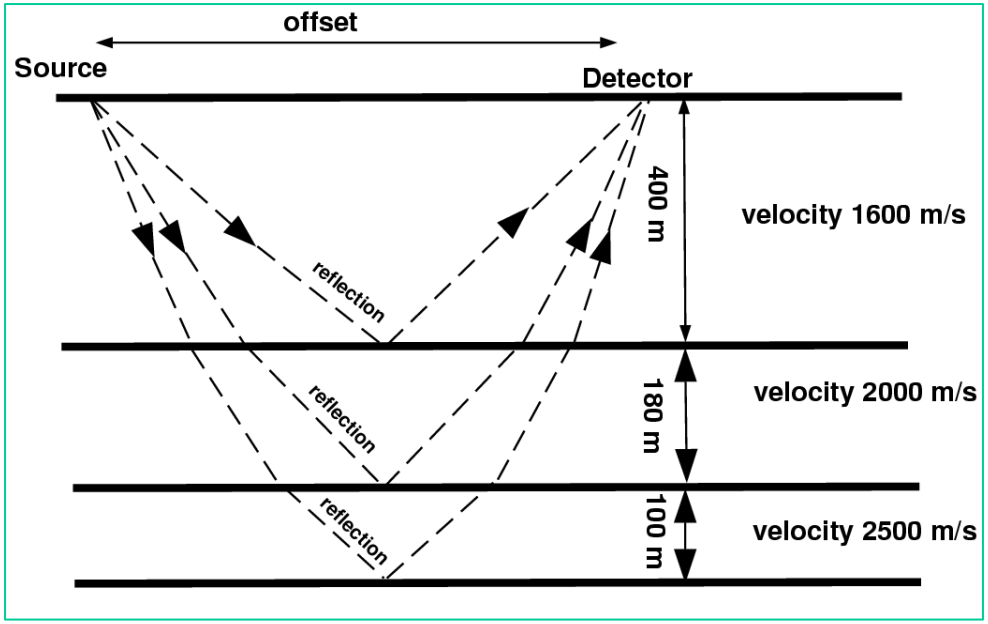
Linear event:
Slower, Direct

Linear event:
Slow, Direct

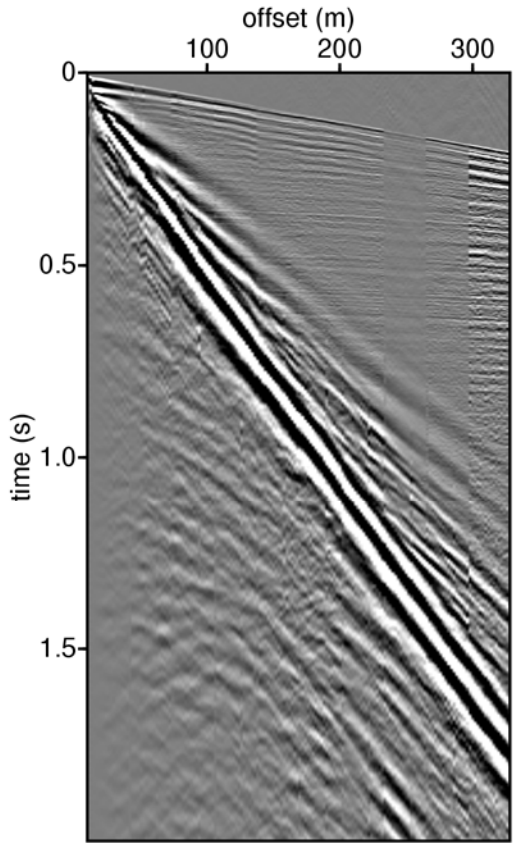
Interpretation of Wassenaar record



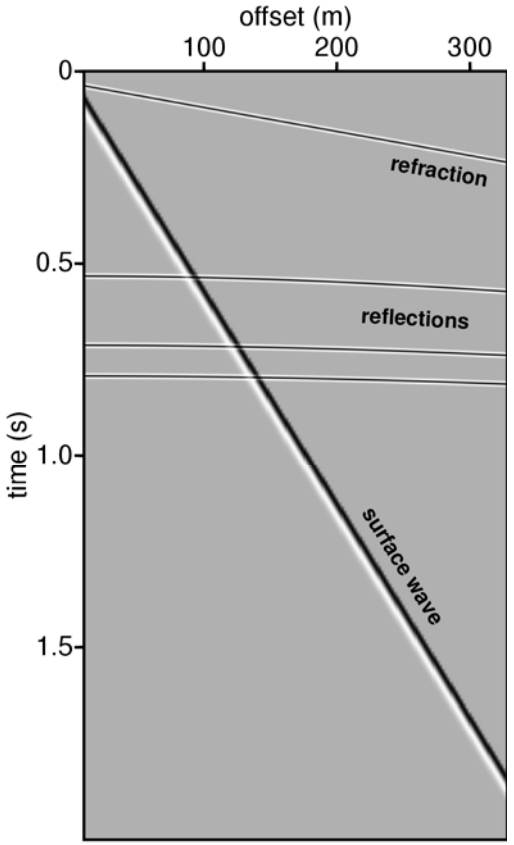




Modelling of Wassenaar record



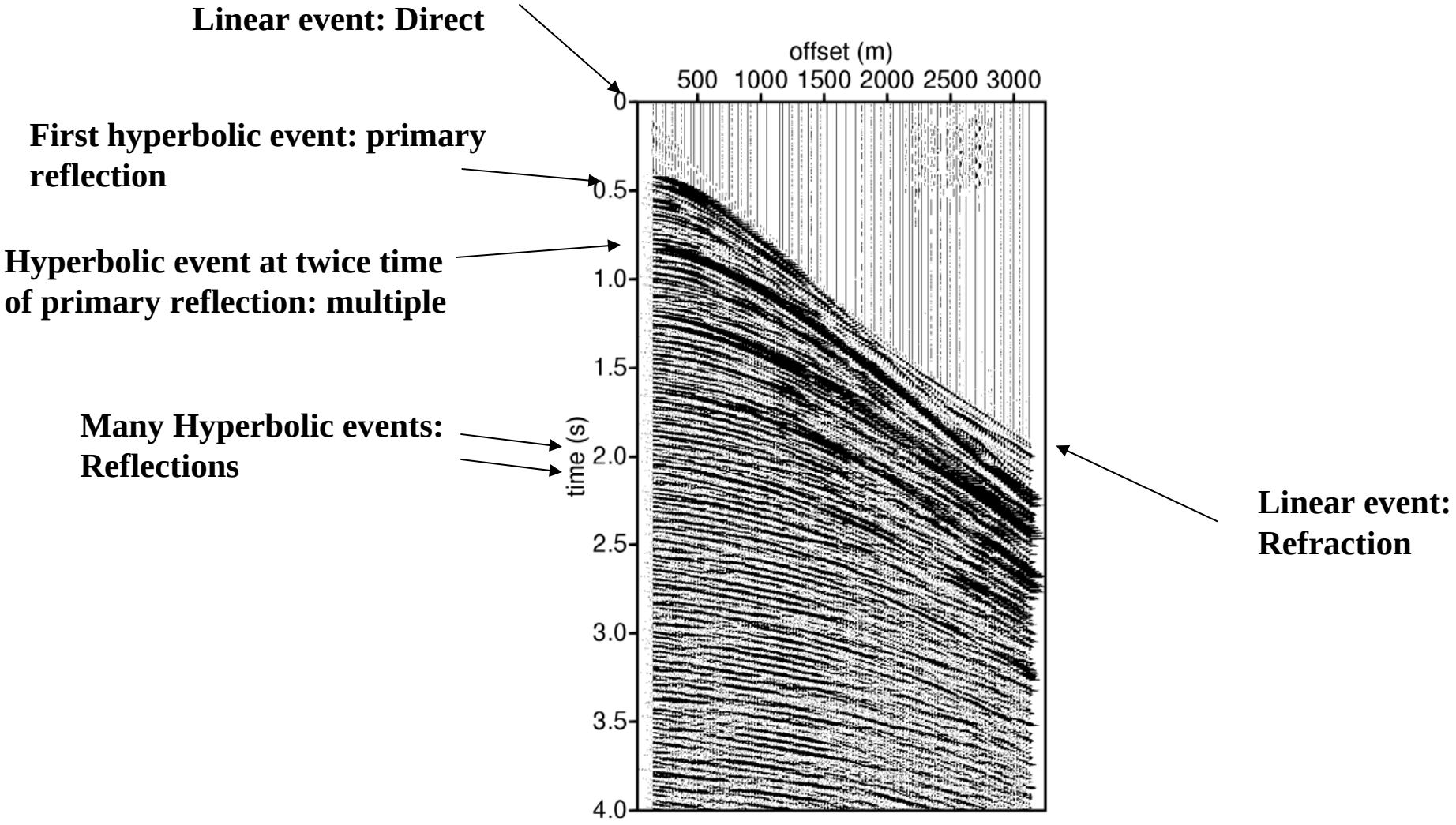
Observed data



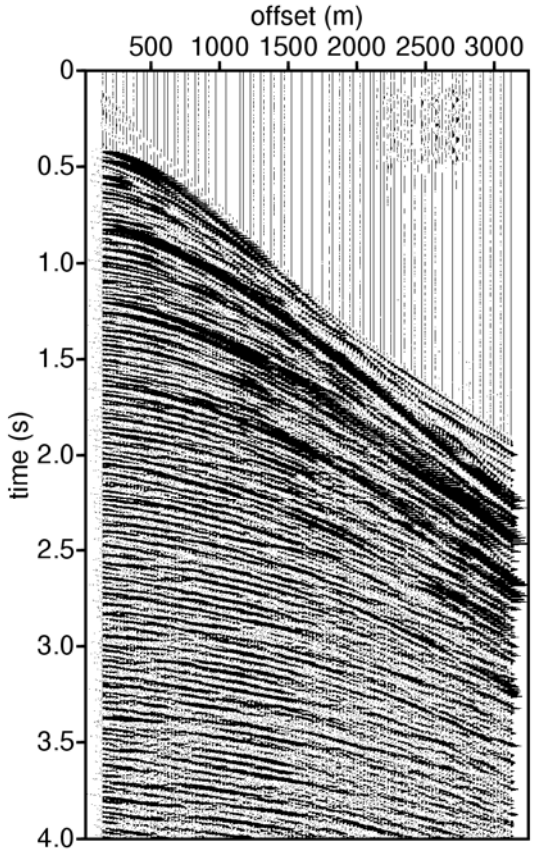
Modelled data

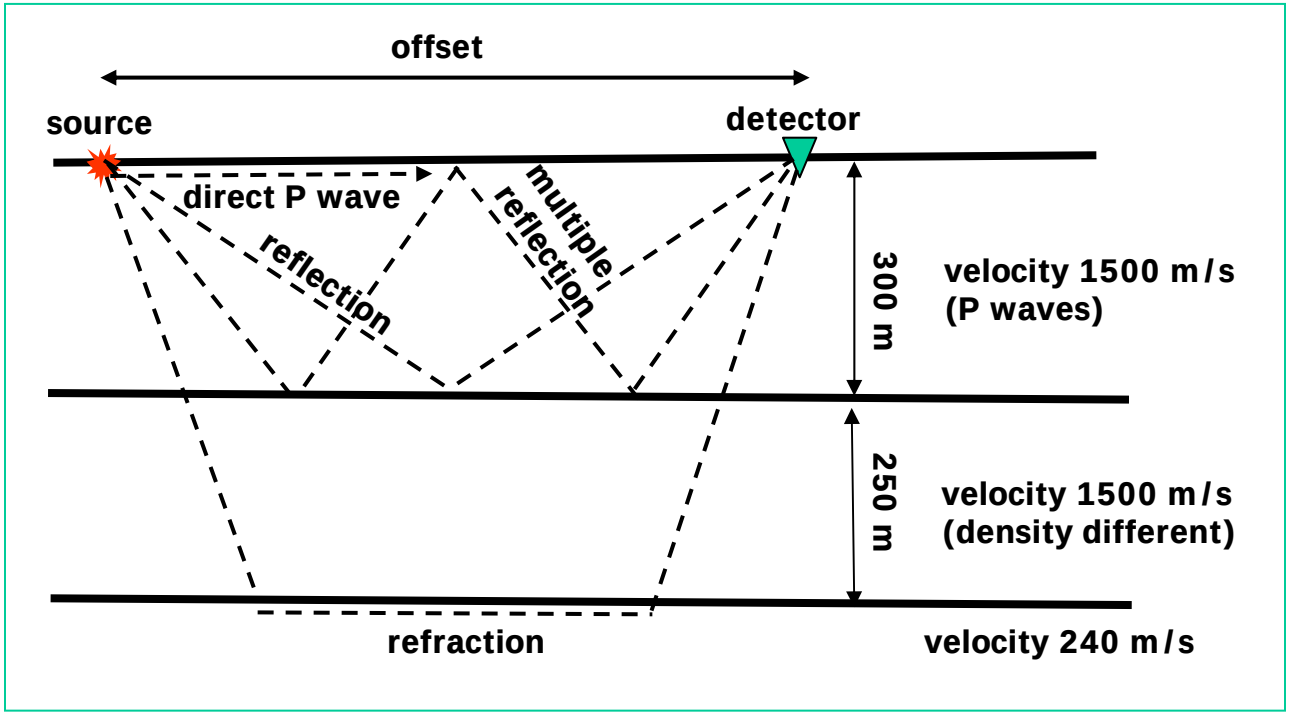
(ray theory approx.)

A seismic shot record at sea

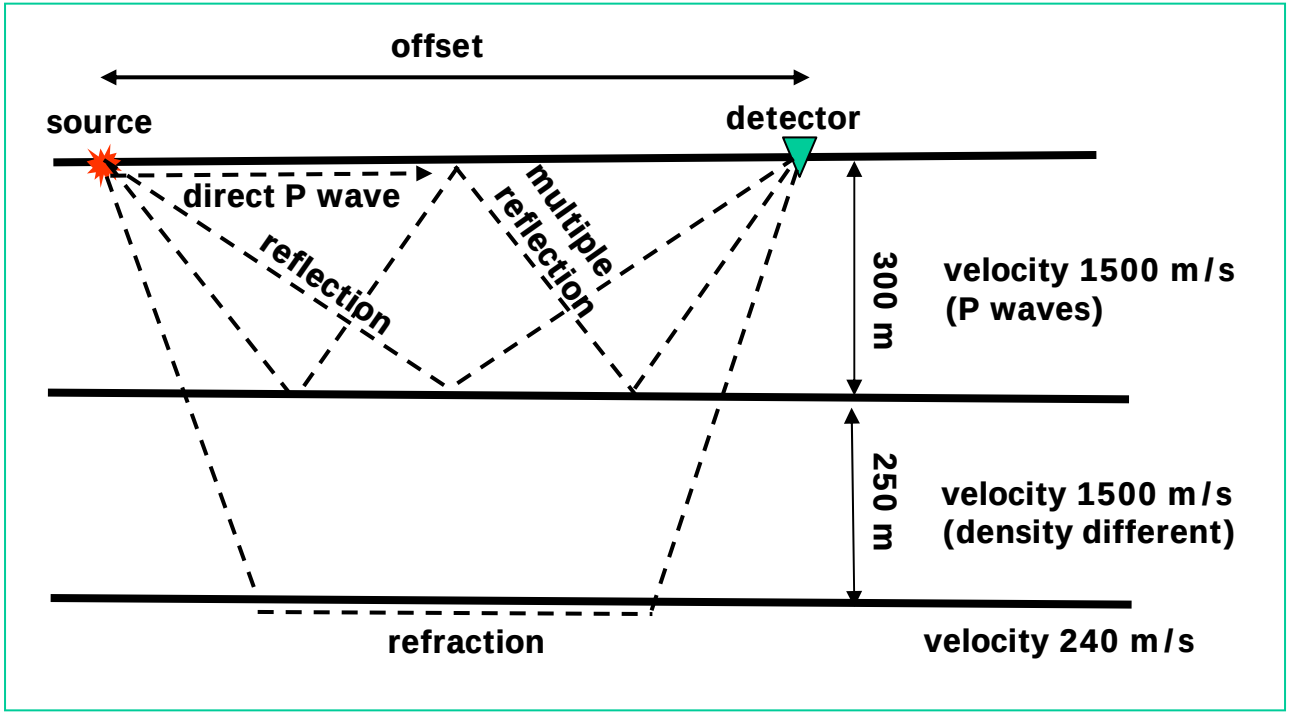


Interpretation of marine record

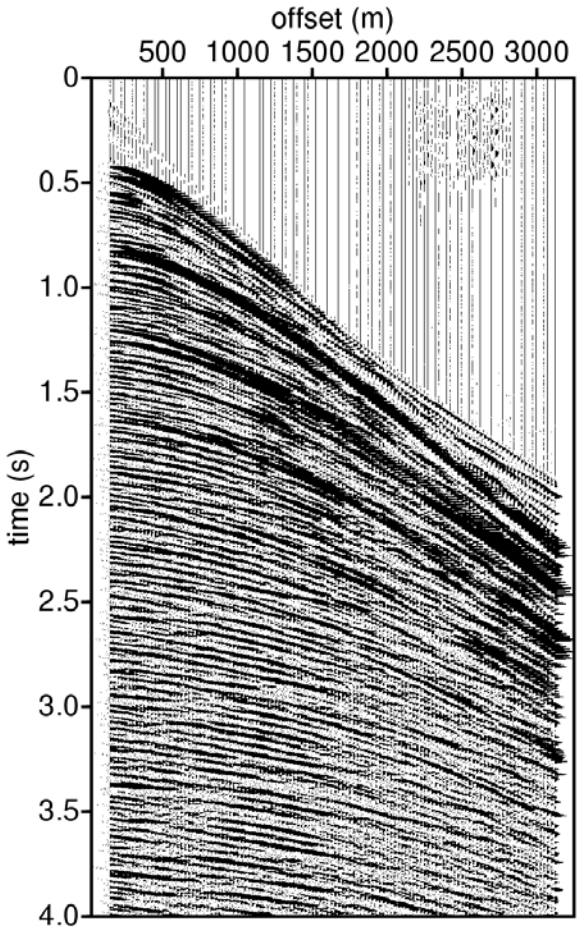




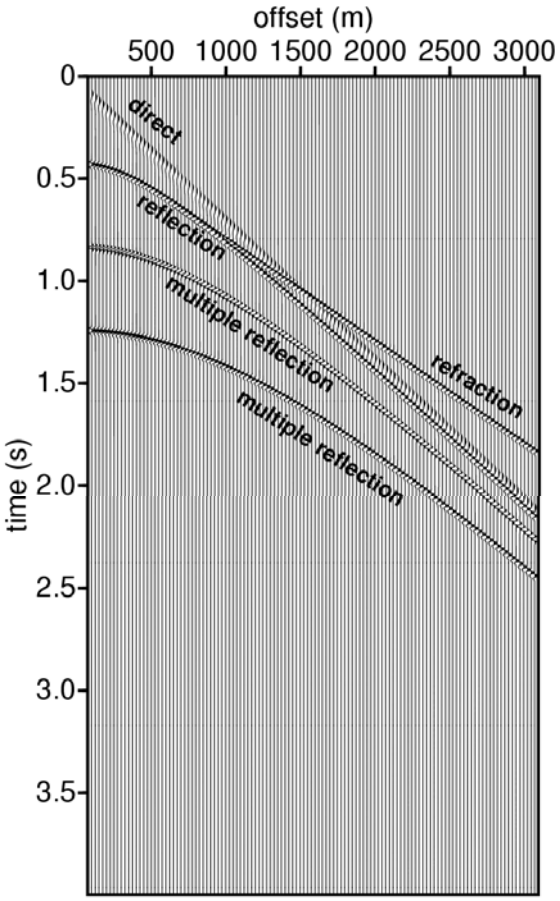
Picture made with PowerPoint



Old: Modelling of marine record



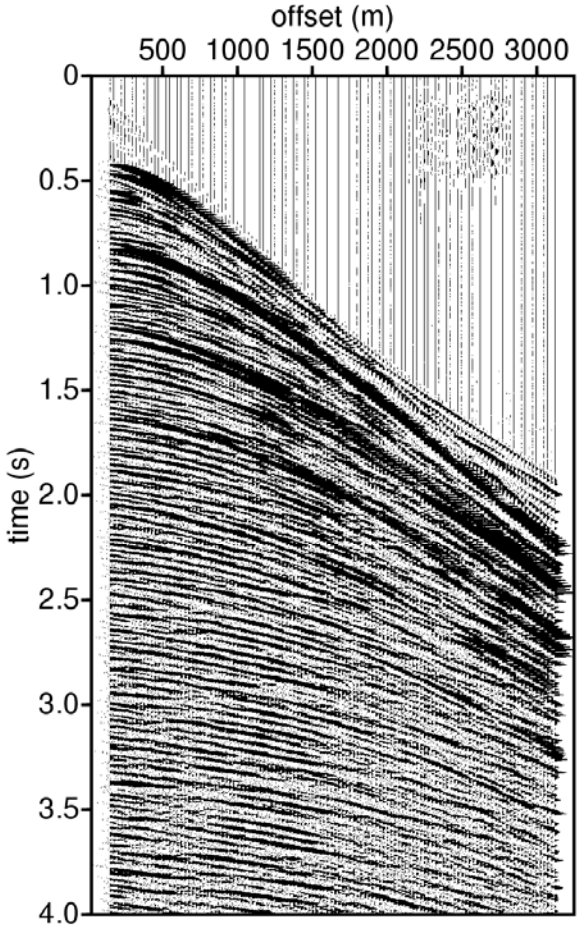
Observed data



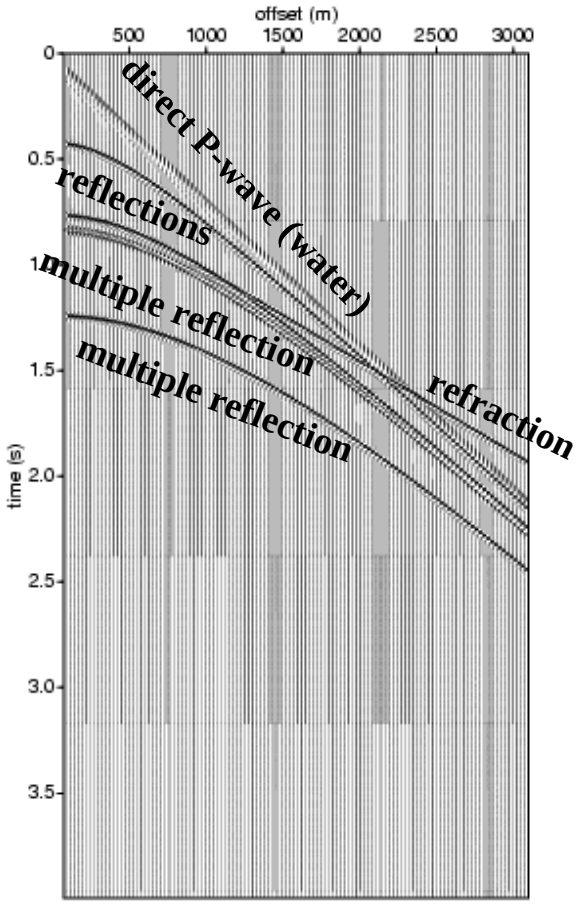
Modelled data

(ray theory approx.)

Modelling of marine record



Observed data



Modelled data

(ray theory approx.)