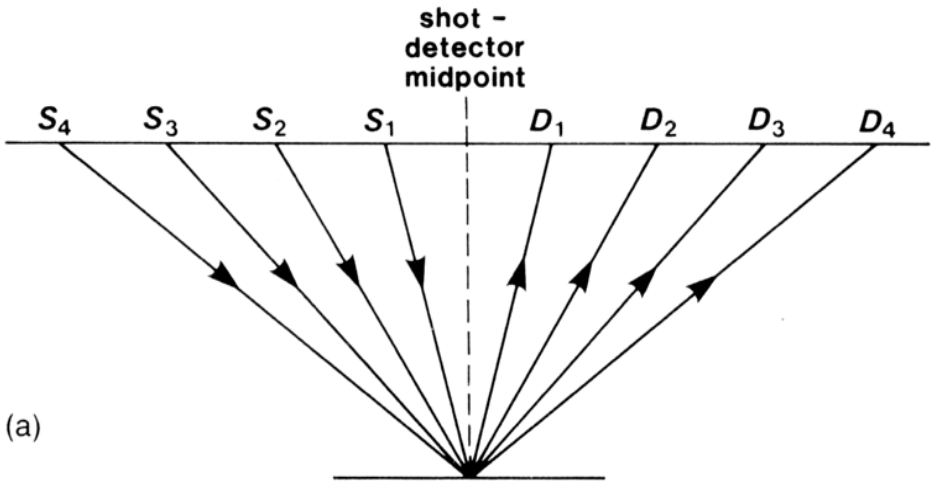
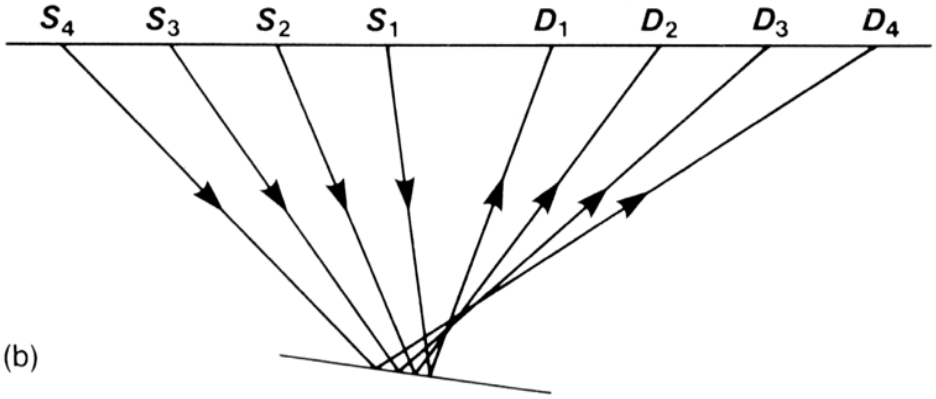
Reflection seismic 1
script

Velocity analysis

- Common midpoint measurement (CMP – CDP)
- Velocity analysis
- Normal move-out (NMO) correction
- Artefacts that can occur: Stretching
- Stacking

Difference between CMP und CDP





horizontal Reflector

CMP = CDP

Dipping Reflector

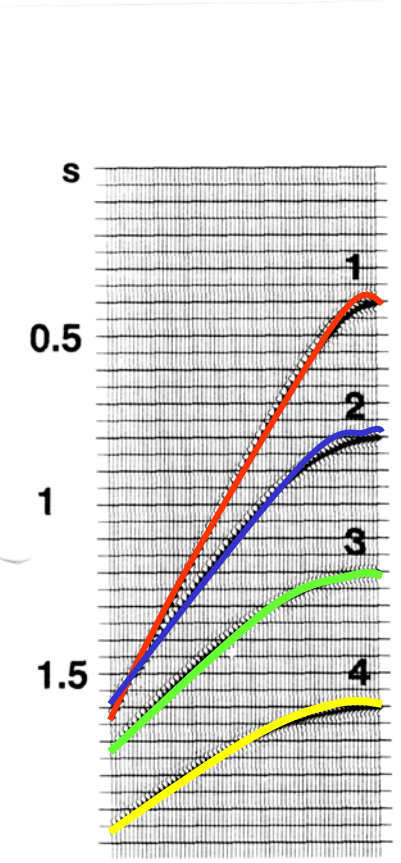
CMP≠ CDP

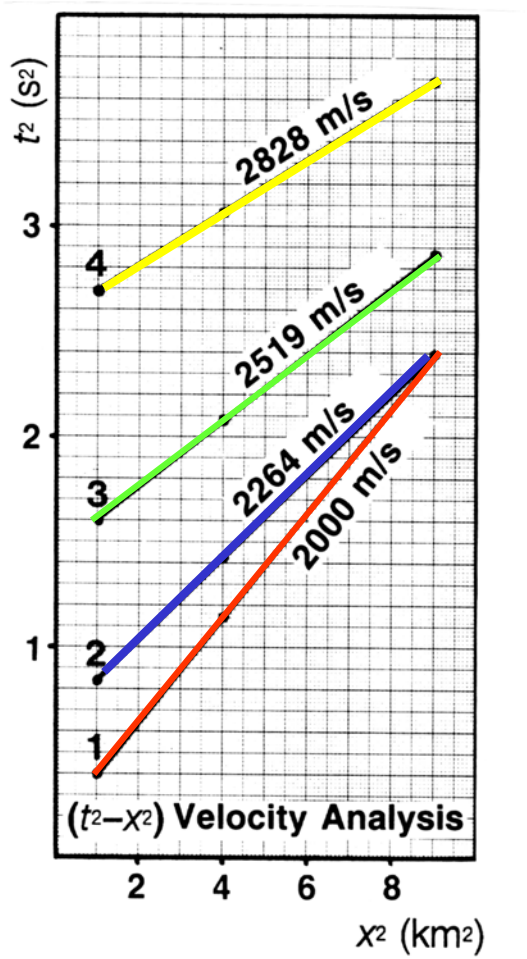
CMP = common mid point
CDP = common depth point

methods of velocity-analysis

- x^2-t^2 - analysis
- Methods using NMO correction:
  - CVP - constant velocity panels
  - CVS - constant velocity stacks
  - velocity spectral analysis (semblance analysis)

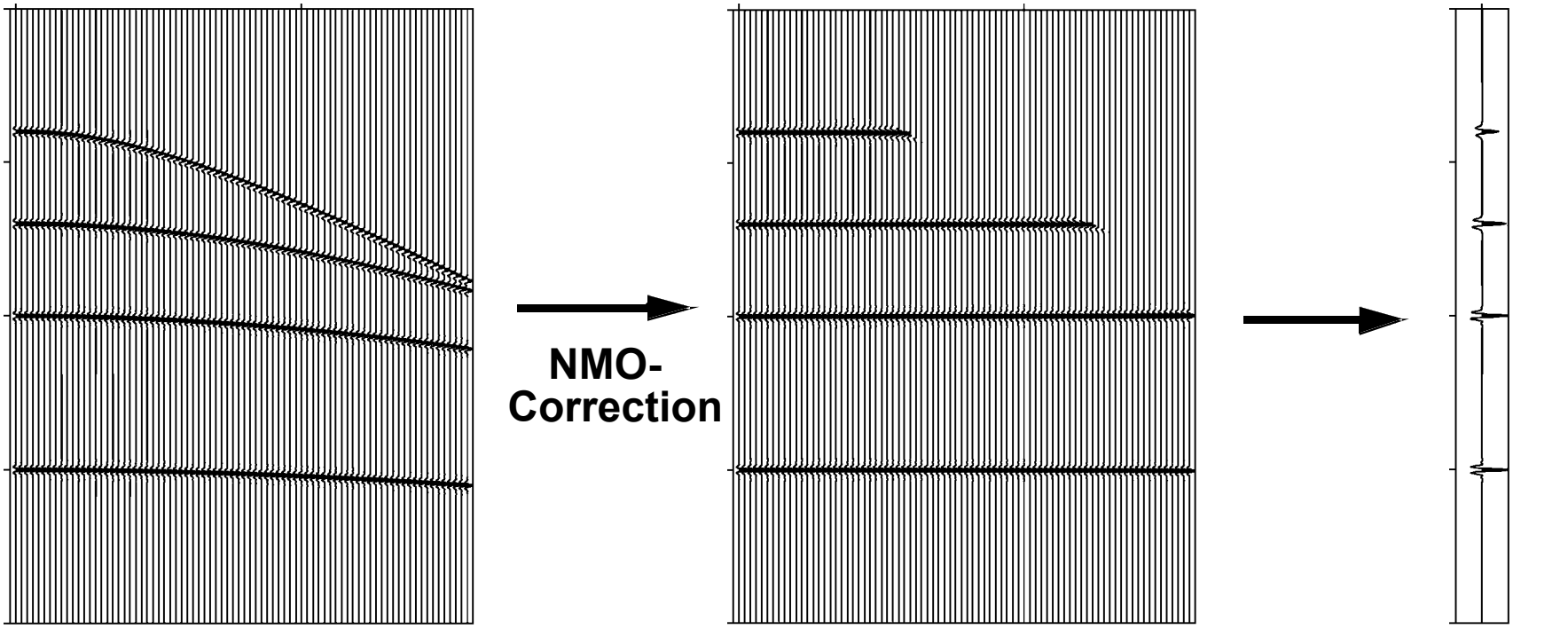
x^2-t^2 - analysis





$$t^2 = t_0^2 + \frac{x^2}{v_{stack}^2}$$

Aim of Velocity analysis

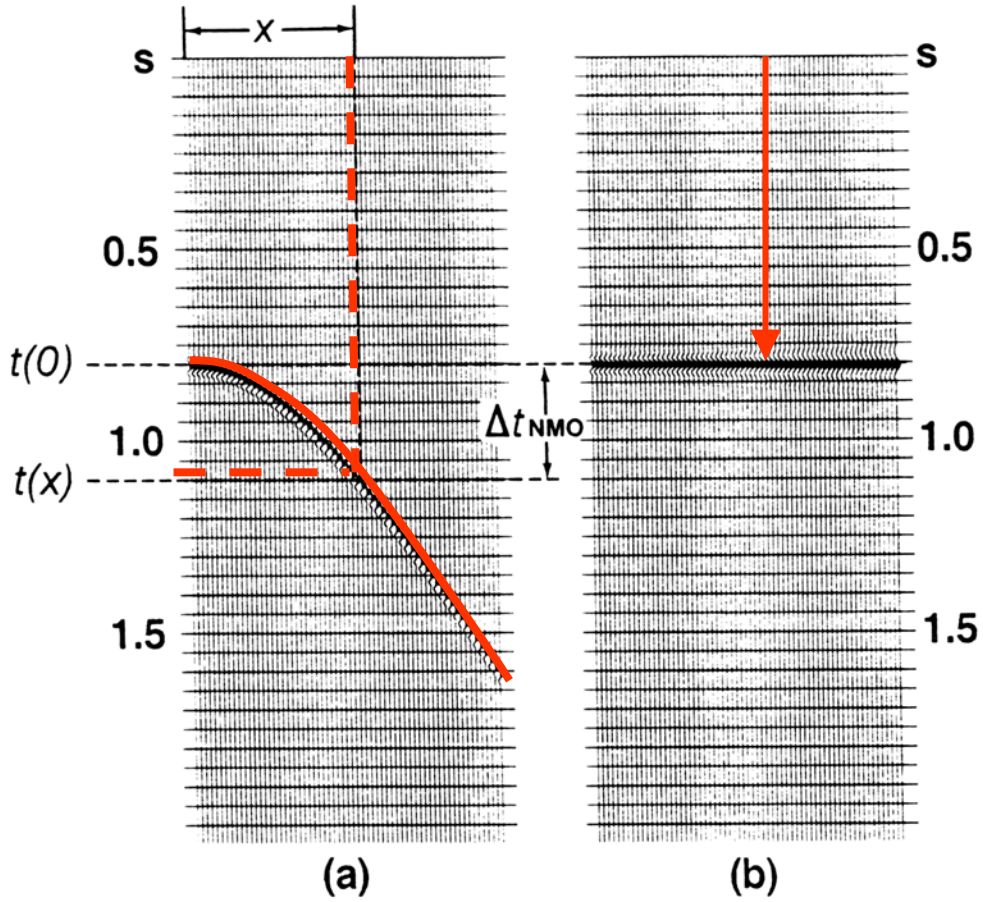


Reflection hyperbola

horizontal alignment

Stacking

(NMO = Normal Moveout)



$$t^2 = t_0^2 + \frac{x^2}{v_{stack}^2} = t_0^2 + \Delta t_{\mathrm{NMO}}^2$$

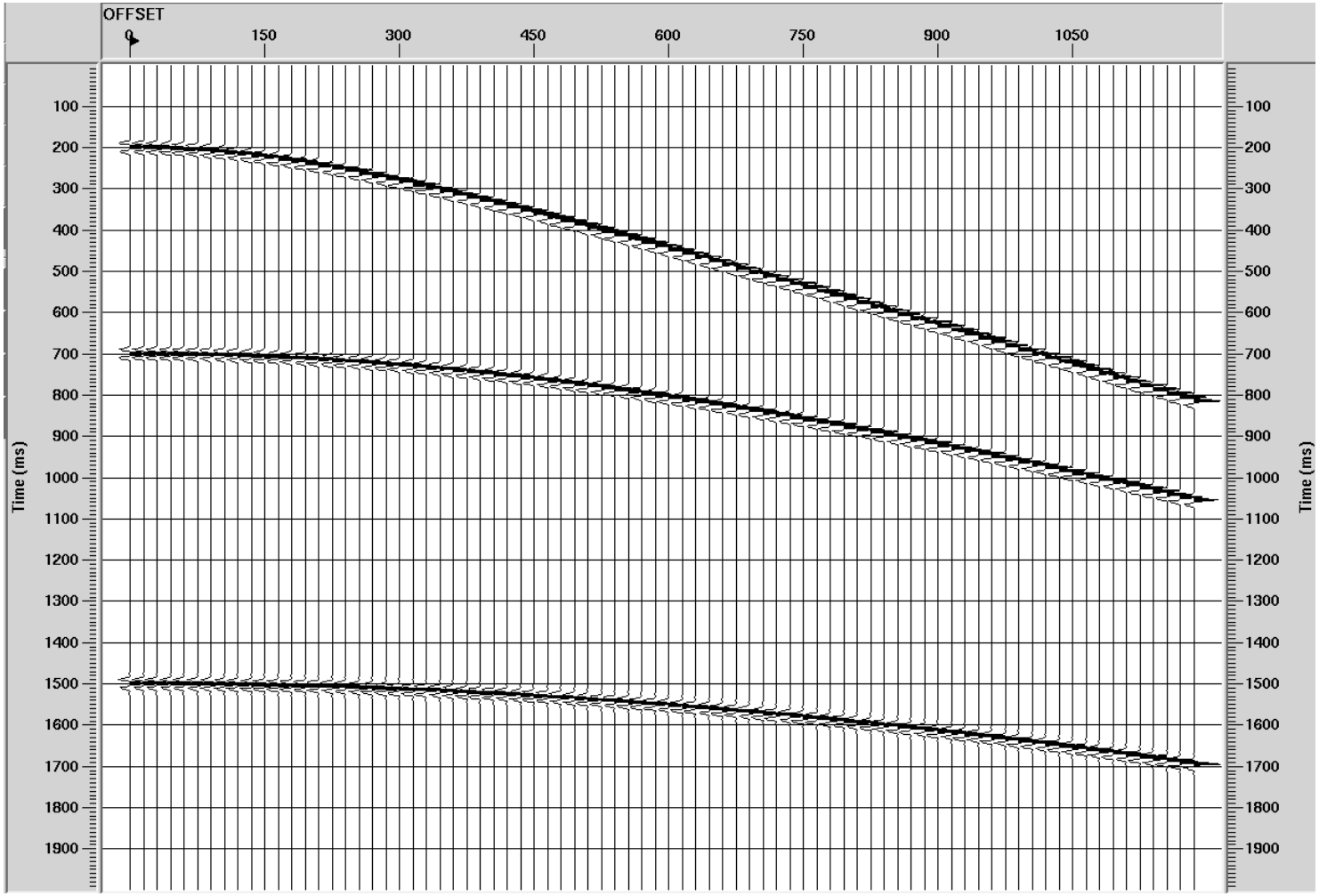
Δt_{NMO}= Moveout

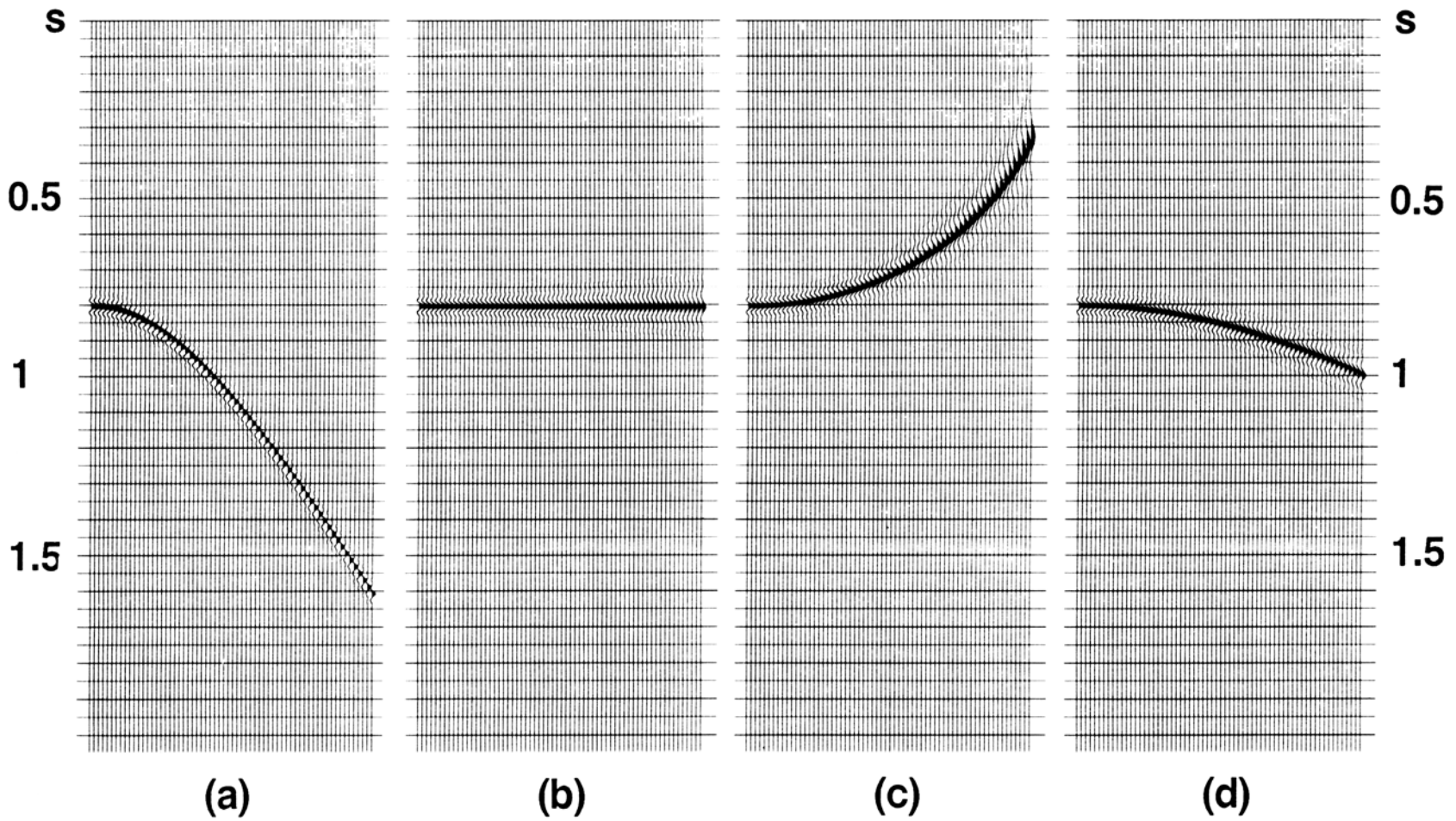
$$t = t_0\sqrt{1+\left(\frac{x}{v_{stack}t_0}\right)^2} \approx t_0\left(1+\frac{1}{2}\left[\frac{x}{v_{stack}t_0}\right]^2\right)$$

$$\Delta t_{NMO} = t - t_0 \approx \frac{x^2}{2v_{stack}^2 t_0}$$

V_{stack} approximates V_{rms} for small spreads

Change of moveout with depth





(a) Reflection is not corrected

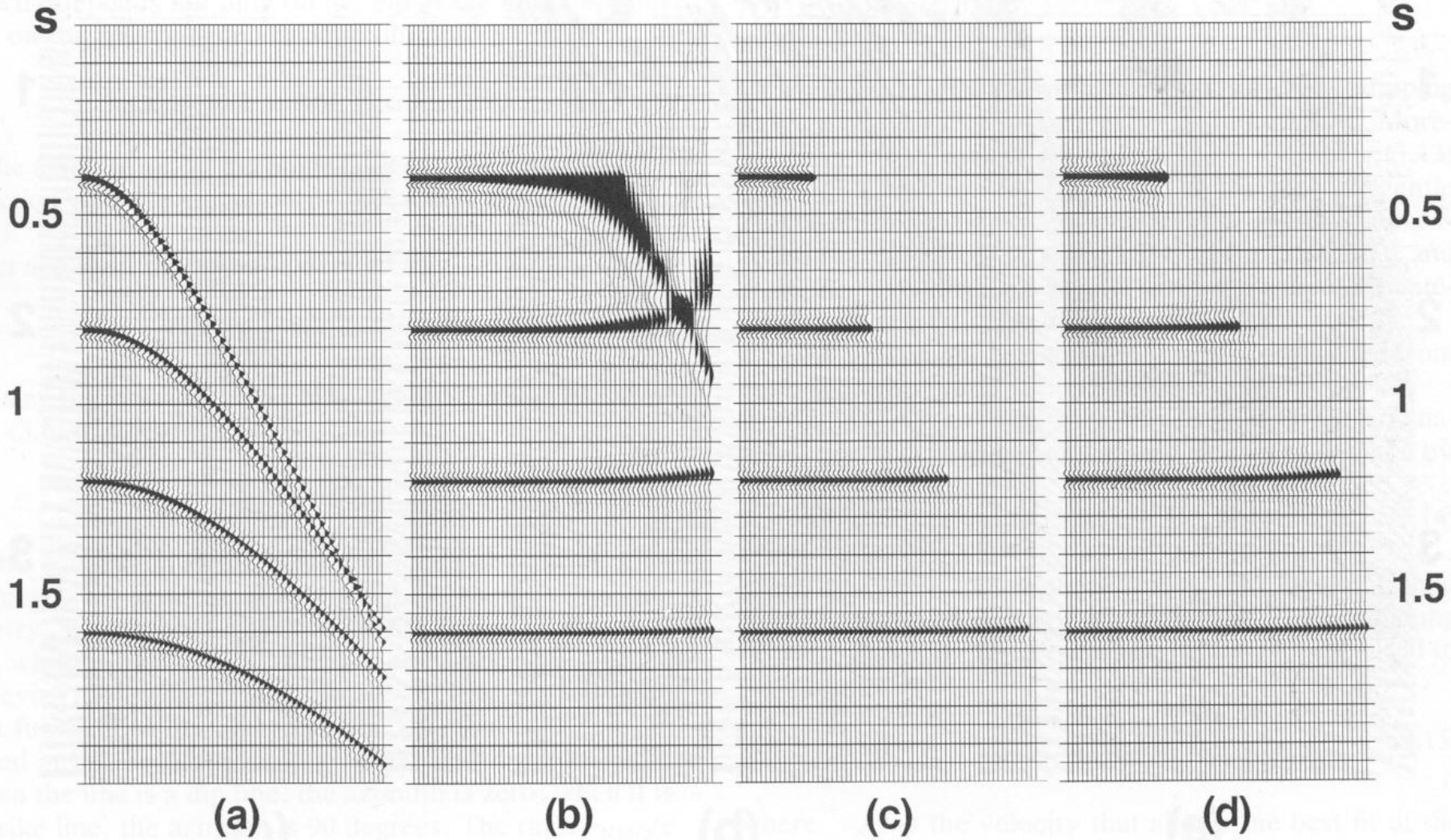
(b) Corrected with proper velocity

(c) Velocity is too low

(d) Velocity is too high

Yilmaz, 1987

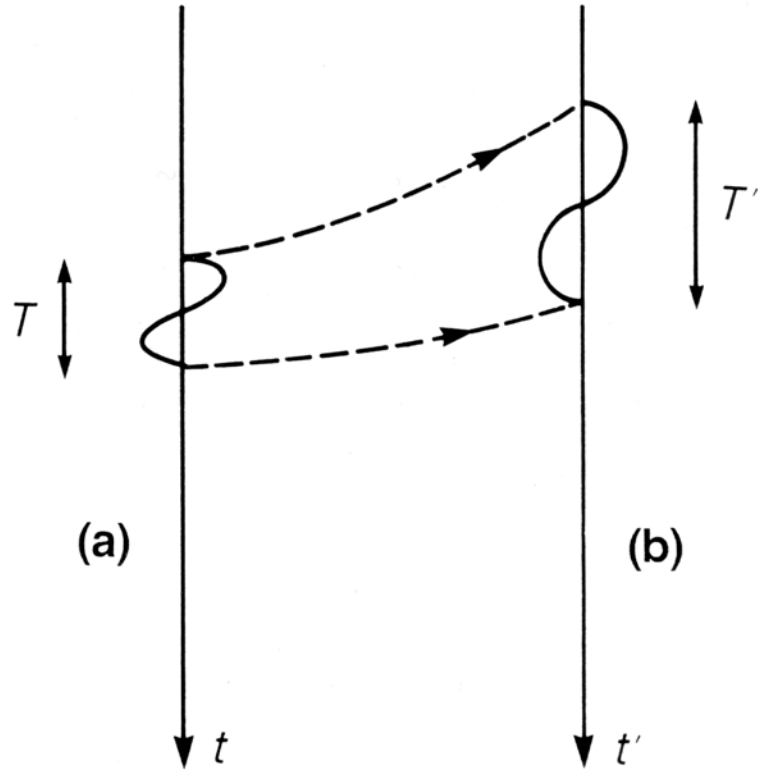
Threshold stretch limits



50% 100%

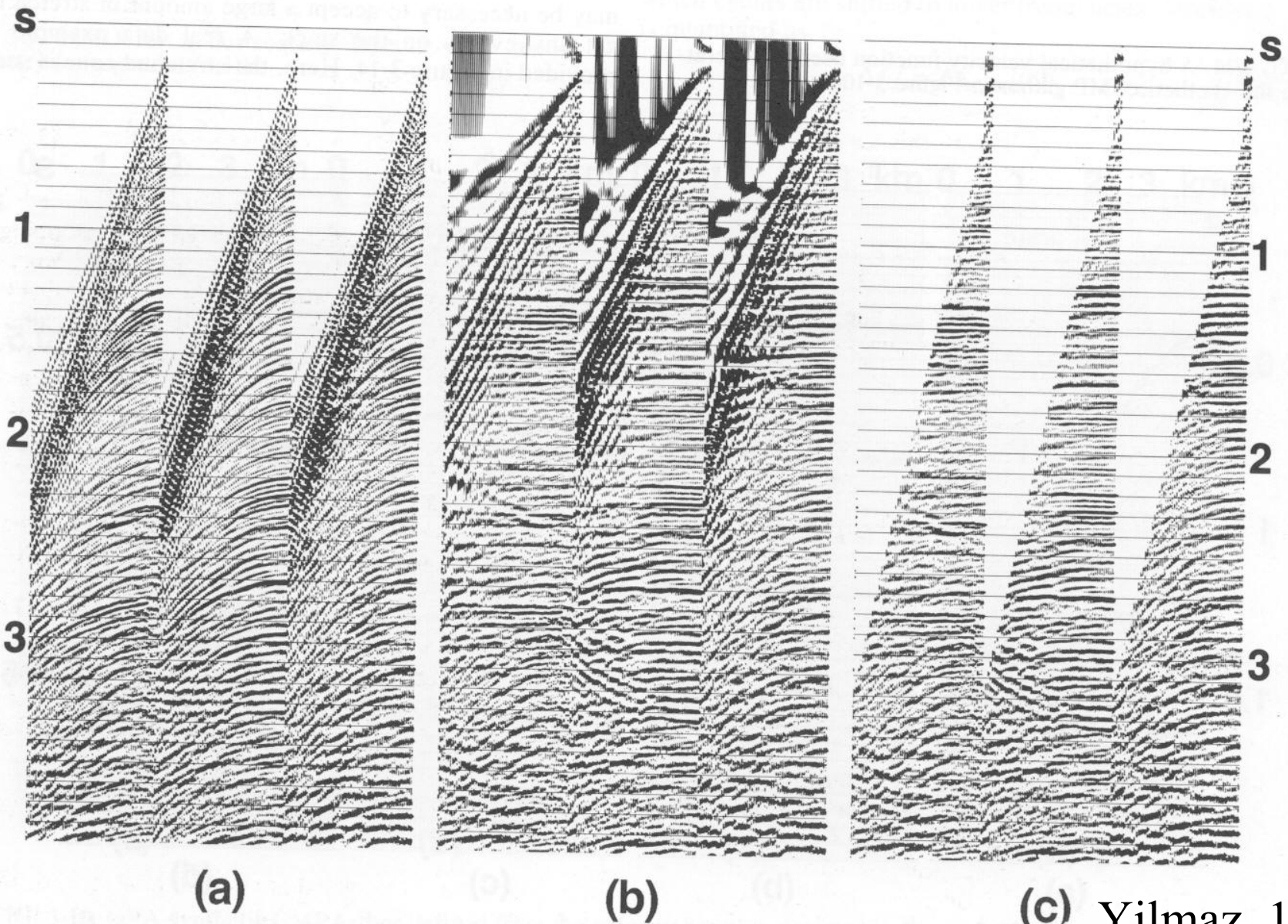
Yilmaz, 1987

Stretching

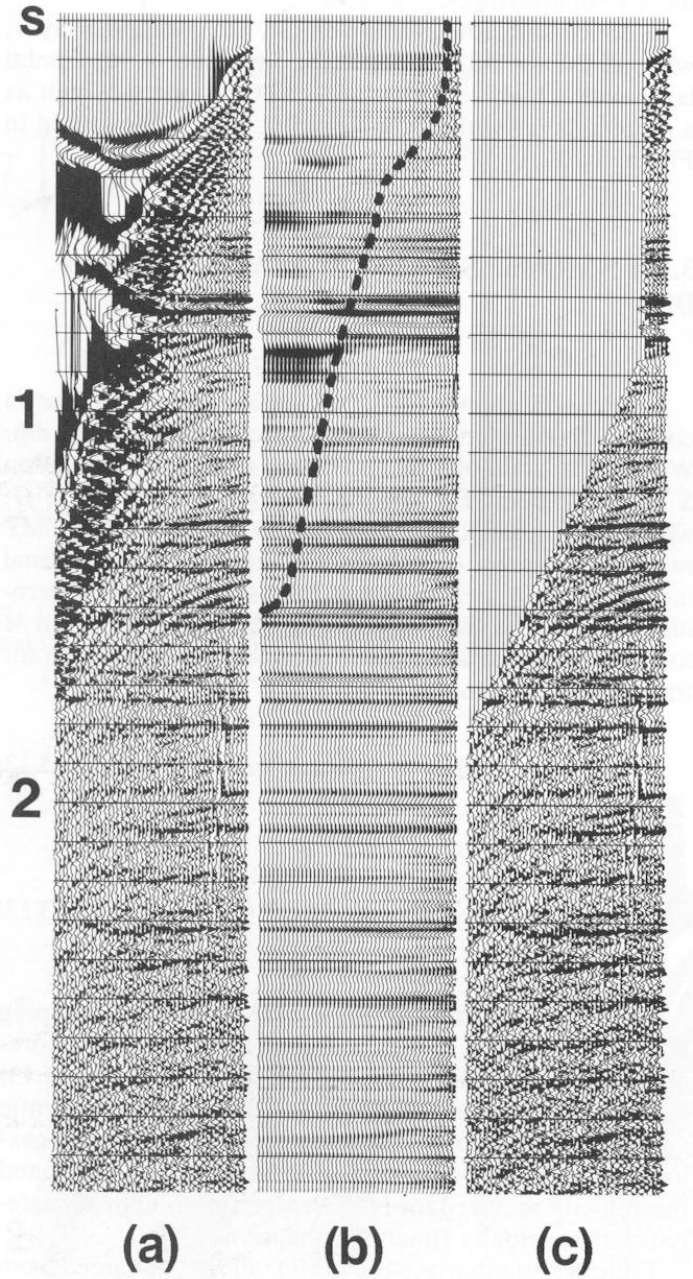


$$\Delta t_{NMO} = t_0 - t \approx \frac{x^2}{2v_{stack}^2 t_0}$$

NMO correction and muting of a stretched zone



Yilmaz, 1987



Optimum mute selection

(a) NMO corrected gather

(b) Subtract gather

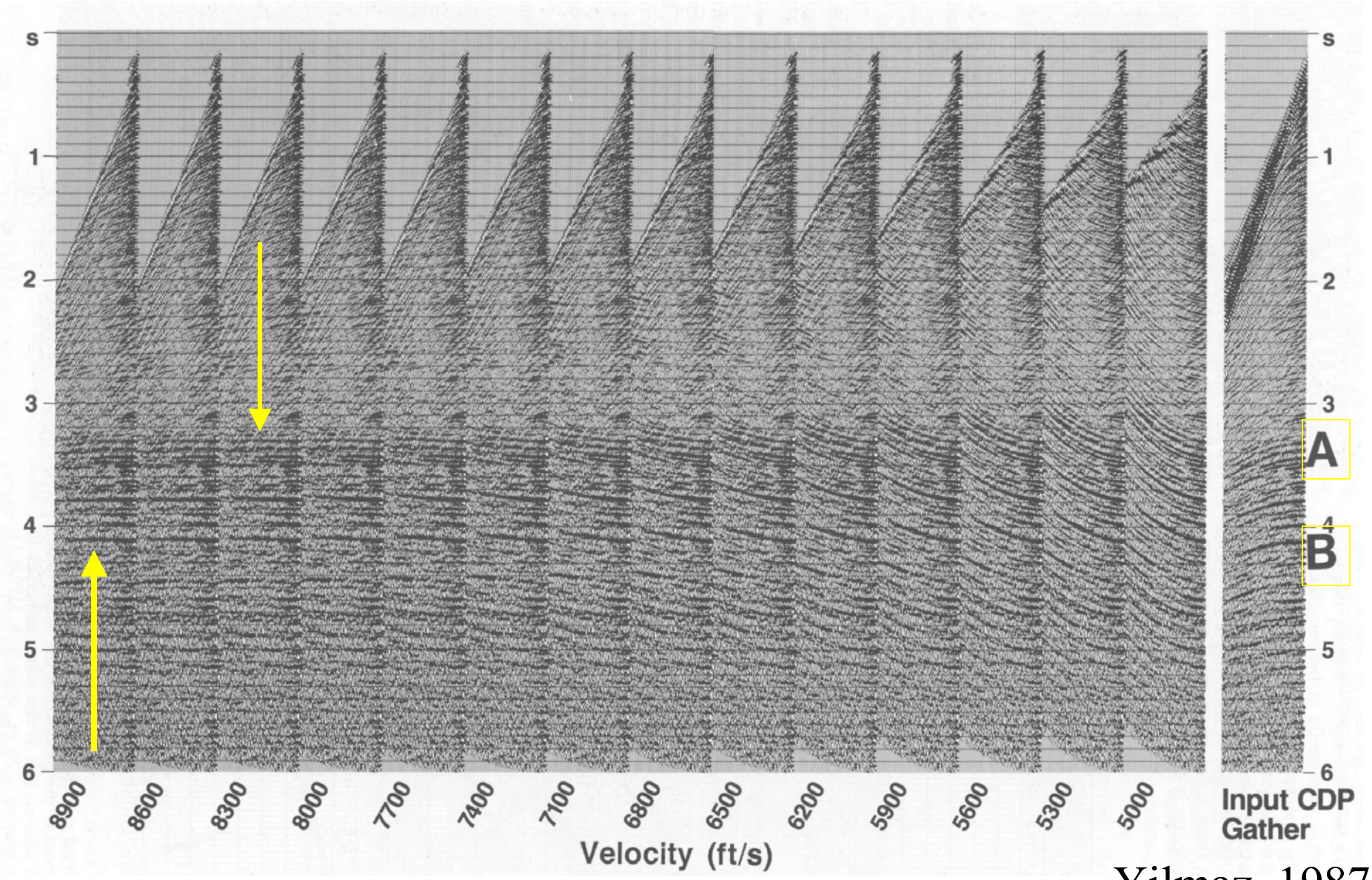
Right trace = right trace

Second trace on the right is the stack
of the two near traces of original gather
Leftmost trace is the stack of all traces
-> Dotted line indicates the mute zone

(c) Poor mute choice

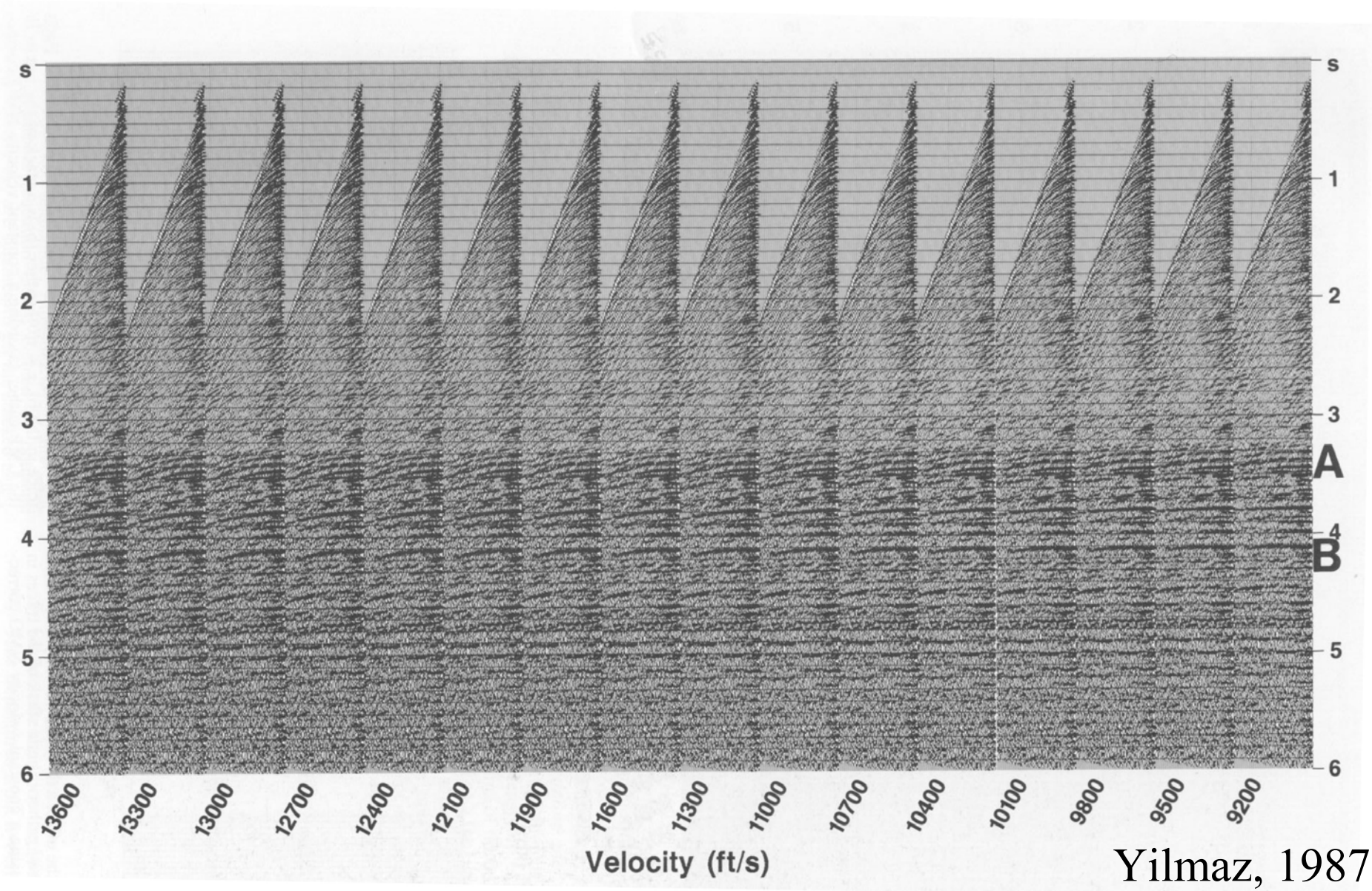
Yilmaz, 1987

Constant velocity moveout corrections (1) (CVP)



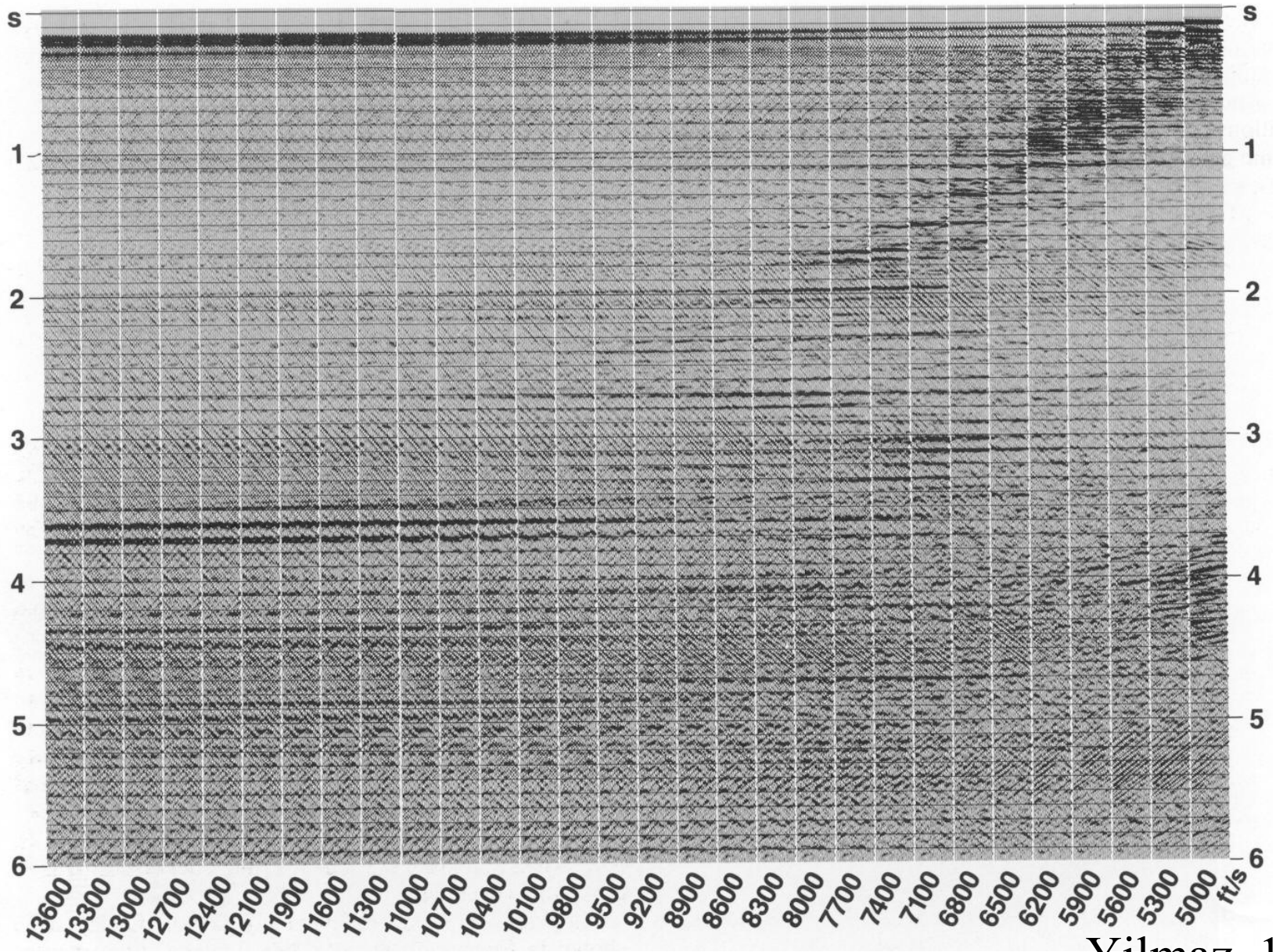
Yilmaz, 1987

Constant velocity moveout corrections (2) (CVP)



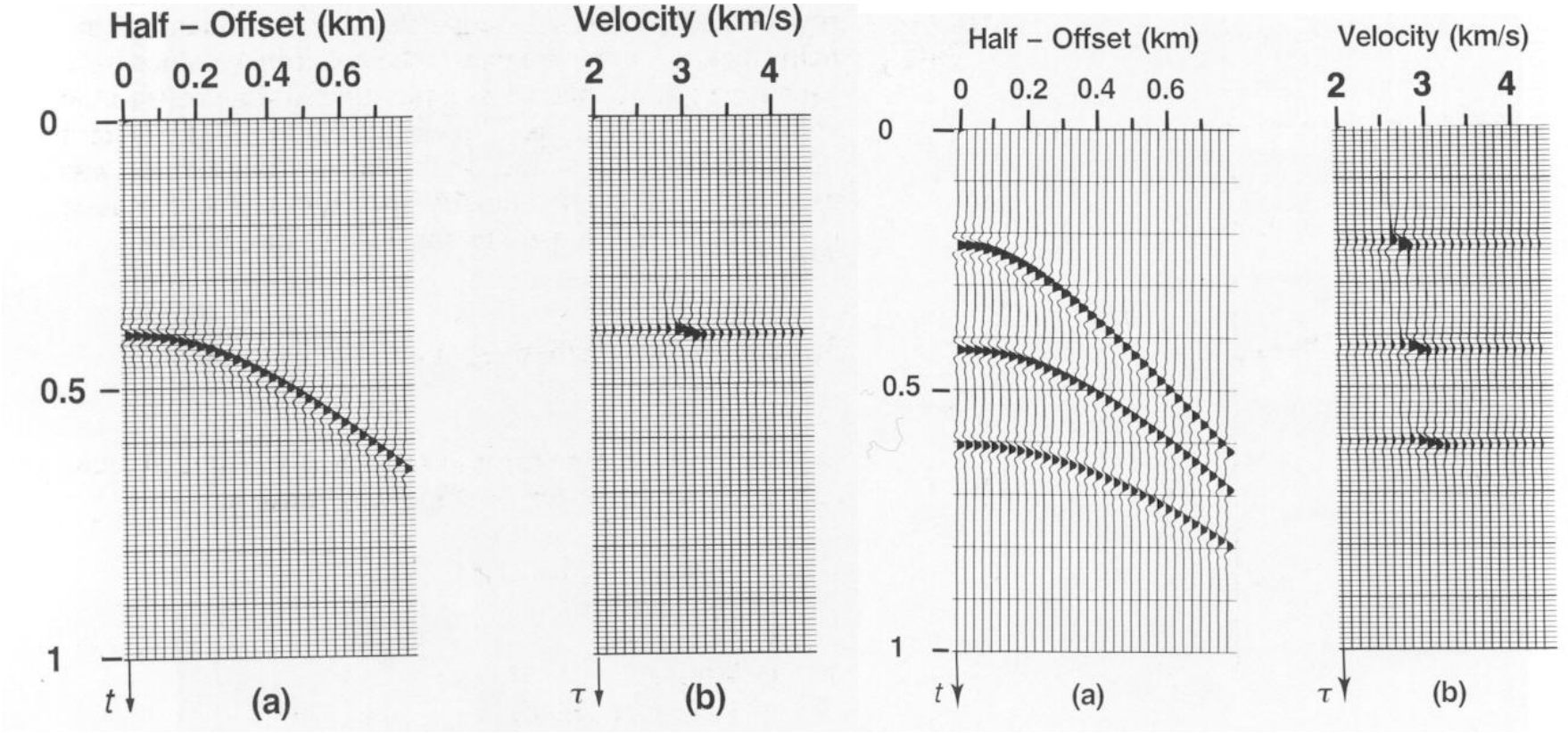
Yilmaz, 1987

Constant velocity stacks of 24 CMP gathers (CVS)



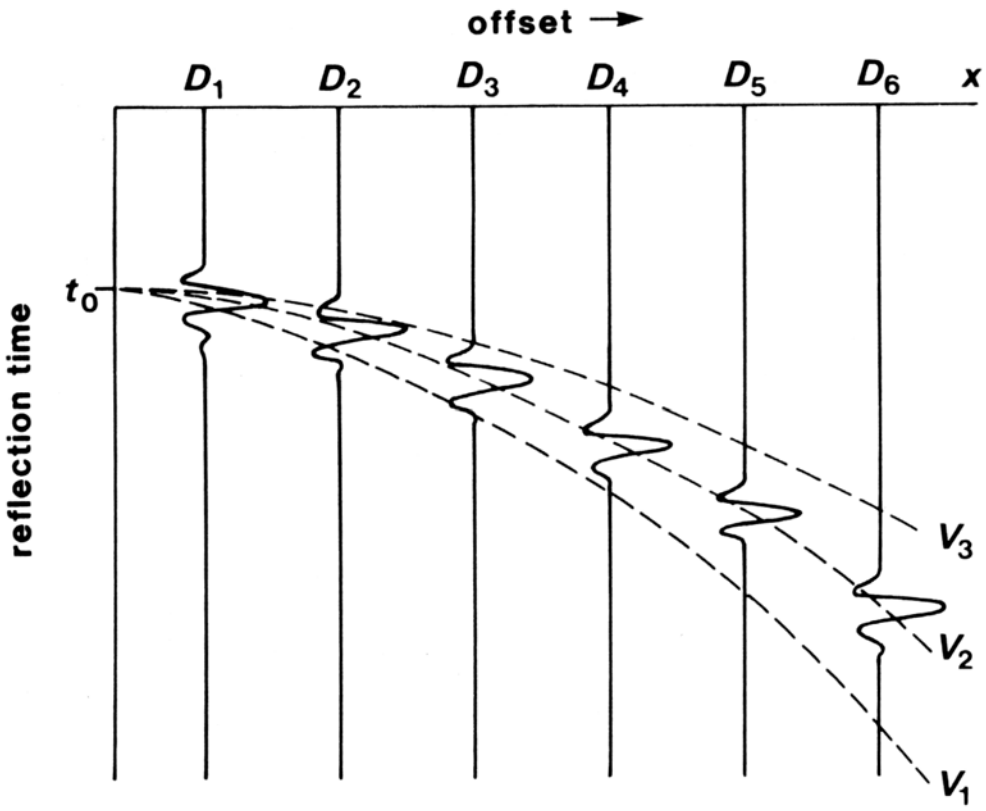
Yilmaz, 1987

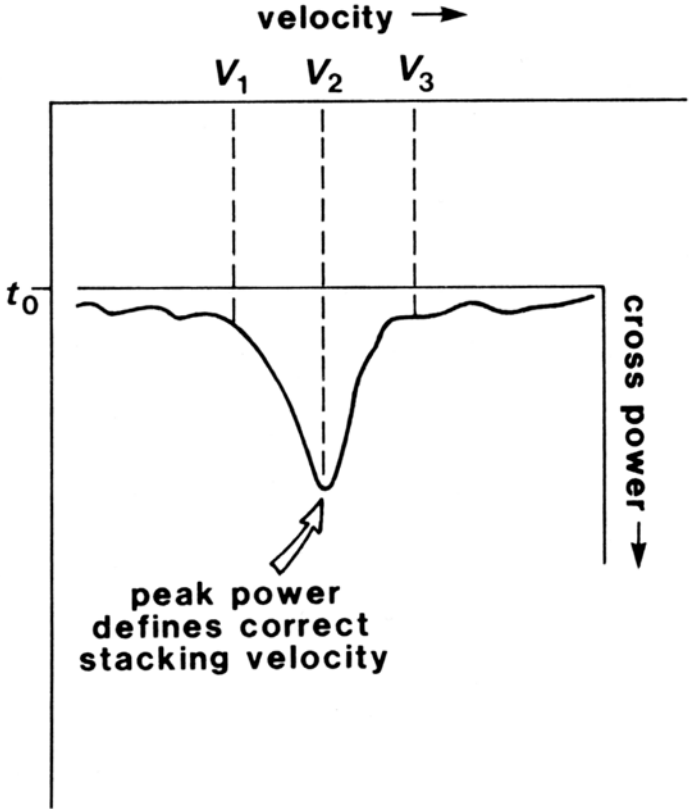
Velocity spectrum



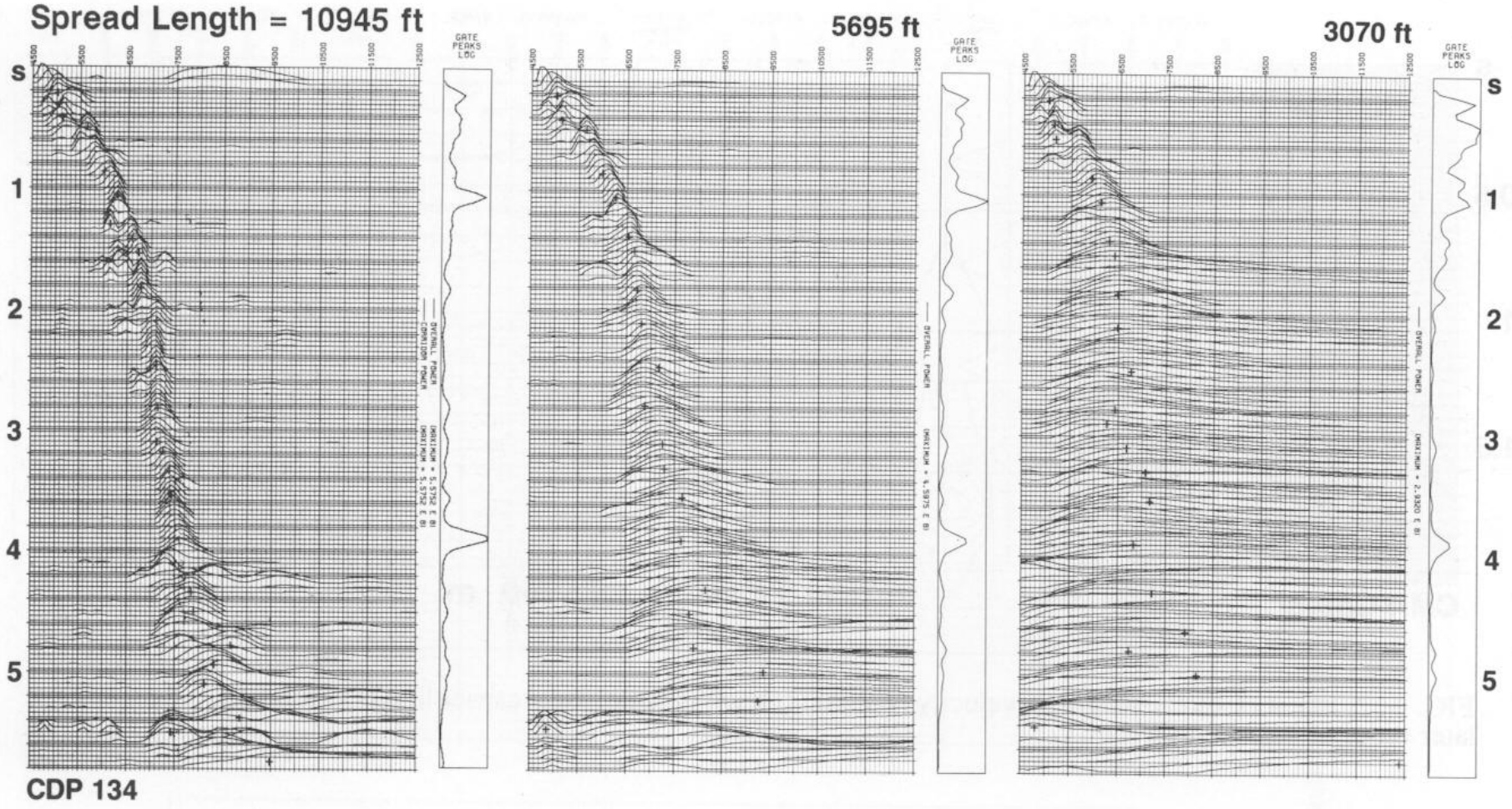
Mapping of the offset axis to the velocity axis

Stacking velocity

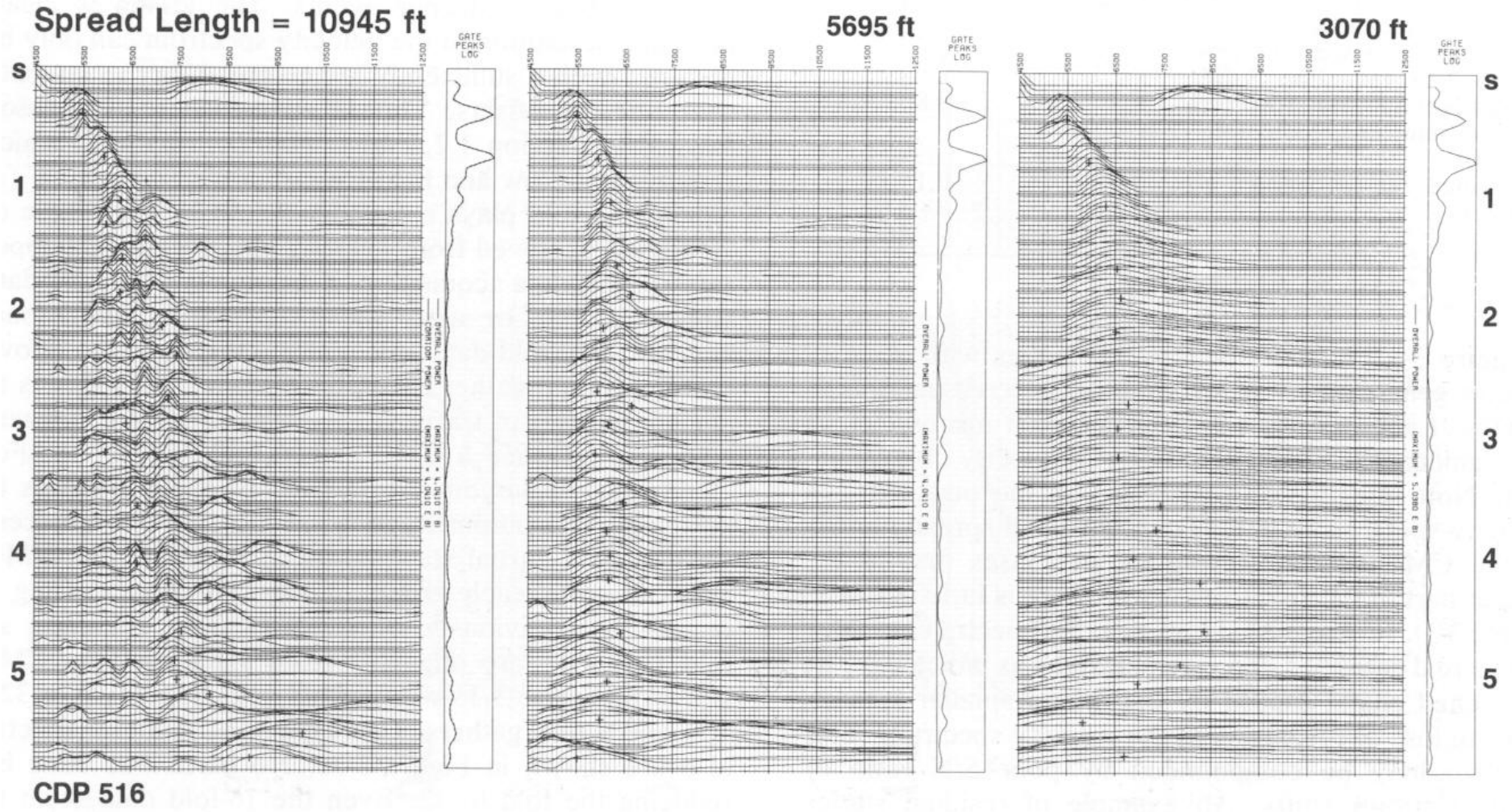




Influence of missing long offset traces on velocity spectra



Influence of missing long offset traces and statics on velocity spectra



Methods to calculate the Velocity-Spectrum

Stacked Amplitudes

$$s_t = \sum_{i=1}^{n} w_{i,t}$$

Normalized Stacked Amplitudes

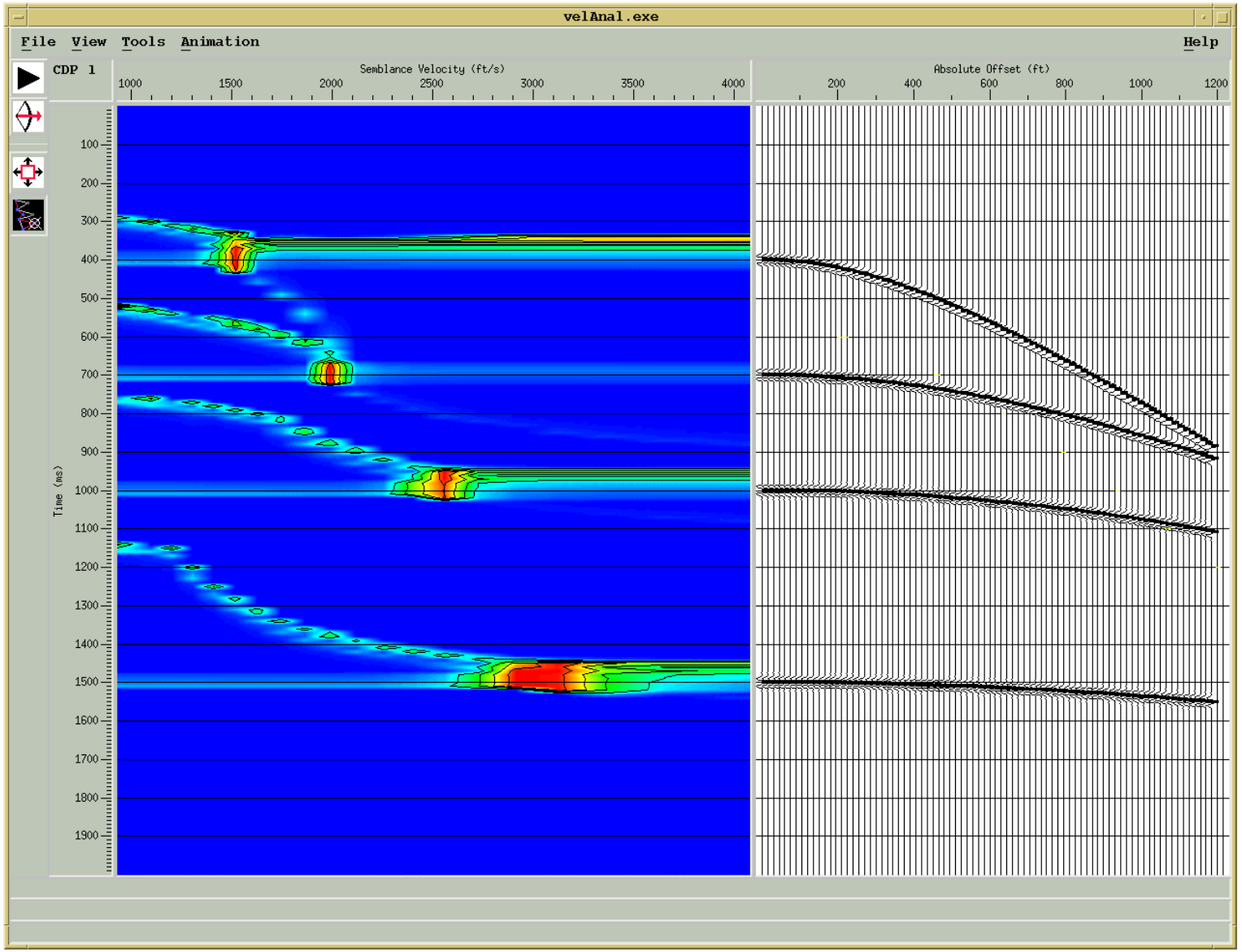
$$ns_t = \frac{\left| s_t \right|}{\sum_{i=1}^{n} \left| w_{i,t} \right|}$$

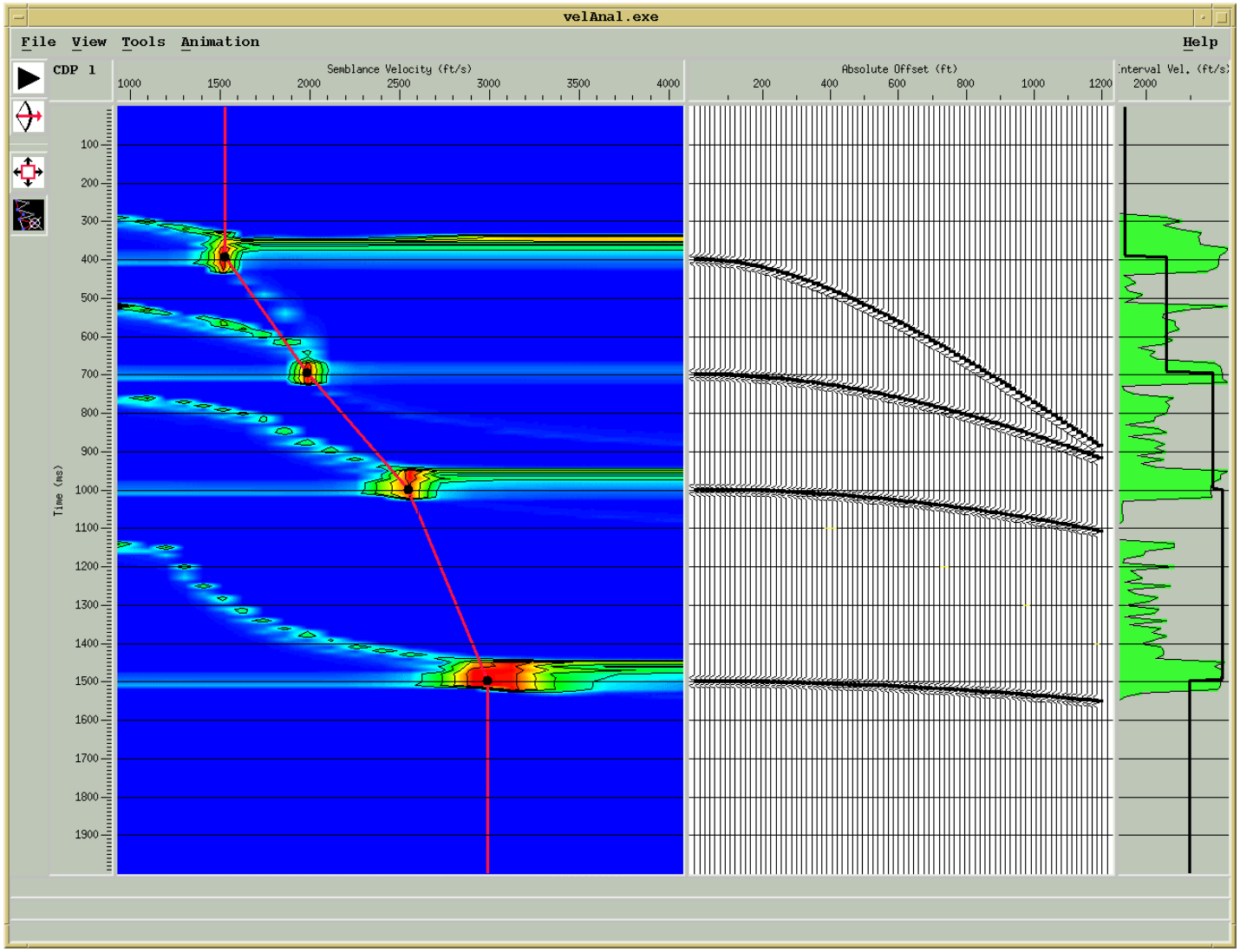
Semblance

$$\text{Semblance}_t = \frac{1}{n} \frac{\sum_t s_t^2}{\sum_t \sum_i w_{i,t}^2}$$

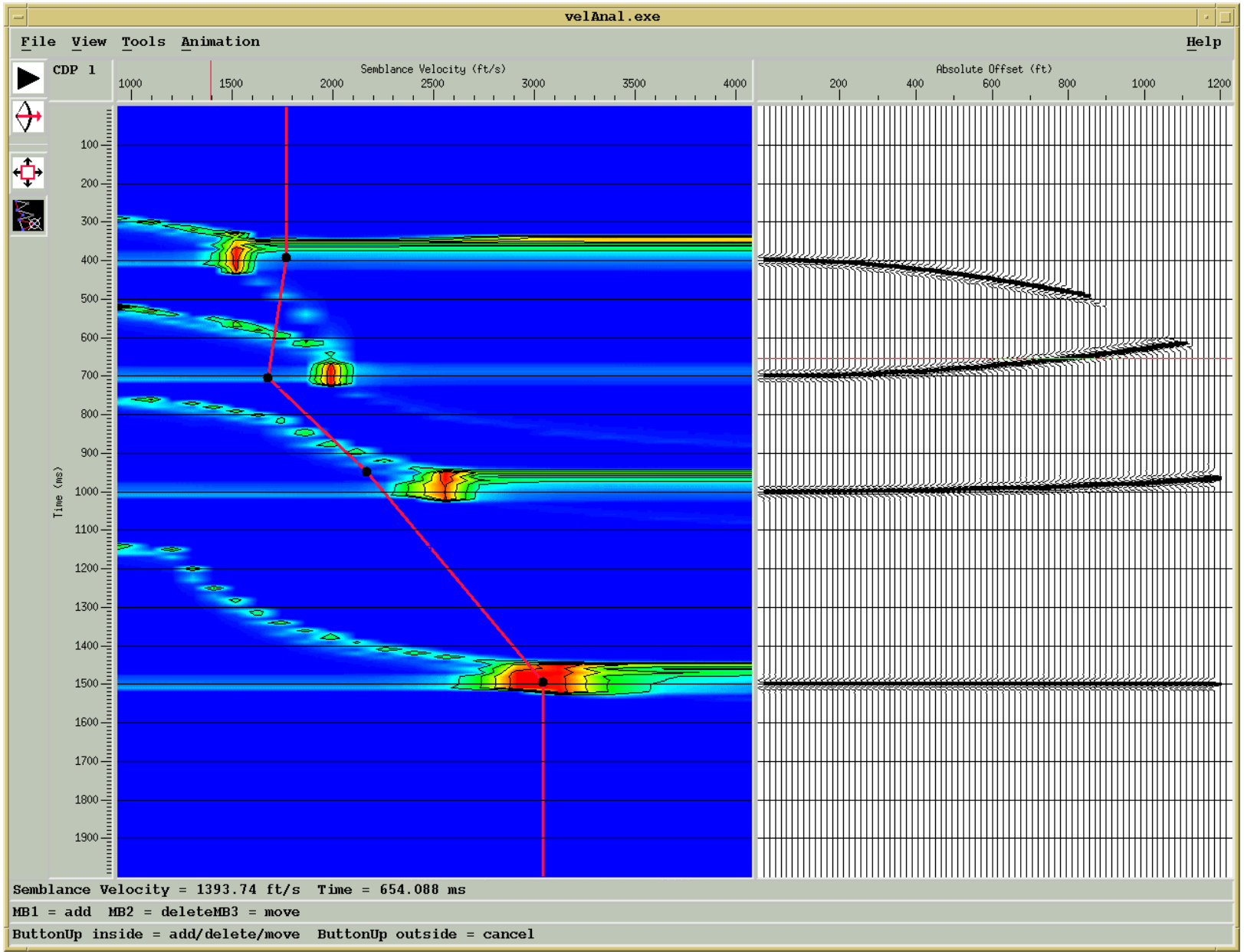
$w_{i,t}$ value for i-th trace, time t

Semblance-Analysis

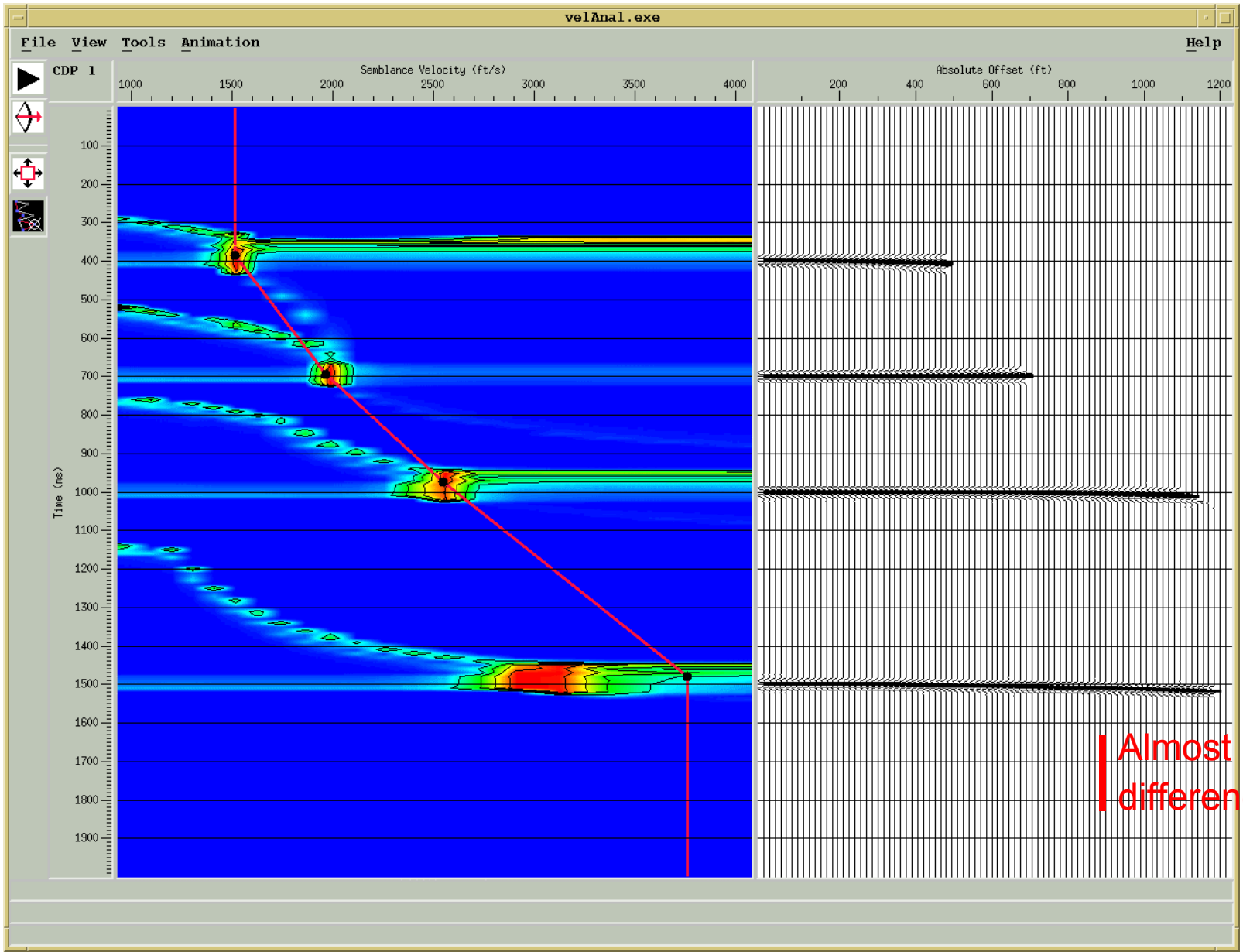



velAnal.exe
File View Tools Animation
Help
CDP 1
Semblance Velocity (ft/s)
1000 1500 2000 2500 3000 3500 4000
Absolute Offset (ft)
200 400 600 800 1000 1200
Interval Vel. (ft/s)
2000
Time (ms)
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900

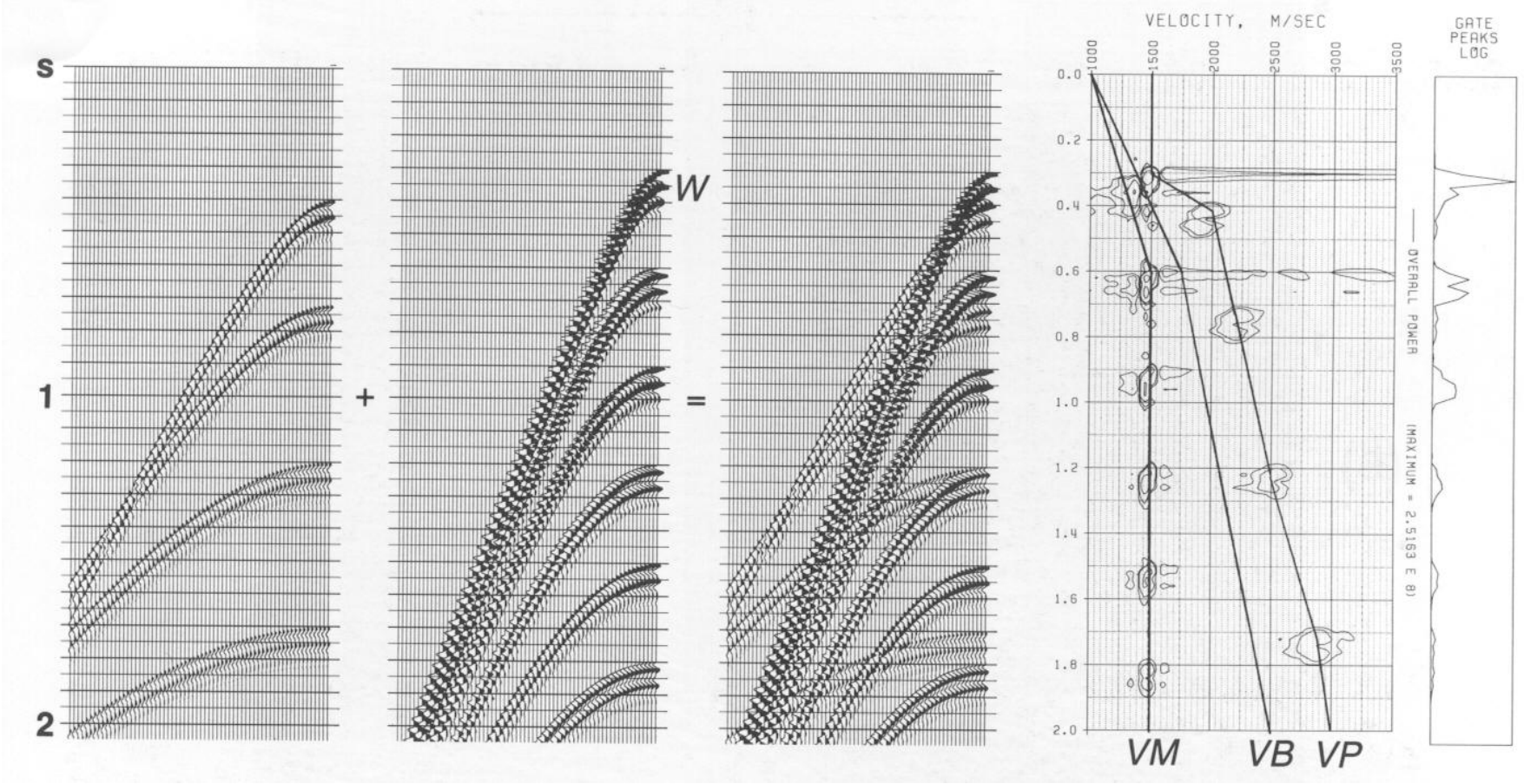
Results using wrong velocities



Error for high velocities and small traveltimes



Synthetic CMP gathers containing multiples

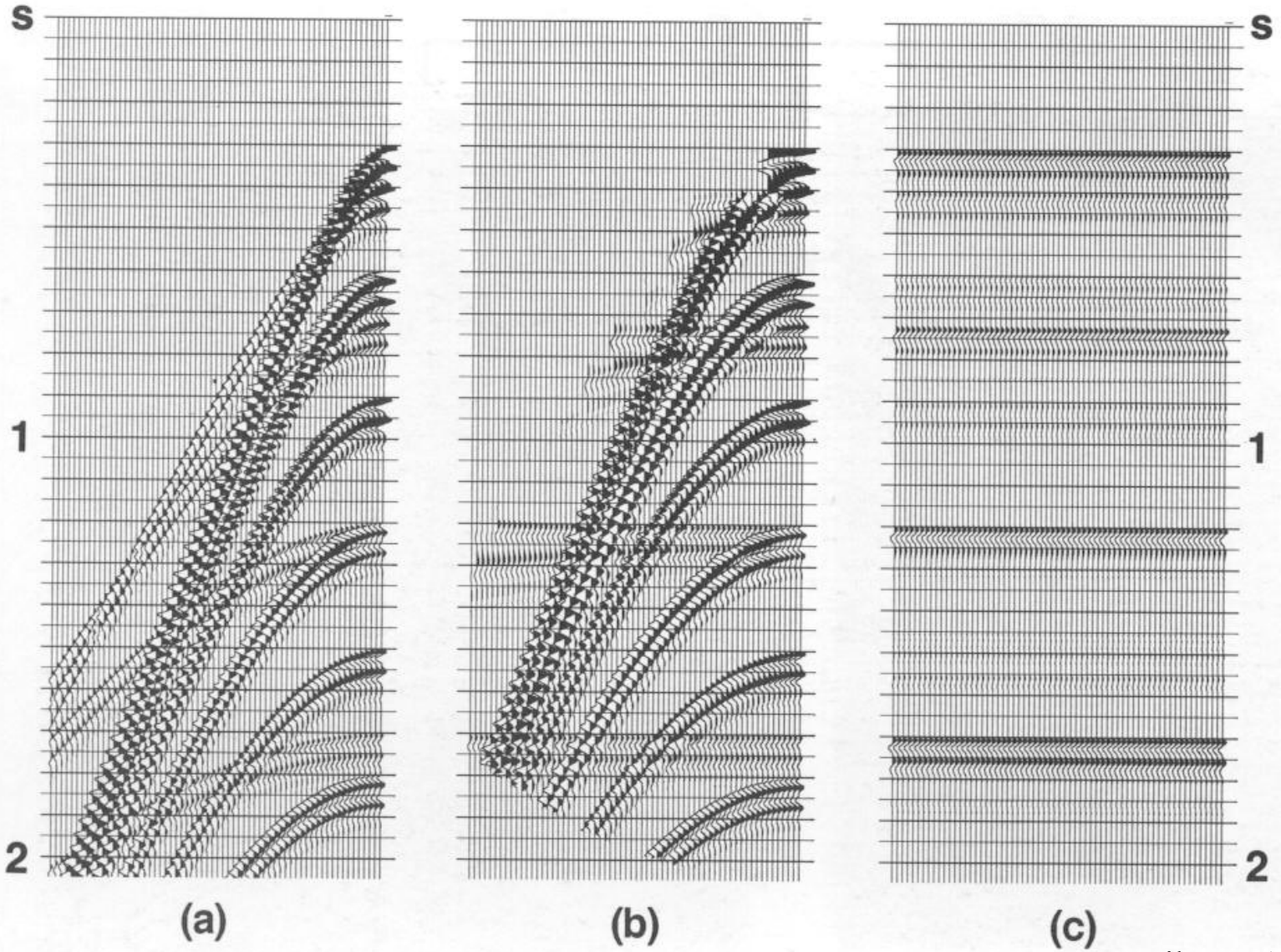


primaries + Water-bottom primary (W) +multiples = ↑

VM velocity multiples
VP velocity primaries

Yilmaz, 1987

NMO correction using primary velocity function



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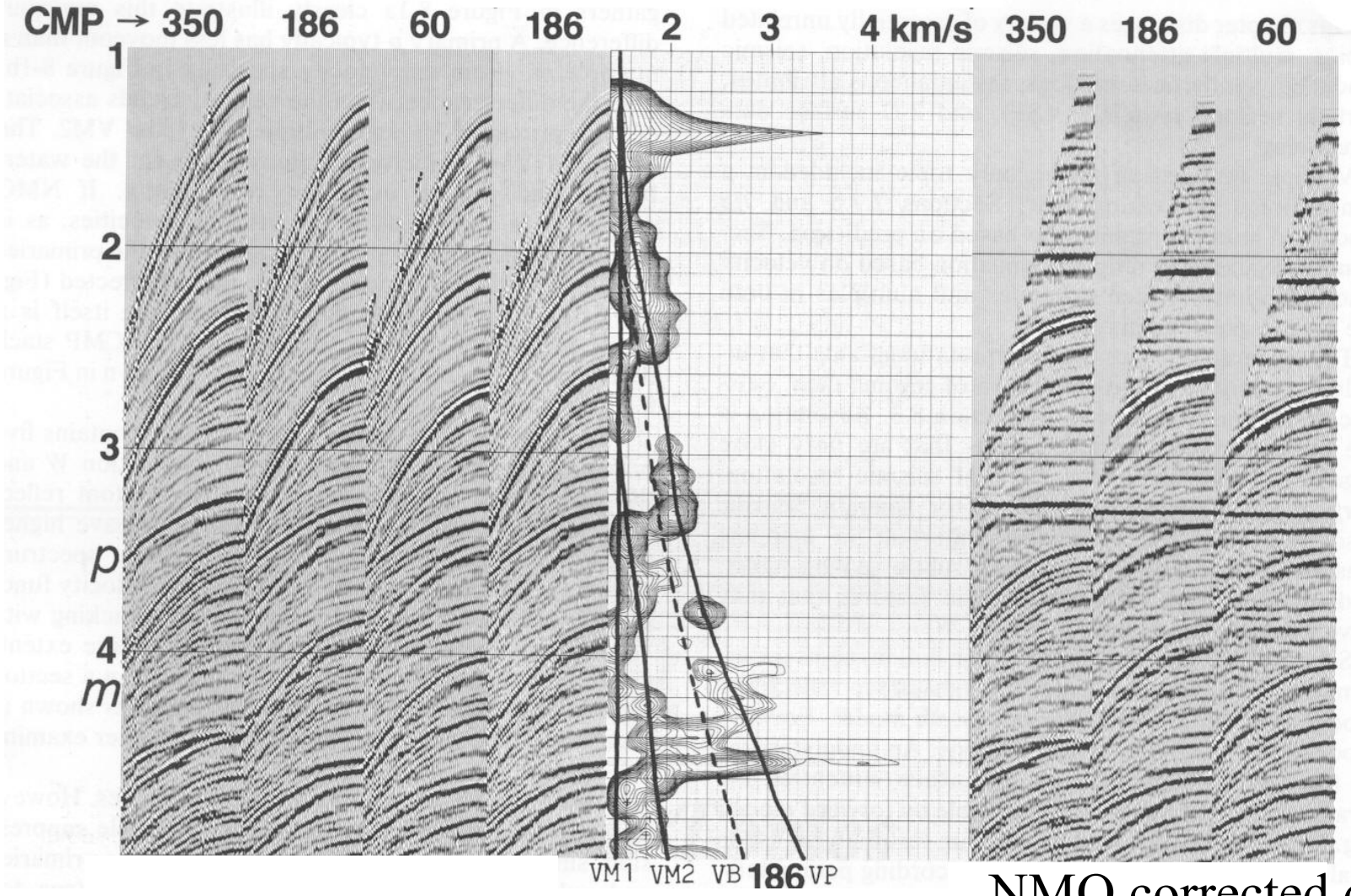
CMP gathers with strong multiples



VM1= slow (water-bottom) multiples
VM2= fast (peg-leg) multiples

NMO corrected data using primary velocities

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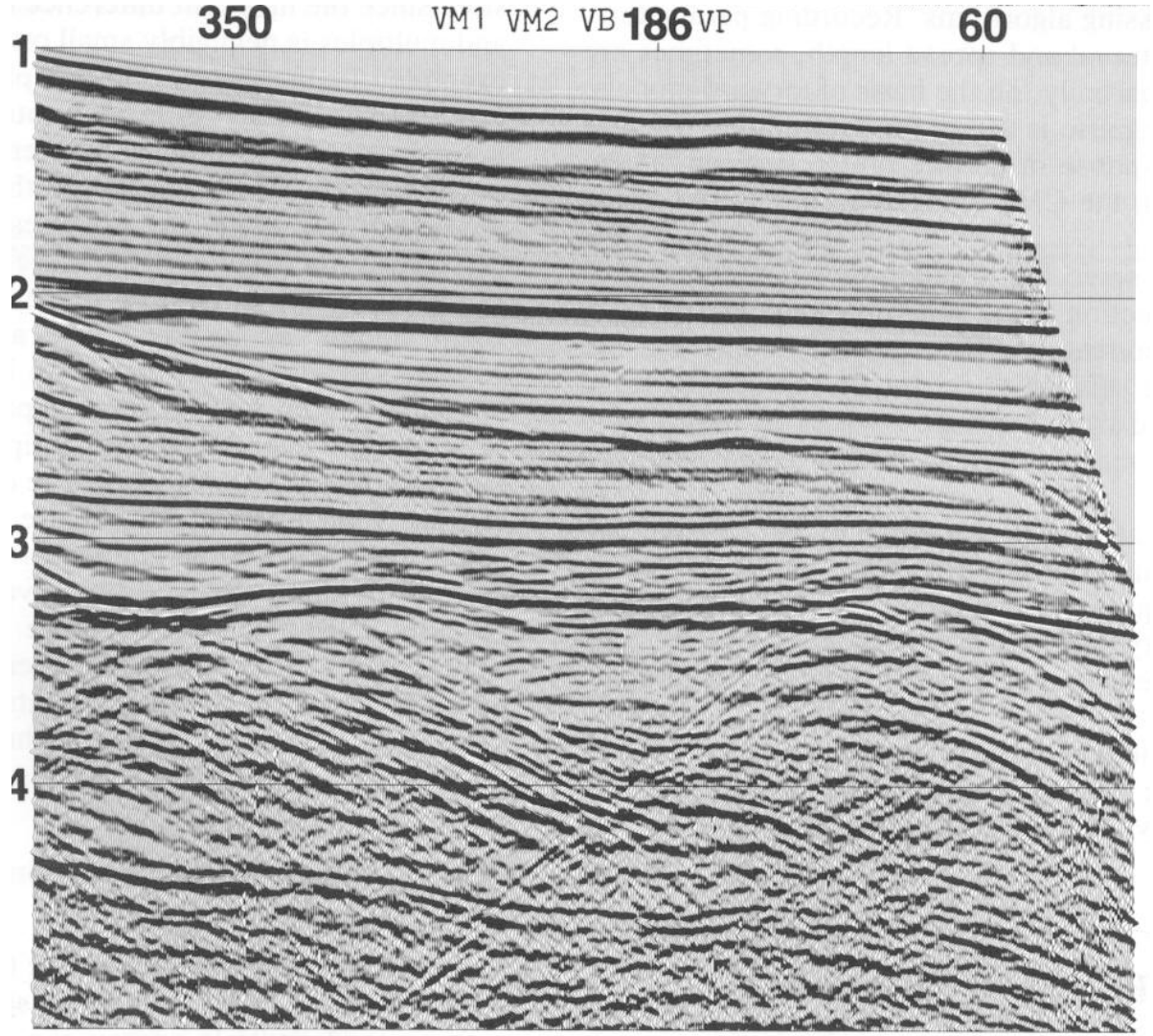
CMP stack using former gathers



Yilmaz, 1987

Factors affecting velocity estimates

- Depth of the reflectors
- Move-out of the reflection
- Spread length
- S/N ratio
- Static corrections
- Dip of the reflector
- Number of traces