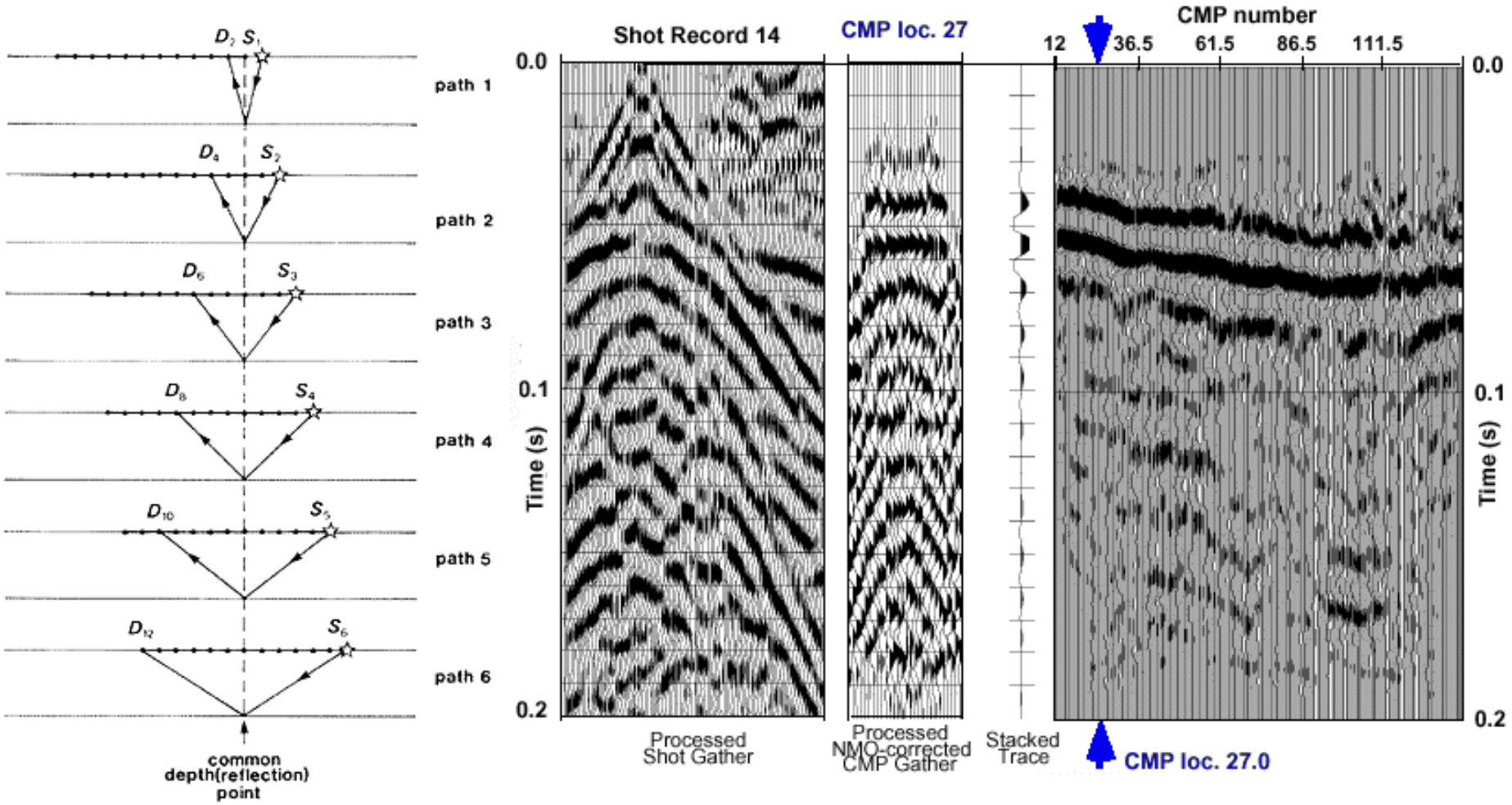
Processing: reflection

Reading on the GPG:

https://gpg.geosci.xyz/content/seismic/seismic_reflection_processing.html

CSG → CMP → Zero Offset Trace

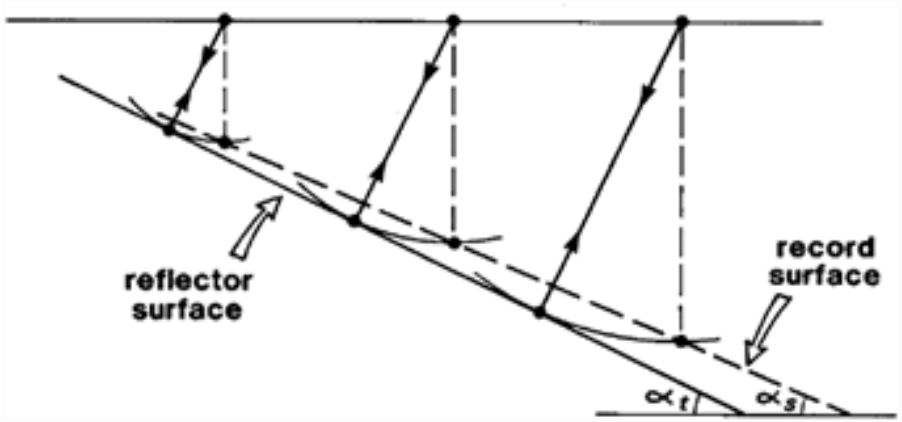


CSG = common shot gather
CMP = common midpoint gather

Migration: Dipping reflector

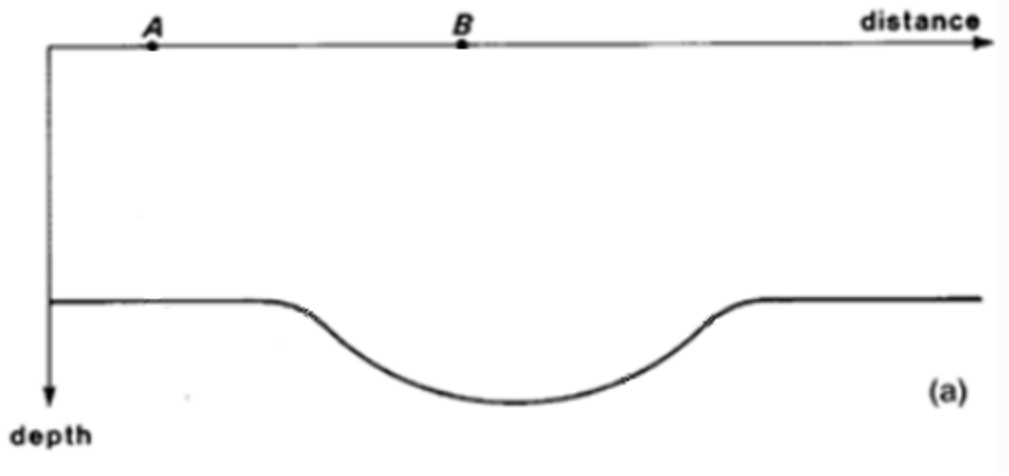
- Incorrect location of reflectors that are not flat laying.
- Migration → Correct location and depth/time of reflectors.

$$sin(\alpha_t) = tan(\alpha_s)$$

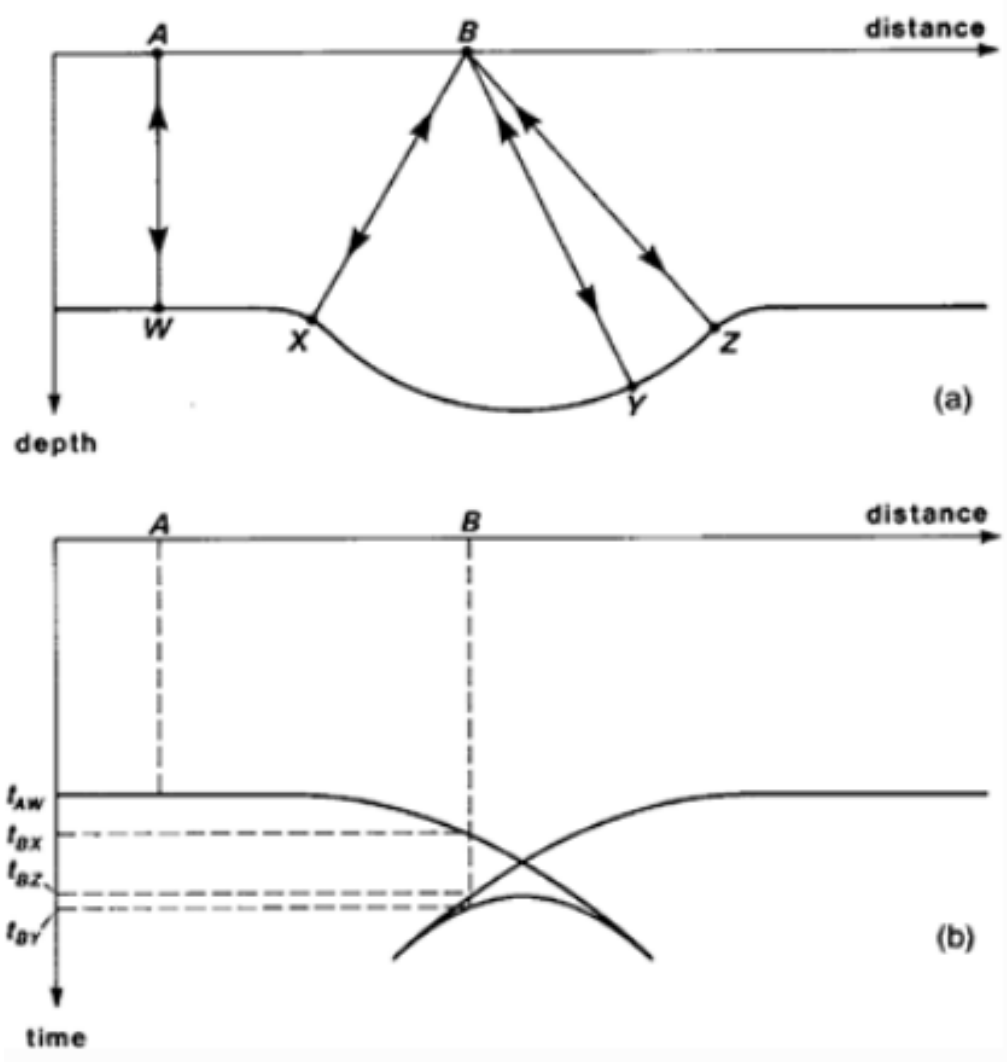


Migration: Syncline Reflector

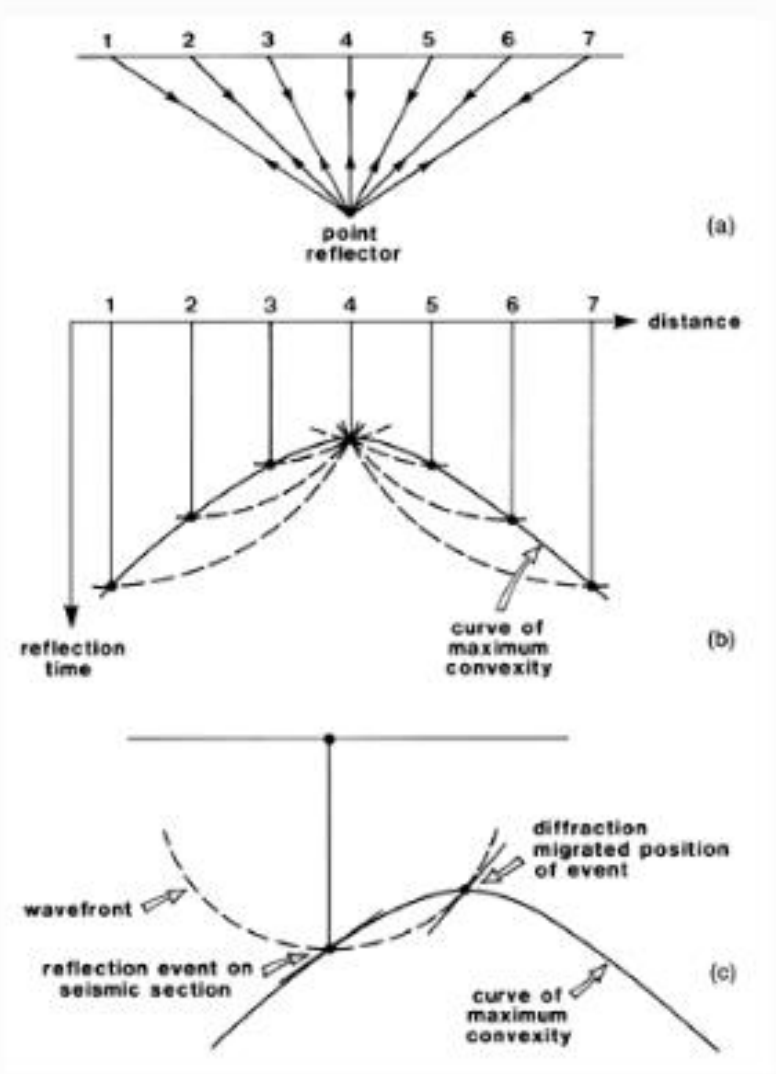
- Draw zero offset reflection rays for several points along the profile
- Assuming a constant velocity in the upper layer sketch the reflection profile.



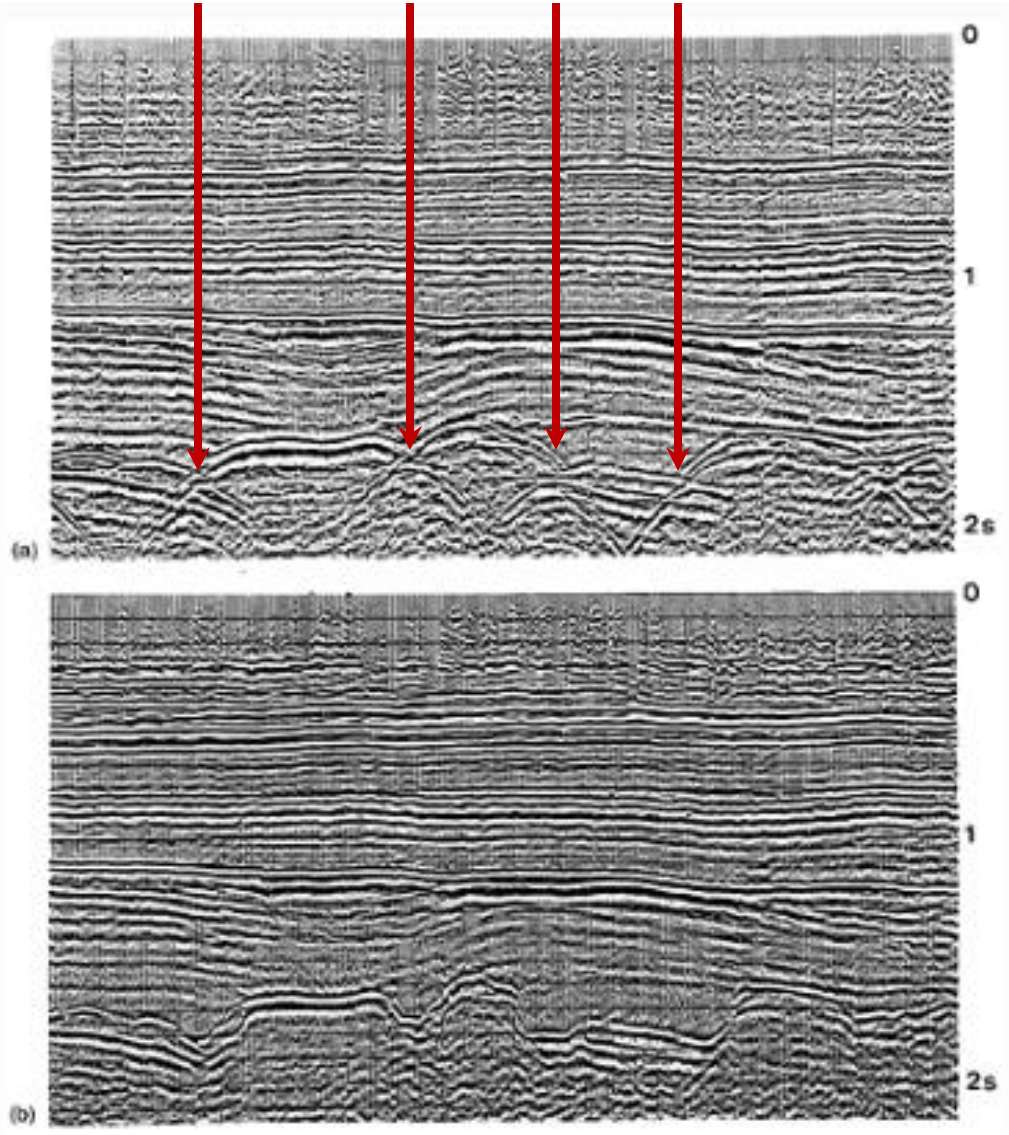
Migration: Syncline Reflector



Migration of field data



Bowtie reflections from synclines



Processed CMP section (Depth converted)

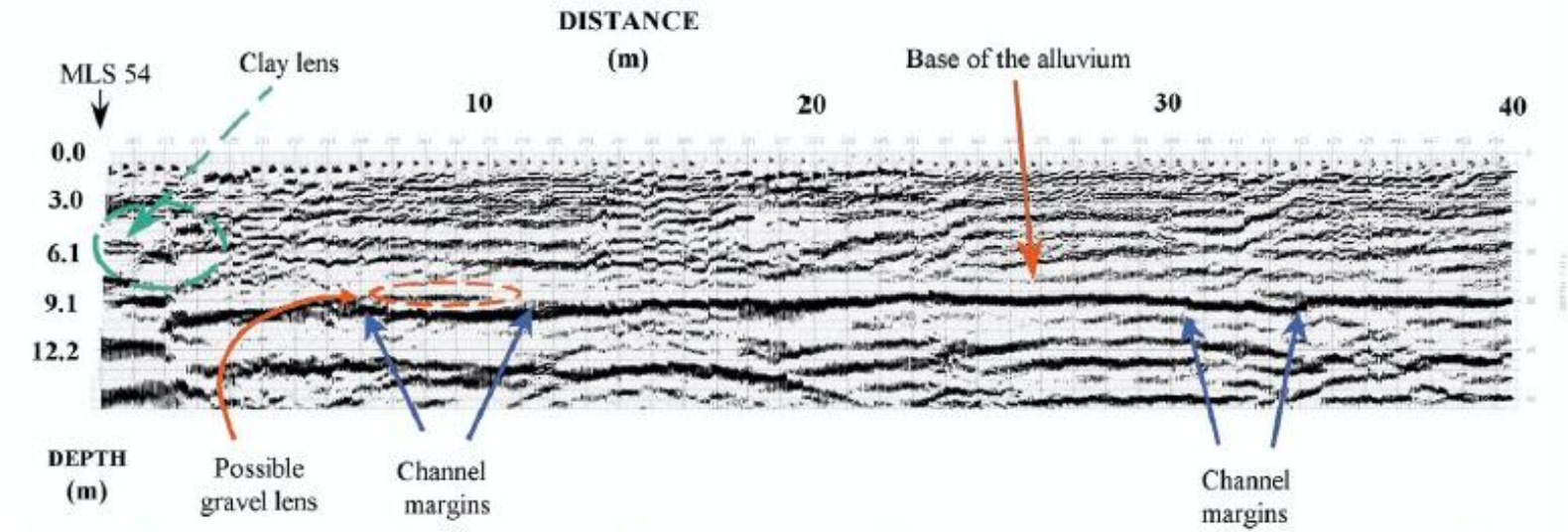
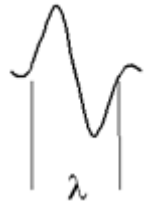


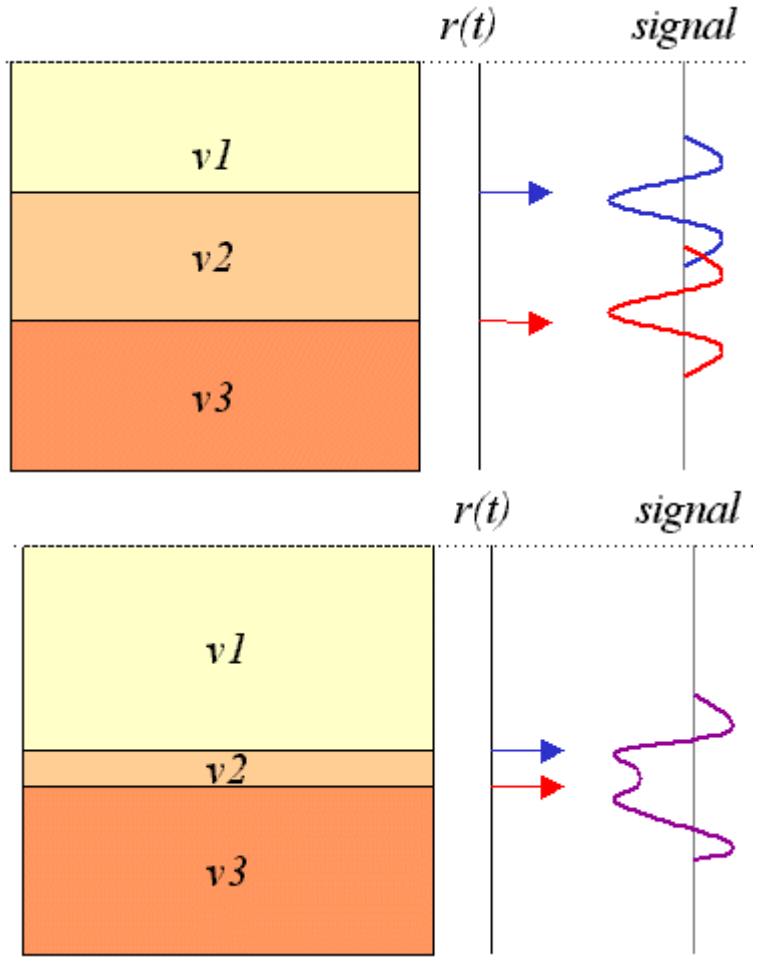
Figure 10. Depth-converted *SH*-wave, stacked section. The top of the shale at a depth of approximately 9 m is very clear cut. Depressions in the top of the shale are interpreted to be channels, possibly filled with a gravel lens (CMP 255-275). Reflections from a depth of 6 m correlate with the presence of clay lenses in borehole MLS 54.

- Conversion of time to depth:
  - Requires an average velocity
  - Obtained from stacking velocity used to perform NMO correction

Vertical resolution

$$\lambda = vT = \frac{v}{f}$$





- Rayleigh resolution criterion: peak separation of at least peak-trough distance ($\lambda/2$).
- Account for 2-way travel time through layer
- Vertical resolution = $\lambda/4$

seismic wavelength, metres

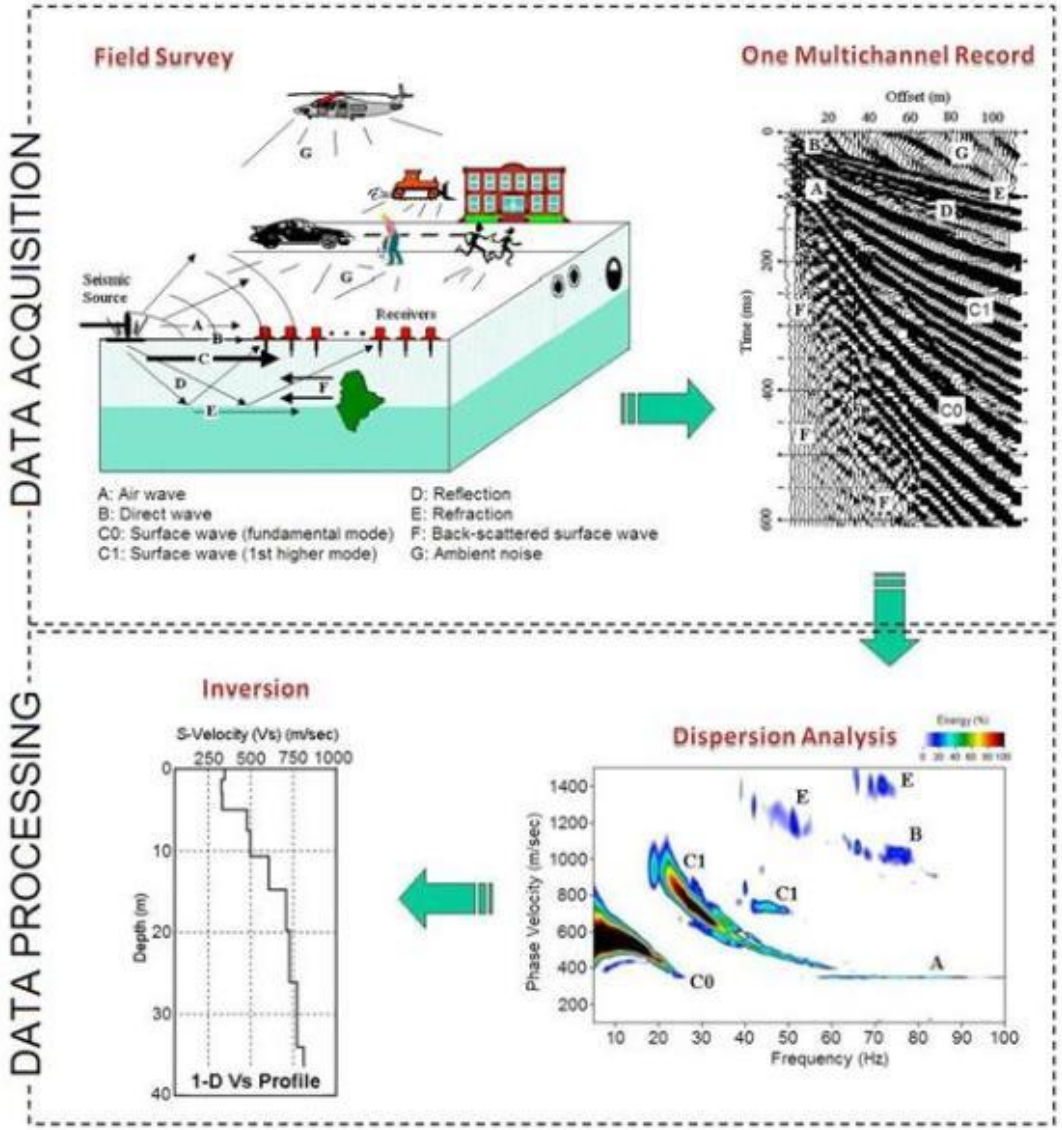
		V, m/sec					
f, Hz	T, sec	330	500	1000	1500	2000	4000
10	0.1	33	50	100	150	200	400
100	0.01	3.3	5	10	15	20	40
1000	0.001	0.33	0.5	1	1.5	2	4

MASW

Reading on the GPG:

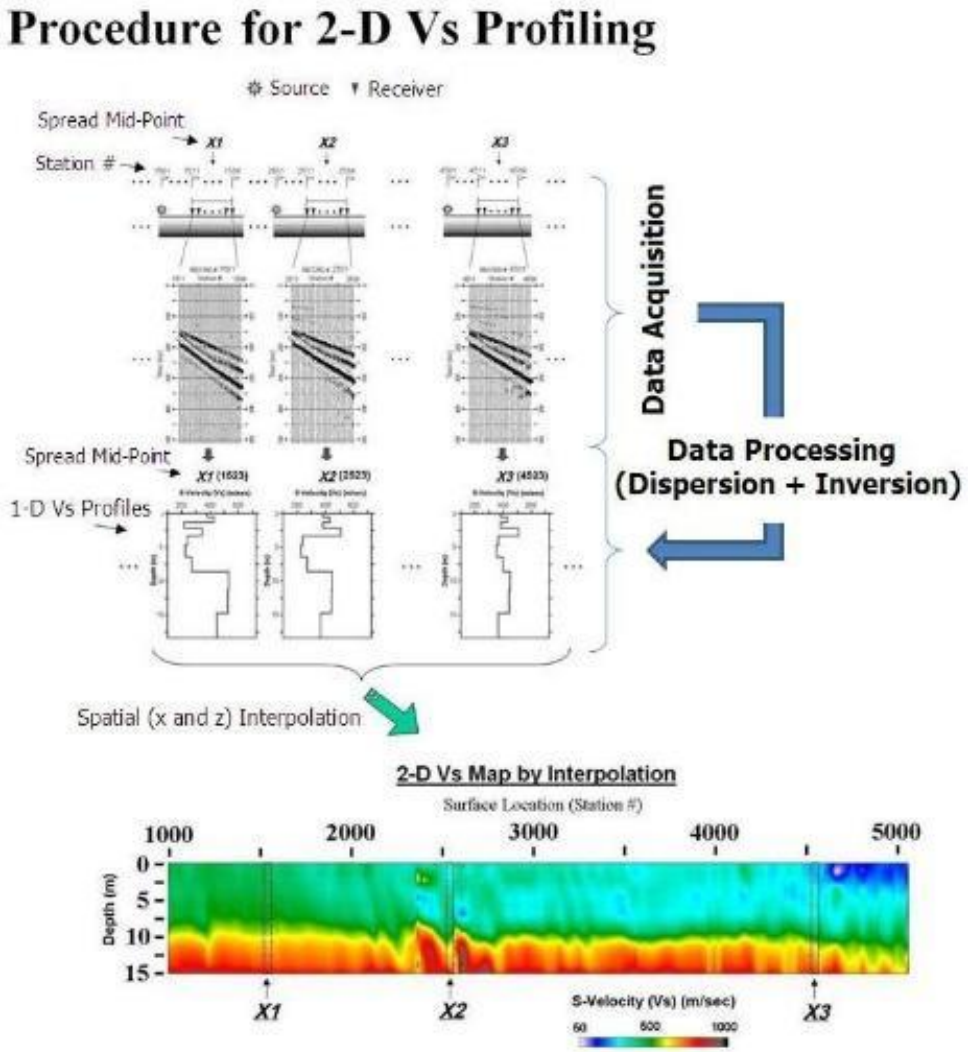
https://gpg.geosci.xyz/content/seismic/seismic_reflection_processing.html

Multichannel Analysis of Surface Waves

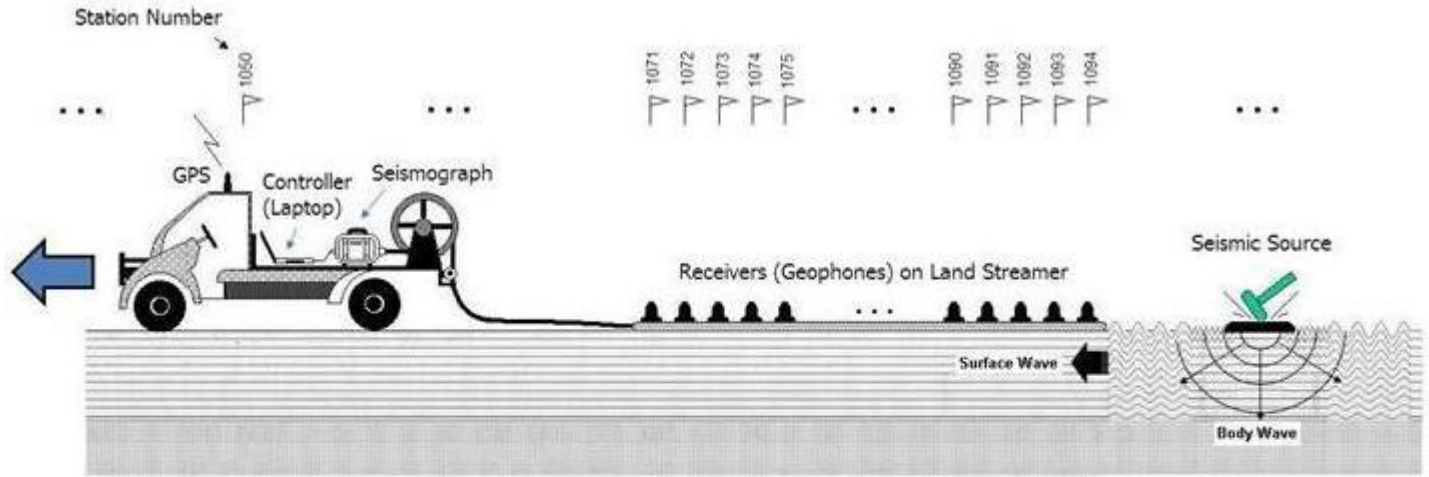


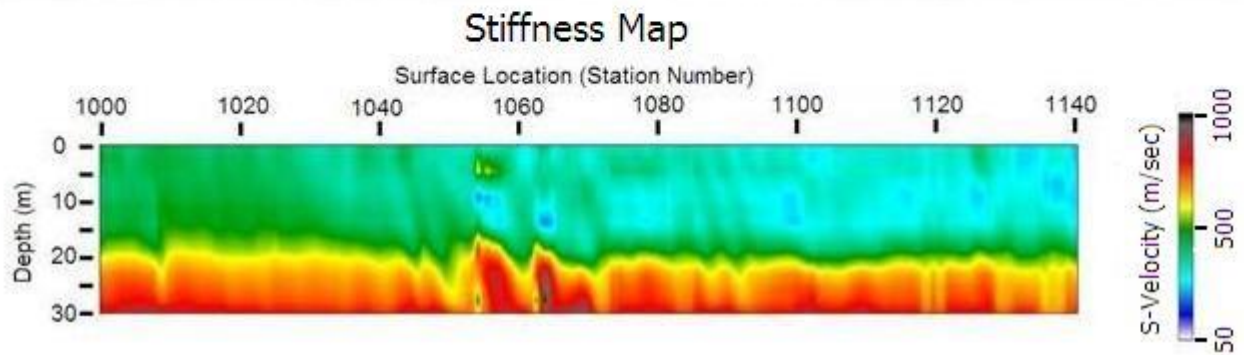
- www.masw.com
- Uses surface waves to study the propagation of shear waves in the subsurface
- Compared to reflection and refraction techniques, it's quite new and mostly used for geotechnical work.

Procedure for 2D vs profiling

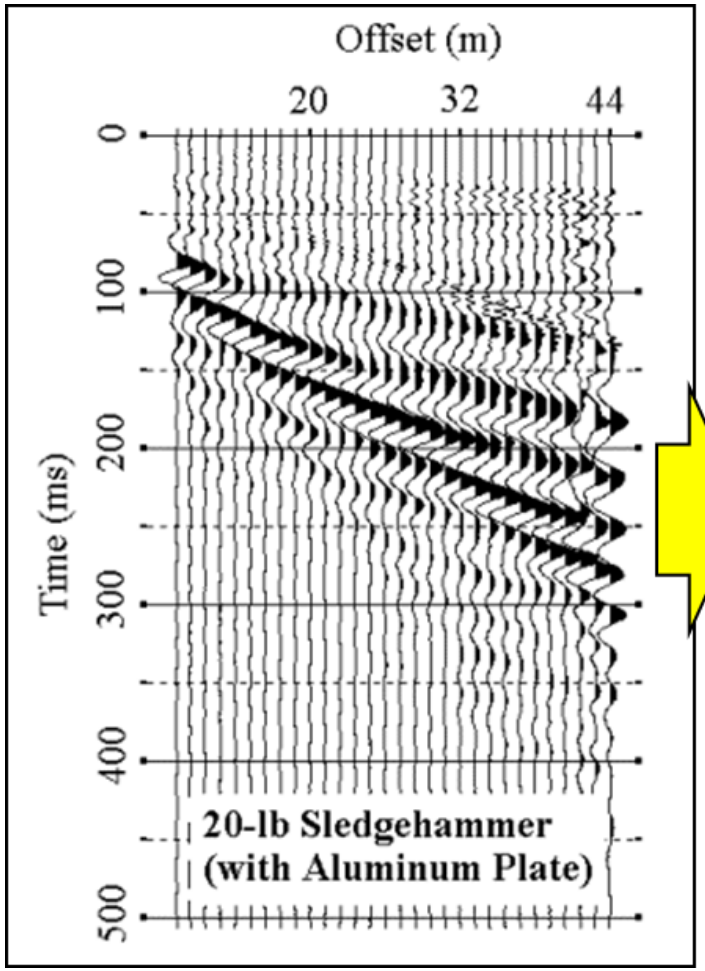


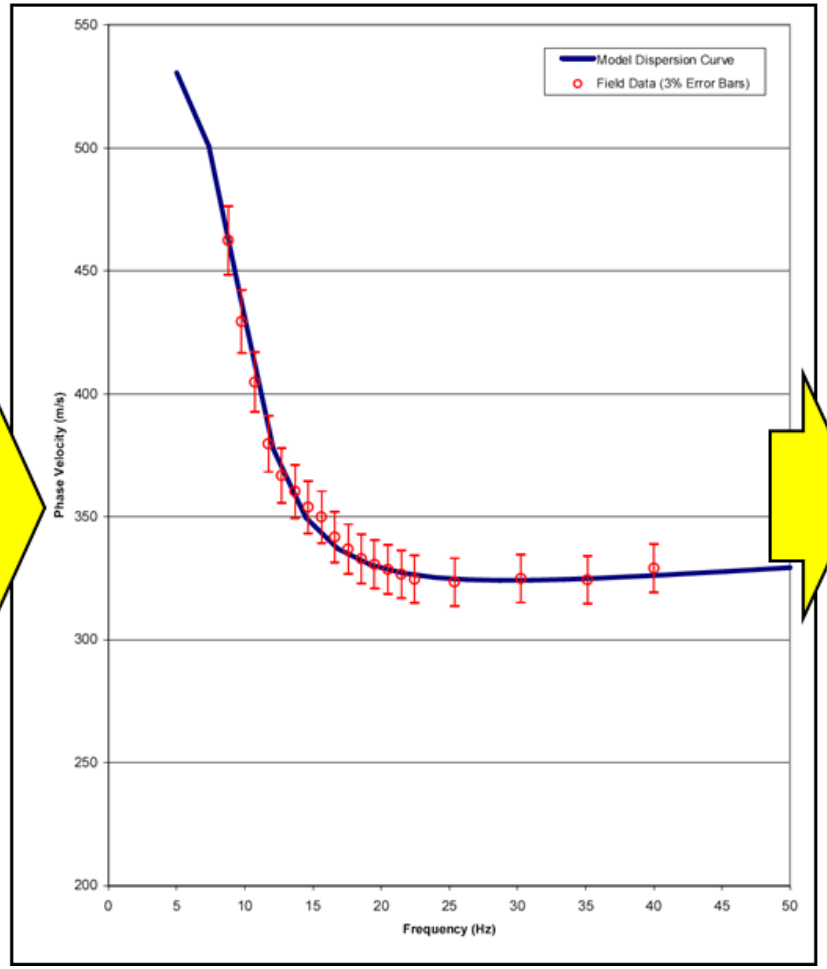
Obtaining a 2D profile

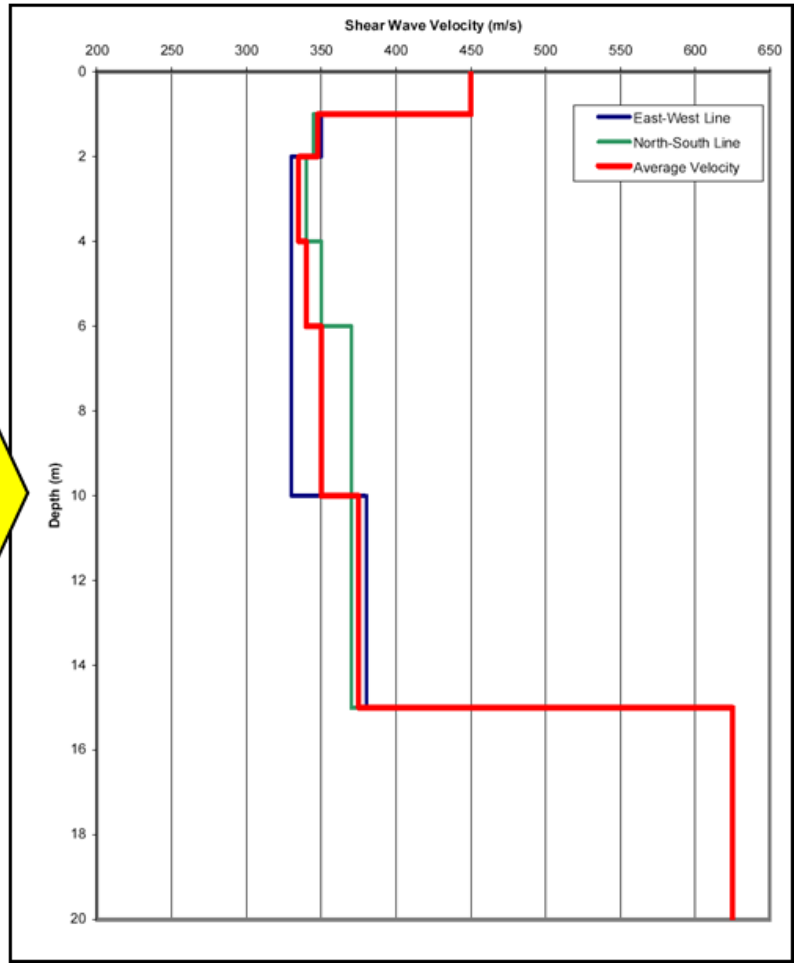




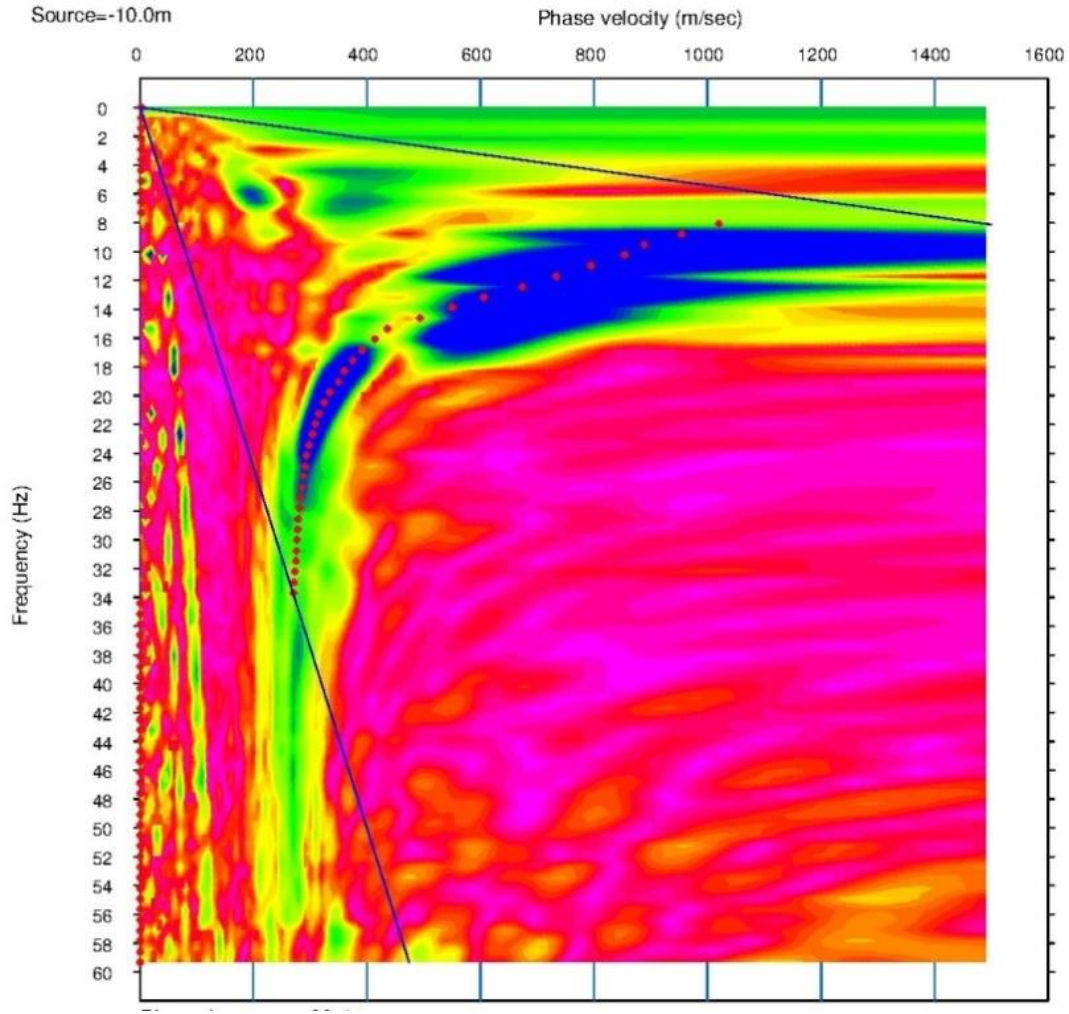
Results


Offset (m)
20
32
44
Time (ms)
0
100
200
300
400
500
20-lb Sledgehammer
(with Aluminum Plate)


Model Dispersion Curve
Field Data (3% Error Bars)
Phase Velocity (m/s)
Frequency (Hz)
550
500
450
400
350
300
250
200
0
5
10
15
20
25
30
35
40
45
50


Shear Wave Velocity (m/s)
200
250
300
350
400
450
500
550
600
650
Depth (m)
0
2
4
6
8
10
12
14
16
18
20
East-West Line
North-South Line
Average Velocity

Results


Source=-10.0m
Phase velocity (m/sec)
0
200
400
600
800
1000
1200
1400
1600
Frequency (Hz)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60

Case history: Hodgson et al

- Setup
  - City of Dublin is underlain by Dublin Boulder Clay (DBC).
  - Hard lodgement till with high stiffness and low permeability.
  - Large cobbles and boulders above DBC.
- Properties
  - Elastic parameters, stiffness is related to shear velocity
- Survey
  - Seismic, MASW
- Data Acquisition
  - Roll-along survey
  - Land streamer 24 plated-coupled 4.5Hz geophones
  - Tractor-mounted weight drop with shots every 6m

Case history: Hodgson et al

- Analysis
  - Dispersion curve analysis of surface waves
  - Invert to obtain Vs
  - Generate a 2D profile.
- Interpretation
  - Low Vs (200-700 m/s) associated with glacial till (0-10m thickness)
  - High velocity material (Vs>900 m/s) at depth
- Synthesis
  - Borehole verified the high velocity material as limestone bedrock
  - The depth is variable.